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Phytochemical, Anti-oxidant and *In-vitro* Anti-diabetic Evaluations of Aqueous and Boiled Leaf Extracts of *Thaumatococcus daniellii* (Benth)

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Abstract

Thaumatococcus daniellii (Benth), commonly referred to as the "miracle fruit plant," is traditionally used in cooking, where its leaves serve as natural food wrappers and flavour enhancers. This study investigate the scientific benefits of using *T. daniellii* in cooking by analyzing the phytochemistry, antioxidant, and *in vitro* anti-diabetic properties of the fresh leaf boiled extract (FBE) and dried leaf aqueous extracts (DAE). Quantitative Phytochemical screening was done using spectrophotometric method. The antioxidant potential was evaluated through assays such as 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging, 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) radical scavenging, ferric-reducing antioxidant power (FRAP), peroxide-mediated antioxidant (PMA) activity, and metal chelating activity (MCA). The *in vitro* anti-diabetic potential was assessed using α-amylase inhibition assays to determine the potency of the extract in modulating glucose metabolism. Phytochemical analysis revealed distinct differences between the extracts. FBE had lower flavonoid (0.368 ± 0.023 mg QE/g) and alkaloid (642.44 ± 15.56 mg AE/g) content than DAE (0.472 ± 0.00523 mg QE/g and 665.78 ± 35.29 mg AE/g, respectively). Conversely, FBE showed higher tannin (278.13 ± 27.36 mg TAE/g) and phenol (0.048 ± 0.003 mg GAE/g) levels compared to DAE. Antioxidant assays highlighted varied results. FBE exhibited higher DPPH radical scavenging activity (36.72 ± 1.84%) and ferric-reducing antioxidant power (0.1895 ± 0.007 mg Fe^{2+}/g) than DAE, while DAE demonstrated superior peroxide-mediated antioxidant activity (0.069 ± 0.0002 mg AAE/g). Metal chelating activity was similar for both extracts, and neither showed significant ABTS radical scavenging activity. The α-amylase inhibition assay revealed DAE's significant higher *in vitro* anti-diabetic potential (55.56 ± 2.26%) compared to FBE (12.82 ± 2.56%), suggesting that boiling diminishes this property.This study demonstrates that *T. daniellii* retains significant health-promoting bioactive properties, regardless of preparation method, making it a valuable addition to culinary and therapeutic applications.

Keywords: *Thaumatococcus daniellii*, phytochemistry, Antioxidant activity, Anti-diabetic activity

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1. Introduction

The sweet prayer plant, or *Thaumatococcus daniellii* (Benth) of the family Marantaceae, is a perennial herb indigenous to tropical Africa (Agha *et al*., 2022). It is renowned for its economic and medicinal significance, primarily due to its leaves and the thaumatin protein extracted from its fruit, which is widely used as a natural sweetener (Chinedu *et al*., 2022). In Nigeria and other parts of West Africa, the leaves of *T. daniellii* are traditionally used as natural wrappers for cooking and preserving food, imparting a distinct flavor and aroma to local delicacies such as moi-moi (steamed bean pudding) and ofada rice (Yusli *et al*., 2023). Recent studies have highlighted the plant's potential as a source of bioactive compounds, including phytochemicals with antioxidant and anti-diabetic properties (Olabisi *et al.,* 2023). These qualities are especially important in the fight against diabetes and oxidative stress, two of the world's worst health issues. Phytochemicals such as phenolics, flavonoids, and alkaloids have been extensively studied for their antioxidant and anti-diabetic properties (Muhammad *et al*., 2021). These compounds play a crucial role in mitigating oxidative stress and regulating key enzymes involved in glucose metabolism, offering promising therapeutic avenues for managing diabetes and its complications (Fazeli-Nasab *et al*., 2023).

This study compares the phytochemical composition, antioxidant capacity, and in-vitro anti-diabetic activities of aqueous and boiled leaf extracts of *T. daniellii* in order to determine the best preparation methods that maximize the plant's therapeutic potential. The results of this study could provide a scientific basis for the use of *T. daniellii* in traditional cuisines as well as in medicine and its development into functional foods or pharmaceuticals for managing oxidative stress and diabetes.

2. MATERIALS AND METHODS

2.1 MATERIALS

Reagents used include aluminum chloride, petroleum ether, ethyl acetate and methanol (Guangdong Guanghua Sci. Tech. Co. Ltd. Guangdong). Chloroform (Lobal Chemie, Mumbai, India), acetone (Merck, Germany), sulphuric acid (BDH Chemicals Ltd., Poole England), Mayer's and Wagner's reagents (Bioraj, Ilorin, Nigeria), hydrochloric acid, ferric chloride (BDH Chemicals Ltd., Poole England), glacial acetic and acetic anhydride (JHD Chemicals., China), gallic acid (BDH Laboratory supplies., Poole England), Folin-Ciocalteu's phenol reagent (JHD Chemicals., China), sodium carbonate (Na_2CO_3) (BDH Chemicals Ltd., Poole England), sodium chloride (NaCl) (Qualikems chemicals., India), 1,1-Diphenyl-2-picrylhydrazyl (DPPH), quercetin (BDH Chemicals Ltd., Poole England), potassium

ferricyanide (BDH Chemicals Ltd., Poole England), iron III chloride ($FeCl_3$) (BDH Chemicals Ltd., Poole England), distilled water, aqueous sodium hydroxide (BDH Chemicals Ltd., Poole England).

The equipment used include; OHAUS analytical balance (OHAUS, New Jersey, USA); Electric oven Electro-Heating Standing temperature Air Dry Oven (Jinotech Instruments, Korea); Water bath (Fisher Scientific Company, USA); UV spectrophotometer (GS-UV 61PC Double beam spectrophotometer, General Scientific, India).

2.2 METHOD

Collection of Plant Material

T. daniellii leaves were sourced from the Kunlende Market, Ilorin, Kwara State, Nigeria and identified properly by a botanist, Dr. Bolu, a taxonomist in the Department of Plant Biology, University of Ilorin, Nigeria, and a Voucher Number *UILH/006/1237* deposited.

Preparation and Extraction

To obtain the dried leaf of *T. daniellii*, the fresh plant leaves were washed with distilled water and dried at 40 °C using in an oven for 72 h for 2 weeks. The dried leaves were then pounded using a mortar and pestle for size reduction. For the boiled leaf stock of *T. daniellii* preparation, the plant material was thoroughly washed and then rinsed with distilled water.

Finely ground dried leaves stock (167.8g) were placed in an extraction bottle and to it, 2000 mL of distilled water was added and the bottle was capped. This was then left to stand for 24 hours after which the extract was strained using a stainer. The strained extract was then placed in a crucible and placed on top of a water bath at 40^{o}C to be concentrated. Once fully dried, the dried aqueous extract (DAE) was scraped off and weighed.

To extract fresh leaves, 215 g of fresh leaves were placed in a clean boiling pot and to it, 1500 mL of distilled water was added and heated to 100°C for 90 min to simulate the culinary act. This was then left to cool and then, the extract was strained. The extracts were then placed on a crucible and dried over a waterbath at 40^{o}C after which the fresh boiled extract (FBE) was scrapped and weighed.

The percentage yield for each extract was calculated using the formula:

$$\text{Percentage yield} = \frac{\text{Weight of extract}}{\text{Weight of powdered plant material}} \times 100$$

QUANTITATIVE PHYTOCHEMISTRY

All test were carried out at concentration of 0.01 mg of extract and were all done in triplicates.

Total Phenolic Content (TPC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

Precisely 1 mL of Folin reagents and 0.8 mL of sodium carbonate (75% w/v) was added to 1 mL (56 µL of sample + 944 µL of distilled water) of the BFE and DAE of *T. danielli* and left on standing for 60 minutes at room temperature. After which the absorbance was taken at 765 nm using a UV Vis spectrophotometer and the data was recorded (Njinga *et al*., 2024; Abdulaziz *et al.,* 2024). All tests were carried out at concentration of 0.01 mg of extract.

Total Flavonoid Content (TFC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

To the 500 µL (50 µL of extract + 450 µL of distilled water) of the BFE DAE BFE and DAE of *T. danielli*, 2 mL of aluminium chloride (10 %w/v) was added, shaken and kept at room temperature for 30 minutes. All tests were carried out at concentration of 0.01 mg of extract The absorbance of the reaction mixture after 30 minutes was taken at 420 nm (Njinga et al., 2024; Abdulaziz *et al.,* 2024).

Total Tannin Content of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

To the 200 µl (44 µl + 15 µl of distilled water) of the boiled and dried test samples, Catechin and 1.5ml of reagents (5g Vanillin and 8% concentrated HCL; 1:1 in methanol) mixture was added and incubated at room temperature for 20 minutes and absorbance was taken at 500 nm using UV-Vis spectrophotometer (Njinga et al., 2024).

Total Alkaloid content (TAC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

To 100 µL (42 µL of sample + 58 µL of distilled water) of the boiled and dried extract, 1 mL of BCG reagent was added and then, to it, 1 ml of Na_3PO_4 Buffer. The resulting solution was extracted with 2 ml of chloroform ($CHCl_3$) and the absorbance was taken at 570 nm using a UV-Vis Spectrophotometer. All tests were performed in triplicates for both the boiled and dried extract (Jatav and Tenguria, 2022).

Total Saponin content (TSC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

To 500 µL (120 µL of sample + 380 µL of distilled water) of the boiled and dried extract, 0.5 µL of 80% vanillin in ethanol and 5 µL of 72% distilled H_2SO_4 were added. The resulting solution was heated in a water bath at 60°C for 10 minutes and cooled in ice H_2O. The absorbance was taken at 535 nm using a UV-Vis Spectrophotometer. The saponin concentration was reported as Quillaja saponin equivalents per gram of sample dry matter (µg

QSE/g DM), with Quillaja saponin (Sigma-Aldrich) acting as a reference. All tests were performed in triplicates for both the boiled and dried extract (Ozay and Mammadov, 2019).

Antioxidant Assays

All antioxidant assay were carried out at concentration of 0.01 mg of extract and were all done in triplicates

DPPH Radical Scavenging Activity (DPPH) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

Exactly 1.25 mL of the boiled and dried extracts (concentration of 0.25 mg/mL) were added separately in different bottles containing 1.25 mL of methanolic solution of DPPH (100 µM). The mixture was kept in the dark at room temperature for 30 minutes (Njinga *et al*.,2020, Liu *et al*., 2020).

The absorbance (A) was measured at 515 nm and converted into percentage anti-oxidant activity using the following equation:

$$\%\ \text{DPPH Scavenging activity} = \frac{\text{Absorbance (DDPH)} - \text{Absorbance (Extract)}}{\text{Absorbance (DDPH)}} \times 100$$

Phosphomolybdate Assay (PMA) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

300 µL of the boiled and dried extracts were added separately in different bottles, to 3 mL of Phosphomolybdate complex. The mixture was kept in a water bath at 95 °C for 90 min. The absorbance (A) was measured at 765 nm (Yumita *et al.,* 2023).

ABTS Radical Scavenging Activity (ABTS) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

Exactly 125 µL of the boiled and dried extracts (53 µL of sample + 72 µL of distilled water) was added separately in different bottles, to 2.5 mL of ABTS reagent. The mixture was kept in the dark at room temperature for 30 minutes and the absorbance (A) was measured at 730 nm (Baliyan *et al.,* 2022).

Ferric Reducing Antioxidant Property (FRAP) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

One hundred microliter of the boiled and dried extracts (72 µL of sample + 28 µL of distilled water) were added separately in different bottles, to 3.5 mL of working Solution (FRAP Reagent). The mixture was kept in a water bath at 37°C for 30min and the absorbance (A) was measured at 593 nm. (Patel *et al.,* 2020).

Metal Chelating Activity (MC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

Five hundred microliter of the boiled and dried extracts (48 µL of sample + 452 µL of distilled water) was added separately in different bottles and to it, 1250 µL of Ferrozine and then, 625 µL of ferrous chloride ($FeCl_2$) were added. The mixture was shaken at kept at room temperature for 10 minutes. The absorbance (A) was measured at 562 nm (Attar and Ghane, 2019).

***In vitro* Anti-diabetic activity**

Enzyme Inhibition Assay of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

A 100 µL sample of plant extract was mixed with 111 µL of alpha-amylase (18 units) and adjusted to 1 mL with 0.02 M sodium phosphate buffer (pH 6.9). The mixture was incubated at 25°C for 10 minutes, followed by the addition of 500 µL of 1% starch substrate. After a 30-minute incubation at 25°C, 500 µL of DNS reagent was added, and the samples were boiled for 5 minutes. The cooled samples were diluted with 8 mL of distilled water, and absorbance was measured at 540 nm. The percentage inhibition was calculated using the formula:

$$\%\ \text{inhibition} = \frac{\text{A(control)} - \text{A (test)}}{\text{A (control)}} \times 100$$

where $A_{control}$ = absorbance of the blank control (containing all reagents except the test solution) and A_{test} = absorbance of the test sample (Okokon *et al.*, 2023).

All tests were carried out at concentration of 0.01 mg of extract and were all done in triplicates

Statistical Analysis

The data obtained from the various analyses, including quantitative phytochemical analysis, antioxidant activities, and in-vitro anti-diabetic (alpha-amylase inhibition) activity, were subjected to statistical analysis using the **Independent Samples T-Test**. p-value less than 0.05 ($p < 0.05$) was considered indicative of a statistically significant difference between the two groups.

3. RESULTS AND DISCUSSION

Percentage Yield

The dried aqueous extract showed a higher percentage yield (11.69%) than the fresh boiled extract (2.67%) as shown in Table 1.

Table 1. Percentage yield of Fresh boiled and Dried aqueous extracts of *T. daniellii*

Extract	Weight of plant material (g)	Weight of extract (g)	Percentage Yield (%)
DAE	316.1	8.96	11.69
FBE	215.9	5.76	2.67

DAE = Dried Aqueous Extract, FBE = Fresh Boiled Extract

QUANTITATIVE PHYTOCHEMISTRY

Total Phenolic Content (TPC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The total phenolic content (TPC) was significantly higher in the fresh-boiled extract compared to the aqueous dried extract. Specifically, the fresh boiled extract exhibited a TPC of 0.048 ± 0.003 mg GAE/g, while the dried boiled extract showed a lower TPC of 0.020 ± 0.004 mg GAE/g. This result suggests that boiling may enhance the extraction of phenolics from *T. daniellii* leaves, as illustrated in Figure 1.

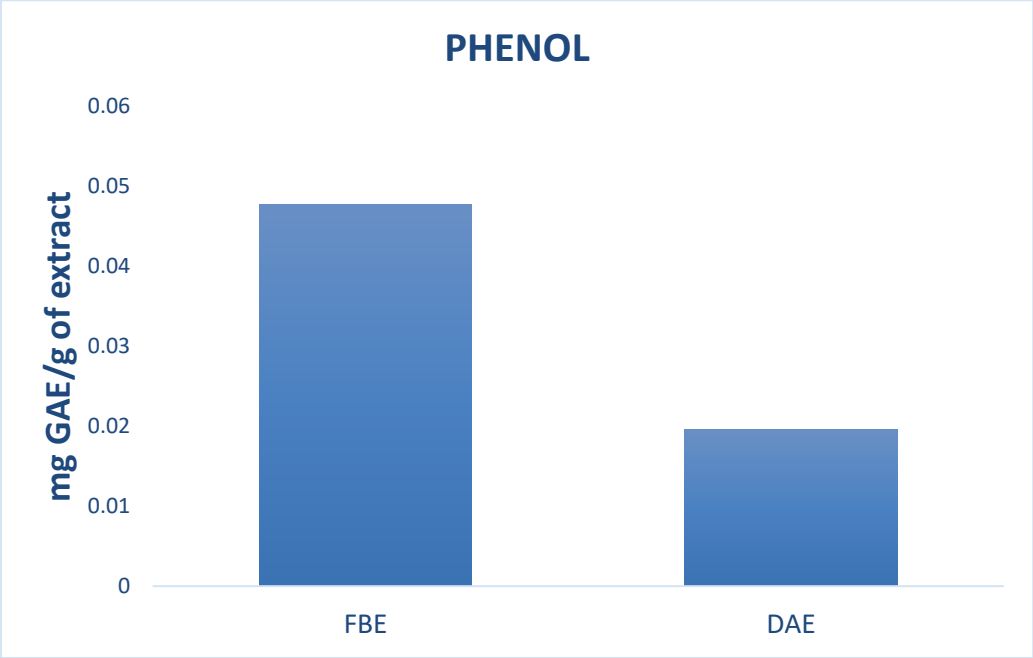

Figure 1. Total phenolic Content of Fresh-Boiled and Aqueous Dried Extract

Total Flavonoid Content (TFC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The flavonoid content was found to be slightly lower in the fresh-boiled extract compared to the aqueous dried extract. The fresh boiled extract contained 0.368 ± 0.023 mg QE/g of extract, whereas the dried boiled extract had a higher flavonoid content of 0.472 ± 0.005 mg QE/g of extract. This indicates that the drying process may preserve or concentrate flavonoids, as shown in Figure 2.

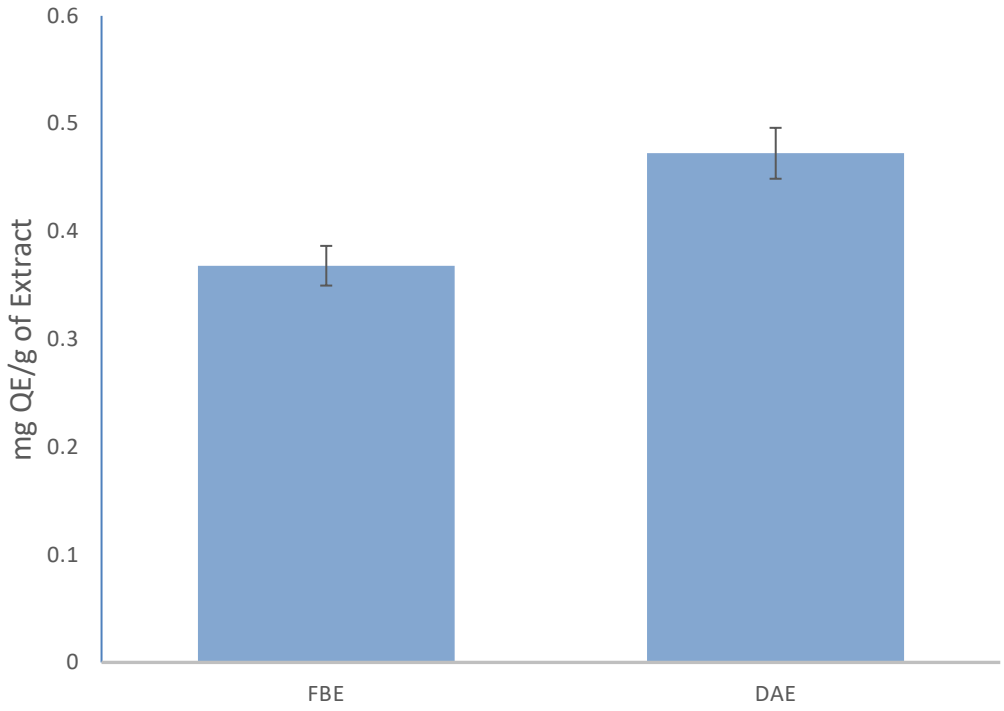

Figure 2. Total Flavonoid Content of Fresh-Boiled and Aqueous Dried Extract

Total Tannin Content of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The tannin content was higher in the fresh-boiled extract than in the aqueous dried extract, with values of 278.13 ± 27.36 mg TAE/g and 247.47 ± 5.33 mg TAE/g of extract, respectively. This suggests that boiling may release more tannins into the extract compared to drying, as depicted in Figure 3.

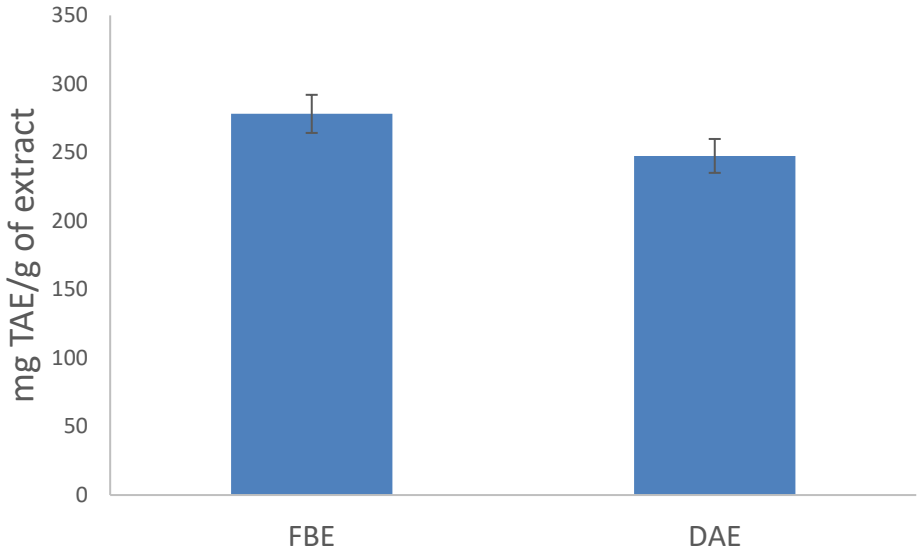

Figure 3. Total Tannin Content of Fresh-Boiled and Aqueous Dried Extract

Total Alkaloid content (TAC) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

Alkaloid content was also slightly higher in the aqueous dried extract than in the fresh-boiled extract. The dried boiled extract recorded an alkaloid content of 665.78 ± 35.29 mg AE/g, while the fresh-boiled extract had a value of 642.44 ±15.56 mg AE/g. This finding indicates that drying might slightly concentrate the alkaloid content, as illustrated in Figure 4.

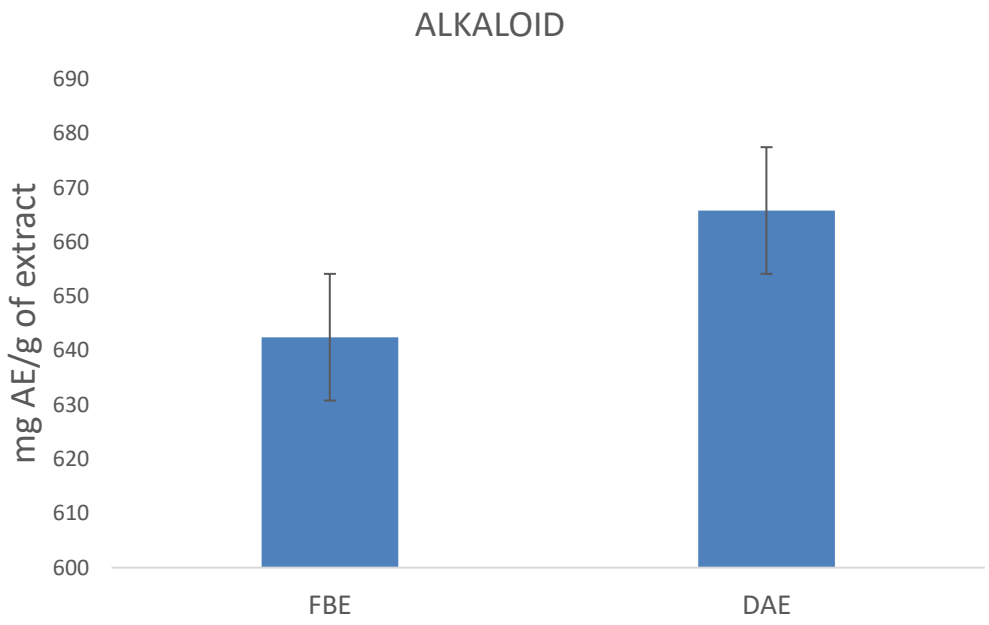

Figure 4: Total Alkaloid Content of Fresh-Boiled and Aqueous Dried Extract

Total saponin content (TSC) of the fresh boiled and aqueous dried extract of *T. daniellii*

The saponin content was nearly identical between the fresh-boiled and aqueous dried extracts, with values of 224.39 mg DE/g and 224.84 mg DE/g, respectively. This suggests that both boiling and drying processes have a minimal impact on the saponin content of the leaves, as shown in Figure 5.

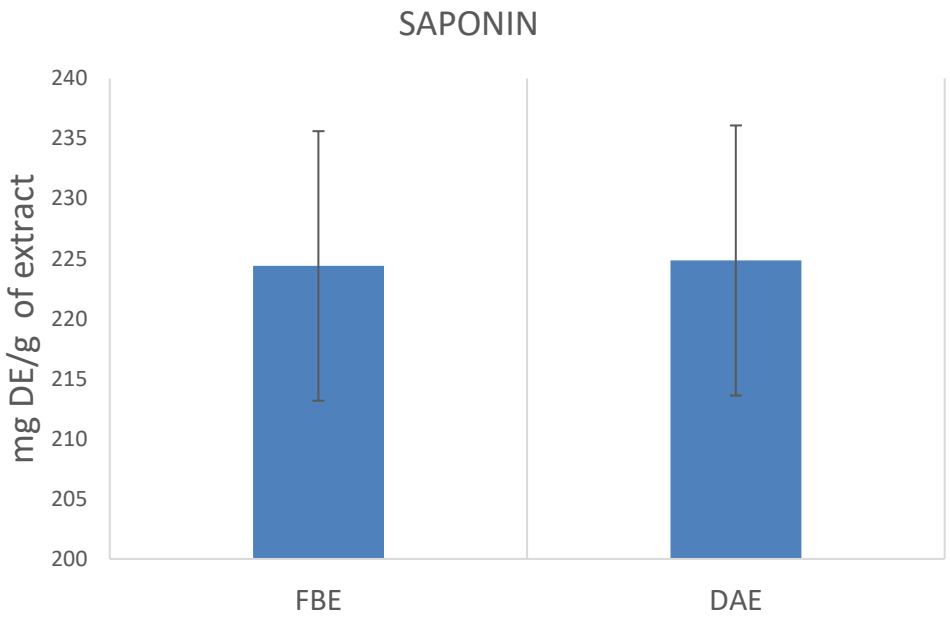

Figure 5: Total Saponin Content of Fresh-Boiled and Aqueous-dried extract

ANTI-OXIDANT ASSAY

DPPH Radical Scavenging Activity (DPPH) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The DPPH radical scavenging activity was significantly higher in the fresh-boiled extract compared to the aqueous dried extract. The FBE exhibited a DPPH scavenging activity of 36.72 ± 1.85% whereas the dried boiled extract showed a lower activity of 23.05 ± 4.14%. This suggests that boiling enhances the antioxidant potential of *T. daniellii* leaves, as demonstrated in the figure below.

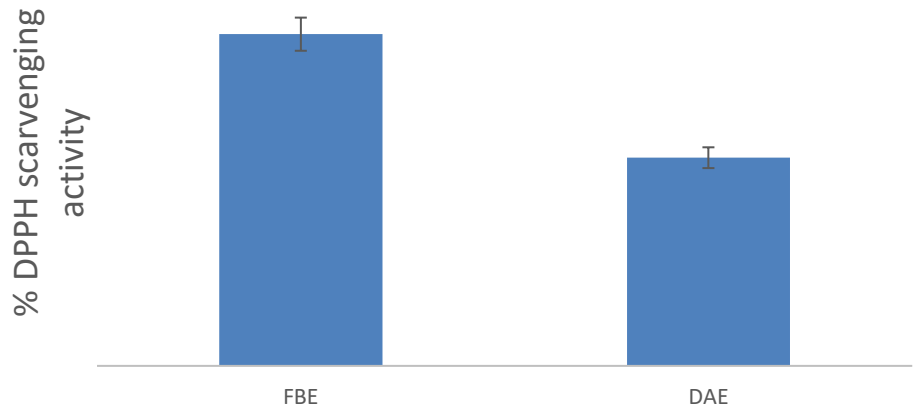

Figure 6. Percentage DPPH Activity of Fresh-Boiled and Aqueous Dried Extract

Phosphomolybdate Assay (PMA) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The PMA assay revealed that the DAE had a higher antioxidant activity compared to the fresh boiled extract. The dried boiled extract recorded a PMA activity of 0.0688 ± 0.0002 Ascorbic acid equivalent/g (AAE/g) of Extract, while the fresh boiled extract showed a negative value of -0.0191 ± 0.007 AAE/g Extract, indicating reduced activity in the fresh boiled extract. This result suggests that drying might preserve certain antioxidants that are sensitive to boiling, as illustrated in Figure 7.

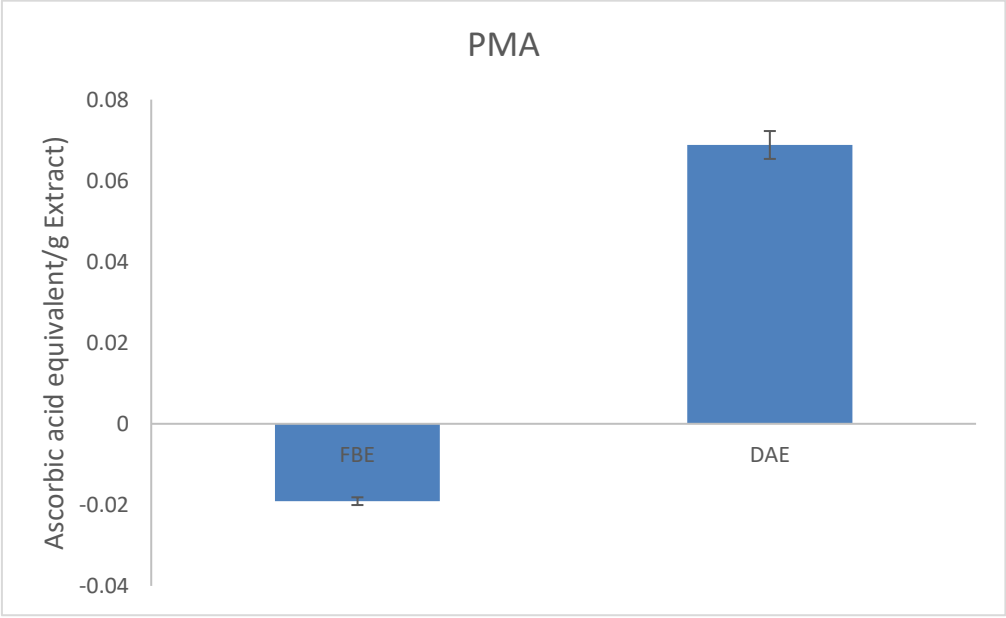

Figure 7: PMA Activity of Fresh-Boiled and Aqueous Dried Extract

ABTS Radical Scavenging Activity (ABTS) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The ABTS radical scavenging activity was lower in both extracts, with the fresh boiled extract showing a higher activity of -24.67 ± 5.40 % compared to -37.76 ± 2.38 % in the dried boiled extract. These negative values suggest that both extracts exhibited low ABTS radical scavenging activity, with the dried boiled extract being less effective, as depicted in Figure 8.

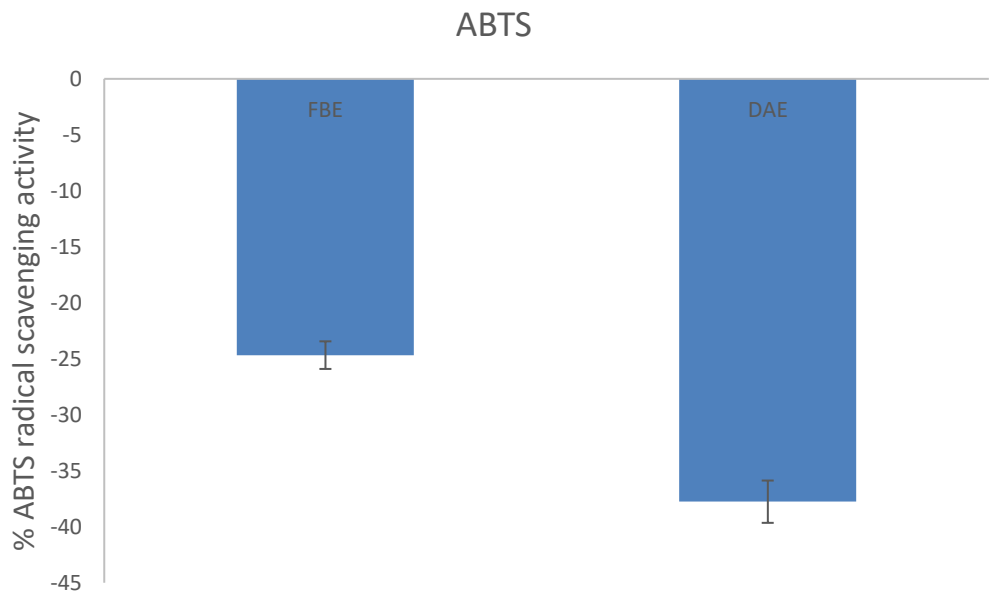

Figure 8. Percentage ABTS Activity of Fresh-Boiled and Aqueous Dried Extract

Ferric Reducing Antioxidant Property (FRAP) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The FRAP assay demonstrated that the fresh boiled extract had a higher reducing power than the dried boiled extract, with values of 0.190 ± 0.007 mg Fe^{2+}/g extract and 0.133 ± 0.006 mg Fe^{2+}/g extract, respectively. This indicates that the fresh boiled extract possesses a greater ability to reduce ferric ions, highlighting the potential of boiling to enhance antioxidant capacity, as shown in Figure 9.

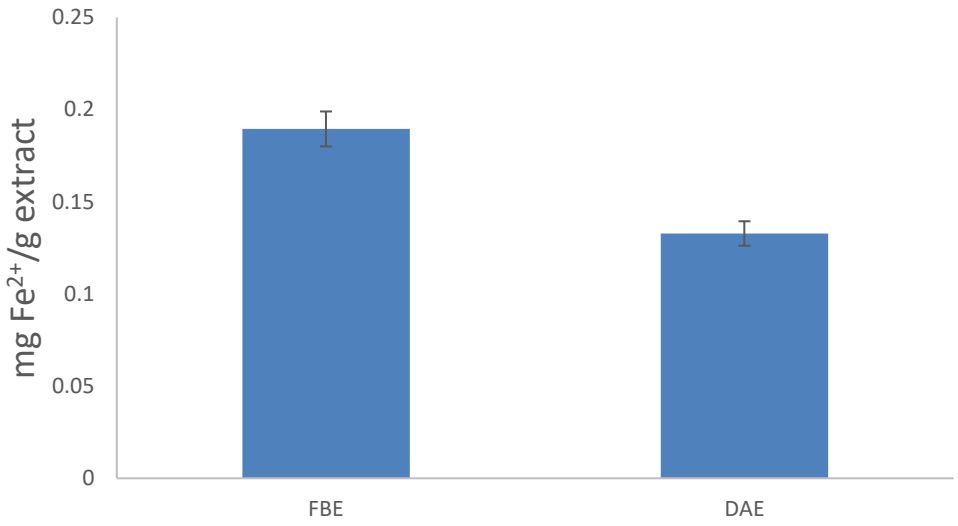

Figure 9: FRAP Activity of Fresh-Boiled and Aqueous Dried Extract

Metal Chelating Activity (MCA) of the Fresh Boiled and Aqueous Dried Extract of *T. daniellii*

The metal chelating activity was slightly higher in the fresh boiled extract than in the dried boiled extract. The fresh boiled extract exhibited a chelating activity of 28.41 ± 0.004 %, while the dried boiled extract showed a slightly lower activity of 27.70 ± 0.721 %. This indicates that boiling may marginally enhance the metal chelating properties of the extract, as shown in Figure 10.

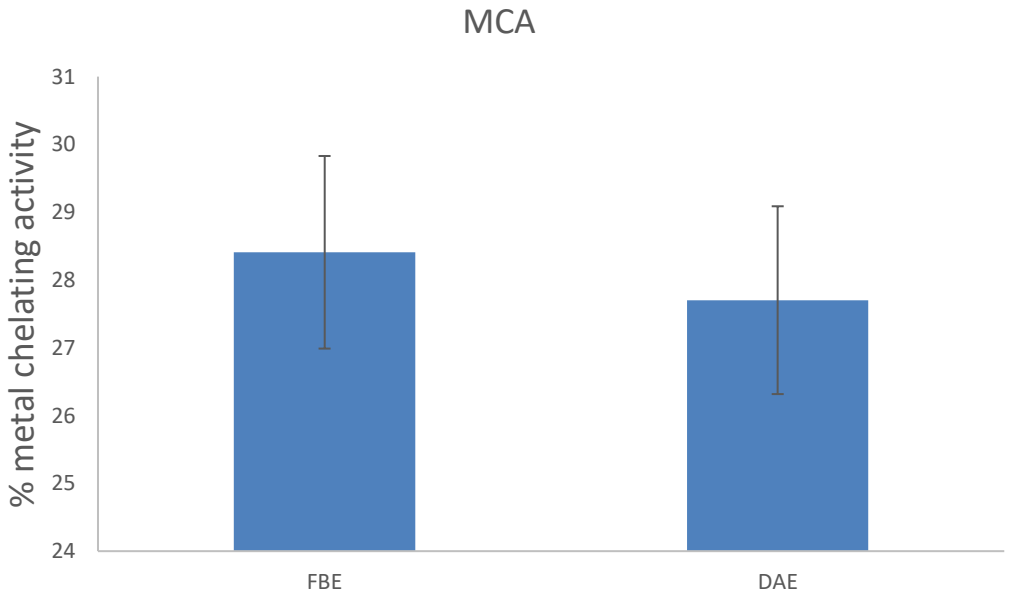

Figure 10: MCA Activity of Fresh-Boiled and Aqueous Dried Extract

IN-VITRO ANTIDIABETIC ASSAY

The in-vitro anti-diabetic activity, measured through the α-amylase inhibitory assay, revealed distinct differences between the boiled extract and the aqueous extract of *T. daniellii*. The aqueous extract demonstrated a significantly higher α-amylase inhibition, with a percentage inhibition of 55.56 ± 2.26%. In contrast, the boiled extract showed a much lower inhibition of 12.82 ± 2.56%. These results suggest that the aqueous extract is more effective at inhibiting the α-amylase enzyme, which plays a key role in carbohydrate digestion, as shown in Figure 11.

This disparity in inhibition percentages indicates that the process of boiling may reduce the anti-diabetic efficacy of the extract. The corresponding figure visually represents these differences, highlighting the superior performance of the aqueous extract in modulating glucose metabolism through α-amylase inhibition.

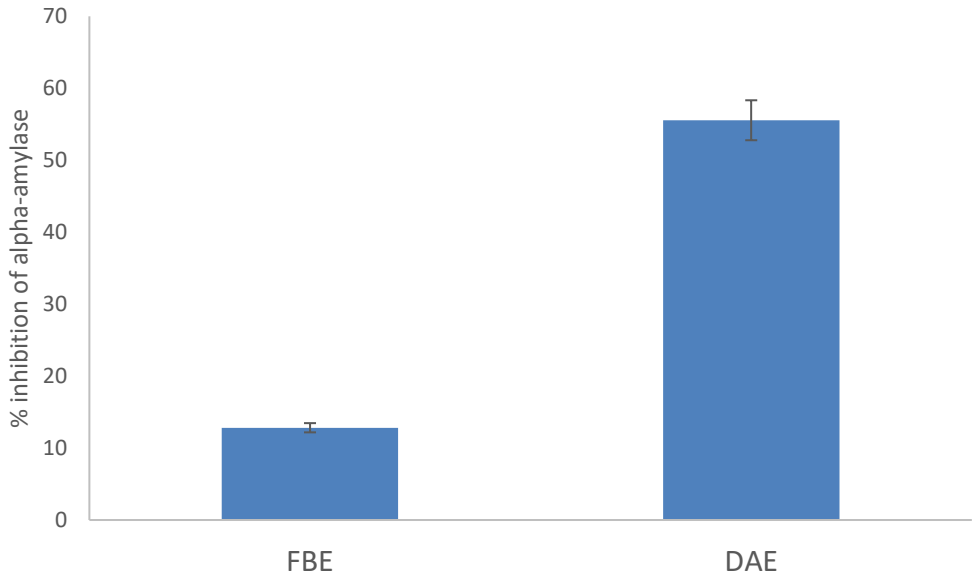

Figure 11:. Percentage Alpha-Amylase Inhibition of Fresh-Boiled and Aqueous Dried Extract

3.1 DISCUSSION

Boiling *T. daniellii* leaves has varied effects on their phytochemical composition and biological activities, with both positive and negative outcomes. Heat treatment tends to degrade heat-sensitive compounds like flavonoids and alkaloids, leading to lower levels in the boiled extracts (Zhang *et al.*, 2021; Adeoye *et al.*, 2022). This suggests that boiling reduces the stability and

availability of these compounds, which are crucial for the plant's therapeutic properties. However, tannins and phenols appear more resilient, with increased levels in the boiled extracts. This indicates that boiling may enhance the release or stability of these bioactive compounds, potentially improving their health benefits (Olowe *et al.,* 2023; Chaves *et al.,* 2020).

In terms of antioxidant activity, boiling generally enhances the leaf's ability to neutralize free radicals, as observed in assays like DPPH, FRAP, and MCA, where the boiled extracts show higher activity compared to the dried extracts (Eze *et al.,* 2021; Li *et al.,* 2019). These activities are vital for reducing oxidative stress, which is linked to chronic diseases like cancer and cardiovascular disorders (Figueroa *et al.,* 2020). The increased antioxidant potency from boiling suggests that heat may activate or release compounds that are more effective in combating oxidative damage (Martins *et al.,* 2022). However, not all antioxidant pathways benefit from boiling. For instance, in the PMA assay, which measures peroxide-induced oxidation, the dried extract shows higher activity compared to the boiled extract. This reduction in peroxide-induced oxidation after boiling suggests that boiling may diminish certain antioxidant functions that are crucial for protecting against oxidative stress (Nguyen *et al.,* 2021).

Regarding the anti-diabetic potential of *T. daniellii*, FBE significantly reduces the extract's ability to inhibit alpha-amylase, an enzyme involved in carbohydrate digestion and blood sugar regulation. The decrease in this activity indicates that the bioactive compounds responsible for this effect are particularly sensitive to heat, and their degradation during boiling diminishes the plant's potential as an anti-diabetic agent (Musa *et al.,* 2023; Patel *et al.,* 2020).
Therefore, while boiling may enhance certain properties of the leaf, such as specific antioxidant activities like DPPH, FRAP, and MCA, it also compromises others, particularly its anti-diabetic activity and peroxide-induced antioxidant functions (Ahmed *et al.,* 2023; Lee *et al.,* 2019).

4. CONCLUSION

This study provides valuable insights into the phytochemical, antioxidant, and anti-diabetic properties of *T. daniellii*, underscoring its potential health benefits when used in cooking. The comparative analysis of fresh-boiled extract (FBE) and dried aqueous extract (DAE) reveals

distinct differences in their chemical composition and bioactivity, highlighting the impact of processing methods on the plant's functional properties.

The FBE demonstrated higher concentrations of tannins and phenols, which may contribute to its stronger antioxidant potential as evidenced by the FRAP assay and DPPH radical scavenging activity. However, its antioxidant activity in other assays, such as PMA and ABTS, was either lower or negative compared to the DAE. This suggests that while boiling enhances certain antioxidant properties, it may also degrade or modify specific bioactive compounds, resulting in a mixed antioxidant profile.

On the other hand, the DAE exhibited superior anti-diabetic activity, with significantly higher alpha-amylase inhibition compared to the FBE. This finding highlights the potential of the dried extract as a natural agent for managing glucose metabolism and supporting blood sugar regulation. The reduced anti-diabetic efficacy of the FBE suggests that boiling diminishes the bioavailability or activity of key phytochemicals responsible for alpha-amylase inhibition.
Overall, the study demonstrates that *T. daniellii* retains significant health-promoting properties, regardless of preparation method, making it a valuable addition to culinary and therapeutic applications.

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Contribution declaration*:*

Njinga N.S., Ndifor, A.R., Shittu A.O., Bamidele O.D., Kola-Mustapha A.T. and Bakare-Odunola M.T. designed the study.

Muhammadbashir L., Kayode S.O., Ohunene S.R., Mbakop C, Njinga N.S. determined phytochemistry, antioxidant and anti-diabetic activities.

Abdulazeez I, Giwa H.B., Bakare-Odunola M.T., Njinga N.S., A.T. Kola-Mustapha did the statistical analysis

Abdulazeez I, Giwa H.B., Abdulrazaq S., Mbakop C., Ndifor A.R., Kola-Mustapha A. T. and Shittu A.O. drafted the initial manuscript. All authors approved the final article.

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