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A COMPARATIVE STUDY OF ANTIOXIDANT COMPOSITION OF *Balanites aegyptiaca* AND *Adansonia digitata* FRUITS.

[1]Y. Yahaya., [1]A U. Birnin Yauri., [2]A Y. Kalgo and [2]A Y. Bako

[1]Department of Pure and Industrial Chemistry, Abdullahi Fodio University of Science and Technology Aliero, Kebbi State, Nigeria.

[2]Department of Chemistry, College of Sciences, Federal University of Agriculture, Zuru, Kebbi State, Nigeria.

[2]Corresponding Author: (adamuyakubukalgo@gmail.com 07062440761)

ABSTRACT

The comparative study of the antioxidant composition of *Balanites aegyptiaca* and *Adansonia digitata* fruits from Kalgo, Kebbi State, Nigeria was conducted by determining the proximate composition, qualitative and quantitative phytochemicals, antioxidant mineral elements, antioxidant vitamins, and antioxidant activity. Standard methods of AOAC (2005) were used for proximate and phytochemical analyses. Atomic Absorption Spectroscopy (AAS) was used for mineral elements, spectrophotometric methods for vitamins A and E, and titrimetric method for vitamin C. The antioxidant activity was determined using the DPPH assay. Phytochemical screening indicated the presence of flavonoids, saponins, phenols, alkaloids, tannins, steroids, and terpenoids. Quantitative analysis showed significant differences ($p<0.05$) in flavonoids (27.14±1.20 vs. 19.75±1.20 mg QE/g) and phenolic compounds (39.74±1.50 vs. 28.96±1.20 mg GAE/g),but not in saponins. Antioxidant elements (ppm) for *Balanites aegyptiaca* and *Adansonia digitata* were: Cu (0.020±0.003 vs. 0.010±0.003), Fe (0.050±0.006 vs. 0.030±0.002), Zn (0.060±0.010 vs. 0.050±0.010), Se (0.040±0.002 vs. 0.020±0.003), and Mn (0.030±0.006 vs. 0.010±0.006), with significant differences in all except Zn. Vitamin analysis (mg/L) showed significant differences in Vitamin C (2.05±0.10 vs. 1.89±0.07) and Vitamin E (0.62±0.02 vs. 0.57±0.02), but not in Vitamin A. The DPPH assay revealed that *Balanites aegyptiaca* had superior, concentration-dependent antioxidant activity (30.95% to 38.19%) compared to *Adansonia digitata* (23.57% to 34.53%), attributed to its higher levels of antioxidant micronutrients and vitamins. This study concluded that, *Balanites aegyptiaca* fruit possesses a significantly richer antioxidant profile when compared with *Adansonia digitata*, making it a potent natural source for dietary and therapeutic applications.

Keywords: Antioxidants, Phytochemicals, Elements, Vitamins, DPPH

1.0 INTRODUCTION

Antioxidants are substances that delay or prevent the oxidation of cellular oxidizable substrates [1]. They are molecules that prevent cellular damage caused by the oxidation of other molecules by neutralizing free radicals highly reactive species containing unpaired electrons [2]. Oxidation reactions produce free radicals, which can start chain reactions that damage cells. Antioxidants terminate these chain reactions by removing free radical intermediates and inhibit other oxidation reactions [3]. They exert their effects by scavenging reactive oxygen species (ROS) [4].

Oxidative stress, resulting from an imbalance between ROS and the body's antioxidant defenses, is implicated in the onset of chronic diseases such as cardiovascular disorders, diabetes, cancer, and neurodegenerative conditions [5]. This has fueled global interest in identifying safe, affordable, and effective natural antioxidant sources, especially from plant-based foods. In many African communities, indigenous fruits like *Balanites aegyptiaca* (Desert Date, 'Aduwa' in Hausa) and *Adansonia digitata* (Baobab, 'Kuka' in

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BOOK OF PROCEEDINGS

Hausa) are traditionally valued for their nutritional and medicinal benefits [6, 7].

Balanites aegyptiaca, belonging to the Zygophyllaceae family, is a multi-branched, spiny tree found in arid regions. Its fruit pulp is used in traditional medicine and is endowed with antioxidant power [8]. *Adansonia digitata*, from the Malvaceae family, is a massive tree with fruit pulp that is consumed as food and used medicinally [9]. Despite their abundance and cultural acceptance, systematic comparative studies on their antioxidant composition remain scarce.

This research aims to bridge that gap by providing a comparative analysis of the antioxidant composition of *Balanites aegyptiaca* and *Adansonia digitata* fruit pulps, validating their traditional uses and highlighting their potential for integration into health-promoting strategies.

2.0 MATERIALS AND METHODS

2.1. Sample Collection and Preparation:

Fruit samples of *Balanites aegyptiaca* and *Adansonia digitata* were collected from Kalgo town, Kebbi State, Nigeria. Mature, healthy, ripened fruits were harvested from five mature trees of each species. The fruits were washed, air-dried, and the edible pulp was manually separated from seeds and fibrous components and then powdered for analysis.

2.2. Proximate Analysis:

Proximate composition (moisture, ash, crude lipid, crude fiber, crude protein, and carbohydrate) was determined using standard methods of the Association of Official Analytical Chemists (AOAC, 2005) [10].

2.3. Phytochemical Analysis

2.3.1. Qualitative Screening:

The powdered samples were screened for flavonoids, saponins, phenols, alkaloids, tannins, steroids, and terpenoids using standard chemical tests [11].

2.3.2. Quantitative Analysis:

Total flavonoid content (TFC) was determined using the aluminum chloride method with quercetin as a standard [12]. Total saponin content was determined using the vanillin-sulfuric acid method with diosgenin as a standard [13]. Total phenolic content (TPC) was determined using the Folin-Ciocalteu method with gallic acid as a standard [14].

2.4. Antioxidant Elements Analysis:

The analysis of copper (Cu), iron (Fe), zinc (Zn), selenium (Se), and manganese (Mn) was conducted using Atomic Absorption Spectroscopy (AAS) after dry ashing and acid digestion of the samples [10].

2.5. Antioxidant Vitamins Analysis:

Vitamin A and E were determined using spectrophotometric methods, while Vitamin C was determined using a titrimetric method with 2,6-dichlorophenolindophenol [15, 16].

2.6. DPPH Radical Scavenging Assay:

The antioxidant activity of the fruit pulp extracts was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay [17]. Different concentrations (20-100 mg/ml) of the extracts were tested, and ascorbic acid was used as a standard. The percentage scavenging activity was calculated.

2.7. Statistical Analysis:

A two-sample independent t-test was used to compare the means of the antioxidant compositions between the two fruits. One-way analysis of variance (ANOVA) was used to analyze the DPPH assay results. A p-value of less than 0.05 was considered statistically significant.

3.0 RESULTS AND DISCUSSION

3.1. Proximate Composition:

The results of the proximate analysis are presented in Table 1. *Balanites aegyptiaca* fruit showed significantly higher ($p<0.05$) values for ash, crude lipid, crude fiber, and carbohydrate content compared to *Adansonia digitata*. The moisture and

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crude protein contents were not significantly different ($p>0.05$) between the two fruits. The low moisture content in both fruits is advantageous for storage and shelf life. The high ash content in *B. aegyptiaca* indicates a richer mineral composition. The elevated crude fiber content underscores its potential for promoting digestive health. The high carbohydrate content positions *B. aegyptiaca* as a superior energy source.

Table 1: Proximate composition (% dry weight) of *Balanites aegyptiaca* and *Adansonia digitata* fruits.

Parameter	*Balanites aegyptiaca*	*Adansonia digitata*	p-value	Significance
Moisture	1.20 ± 0.20	0.80 ± 0.20	0.114	NS
Ash	6.00 ± 0.02	2.50 ± 0.20	0.0001	Sig
Crude Lipid	3.50 ± 0.00	2.50 ± 0.20	0.000	Sig
Crude Fiber	30.50 ± 1.00	26.50 ± 1.41	0.018	Sig
Crude Protein	15.76 ± 1.20	17.07 ± 1.00	0.258	NS
Carbohydrate	50.54 ± 1.05	43.13 ± 1.09	0.001	Sig

Values are mean ± SD (n=3); Sig= Significant ($p<0.05$); NS = Not Significant.

3.2. Qualitative Phytochemical Screening: The qualitative screening (Table 2) revealed that both fruits contained flavonoids, saponins, phenolic compounds, alkaloids, tannins, steroids, and terpenoids. *Balanites aegyptiaca* showed a higher abundance ("+++") of flavonoids, saponins, and phenolic compounds compared to *Adansonia digitata*.

Table 2: Qualitative phytochemical screening of the fruit pulps.

Phytochemical	*Balanites aegyptiaca*	*Adansonia digitata*
Flavonoids	+++ (Abundant)	+ + + (Abundant)
Saponins	+++ (Abundant)	+ + (Moderate)
Phenolic compounds	+++ (Abundant)	+ + + (Abundant)
Alkaloids	+ + (Moderate)	+ + (Moderate)
Tannins	+ (Low)	+ + (Moderate)

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Phytochemical	*Balanites aegyptiaca*	*Adansonia digitata*
Steroids	+ + (Moderate)	+ + (Moderate)
Terpenoids	+ + (Moderate)	+ (Low)

3.3. Quantitative Phytochemical Analysis: The quantitative results (Table 3) showed that *Balanites aegyptiaca* had significantly higher ($p<0.05$) concentrations of flavonoids and phenolic compounds than *Adansonia digitata*. The difference in saponin content was not statistically significant ($p>0.05$). The higher levels of flavonoids and phenolics in *B. aegyptiaca* are directly linked to its stronger antioxidant activity, as these compounds are potent free radical scavengers [18].

Table 3: Quantitative phytochemical analysis of the fruit pulps.

Parameter	*Balanites aegyptiaca*	*Adansonia digitata*	p-value	Significance
Flavonoids (mg QE/g)	27.14 ± 1.20	19.75 ± 1.20	0.0420	Sig
Saponins (mg DE/g)	17.06 ± 0.50	12.36 ± 1.00	0.8463	NS
Phenolic compounds (mgGAE/g)	39.74 ± 1.50	28.96 ± 1.20	0.0305	Sig

Values are mean ± SD (n=3);Sig= Significant ($p<0.05$); NS = Not Significant.

3.4. Antioxidant Elements Composition: The results for antioxidant elements are shown in Table 4. *Balanites aegyptiaca* contained significantly higher ($p<0.05$) concentrations of Cu, Fe, Se, and Mn. The difference in Zn content was not significant. These elements act as cofactors for enzymatic antioxidants like superoxide dismutase (SOD) and glutathione peroxidase (GPx) [19]. The superior mineral profile of *B. aegyptiaca* enhances its potential to support the body's endogenous antioxidant defense systems.

Table 4: Antioxidant elements composition (ppm) of the fruit pulps.

Element	*Balanites aegyptiaca*	*Adansonia digitata*	p-value	Significance
Cu	0.020 ± 0.003	0.010 ± 0.003	0.0277	Sig
Fe	0.050 ± 0.006	0.030 ± 0.002	0.0001	Sig
Zn	0.060 ± 0.010	0.050 ± 0.010	0.2879	NS
Se	0.040 ± 0.002	0.020 ± 0.003	0.0028	Sig
Mn	0.030 ± 0.006	0.010 ± 0.006	0.0277	Sig

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Values are mean ± SD (n=3); Sig= Significant (p<0.05); NS = Not Significant.

3.5. Antioxidant Vitamins Composition:
As shown in Table 5, *Balanites aegyptiaca* had significantly higher (p<0.05) levels of Vitamin C and Vitamin E. The Vitamin A content was not significantly different between the two fruits. Vitamins C and E are potent non-enzymatic antioxidants; Vitamin C scavenges free radicals in aqueous environments, while Vitamin E protects lipid membranes from peroxidation [20, 21]. The higher concentration of these vitamins in *B. aegyptiaca* contributes substantially to its overall antioxidant efficacy.

Table 5: Antioxidant vitamins composition (mg/L) of the fruit pulps.

Vitamin	*Balanites aegyptiaca*	*Adansonia digitata*	p-value	Significance
A	1.78 ± 0.40	1.72 ± 0.30	0.8463	NS
C	2.05 ± 0.10	1.89 ± 0.07	0.0420	Sig
E	0.62 ± 0.02	0.57 ± 0.02	0.0305	Sig

Values are mean ± SD (n=3); Sig= Significant (p<0.05); NS = Not Significant.

3.6. DPPH Radical Scavenging Assay:
The results of the DPPH assay (Table 6) demonstrated a concentration-dependent increase in antioxidant activity for both fruit extracts and the ascorbic acid standard. At all concentrations tested (20-100 mg/ml), *Balanites aegyptiaca* exhibited significantly higher (p<0.05) free radical scavenging activity than *Adansonia digitata*. While ascorbic acid was the most potent, the activity of *B. aegyptiaca* was notable, reaching 38.19% at 100 mg/ml. This superior activity was attributed to its higher content of phenolic compounds, flavonoids, antioxidant vitamins, and specific mineral elements, which act synergistically to neutralize free radicals.

Table 6: DPPH radical scavenging activity (%) of the fruit pulps.

Concentration (mg/ml)	*Adansonia digitata*	*Balanites aegyptiaca*	Ascorbic Acid
20	23.57 ± 0.08	30.95 ± 0.06	36.33 ± 0.03
40	24.57 ± 0.04	32.69 ± 0.05	36.63 ± 0.13
60	27.15 ± 0.05	34.55 ± 0.06	45.11 ± 0.02
80	30.97 ± 0.04	36.46 ± 0.03	51.30 ± 0.09
100	34.53 ± 0.06	38.19 ± 0.03	57.48 ± 0.02

Values are mean ± SD (n=3).

4.0 CONCLUSION
This study provides a comprehensive comparative analysis of the antioxidant composition of *Balanites aegyptiaca* and *Adansonia digitata* fruits.

The results clearly demonstrate that *Balanites aegyptiaca* fruit possesses a significantly superior antioxidant profile. It contained higher levels of ash, fiber, carbohydrates, flavonoids, phenolic compounds, key antioxidant minerals (Cu, Fe, Se, Mn), and vitamins (C and E). Consequently, it exhibited stronger concentration-dependent free radical scavenging activity in the DPPH assay. While *Adansonia digitata* remains a valuable nutritional resource, particularly for its protein content, *Balanites aegyptiaca* emerges as a more potent source of natural antioxidants. These findings validate the traditional use of these fruits and highlight *Balanites aegyptiaca* as a promising candidate for developing functional foods and nutraceuticals to combat oxidative stress-related diseases.

5.0 RECOMMENDATIONS

Further research is recommended to:

1. Isolate and characterize the specific bioactive compounds responsible for the antioxidant activity using techniques like HPLC and GC-MS.
2. Evaluate the in vivo antioxidant potential and bioavailability of these compounds.
3. Investigate the synergistic effects of the phytochemicals present.
4. Explore the stability of these antioxidants under different processing and storage conditions to facilitate their commercial application.

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