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Some Aspects of Nutrient, Antinutrient, Minerals and Sugars Contents of *Thaumatococcus daniellii* (Benn.) Seeds

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Authors' contributions

This work was carried out in collaboration between all authors. Authors GOO and ROA designed and supervised the research work while authors RTL and MAS co-supervised the research work as well as in search for relevant literature. All authors read and approved the final manuscript.

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ABSTRACT

Thaumatococcus daniellii is an under-exploited, wild rhizomatous perennial herb from Africa that is classified as one of the non-timber forest products. The aril contains an intensely sweet and non-toxic protein used as sweetener in food and other related industries. This study evaluated the nutrient, antinutrient, minerals and sugars contents of *T. daniellii* seeds. The proximate analysis of the seeds in percent on dry basis revealed 9.18±0.04 ash, 10.52±0.10 moisture, 2.48±0.02 crude fat, 29.45±0.13 crude fibre, 6.67±0.05 protein, 41.70±0.73 carbohydrate and the energy value was calculated to be 213.29±0.11 Kcal/100 g. Minerals analysis of the seeds in mg/kg revealed the presence of sodium 113.00±0.01, potassium 155.30±0.00, calcium 56.00± 0.02, magnesium 62.00±0.01, iron 1.05±0.00, zinc 1.24±0.00, phosphorous 112.00±0.01, manganese 0.11±0.00 and

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copper 0.12±0.00. Anti-nutrients analyses of the seeds are phytates 7.98±0.02%, tannins 0.49±0.01 mg/g, oxalates 7.84±0.15%, flavonoids 7.89±0.01 mg/g and total phenols 6.25±0.01 mg/g. Sugar analysis of the seeds gave the presence of the followings in mg/g; glucose 74.25±0.10, fructose 78.75±0.02, invert sugar 76.35±0.21, maltose 115.20±0. 05 and sucrose 71.25±0.11 while total and reducing sugars in % gave 2.06±0.01 and 8.25±0.03 respectively. The research work revealed the potentials of the seeds for both domestic and industrial usage.

Keywords: T. danielli; proximate; mineral; sugar; domestic; industrial.

1. INTRODUCTION

Thaumatococcus daniellii is a non-timber forest product along with other materials such as mushrooms. Non-timber forest product (NTFP) exploitation has been recognized as potential alternative to forest management practices such as clear- cut logging [1]. It is a rhizomatous seed plant found in the tropical rain forest and coastal areas of West Africa countries. In Nigeria, it is mostly found in the western region of the country. Its common names include miracle fruit and the leaf known as "ewe eran'' in Yoruba speaking areas of Nigeria. It is perennial monocotyledonous herbs that propagates itself by rhizomes and form an undergrowth of trees. It has long, slender stalks that can grow up to two or three meter high, each bearing a single tough, ovoid shape leaf of bearing varying sizes depending on the plant's age and habitat. Its habitat is the underground of forest tree. *T. daniellii* is also found in swampy areas or very wet soils, near water bodies, sandy soils and abandoned farm. Vegetative growth of *T. daniellii* is seasonal with flowering and subsequent fruit set.

Main flowering occurs at the beginning of the rainy season but occasional flowering may arise before or after this main season. The duration from flowering opening to fruit ripening average about 13 weeks. *T. daniellii* is a species of flowering plants with the latin name "Marantaceae".

It is a plant species from Africa known for being the natural source of thaumatin; an intensely sweet protein which is of interest in the development of non-caloric sweeteners. It is at least 3000 times as sweet as sucrose [2]. Thaumatin is a food additive classified as a GRAS (Generally Recognized as Safe) by the US Food and Drug Administration and has potential uses in the manufacturing of drugs, confectionaries and beverage [3]. It is not a carbohydrate, thus can be ideal sweetener for diabetic people [4]. In Nigeria, the leaves are used for boiling foods such as beans puddings and for wrapping foods such as locust beans, pounded yam and pap. Nutrients and antinutrients contents of different seeds have been reported by several researchers [5,6,7,8] and earlier studies on chemical composition of seed, tissue, leaf and fruit of *T. danielli* have been documented by Abiodun et al. [9], Elemo et al. [10] and Chinedu et al. [11]. Despite these levels of information, reports on the sugar fractions of the seed in addition to the nutrient, antinutrient and mineral components is reported here to supplement existed information on *T. daniellii* seed in order to enhance its optimal usage industrially and in areas where it can be newly introduced as a source of natural sweetener.

2. MATERIALS AND METHODS

2.1 Sample Collection and Pretreatments

The raw materials used are matured, healthy and freshly harvested *T. daniellii* seeds collected from a farm at Dagbolu in Ikirun, Ifelodun Local Government area of Osun State, Nigeria. The seeds were removed from the fleshy part, washed thoroughly in deionised distilled water and oven-dried at 40℃ for 48 h. The dried seeds were milled using manual blender because of the hardness of the seeds. The ground sample was packed in a polythene bag and kept in a dessicator containing silica gel inside a refrigerator at 4℃ until used for further analysis.

2.2 Proximate Composition

The proximate composition of the sample was determined using the method reported by Ogbonna and Ukaan [12] where moisture content was estimated by drying in an air oven at 105℃ to a constant weight. Crude protein was by Kjeldahl method. Crude fat was determined using continuous extraction in Soxhlet apparatus with diethyl ether as solvent. Ash content was determined by incinerating in a furnace at 550℃ for 5 h. Crude fibre was determined by

segmental hot digestion of the defatted sample with dilute acid and alkaline solutions. The carbohydrate was determined by difference. 100 - % (moisture + crude fat + crude fibre + ash + crude protein). The energy value of the sample was evaluated using the formula reported by Jamil et al. [13]. Energy value (Kcal/100 g) = 2.62 × % protein + 8.37 × % fat + 4.2 × % carbohydrate.

2.3 Elemental Composition

The sample was digested and determined according to the methods reported by Sivrikaya et al. [14]. The Na and K contents were determined by flame emission spectroscopy while Cu, Zn, Ca, Mg, Fe, Mn and P were determined on atomic absorption spectrophotometer.

2.4 Determination of Antinutritional Factors

Antinutritional factors were determined according to the following methods as reported by Ingweye et al. [15]. Phytates, tannins, and saponins and oxalates were determined according to the methods highlighted by Mohammed et al. [16], Price et al. [17] and Dye, [18] respectively. The total phenols, saponins and flavonoids were determined by the methods described by Mbagwu et al. [19].

2.5 Sugar Analysis

The sugar analysis of the sample was determined according to the methods described by A.O.A.C, [20].

3. RESULTS AND DISCUSSION

3.1 Results

Table 1 showed the proximate composition of *T. daniellii* seed sample. From the seed sample, the ash content was found to be 9.18±0.4%. The value is comparable to 9.0±0.45% and 9.1±0.71% obtained by [13] for Barkavi variety of date fruit and Elemo et al. [10] for *T. danielli* seed. Our value for ash is however a little bit high compared to 8.17% obtained by Abiodun et al. [9] for defatted seed of *T. danielli*. The ash content is an indicator for mineral content in a food material. The moisture content of the seed sample is 10.52±0.10%, this is a little bit higher than the range of 5.12-7.80% obtained for 13 sesame accessions [11] but low compared to 31.2±4.66% and 15.15±0.04% obtained for *T. danielli* seed by Elemo et al. [10] and Chinedu et al. [11] respectively. Long shelf life could be attributed to the low moisture content as high value can hasten spoilage, encourages nutrient loss and enhances microbial growth.

Table 1. Mean value and standard deviation (S.D.) for proximate composition (%) of *T. daniellii* seed

Parameter	Mean value ± S.D
Ash content	9.18±0.04
Moisture content	10.52±0.10
Crude fat content	2.47±0.02
Crude fibre content	29.45±0.13
Protein content	6.67±0.05
Carbohydrate content (by difference)	41.70±0.73
Energy value (Kcal/100g)	213.29

n= 3

The fat content of 2.47±0.02% is considered low compared to 4.23±0.02%, 9.06±0.15% and 12.20% reported for Africa bread fruit, Pride of Barbados and defatted seed flour of *T. danielli* by [21,22,9] respectively. The low fat content would be a useful parameter in food composition for obese people that required low fat in their food material. The crude fibre content of the seed sample is 29.45±0.13% which is significantly low to 45.72±3.71% but higher than 16.14% obtained from citrus seeds and *Blighia Sapida* [23,24] respectively. Crude fibre is an essential part of diet, which reduces serum cholesterol levels and occurrence of breast cancer. Crude protein of the seed sample was found to be 6.67±0.05%. This is considered low compared to 10.06±0.12%, 10.36±0.04 g/100 g and 9.5% obtained for *Mangifera indica* [25] and *T. danielli* seeds [11,10] respectively. The WHO/FAO recommended daily allowance for children in the age range of 1-10 years is 0.88 g protein per kg body weight [13], therefore consumption of 100 g of this sample will provide 6.67 g of protein and will adequately satisfy the recommended daily allowance in children. Proteins are useful in repairing worm out tissue and building up of new cells in the body. Carbohydrate content of the seed sample was found to be 41.70±0.73%, this value is lower than 73.26±0.01% for Africa bread fruit [21]. The high carbohydrate content of the seed sample shows that it will be a good source of energy to the body system. Carbohydrates are also useful in promoting the utilization of dietary fats and reduction in protein wastage [26]. The

energy value of the seed was found to be 213.29 Kcal/100 g which is an indication that the sample could be a cheap source of energy to the body system.

Table 2 showed the minerals analysis of the seed sample in mg/kg. The trend for the relative abundance of these elements is K> P > Mg > Ca > Na > Zn > Fe > Cu > Mn. Abiodun et al. [9] reported K, Ca,Na and Mg as major minerals in the seed flour. The high amount of K mineral obtained here is line to the findings that K is the most abundant element in Nigeria Agricultural products [27]. K is the principal intracellular cation that is mainly involved in membrane potential and electrical excitation of nerve and muscle cells [28]. P was the next abundant element to K and this mineral has been found useful in bone and teeth formation. Ca, Mg and Zn are essential minerals that are interrelated in their roles in physical health as they regulate many body functions. Adequate dietary Ca helps to prevent osteoporosis or bone loss and is tightly linked to many of the roles that vitamin D plays in the body. Mg is crucial in regulating heartbeat, blood sugar levels and supports the immune system. Zn plays a vital role in gene expression, regulation of cellular growths and participates as a co-factor of enzymes responsible for carbohydrates, proteins and nucleic acids metabolism [29]. Mn is a micro element that is useful in human nutrition. The value obtained for Mn is lower than that reported for *Chanca piedra* [30]. Other mineral elements in combination with others or singly as listed above are important for several metabolic actions in the body.

Table 2. Mean value and standard deviation (S.D.) for minerals composition (mg/kg) of *T. daniellii* seed

Parameter	Mean Value ± S.D
Na	13.00±0.00
K	155.30±0.01
Ca	56.00±0.02
Mg	62.00±0.01
Fe	1.05±0.00
Zn	1.24±0.00
P	112.00±0.01
Cu	0.12±0.01
Mn	0.11±0.02

n=3

Table 3 showed the anti-nutrients analysis of *T. daniellii* seeds. The phytate content of the seed was found to be higher while oxalate was slightly lower than the values recorded for *Deteriummicro carpium* seed [31]. Phytic acids are present in most plant foods as phytates, they chelates with divalent elements to form insoluble complexes which adversely affect the bioavailability of these minerals [32]. Dietary oxalate plays an important role in calcium oxalate kidney stone disease because of its absorption and excretion in urine. To prevent oxalate kidney stone disease, it has been advised that more efforts should be put in place to decrease the intake of oxalate-rich foods and increase the intake of calcium-rich foods [33]. It is interesting to note that this sample fits into the above requirements of low oxalate and moderately high calcium contents food material. The value of oxalate obtained in this present study is lower than the lethal dose reported by Udosoro et al. [34]. Tannin value of 0.49± 0.01 mg/g is lower than the amount reported for mango seed [25]. Tannins are aromatic compounds containing phenolic groups that can interact with salivary proteins in the mouth and render the tissues astringent to taste. They are toxic and interfere with digestion and absorption of proteins and utilization of vitamins and minerals. Tannins are capable of leaving available protein by antagonistic competition and can elicit protein deficiency syndrome commonly called kwashiorkor [35]. Boiling has been reported to be a very good means of reducing tannin contents of food materials [34]. The values obtained for flavonoids and total phenols were 7.89±0.10 mg/g and 6.25±0.01 mg/g respectively. Flavonoids protect against platelet aggregation, hepatotoxins and have anti- microbial and anti-cancer activities while most phenolics are antioxidants and can contribute to the stability of the materials against oxidation [36].

Table 3. Mean value and standard deviation for anti-nutrient analysis (mg/g) of *T. danielli* seed

Parameter	Mean Value ± S.D
Phytates	7.98±0.02
Tannins	0.49±0.01
Oxalates	7.84±0.15
Flavonoids	7.89±0.01
Total phenols	6.25±0.01

n=3

Table 4 shows the sugar analysis of the seed sample. From the results, 74.25±0.10 mg/g was obtained for glucose which is lower than the recommended dietary allowance (RDA) of 130 g per day. The glucose from this source can be

used as supplement in other food materials. Glucose is important as the energy source for red blood cells and the preferred energy source for the brain and the central nervous system (CNS). The sucrose value of 71.25±0.11 mg/g was obtained for the seed. Sucrose provides body with the energy required to perform physical and mental functions. Consumption of adequate sucrose ensures that the body gets the optimal amount of energy. The fructose of the seed sample was found to be 78.75±0.02 mg/g, fructose is the sweetest of all naturally occurring carbohydrates with a very low glycemic index (GI) of 23% and might be therapeutically use as a dietary supplement for patients with diabetes mellitus. Total sugar and maltose contents of the seed sample were found to be 2.06 ± 0.50% and 115.20±0.50 mg/g respectively. Maltose is a useful material in the production of malt; an important intermediate in the digestion of starch. The invert sugar value was found to be 76.35±0.21 mg/g. Invert sugar is sweet-taste and provides more powerful preserving qualities to products. The shelf life of partial inverts is approximately six months depending on storage and climatic conditions. Reducing sugar of the sample was found to be 8.25±0.03%; this value is higher than 4.85% obtained for raw mung bean seed [37]. Reducing sugar is of importance in determining the flavor of food and the levels of reducing sugars in food materials are indicative of the quality of those food products.

Table 4. Mean value and standard deviation (S.D.) for sugar analysis (mg/g) of *T. danielli* seed

Parameter	Mean Value ± S.D
Glucose	74.25±0.02
Fructose	78.75±0.02
Invert sugar	76.35±0.02
Maltose	115.20±0.05
Sucrose	71.25±0.11
Total sugar (%)	2.06±0.01
Reducing sugar (%)	8.25±0.03

n=3

4. CONCLUSION

The results of this study shows that *T. daniellii* seeds are rich in crude protein, dietary energy and minerals (especially K, Ca, P). The sample was found to contain fairly lower amount of antinutrients which makes it safer for consumption and would not impair the release and availability of minerals to the body. The moderately high values of the sugar fractions would also make the seeds useful as an alternative to the synthetic sweetener in food and confectionary industries.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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