JHER Vol. 31, No. 2, December 2024, pp. 105 - 113

Vitamins and Phytochemical Compositions of African Velvet Tamarind (*Dialium guineense)* Fruit Pulp

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Abstract

This study determined the vitamin C, niacin, carotenoids, saponins, flavonoids tannins, phenolic acids, and alkaloids compositions of African velvet tamarind *(Dialium guineense*). African velvet tamarind (AVT) was purchased from Watt Market, Calabar. After sorting, the seeds were manually separated from the pulp. The pulp was blended into a homogeneous powder and stored for chemical analysis. Chemical analysis was carried out using standard analytical procedures. Means and standard deviations were used for data analysis. Results show that niacin content of the fruit was 3.6 mg/100g ± 0.03. The Vitamin C content was 26.4 mg/100g ±0.02. The Vitamin A (RAE) contents was 109 ug/100g ±0.21. Among the carotenoids, Lutein (1163±021 µg/100g) was more abundant, while Phenolic acids (12.8±0.07 mg/100g) were the most abundant phytochemical. Leveraging on this data, consumers and health workers can make more informed food choices. Food processors should consider processing this fruit pulp into food powder, which can be used for nutrient enrichment.

Keywords: Dialium Guineense, Vitamin Compositions, Phytochemicals Compositions, Fruit Pulp.

Introduction

Fruits and vegetables are edible parts of plants like seed-bearing structures, flowers, buds, leaves, stems, shoots, and roots cultivated or harvested wild and eaten in their raw form or with minimal processing (Food and Agriculture Organization (FAO), 2021). Fruit consumption, like vegetables, has been widely recommended by researchers and was reemphasized during the International Year of Fruits and Vegetables in 2021 as one of the important steps in improving health. Inadequate consumption of fruits and vegetables was implicated in about 1 percent of Disability-Adjusted Life Years (DALYs) and also the cause of about 2.8 percent of deaths worldwide (World Health Organization (WHO), 2023). Studies have associated inadequate fruit and vegetable consumption to chronic lung diseases, poor management of diabetes mellitus, gut health, and some sensory organ malfunction (Smith *et al.,* 2022; Mirza *et al*., 2024). Nigeria is blessed with variable fruits with diverse nutritional and health benefits, some of these fruits like the Black velvet tamarind among others are underutilized and may go extinct (Obiefuna *et al.,* 2016).

Black velvet tamarind (BVT)/ African velvet tamarind (AVT) *(Dialium guineense*) is a tropical tree that belongs to the fabaceae family, AVT is commonly found in dense savanna forests and gallery

forests, its fruiting time is from October to January. It has an orthodox kind of seed. The tree of AVT is shrubby with a densely leafy crown. It is usually average in height of about 30 meters. It has a short bole (80cm) without buttresses with narrow, thin, butt flares (The Green Institute, 2024; International Institute of Tropical Agriculture, (IITA), 2017). Among the three major languages in Nigeria, it is called *icheku* in Igbo, *awin* by the Yorubas and the Hausas call it *tsamiya-kurm*. Generally, it is fondly referred to as *licky-licky* in pidgin English. It has small edible fruits with a black velvety inedible circular and flattened pod that may contain one or two smooth, stony shiny-black seeds surrounded by dry, orange to brown coloured edible pulp. The fruit pulp has a sweet-sour, astringent flavour (International Institute for Tropical Agriculture, 2017). The fruit when ripe, usually falls off its parent tree and can picked from the ground. The fruit can easily be licked after minimal processing like breaking the velvety pod with the fingers. The pulp can also be washed off from the seeds (International Institute of Tropical Agriculture, 2017) and used for local juices and drinks. Since AVT has an orthodox seed, it is likely to have the ability to endure extreme freezing and drying conditions and can survive outside its natural habitats. AVT could be dried to an internal moisture of less than 12% and can be stored in a conventional freezer at a temperature of –18°C + 3°C (Walters & Maschinski, 2020). Storage in conventional freezers is generally inexpensive.

Their use varies as they are used for the production of beverages, probiotics, and prebiotics. AVT is eaten fresh or dried as an on-the-go snack. The fruits are consumed out of hand, discarding the exterior brittle shell, and the flesh is sucked from the seeds. It is used in beverage industries as a sweetener (Abiodun *et al*., 2017) or infused and consumed hot or chilled as a drink. AVT has very low-fat contents, high carbohydrates, and appreciable protein contents for a fruit (Airaodion *et al*., 2021). The high ash content of *AVT* pulp is an indication of the mineral contents. The fruit pulp is also rich in vitamins and minerals, as well as carbohydrates. The moisture content of AVT fruit pulp is low, it falls within the safe levels of moisture reported for most fruits (Afolabi, 2014), and as such could make it less perishable than most fruits. AVT can increase gastric mucus secretion which may confer an anti-ulcer effect (Balogun *et al*., 2013). The sweet-tart, subtly acidic, and sour flavour makes it ideal for raw or cooked food preparations. It is essentially a good source of nutrients for humans (Airaodion *et al*., 2021) and animals because it contains several nutrients and antioxidants (Akinpelu *et al,* 2011). Generally, fruits are vitamin and mineral-dense, and they also have phytochemicals., as a result, has therapeutic potential. *The* pulp of AVT is abundant in iron, calcium, magnesium, and potassium (Ogbuewu *et al*., 2023). AVT is called vitamin C plant probably because of the high content of this vitamin. Vitamin C is an antioxidant vitamin thus, might be the reason for some of the health benefits of the plant. A lot of research has been conducted to determine the nutrient compositions of the seeds, fruit coats, barks, and other parts of the tree (Ofosu *et al*., 2013), therefore, the relatively high ascorbic acid content indicates that it could be used as a source of dietary antioxidant.

AVT has been listed among underutilized fruits. It could go extinct as

the trees are barely available due to urbanization, economic and environmental reasons among others (Obiefuna *et al.*, 2016). The fruits are now imported (Akinfenwa, 2022). Enhanced production, processing, preservation, and storage of underutilized fruits like the AVT growing in wild bushes and the scientific evaluation of their chemical contents may contribute to mitigating the situation. The literature on the chemical compositions of AVT fruit pulp is scanty as it is mostly considered lesser known and underutilized. Knowing the chemical composition of food makes the consumers aware of the nutritional and health value of such foods, their toxicological effects, safety, and stability to microbiological, chemical, or physical changes (FAO/WHO, 2004; Aletan & Kwazo, 2019).

The inadequate nutrient compositional information on the fruit pulp of AVT has encouraged the population to ascribe some of their nutritional benefits to superstition. Until recently, most research on the health benefits of AVT has focused on other parts of the AVT plant including the leaves and, seeds among others. Some researchers have also concentrated their research on major nutrients, yet, the available data are not sufficient, and the drive to identify other bioactive components present in the fruit pulp of AVT that may reduce the risk of chronic diseases is on the rise. To enrich the food composition database of this plant, this study seeks to determine some of its chemical compositions. This will contribute to enriching the database on AVT.

Purpose of the study

The major purpose of this study was to investigate the selected chemical composition of African velvet tamarind. Specifically, the study determined:

(1) vitamin (vitamin C, Niacin, and Retinol Activity equivalent) composition of AVT.
(2) phytochemical composition of AVT.
(3) Carotenoids profile AVT

Materials and Method: Procurement of Material

Fruits of AVT were purchased from Watt Market, Calabar, Cross River State, Nigeria in March. The purchased fruit was wrapped in paper and inserted in Woven Polypropylene Bags to ensure it was kept. It was transported to the Human Nutrition and Dietetics laboratory, Faculty of Basic Medical Sciences, University of Calabar, Cross River State for preparation for analysis.

***Sample Preparation*:** The fruits were selected to remove dirt and unwanted particles, they were washed with tap water to free them from dust and any other debris. The fruit pulp was shelled and deseeded and then blended (Binatone BLG-620) electric blender) to a homogeneous powder for chemical analysis. The sample was packed in an airtight sample bottle and stored in a refrigerator before analysis.

***Chemical Analysis*:** The method as described by Ward & Trenerry, (1997) was used for the determination of Niacin, with this method, niacin is liberated from the food matrix through alkaline digestion using aqueous calcium hydroxide and the extract purified and concentrated.

Vitamin C was determined using the method as described by the Association of Official Analytical Chemists (1988). With this method, Acid extracts (Metaphosphoric) of AVT was prepared and the pH of the fruit were adjusted and the extract's reducing capacity was measured by titration.

Alkaloids, Flavonoids, and phenolic acid contents of the samples were determined using the method described by AOAC (2010). Saponins determination was carried out by Fenwick & Oakenfull, (1983) procedure. The reagents used were reagent grade acetone, methanol, solution of concentrated e*n*-buthanol-methanol-ammonia (3.5:1:2.5), Standard solution of saponins purified in methanol, Solution of sulphuric acid in methanol (100 ml per litre). The tannin contents of the samples were determined using the methods described by Harbone (1973).

The carotenoid contents of the samples were determined using the method described by Rodriguez-Amaya & Kimura (2004). Three grams (3g) of the sample was weighed into a beaker. Sufficient water (10ml) was added to the sample. It was allowed to stand for 30 mins. Cold acetone (20 ml) was added to the mixture and filtered with suction through a sintered glass funnel. Some 50ml acetone was added and ground again with the pestle to extract the carotenoids.

***Data Analysis*:** All tests were in replicates and data obtained were statistically analyzed means and standard deviations. Retinol Activity Equivalent (RAE) was calculated according to the following formula as described by Vincent *et al*., (2020). Beta-carotene equivalents (µg/100 g EP) = beta-carotene (µg/100 g EP) + alpha-carotene (µg/100 g EP) / 2 + beta-cryptoxanthin (µg/100 g EP) / 2.
RAE (µg/100 g EP) = beta-carotene equivalents (µg/100 g EP) / 12)

Results of the study

The findings from this study were presented as follows:

Table 1: Vitamin (Vitamin C, Niacin, and Retinol Activity Equivalent) Composition of AVT (mg/ug/100g as Consumed)

Vitamin	Contents
B3 (Niacin) Mg/100g	3.6±0.03
Vitamin C Mg /100g	26.4±0.02
Vitamin A (RAE)	109 ug/100g ±0.21

Data were mean of two determinations (n=2). Data are presented as Mean ± SEM.

Table 1 shows the vitamin composition of the AVT, vitamin C content was (26.4±0.02 mg/100g), vitamin B3 was (3.6±0.03mg/100g) and Vitamin A(RAE) was 109 µg/100 g ±0.21.

Table 2: Phytochemicals composition (mg/100g) of AVT pulp as consumed

Parameters	Values
Saponins	0.45±0.00
Tannins	1.29±0.01
Phenolic acids	12.83±0.07
Alkaloids	3.88±0.02
Flavonoids	5.36±0.04

Data were mean of two determinations (n=2). Data are presented as Mean ± SEM

Table 2 shows the phytochemical composition (mg/100g) of AVT. It is as follows: Saponin (0.45±0.00 mg/100g), Tannin (1.29 ± 0.01 mg/100g), Phenolic acid (12.83 ± 0.07 mg/100g), Alkaloid (3.88 ±0.02 mg/100g) and Flavonoid (5.36 ± 0.04 mg/100g).

Table 3: Carotenoids profile (µg/100 g /EP) of AVT as consumed

Parameters	Values
Beta carotene	885 ± 0.01 µg/100 g
Alpha carotene	366 ± 0.04 µg/100 g
Lutein	1163±021 µg/100 g
Cryptoxanthin	483±0.02 µg/100 g
Zexanthin	542±0.00 µg/100 g
Beta-carotene equivalents	1309 µg/100 g

Data were means of two determinations (n=2). Data are presented as Mean ± SEM

Table 3 shows the carotenoid profile of African velvet tamarind (µg/100 g). They are as follows: beta carotenoid (885 ± 0.01 µg/100 g), alpha (366 ± 0.04 µg/100 g), lutein (1163±021 µg/100 g), cryptoxanthin (483±0.02 µg/100 g) and zeaxanthin (542±0.00 µg/100 g). The value of the Beta-carotene equivalent is 1309 µg/100 g.

Discussion

Findings on the vitamin compositions of AVT in niacin is appreciable. The content of niacin in AVT is higher than the contents found in 28 fruits as studied by Catak & Yaman (2019). Niacin functions as a reductive biosynthesis in steroid and fatty acid synthesis, it is also important in the oxidation of carbohydrates. Its deficiency results in pellagra, a wasting disease that manifests as bilateral and also symmetrical erythematous dermatitis. In a state of deficiency of Niacin, Pellagra is most likely as an individual might manifest symptoms of dementia after having episodes of insomnia and apathy displaying variable character changes, loss of memory, confusion, and in severe state, coma or death (Redzic, *et al*., 2023; Morris *et al*., 2004). Niacin deficiency is also associated with severe diarrhea because of the inflammation of the intestinal mucous surfaces and adequate intake may improve growth performance in humans given the result of a study using pigs (Liu *et al.,* 2021). Vitamin C contents of AVT observed in this study may provide over 50 percent of the recommended nutrient intake (FAO/WHO, 2004). As such it is a cheap and good source of vitamin C. Vitamin C deficiency will promote anemia because of its role in iron absorption, and stabilization of folate in food and also in the plasma (Loganathan *et al*., 2023; Golding, 2018).

Saponin levels observed in AVT were low and within safe levels. A study on the lethal dose of saponin was observed to be 200 mg/kg (Diwan, *et al*., 2000). Saponin contents above safe levels are known to exact negative effects like haemorrhage and erosion of the mucosa of the small intestine or necrosis of liver cells and renal (Diwan *et al.,* 2000).

The level of tannin observed from this study is not surprising as the fruit tastes nice aside from being sour as products with high tannin levels are known to have a bitter taste thus reducing consumer choice for such foods (Pandey and Rizvi, 2009; Kyraleou *et al.,* 2017). Tannin levels in the range of 0.02mg/g - 0.05mg/g are regarded as low (Trugo & Baer, 2004) foods high in tannin aside from their bitter taste, are known to form complexes with protein, starch, cellulose or minerals (Aldred, 2009).

The safe level for a wide range of phenolic compounds is 5mg/kg (European Food Safety Authority, 2012). The phenolic acid content of AVT is quite high as observed from this study. Generally, foods rich in phenolic acids are known to protect against chronic diseases, including cardiovascular disease, neurodegenerative disease, and cancer (Rio, 2013). Particularly, Flavonoids have a wide range of applications in the food, pharmaceutical, and cosmetic industries. Their importance is attributable to their anti-oxidative, anti-inflammatory, anti-mutagenic, and anti-carcinogenic properties (Kopustinskiene *et al*., 2020; Al-Khayri, 2022).

They are different alkaloids that occur naturally in foods, alkaloids have medicinal properties when consumed the high level of alkaloid present in AVT potentiates it with the ability to exert the health benefits attributable to foods rich in

alkaloids which include but are not limited to the anticancer properties of alkaloid rich foods (Dhyani *et al.,* 2022*)*.

Tannins observed from this study are within the safe levels of less than 22mg/kg, as such, may not antagonize protein absorption (Gilani, *et al*., 2005). Lawrence *et al.,* (2017) reported that the tannins component possesses excellent cardio-protective qualities in addition to the antioxidant action. It precipitates lipoprotein which carries cholesterol and thus reduces the level of in-take cholesterol. Mensah *et al.* (2019) also reported the usefulness of tannins in fruit aid in the management of hypertension.

The carotenoids present in AVT are among the major carotenoids important to human nutrition (Rodriguez-Amaya, 2017; Johnson, 2002). The β-carotene which happens to be the most abundant carotenoid that exhibits provitamin A activity is found in high concentration in AVT aside that, other provitamin A carotenoids like the α-carotene and β-cryptoxanthin were also identified. Their contributions to the RNI/day of vitamin A is 36 to 40 percent in adults (male and female respectively) is appreciable (FAO/WHO, 2004). Lutein and zeaxanthin are also known to be important in human nutrition. The number of carotenoids found in this study is not surprising as carotenoids are found naturally in many coloured plants (fruits and vegetables) and AVT is not an exception (Gropper, *et al*., 2009)

Conclusion

AVT is a lesser-known fruit, although it is not a citrus fruit, it has abundant vitamin C and Niacin levels. It also has high levels of phytochemicals like phenolic acids and flavonoids. Beta-carotene equivalents (Retinol activity equivalents) were appreciable. Zeaxanthin and lutein were also found present.

Recommendation

1. Researchers should isolate and categorize the specific phenolic acids and alkaloids in AVT
2. Consumers should leverage on the information on the chemical compositions in making food choices
3. Food processors should consider processing the fruit pulp of AVT into powder to enhance food use.

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