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Nutritional Composition and GC-MS Phytochemical Analysis of *Thaumatococcus daniellii* Leaves

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Authors' contributions

This work was carried out in collaboration among all authors. Author AVI designed the study, wrote the protocol and first draft of the manuscript. Authors NJE and ECC managed the literature search and analyses of the study while Authors JAN and CA performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Aims: There is a high risk associated with using artificial materials like polyethylene or foil for wrapping foods before cooking. The present study investigated the phytochemical and nutrient composition of *Thaumatococus daniellii* leaf, a local food wrapper.
Place and Duration of Study: Biochemistry Unit, Department of Science Laboratory Technology, Imo State Polytechnic Umuagwo, between April and May 2018.
Methodology: The phytochemical compounds were analyzed using gas chromatography coupled with mass spectrometry (GC-MS) while proximate and vitamin composition was determined using standard analytical methods.
Results: The GC-MS phytochemical analysis revealed the presence of eight (8) bioactive compounds 1,2,3,4-Butanetetrol, d-Glycero-d-idoheptose, Cyclopentane,1-ethyl-1-methyl-, 6-Octyl-

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1-ol,3,7-dimethyl-, 2-Octenal, E- Octane,1-chloro-,2-Acetoxy-1,1,10-trimethyl-6,9-epidioxydecalin and Bicyclo[3.1.1]heptan-3-ol,2,6,6-trimethyl-,(1α,2β,3α,5α)- while vitamin assay results showed that *Thaumatococcus daniellii* leaf contained 3.1mg/100g of vitamin A, 1.07 mg/100 g vitamin B_1, 1.32 mg/100 g vitamin B_3, 1.11 mg/100 g of vitamin B_5, 16.34 mg/100 g of vitamin B_6, 11.86 mg/100 g of vitamin B_{12} and 25.19 mg/100 g of vitamin C. Result of proximate analysis indicates that *Thaumatococcus daniellii* leaf contains 10.15% ash, 9.67% moisture, 20.41% protein, 11.42% lipids, 13.78% fibre and 34.57% carbohydrate.

Conclusion: In summary, our findings indicate that *Thaumatococcus daniellii* leaves contain bioactive compounds, an appreciable number of vitamins and high nutritional constituents. Hence *Thaumatococcus daniellii* leaves can be incorporated into animal feed, taking into cognizance the high protein, fat and vitamin contents. These suggest that it may play critical medicinal and nutritional roles and probably be a safer alternative to polyethylene paper and aluminum foil wraps; hence justifying its local usage as food wrapper. The leaves may also serve as a lead for the production of a healthier material for wrapping local foods.

Keywords: Thaumatococcus daniellii; phytochemical; nutrient composition.

1. INTRODUCTION

In the traditional African system of food packaging, cereal grains, and seeds are either cooked or fermented using local packaging materials such as wineskin, wooden boxes, and leaves. Leaves such as *Thaumatococcus daniellii* play a vital role in the traditional packaging of food products like bean pudding and local pastries, owing to its beneficial packaging properties such as aroma, taste, low cost and does not transfer any color to the wrapped food. The use of this leaf is very ancient, and a close study on this leaf revealed that it has a large surface area and can be used to wrap large volumes of foods, [1]. *Thaumatococcus daniellii* is a plant species of African origin, it is the natural source of thaumatin, an intensely sweet protein of interest in sweeteners' development. It is a rhizomatous, flowering herb native to the rainforests of western Africa [2]. *Thaumatococcus daniellii* grows to a height of about three to four meters with large, smooth leaves spanning about 46 centimeters long. It bears pale purple flowers and a soft fruit containing a few shiny black seeds. The leaves are used to wrap food and have been reported to have many traditional medicinal uses [1]. In traditional medicinal use, the leaf sap is used as an antidote against venoms, stings, and bites. Leaf and root sap are also used as a sedative and for treating insanity [3]. Given all the reputed medicinal efficacy of this plant leaf, the present study aims at evaluating the nutrient and bioactive constituents of this plant leaf in order to give credence to the holistic utilization of this plant in the wrapping of foods and treatment of diseases.

2. MATERIALS AND METHODS OF ANALYSIS

2.1 Sample Collection and Preparation

Fresh leaves of *Thaumatococus daniellii* were collected from Ulakwo autonomous community in Owerri North Local Government Area, Imo State. The leaves were thoroughly washed with tap water, dried and pulverized into a coarse powder using a grinder.

2.1.1 Quantitative determination of phytochemicals using GC-MS analysis

The sample for GC-MS was prepared by dissolving 3g of extracted powder in 50 ml of methanol solvent. For the analysis, GC-MS-QP 2010 SHIMADZU instrument was used. To analyze the sample the column oven temperature and Injector temperature was set at 800°C and 200°C respectively. The flow control mode was maintained in linear velocity with a split injection mode split ratio of 20. The column flow was 1.46 ml/min with a helium carrier gas of 99.9995% purity. The column oven temperature program was set as follows: - The temperature was set at 80°C with 2 mins hold time at the rate of 10. The temperature was 300°C with 10 minutes hold time. The column at 5 mins was used with a length of 30 millimeters and diameter of 0.25 mm and its film thickness will be 0.25 μm. The ion source temperature for MS condition was 200°C and interface temperature was 240°C. Starting m/z (Mass to charge) ratio was 40 and ending with m/z ratio of 700 (40-700 m/z).

2.1.2 Identification of components

Interpretation of mass spectrum GC-MS was conducted using the NIST Database. The spectra of the unknown components were compared with the spectrum of known components stored in the NIST library. The name, molecular weight, and structure of the components of the test materials were ascertained.

2.1.3 Determination of proximate and vitamin composition

Proximate composition of the dried leaf sample was determined. Moisture, crude, fibre and ash contents of the dried leaves were carried out in triplicates according to the method described by [4] while protein content was determined by the Kjeldahl method of [5]. Carbohydrate content was ascertained using the method of [6], while lipid content was determined by Soxhlet Extraction Gravimetric method of [7], while vitamin composition was determined by the method of AOAC [8] using a uv-visible spectrophotometer.

3. RESULTS

From Table 1, GC-MS analysis of *Thaumatococcus daniellii* recorded 8 components which include 1,2,3,4-Butanetetrol,[S-(R*, R*)]-, with retention time of 5.158 and peak area of 28.28%; d-Glycero-d-ido-heptose with retention time of 7.470 and peak area of 18.14%; Cyclopentane, 1-ethyl-1-methyl- with retention time of 7.796 and peak area of 18.41%; 6-Octen-1-ol,3,7-dimethyl- with retention time of 8.769 and peak area of 13.97%; 2-Octenal, (E)- with retention time of 10.777 and peak area of 9.24%; Octane, 1-chloro- with retention time of 10.897 and peak area of 8.61%; 2-Acetoxy-1,1,10-trimethyl-6,9-epidioxydecalin with retention time of 13.472 and peak area of 1.78% and Bicyclo[3.1.1]heptan-3-ol,2,6,6-trimethyl-, (1α,2β,3α,5α)- with retention time of 13.987 and peak area of 1.56%.

Table 1. Phytochemical composition of *Thaumatococcus daniellii* leaf

SN	RT	Component	Formula	MW	Peak %
1	5.158	1,2,3,4-Butanetetrol, [S-(R*,R*)]	$C_4H_{10}O_4$	122	28.28
2	7.470	d-Glycero-d-altro-heptulose	$C_7H_{14}O_7$	210	18.14
3	7.796	Cyclopentane, 1-ethyl-1-methyl	C_8H_{16}	112	18.41
4	8.769	6-Octyl-1-ol, 3,7-dimethyl-	$C_{10}H_{20}O$	156	13.97
5	10.777	2-Octenal, (E)	$C_8H_{14}O$	126	9.24
6	10.897	Octane, 1-chloro-	$C_8H_{17}Cl$	148	8.61
7	13.472	2-Acetoxy-1,1,10-trimethyl-6,9-epidioxydecalin	$C_{15}H_{24}O_4$	268	1.78
8	13.987	Bicyclo[3.1.1]heptan-3-ol, 2,6,6-trimethyl-, (1α,2β,3α,5α)	$C_{10}H_{18}O$	154	1.56

Table 2. Vitamin composition of *Thaumatococcus daniellii* leaf (mg/100 g)

Vitamin	*Mean (Mg/100 g) ± SEM
Vitamin A	3.1 ± 0.09
Vitamin B1	1.07 ± 0.01
Vitamin B3	1.32 ± 0.02
Vitamin B5	1.11 ± 0.02
Vitamin B6	16.34 ± 0.02
Vitamin B12	11.86 ± 0.04
Vitamin C	25.19 ± 0.14

**Values are mean of triplicate determinations*

Table 3. Percentage (%) proximate composition of *Thaumatococus daniellii* leaf

Parameter	**Composition (%)
Ash	10.15 ± 0.03
Moisture	9.67± 0.06
Protein	20.41 ± 0.14
Lipids	11.42 ± 0.02
Fiber	13.78 ± 0.11
Carbohydrate	34.57 ± 0.13

***Values are Mean(x) ± SEM of triplicate determinations*

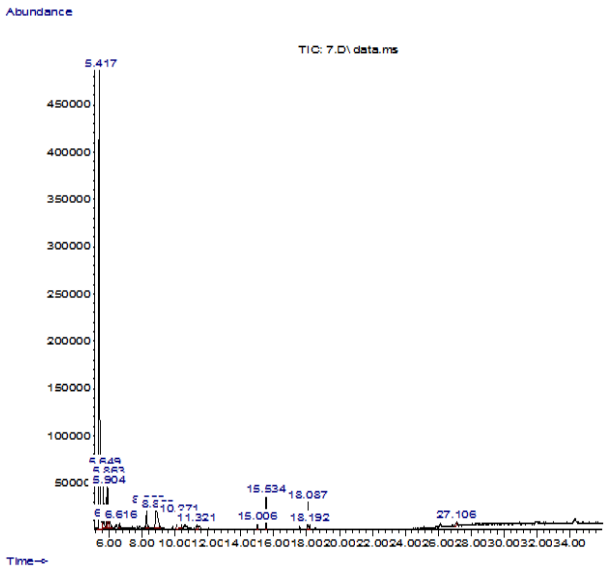

Fig. 1. Chromatogram GC-MS analysis of *Thaumatococcus daniellii*

Vitamin analysis of *Thaumatococus daniellii* leaf shows 3.1 mg/100 g of vitamin A, 1.07 mg/100 g of vitamin B_1, 1.32 mg/100 g of vitamin B_3, 1.11 mg/100 g of vitamin B_5, 16.34 mg/100 g of vitamin B_6, 11.86 mg/100 g of vitamin B_{12} and 25.19 mg/100 g of vitamin C.

Proximate analysis of *Thaumatococus danielli* shows that the plant leaf contains 10.15% ash, 9.67% moisture, 20.41% protein, 11.42% lipids, 13.78% fiber and 34.57% carbohydrate.

4. DISCUSSION

Phytochemicals are biologically active, naturally occurring chemical compounds found in plants which provide health benefits [9]. [1] reported the presence of terpenoids, flavonoids, alkaloids, cardiac glycosides and tannin in the preliminary phytochemical study on *Thaumatococcus daniellii* leaf. Result of the GC-MS analysis shows the following results: 1,2,3,4-Butanetetrol, [S-(R*, R*)]- contained in *Thaumatococcus daniellii* has been reported to maintain tooth mineralization [10]. d-Glycero-d-altro-heptulose contained in *Thaumatococcus daniellii* leaf has been reported to exhibit anti-bacterial activities while Cyclopentane obtained in *Thaumatococcus daniellii* leaf has also been reported to exhibit antifungal activities [11]. This may justify the local use of this leaf in the wrapping of food products. 6-Octen-1-ol,3,7-dimethyl- found in *Thaumatococcus daniellii* leaf has been reported to serve as a flavoring agent while 2-octenal,(E)- in *Thaumatococcus daniellii* leaf has been reported as a flavoring ingredient for improving the aroma and flavor of foods [10]. Octane, 1-chloro- found in *Thaumatococcus daniellii* leaf has been reported to serve as a stabilizer for dibutyl magnesium [10]. 2-Acetoxy-1,1,10-trimethyl-6,9-epidioxydecalin has also been reported to shave antidiabetic potentials in insulin-responsive cells and may hence proof useful for the treatment of type 2 diabetes. Bicyclo [3.1.1] heptan-3-ol, 2,6,6-trimethyl-, (1α,2β,3α,5α)- found in *Thaumatococcus daniellii* leaf has been reported to exhibit antioxidant properties [12]. [1] also described flavonoids as potent antioxidants and free radical scavengers capable of protecting cell membranes from damage. These bioactive compounds found in *Thaumatococcus daniellii* leaf may not only play vital roles in the treatment of diseases but also act as organic food additives enhancing food values. The work of Hamid et al. [13] also revealed the presence of fats and oils, terpenoids, flavonoids, steroids and glycosides in *Thaumatococcus danielli* leaf extracts while Oke et al. [14] posited that *T. daniellii* leaves containes flavonoids, polyphenols, alkaloids and saponins.

Vitamins are a group of organic compounds which are essential for normal physiological functioning but are not synthesized endogenously by the body [15]. Our result shows that *Thaumatococcus daniellii* leaf contained 3.1 mg/100 g of Vitamin A. This vitamin has been noted to promote good vision, especially in low light. It has also been discovered to play an

essential role in reproduction and lactation [16]. The results indicate that *Thaumatococcus daniellii* leaf contained 1.07 mg/100 g of Vitamin B_1 which has been reported to maintain a healthy metabolism, prevents nerve damage, supports the healthy cardiovascular system, boosts immunity and prevents brain disorders [17]. *Thaumatococcus daniellii* leaf also contained 1.32mg/100g of Vitamin B_3 which has been shown to be essential in body energy production, production of macromolecules, including fatty acids and cholesterol and facilitate DNA repair and stress responses [18]. *Thaumatococcus daniellii* leaf contained 1.11 mg/100 g Vitamin B_5 which plays a pivotal role in the breakdown of fats, carbohydrates, and proteins in energy generation in cells. It is also required for the synthesis of red blood cells, steroids, neurotransmitters, and stress-related hormones and helps in maintaining a healthy digestive tract [19]. *Thaumatococcus daniellii* leaf also contained 16.34 mg/100 g of Vitamin B_6 which was reported as a critical player in the production of neurotransmitters, healthy brain development, and function and in the synthesis of serotonin and norepinephrine which influence mood. It also acts in the generation of melatonin which helps regulate the body color [17]. *Thaumatococcus daniellii* leaf contained 11.86 mg/100 g of Vitamin B_{12}. This vitamin has been posited as an essential vitamin for maintaining healthy nerve cells and in the production of DNA and RNA while *Thaumatococcus daniellii* leaf contained 25.19mg/100g of Vitamin C which has been reported to be essential for the growth and repair of tissues in all parts of the body [17]. Vitamin C is a potent antioxidant that facilitates the transport and uptake of non-heme iron at the mucosa, reduction of folic acid intermediates and the synthesis of cortisol. [20] opined that green vegetables with high ascorbic acid content might enhance the absorption of non-heme iron. Its deficiency includes fragility to blood capillaries and scurvy [21]. The proximate composition of *Thaumatococcus daniellii* leaf shows that it has contained 10.15% ash, 9.67% moisture, 20.41% protein, 11.42% lipid, and 34.57% carbohydrate. The leaf of *Thaumatococcus daniellii* has high crude fiber content (13.78%); indicating that *Thaumatococcusdaniellii* leaf can be helpful in improving intestinal motility and prevention of intestinal disorders such as constipation [22]. Our results also indicate that *Thaumatococcus daniellii* leaf may serve as a good source of protein, lipid, and carbohydrate and hence might be incorporated into animal feed.

5. CONCLUSION

This findings indicate that *Thaumatococcus daniellii* leaves contain bioactive compounds, an appreciable number of vitamins and high nutritional constituents. Hence *Thaumatococcus daniellii* leaves can be incorporated into animal feed, taking into cognizance the high protein, fat and vitamin contents. These suggest that it may play critical medicinal and nutritional roles and probably be a safer alternative to polyethylene paper and aluminum foil wraps; hence justifying its local usage as food wrapper. The leaves may also serve as a lead for the production of a healthier material for wrapping local foods.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shalom, Nwodo- Chinedu, Adetayo, Oluwadamisi Y, Popoola ST, Bolaji JD, Tamunotonyesia E. Analyses of the leaf, fruit and seed of *Thaumatococcus daniellii* (Benth.): Exploring Potential Uses. Pakistan Journal of Biological Sciences. 2014;17:849-854.
2. Nwodo-Chinedu S, Omonhinmin A, Dike I, Omotosho O, Osamor V, Oyelade O, Adebiyi E. Species level characterization of *Thaumatococcus daniellii*: Reevaluating *Morphological evidences* via *in-silico* studies. Proceedings of the International Society for Computational Biology Conference. Toronto, Canada. 2008;18-23.
3. Bahadur A, Chaudhry Z, Jan G, Danish M, Rehman A, Ahmad R. Nutritional and elemental analyses of some selected fodder species used in traditional medicine. African Journal of Pharmacy and Pharmacology. 2011;5:1157-1161.
4. James C.S. Analytical chemistry of foods. Blakie Academic and Professional, London. 1995;505–509.
5. Chang SKC. (2003) Protein Analysis. 3rd Edition, New York: Kluwer Academic/Plenum Publisher. 1998;7-10.
6. Muller HG, Tobin G. Nutrition and food processing. London: Croom Helm London. 1980;24-32.
7. Kirk R, Sawyer R. Pearson's composition and analysis of foods. 9th Edition Addison Wesley Longman Ltd, England; 1998.

8. AOAC Official Methods of Analysis. Association of official analytical chemistry. Washington DC; 2009.
9. Mamta S, Jyoti S, Rajeev N, Dharmendra S and Abhishek G. Phytochemistry of medicinal plants. Journal of Pharmacognosy and Phytochemi. 2013; 1(6):168-182.
10. Noda Y, Kneyuki T, Igarashi K, Packer ML. Antioxidant activity of nasunin, an anthocyanin in eggplant peels. Toxicology. 2000;148:119-123.
11. Ekeleme GU, Nwachukwu NC, Ogoda AC, Nnadi CJ, Onuabuchi IA, Osuocha KU. Phytochemical screening and antibacterial activity of *Cnidoscolus aconitifolius* and associated changes in liver enzymes in Wistar rats. Australian Journal of Basic and Applied Science. 2013;7(12):15-162.
12. Raimi OG, Elemo BO, Fatai AA, Bankole HA, Kazeem MI, Banjoko AO. Isolation and partial characterization of a protease enzyme from *Thaumatococcus daniellii* waste. African Journal of Biotechnol. 2011;10: 3186-3190.
13. Hamid AA, Aliyu MA, Abubakar LZ, Mukadam AA, Shehu A, Egharevba G, Adisa MJ, Ajibade SO, Zubair AO, Fagbohun E. *Thaumatococcus daniellii* leaves: Its chemical compositions, antioxidant and antimicrobial activities. Ife Journal of Science. 2017;19(2):409-416.
14. Oke IA, Olufemi A, Oluwagbenga DO, God'swill NA. Phytochemical constituent and antioxidant activity of *Thaumatococcus daniellii* Benn (Benth.) leaves (food wrapper). International Journal of Pharmacology, Phytochemistry and Ethnomedicine. 2016;2:55-61.
15. Zhaoli D, Woon-Puay K. B-Vitamins and Bone Health–A Review of the current evidence. Nutrients. 2015;7(5):3322-3346.
16. Ganiy OBOH. Effect of some post-harvest treatments on the nutritional properties of *Cnidoscolus aconitifolius* leaf. Pakistan Journal of Nutrition. 2005;4:226-230.
17. Emebu PK, Anyika JU. Proximate and mineral composition of Kale grown in Delta State, Nigeria. Pakistan Journal of Nutrition. 2011;10:190-194.
18. Beard JL. Iron biology in immune function, muscle metabolism and neuronal functioning. Journal of Nutrition. 2001;131:5685-5695.
19. Adetugi S, Popoola C. Food analysis and instrumentation (Theory and Practice) 1st Edition, Napthal print. Surulere, Lagos Nigeria. 2001;140-160.
20. Otitoju GTO, Ene-Obong HN, Otitoju O. Macro and micro- nutrient composition of some indigenous green leafy vegetables in South-East Zone Nigeria. Journal Food Processing and Tech. 2014;5:389-343.
21. Achikanu CE, Eze-Steven PE, Ude CM, Ugwuokolie OC. Determination of the vitamin and mineral composition of common leafy vegetables in South Eastern Nigeria. Int. J. Curr. Microbiol. App. Sci. 2013;2(11):347-353.
22. Showemimo FA, Olarewaju JD. Agro-nutritional determinants of some garden egg varieties (Solaniumgilo L.). Pakistan Journal of Food Technology. 2014;2:172-175.

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