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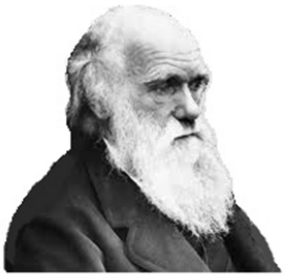

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The phytochemical and antioxidant profile of the ethanol leaf extract of *Jatropha curcas* L.

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ABSTRACT

The growing interest in natural antioxidants has motivated research into medicinal plants with possible therapeutic benefits. *Jatropha curcas* L., sometimes known as physic nut, is a versatile plant that has long been employed in ethnomedicine in Africa and Asia. This study aimed to assess the phytochemical contents and antioxidant activity of *J. curcas* L.'s ethanolic leaf extract. The leaves were harvested, authenticated, dried, and extracted with ethanol by cold maceration. Phytochemical screening found flavonoids (1.12 ± 0.004%), saponins (1.35 ± 0.002%), tannins (1.12 ± 0.004%), alkaloids (1.70 ± 0.003%), terpenoids (0.80 ± 0.001%), and phenols (0.68 ± 0.008%). Four assays were used to determine antioxidant properties: DPPH radical scavenging, Ferric Reducing Antioxidant Power (FRAP), Total Phenolic Content (TPC), and Total Antioxidant Capacity. The extract demonstrated a dose-dependent free radical scavenging action, inhibiting 56.57% DPPH at 250 µg/mL and yielding a FRAP value of 5.46 at 500 µg/mL. TPC and TAC assays demonstrated significant antioxidant potency, with peak absorbance values of 2.74 and 2.92 at 1000 µg/mL and 200 µg/mL, respectively. These findings support the traditional usage of *J. curcas* leaves to treat oxidative stress-related illnesses and highlight their potential for the development of natural antioxidant treatments. This study contributes to current knowledge by giving empirical evidence of the bioactive and antioxidant capabilities of *J. curcas* leaves, which supports their use in pharmaceutical and nutraceutical formulations.

Keywords: Bioactive compounds, Oxidative stress, Free radical scavenging, Ethnomedicine, Nutraceuticals

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1. INTRODUCTION

Jatropha curcas L. is a small tree and a perennial shrub that a well-adapted and drought-resistant. It grows well in poor and marginal soils [1]. It has relatives which belong to the Euphorbiaceae family, with the rest of the 175 taxa in Africa, the Caribbean, Asia, and tropical and subtropical regions [2]. It is known to have a traditional medical importance. As a physic nut, *Jatropha curcas* L. is known to be simple and is simple to cultivate, which makes it economically valuable. It has a long life span of about 50 years.

Over the years, *Jatropha curcas* L. has been known for several other reasons. It has served for the reasons of biofuel and other equally important medicinal purposes. As to the bioactive compounds, the plant is said to contain flavonoids, alkaloids, saponins, tannins, terpenoids, and phenolics in the leaves and stem bark, roots, seeds, and its latex. Certain bioactive factors have been proven to possess some medicinal benefits, like antidiarrheal, antibacterial, anti-inflammatory, wound healing, and anticancer [3].

Specifically, *Jatropha curcas* L. leaves are beneficial in treating parasite infections, fevers, wounds, and even jaundice. Scientific studies have shown that oxidative stress contributes to numerous chronic conditions, such as diabetes, cancer, and neurodegenerative diseases, and *Jatropha curcas* L. leaves also help counteract oxidative stress [4].

Figure 1. Structure of a native *Jatropha* tree [5].

Although *Jatropha curcas* L. has well-known therapeutic capabilities, no extensive phytochemical investigation or evaluation of its antioxidant properties has been done. This study addresses that need and contributes to the growing body of knowledge on herbal therapy by conducting a thorough phytochemical investigation, examining antioxidant capabilities, and evaluating the ethanolic leaf extract of *Jatropha curcas* L.

Many plants contain bioactive compounds that might possess antioxidant properties, which can help in averting diseases caused by oxidative stress. It might be difficult to locate and isolate such phytochemicals. The phytochemical profile and antioxidant activity of *Jatropha curcas* L. ethanolic leaf extract is evaluated in this work in order to identify prospective natural antioxidants for usage in food and pharmaceuticals.

Oxidative stress, which is caused by the imbalance between free radicals and the body's antioxidants, is associated with the development of chronic and degenerative diseases such as cancer, cardiovascular diseases, and aging concerns. Plant-based natural antioxidants, which are derived from natural sources, are gaining popularity due to being more effective and having fewer side effects when compared to synthetic ones. Ethnobotanically used leaves of *Jatropha curcas* L. have shown promising antioxidant and therapeutic activity.

Although several plants have been acknowledged for their ethno-botanical value, very little to no work has been done on the antioxidant properties of ethanolic extracts of Jatropha leaves. Despite its widespread distribution and low cultivation requirements, the plant has not been studied as a sustainable and rich source of bioactive components for pharmaceutical and nutraceutical products. Thus, the goal of this research is to close this gap by identifying and measuring the phytochemicals found in *Jatropha curcas* L. leaves, as well as evaluating their antioxidant activity. This study's findings could help in the development of plant-based antioxidants, herbal therapies, and novel pharmaceutical medications. This study aims to describe the phytochemical constituents and the antioxidant activity of the extracts obtained from the leaves of *Jatropha curcas* L. using ethanol as a solvent.

2. METHODOLOGY

2. 1. Plant material and extract preparation

The leaves of *Jatropha curcas* L. were harvested locally from a community in Ibadan, Oyo state, Nigeria, in May 2025. The plant parts were taxonomically identified, and it was oven-dried at 40 - 50 °C for 7 days and pulverized into powder form. Finally, it was stored in an air-tight container and kept away from moisture until needed for analysis. About 380g of the pulverized sample was soaked in 1500 mL of Ethanol for 72 hours. The mixture was then filtered through a Macerating cloth. The filtrate obtained was concentrated by evaporation on a Rotary Evaporator with consistent heating.

2. 2. Phytochemical Analysis

Qualitative and Quantitative phytochemical analysis of the ethanol leaf extract of *Jatropha curcas* L. (ELEJC) was done using standard procedures [5-8].

2. 3. Antioxidant Analysis

2. 3. 1. DPPH Radical-Scavenging Activity

The stable 1,1-diphenyl-2-picrylhydrazyl radical (DPPH) was used to determine the free radical-scavenging activity of the extracts [9, 10]. Different concentrations of each extract were added, at an equal volume, to an ethanolic solution of DPPH (100 µM). After 15 min at room temperature, the absorbance was recorded at 517 nm. The experiment was repeated three times. Vitamin C, BHA, and quercetin were used as standard controls. IC_{50} values denote the concentration of the sample, which is required to scavenge 50% of DPPH free radicals.

2. 3. 2. Ferric Ion Reducing Antioxidant Power Assay (FRAP)

The reducing power of ferric ions was measured using the Oyaizu method with slight modifications [11]. Different concentrations of ELEJC, ranging from 100 µL/ml to 500 µL/ml, were mixed with 2.5 ml of 20 mM phosphate buffer and 2.5 ml of 1%, w/v potassium ferricyanide, and then the mixture was incubated at 50 °C for 30 min. Afterwards, 2.5 ml of 10%, w/v trichloroacetic acid and 0.5 ml of 0.1%, w/v ferric chloride were added to the mixture, which was kept aside for 10 min. Finally, the absorbance was measured at 700 nm. Ascorbic acid was used as a positive reference standard. All assays were run in triplicate and averaged.

2. 3. 3. Total Phenol Content (TPC)

Total phenolic compound contents were determined by the Folin-Ciocalteau method as described by Nabavi *et al.* [12]. ELEJC (0.5 ml of different dilutions) were mixed with Folin-Ciocalteu reagent (5 ml, 1:10 diluted with distilled water) for 5 min, and aqueous Na_2CO_3 (4 ml, 1 M) was then added. The mixture was allowed to stand for 15 min, and the phenols were determined by the colorimetric method at 765 nm. The standard curve was prepared by 80, 120, 160, and 200 µg/ ml solutions of Gallic acid in methanol: water (50:50, v/v). Total phenol values are expressed in terms of Gallic acid equivalent, which is a common reference compound.

2. 3. 4. Total Antioxidant Capacity (TAC)

The total antioxidant capacity was estimated using the phosphomolybdenum assay [13]. Different concentrations of ELEJC, ranging from 200 µg/mL to 1000 µg/mL, were added to each test tube individually, containing 3 mL of distilled water and 1 mL of Molybdate reagent solution. These tubes were kept incubated at 95 °C for 90 min. After incubation, these tubes were normalized to room temperature for 20-30 min, and the absorbance of the reaction mixture was measured at 695 nm. Mean values from three independent samples were calculated for each extract. Ascorbic acid was used as a positive reference standard.

3. RESULTS

3. 1. Phytochemical analysis

Table 1. Summary of results of the qualitative phytochemical screening of ELEJC.

Phytochemical constituents	Qualitative	Quantitative (% w/w)
Terpenoids	+	0.80±0.001

Flavonoids	++	1.12±0.004
Saponins	+++	1.35±0.002
Tannins	+++	1.12±0.004
Alkaloids	++	1.70±0.003

Key: Ethanol Leaf Extract of *Jatropha curcas* L.
ELEJC: " + " - Trace amount, " ++ " - Moderate amount, " +++ " - Appreciable amount.

3. 2. Antioxidant Assays

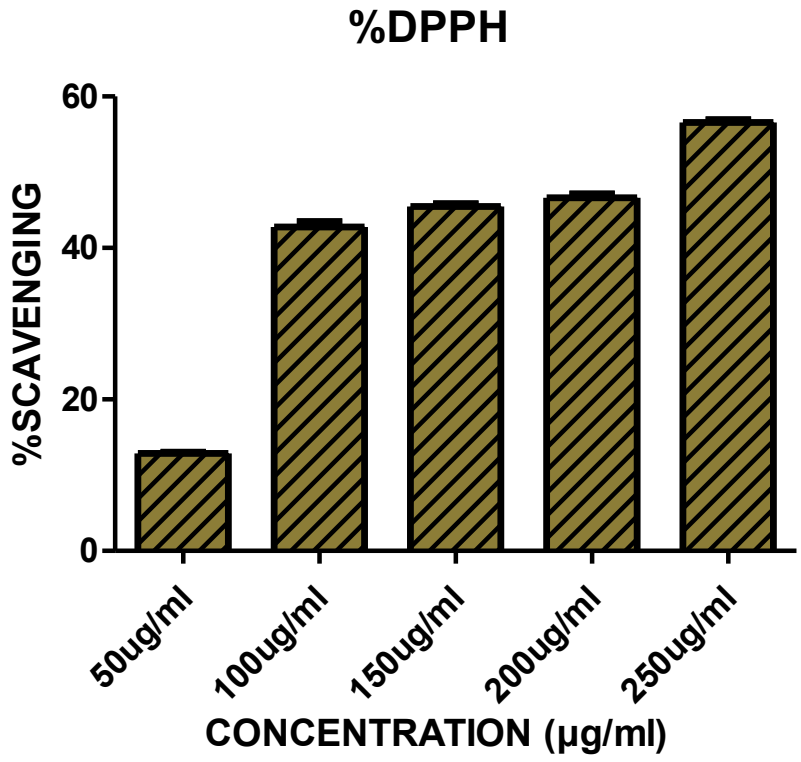

Figure 2. DPPH scavenging of the ELEJC.

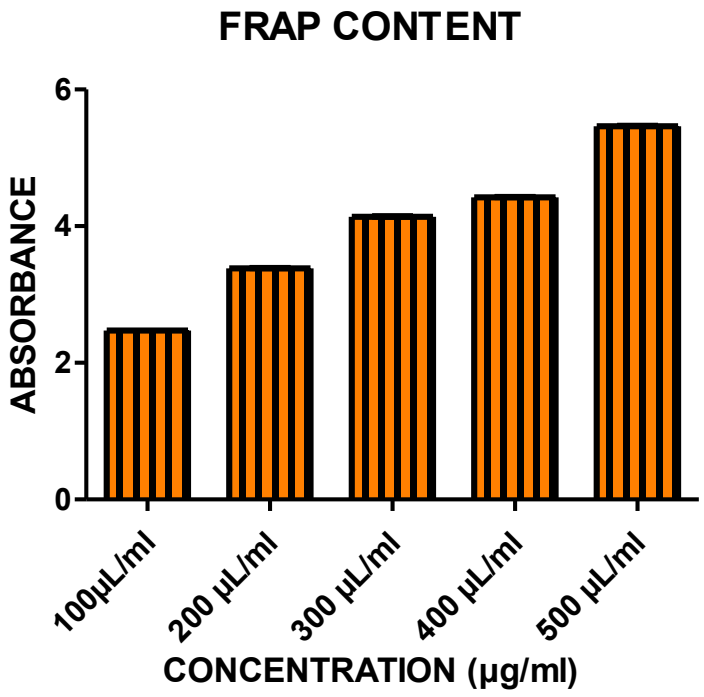

Figure 3. FRAP content for the ELEJC at ascorbic acid equivalence.

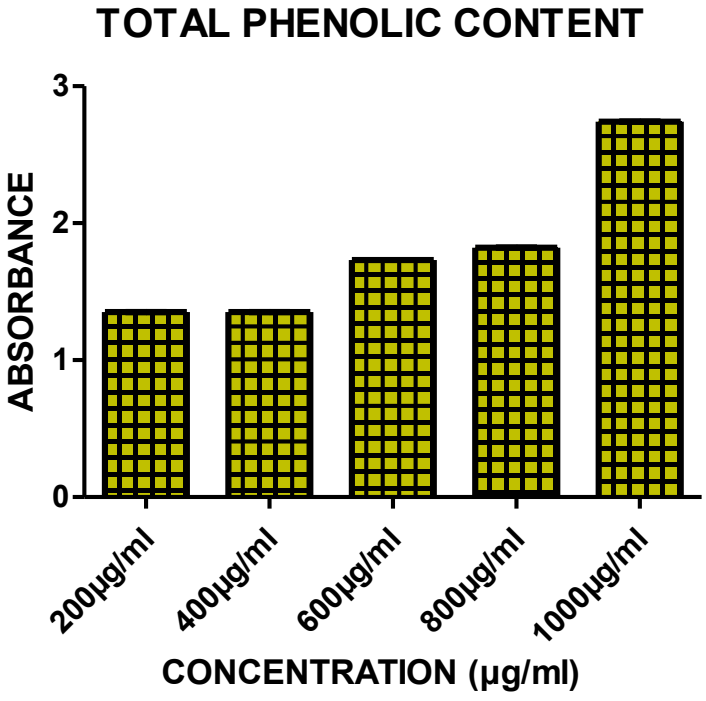

Figure 4. TPC of the ELEJC at Gallic Acid Equivalence.

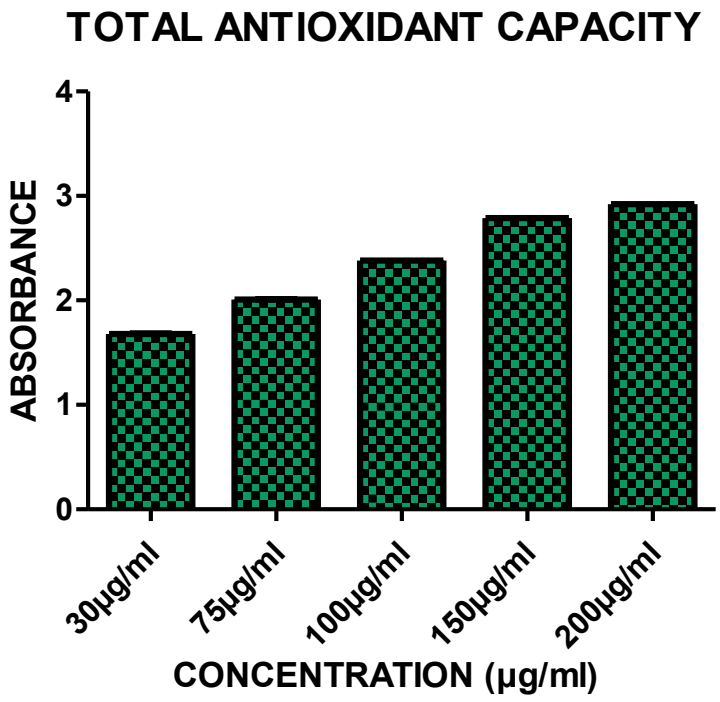

Figure 5. TAC of the ELEJC Relative to the Standard.

4. DISCUSSION

The phytochemical constituents and the antioxidant potential of the ethanol leaf extract of *Jatropha curcas* L (ELEJC) have been studied and documented thoroughly in this work. Previous work using ethanol on leafy parts of some medicinal plants reported similar yields of 6.69%, as this work yields 6.69% [14]. Some of the bioactive molecules extracted using ethanol, a polar solvent with wide-ranging efficacy, include phenols, flavonoids, alkaloids, and even glycosides of these chemicals [15].

Flavonoids, saponins, tannins, alkaloids, terpenoids, cardiac glycosides, and even anthraquinones are some of the secondary metabolites that have been identified and are the subject of phytochemical research. Having antioxidant and therapeutic properties, the suggested metabolites have a noteworthy contribution. For instance, saponins and alkaloids are known to help in the strengthening of membrane permeability, exerting antimicrobial and anti-inflammatory actions [16], and flavonoids, alkaloids, and tannins have been known to possess radical scavenging abilities.

The quantitative phytochemical analysis supports that claim. The extract had the highest proportion of the following alkaloids (1.70 ±0.003%); saponins (1.35 ±0.002%); flavonoids (1.12 ±0.004%); and tannins (1.12 ±0.004%). Moderate amounts of terpenoids (0.80 ±0.001%) and phenols (0.68 ±0.008%) were also present. Alkaloids interact with various enzymes and receptors within the body, contributing to biological activity. This often results in analgesic, anticancer, or antibacterial effects [17]. Saponins' surfactant characteristics have been found to alter cell permeability and immunological responses [18].

The inclusion of flavonoids and phenolic chemicals, both of which are known to have antioxidant qualities, explains ELEJC's efficacy in antioxidant assays. The antioxidant assays reinforced the bioactivity of ELEJC. The DPPH radical-scavenging assay demonstrated concentration-dependent scavenging activity, with the highest value of 56.57% at 250 µg/ml (Fig. 2). Although this value is lower than the standard value of ascorbic acid (72.24%), it still showcases radical neutralizing potential. This supports the findings of Ghasemi et al. [9], who established that plant extracts with polyphenolic compounds exhibit DPPH inhibition in a dose-dependent manner

Along the same lines, the ferric reducing antioxidant power (FRAP) assay showed that the reducing power is increasing with the increasing concentration of the extracts, peaking at 5.46 absorbance at 500 µL/ml (Fig. 3). This tendency indicates that ELEJC has the potential to serve as a very strong electron donor capable of reducing Fe^{3+} to Fe^{2+}, which is important in oxidative stress mitigation [19]. ELEJC showed moderate reducing capability when compared to pure ascorbic acid, which, as mentioned earlier, showed lower reducing power at all tested concentrations. Furthermore, the total phenolic content (TPC) analysis revealed outstanding values, notably at a concentration of 1000 µg/ml, where it measured 2.74 ± 0.002 GAE, showing richness in phenolic compounds (Fig. 4). Phenolics have significant redox properties, allowing them to absorb and neutralize free radicals, chelate metal ions, and break down radical chain reactions [20]. The significant antioxidant TPC, along with the DPPH and FRAP findings, provide additional evidence for phenolics' role in oxidative stress defense.

The phosphomolybdenum technique for total antioxidant capacity (TAC) examination revealed that ELEJC's antioxidant activity progressively rose with concentration, reaching a maximum of 2.92 ± 0.000 at 200 µg/ml (Fig. 5). This is consistent with previous findings, which showed that plant extracts had the highest TAC at greater doses [21]. TAC is the overall sum of the extract's antioxidant activity, as well as all other flavonoids, phenols, and other antioxidants. Because of the synergistic effects they have, the total TAC reflects synergistic activity. In general, the findings confirm that ELEJC includes a wide range of bioactive chemicals and has significant antioxidant activity.

Although the reported antioxidant activity of ELEJC is lower than that of synthetic antioxidants such as BHA and vitamin C, its safety, low cost, and natural origin make it suitable for use in pharmaceutical and functional food applications. Other researchers have identified *Jatropha curcas* extracts as possible supplements for the treatment of inflammation, microbial infections, and disorders caused by oxidative damage [22, 23], which is consistent with our findings.

5. CONCLUSION

This study found that the ethanol leaf extract of *Jatropha curcas* L. includes a wide range of phytochemicals with medicinal potential, including flavonoids, tannins, saponins, and alkaloids. Quantitative analysis revealed significant quantities of alkaloids (1.70%), saponins (1.35%), flavonoids (1.12%), and phenols (0.68%), consistent with the substantial antioxidant activity seen in the DPPH, FRAP, TPC, and TAC assays.

These antioxidant capabilities are most likely related to its high phenolic and flavonoid content. Although the extract's efficiency was not as great as that of traditional antioxidants such as ascorbic acid, its natural origin and biochemical potential make it valuable as a

supplemental antioxidant. Overall, *Jatropha curcas* L. could be a potential resource in the development of plant-based antioxidant medicines or nutraceuticals, necessitating more pharmacological and toxicological studies.

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