



## Analysis of Nigerian Indigenous *Jatropha Tanjorensis* Leaves: FTIR Spectroscopy, Proximate and Mineral Composition

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### ABSTRACT

*Jatropha tanjorensis*, a leafy plant, is renowned for its rich phytochemical composition and significant medicinal properties, making it a focal point of pharmacological research. This study investigates the leaves of Nigerian indigenous *Jatropha tanjorensis* through Fourier Transform Infrared (FTIR) spectroscopy, proximate analysis, and determination of mineral composition. Fresh leaves of *Jatropha tanjorensis* were collected from mature plants in Zaria, Kaduna State, Nigeria, authenticated, air-dried, and ground into powder. The plant powder was evaluated following the standard protocols outlined by the Association of Official Analytical Chemists (AOAC). The Proximate analysis revealed 8.67% moisture, 5.25% crude protein, 12.27% crude fat, 11.33% crude fiber, 8.67% ash, and 53.81% carbohydrates, highlighting its nutritional value and potential health benefits. Mineral analysis indicated significant levels of essential minerals, including calcium (4490.25 mg/kg), magnesium (776.75 mg/kg), potassium (15,500.0 mg/kg), sodium (29,000.0 mg/kg), and phosphorus (4322.27 mg/kg), alongside trace elements such as iron (1702.00 mg/kg), manganese (57.50 mg/kg), and zinc (114.50 mg/kg). Heavy metals like chromium (3.25 mg/kg) and cobalt (25.25 mg/kg) were also detected. FTIR spectroscopy identified functional groups such as O-H, C-H, N-H, C=O, C=C, C-O, and N-H associated with phenolic compounds, hydrocarbons, amines, carbonyl groups, and aromatic compounds. These functional groups are linked to antioxidant, anti-inflammatory, and antimicrobial properties. The findings highlight the therapeutic potential of *Jatropha tanjorensis* leaves, emphasizing their value as a source for nutraceutical and pharmaceutical applications. Further studies are recommended to isolate and characterize the specific bioactive compounds responsible for these activities and explore their applications in nutrition, medicine, and industry.

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### INTRODUCTION

*Jatropha tanjorensis*, a member of the Euphorbiaceae family, has attracted considerable attention for its potential health benefits and medicinal properties. This plant is recognized for its rich phytochemical profile, which includes essential minerals critical for various physiological

functions. Nutrient analysis of medicinal plants, such as *Jatropha tanjorensis*, is crucial in assessing their suitability as dietary supplements and therapeutic agents. Key minerals like calcium, potassium, and iron play significant roles in maintaining bone health, cardiovascular stability, and oxygen transport [1, 2]. However, the

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presence of potentially toxic elements, such as cadmium and lead, raises concerns about potential health risks associated with the consumption of these plants [3, 4].

Proximate analysis is vital in nutritional science and food technology, providing a comprehensive breakdown of the fundamental chemical components in food and plant materials. This analytical technique measures key macronutrients, including moisture, ash, crude protein, crude fat, crude fiber, and carbohydrates, offering valuable insights into various substances' nutritional value and potential applications [5]. Moisture content analysis is critical for determining the water content of a sample, as it significantly influences shelf life and storage conditions. High moisture content can promote spoilage and microbial growth, while low moisture content enhances preservation [6]. Ash content reflects the total mineral composition of the sample, signifying the presence of inorganic compounds essential for various physiological functions in the human body [7].

Crude protein analysis assesses the protein content, essential for the growth, repair, and maintenance of body tissues [8]. Crude fat analysis determines the lipid concentration, which is critical for energy provision and the absorption of fat-soluble vitamins [9]. Crude fiber analysis measures the indigestible portion of the sample, which promotes digestive health by facilitating bowel movements and preventing constipation [10]. Carbohydrate content, typically calculated by difference, provides an estimate of the energy-providing sugars and starches present in the sample [11].

Fourier Transform Infrared (FTIR) Spectroscopy has proven to be a robust and efficient technique for identifying functional groups and elucidating chemical structures in plant materials [12]. FTIR spectra provide a molecular fingerprint of the sample, with characteristic absorption bands corresponding to specific vibrations of functional groups. Recent studies have extensively documented the application of FTIR spectroscopy in analyzing medicinal plants, identifying compounds such as phenolics,

flavonoids, terpenoids, and alkaloids, which are known for their therapeutic potential [13].

Research on *Jatropha tanjorensis* has predominantly focused on its pharmacological activities. Oladele et al. [14] demonstrated the antimicrobial efficacy of the leaf extracts against various bacterial strains, highlighting their potential as natural preservatives. Babayemi et al. [15] emphasized its significant antibacterial activity against bacteria associated with wound infections, while Omoregie and Sisodia [16] reported its antiplasmodial effects and cytotoxicity, suggesting its potential in combating malaria. Additionally, Ukoh et al. [17] found that aqueous leaf extracts enhance fertility and improve gestational outcomes in Wistar rats, suggesting nutritional and reproductive benefits. Usin et al. [18] further explored its impact on lipid profiles, underscoring potential cardiovascular benefits. This study aims to analyze the proximate composition, and mineral profile of *Jatropha tanjorensis* leaves. Furthermore, Fourier Transform Infrared (FTIR) Spectroscopy is utilized to identify the bioactive compounds responsible for the leaves' medicinal properties, thereby enhancing the understanding of their therapeutic potential.

## MATERIALS AND METHODS

Sample collection, authentication, and extraction. The leaves of *Jatropha tanjorensis* were collected in Zaria, Nigeria, and authenticated at Ahmadu Bello University's Herbarium (Voucher No. V/N-ABU01911). After washing with distilled water, the leaves were air-dried, ground into fine powder, and stored in airtight containers following standard protocols [19, 20].

## Proximate Analysis

Proximate analysis was conducted to determine the moisture, ash, crude protein, crude fat, crude fiber, and carbohydrate content of *Jatropha tanjorensis* leaves, following the standard methods outlined by the Association of Official Analytical Chemists [21].

**Moisture content:** Moisture content was determined using the oven-drying method. Three (3) grams of the powdered sample of *Jatropha tanjorensis* leaves was weighed into a pre-weighed crucible. The sample was dried in an oven at 105 °C for 24 hours. The crucible was then cooled in a desiccator and reweighed. The moisture content was calculated as follows:

$$\text{Moisture Content (\%)} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

**Ash content:** Ash content was determined by incinerating the sample in a muffle furnace. Two grams of the dried sample was placed in a pre-weighed crucible and incinerated at 600 °C for 6 hours until a white or light grey ash was obtained. The crucible was cooled in a desiccator and reweighed. The ash content was calculated as follows:

$$\text{Ash Content (\%)} = \frac{\text{Weight of Ash}}{\text{Weight of Sample}} \times 100$$

**Crude protein:** Crude protein was determined using the Kjeldahl method. Exactly 1 gram of the sample was digested with concentrated sulfuric acid and a catalyst (such as copper sulfate) to convert nitrogen to ammonium sulfate. The digest was neutralized with sodium hydroxide and distilled to release ammonia, which was trapped in a boric acid solution. The trapped ammonia was titrated with standard hydrochloric acid. The crude protein content was calculated using a conversion factor (6.25) based on the nitrogen content.  
 $\text{Crude Protein (\%)} = \text{Nitrogen Content} \times 6.25$

**Crude fat:** Crude fat was determined by the Soxhlet extraction method. Exactly 10 grams of the sample was placed in a thimble and extracted with petroleum ether in a Soxhlet apparatus for 8 hours. After extraction, the solvent was evaporated, and the remaining fat was dried and weighed. The crude fat content was calculated as follows:

$$\text{Crude Fat (\%)} = \frac{\text{Weight of Fat}}{\text{Weight of Sample}} \times 100$$

**Crude fiber:** Crude fiber was determined by acid and alkali digestion. Exactly 1 gram of the sample was digested with 1.25 % sulfuric acid followed by 1.25 % sodium hydroxide. The residue was filtered, washed, dried, and ashed. The crude fiber content was calculated as follows:

$$\text{Crude Fiber (\%)} = \frac{\text{Weight of Residue} - \text{Weight of Ash}}{\text{Weight of Sample}} \times 100$$

**Carbohydrate content:** Carbohydrate content was determined by difference, subtracting the sum of moisture, ash, crude protein, crude fat, and crude fiber from 100 %.

$$\text{Carbohydrate (\%)} = 100 - (\text{Moisture} + \text{Ash} + \text{Crude Protein} + \text{Crude Fat} + \text{Crude Fiber})$$

**Mineral composition:** Exactly 1.00 g of dried leaf powder was digested and used for each analysis of mineral content according to the method of Falade et al. [22], and the mineral contents were analyzed by atomic absorption spectrophotometer (ALPHA 4 model, Fisons ChemTech, Analytical, UK).

#### FTIR Spectroscopy Analysis

The FTIR analysis was conducted using an Agilent Technologies FTIR spectrometer. The sample preparation and analysis followed the standard protocols for FTIR spectroscopy as follows [12];

**Sample preparation:** A small amount of the powdered leaf sample was mixed with potassium bromide (KBr) in a ratio of 1:100 and pressed into a thin pellet using a hydraulic press.

**Spectral acquisition:** The FTIR spectra were recorded in the range of 4000 to 650 cm<sup>-1</sup> at a resolution of 8 cm<sup>-1</sup>. Each spectrum was obtained by averaging 30 scans to improve the signal-to-noise ratio. Background scans were also taken to correct for atmospheric interference.

**Data Analysis:** All determinations of the proximate analysis were performed in triplicate, and the results were expressed as mean ± standard deviation. Data were analyzed using the

Statistical Package for Social Sciences (SPSS version 25). One-way analysis of variance (ANOVA), followed by Duncan's post hoc test to compare means was used to determine significant differences between means at  $P < 0.05$ . The obtained FTIR spectra were analyzed to identify characteristic absorption bands corresponding to various functional groups. The spectral data were compared with reference spectra to assign specific functional groups to the observed bands.

## RESULTS

The results of proximate analysis of *Jatropha tanjorensis* leaves are presented in Table 1 which indicates that they contain significant amounts of moisture (8.67%), crude protein (5.25%), crude fat (12.27%), crude fiber (11.33%), ash (8.67%), and carbohydrates (53.81%).

**Table 1:** Nutrient Composition of *Jatropha tanjorensis* Leaves (% Dry Weight Basis)

Nutrient	Composition (%)
Moisture	8.67 ± 0.00b
Protein	5.25 ± 0.00a
Crude Fat	12.27 ± 0.15d
Crude Fiber	11.33 ± 0.58c
Ash	8.67 ± 0.29b
Carbohydrate	53.81 ± 0.96e

Values are expressed as Mean ± SD (n= 3). Values with different superscripts down the column are significantly different ( $p < 0.05$ ).

The mineral composition of *Jatropha tanjorensis* leaves was analyzed on a dry weight basis, revealing a rich profile of essential minerals and trace elements. Table 2 provides a detailed breakdown of the composition in milligrams per kilogram (mg/kg). Major minerals include; Calcium (Ca) measured at 4490.25 mg/kg, Magnesium (Mg) with a composition of 776.75 mg/kg, Potassium (K) at 15500.0 mg/kg, Sodium (Na)

which is the highest among the measured nutrients, recorded at 29000.0 mg/kg, and Phosphorus (P) Present at 4322.27 mg/kg. Trace Elements include; Iron (Fe) at 1702.00 mg/kg, Manganese (Mn) contained at 57.50 mg/kg of manganese, and Zinc (Zn) present at 114.50 mg/kg. Heavy Metals include; Chromium (Cr) at 3.25 mg/kg and cobalt (Co) at 25.25 mg/kg.

**Table 2:** Mineral Composition of *Jatropha tanjorensis* Leaves (% Dry Weight Basis)

Minerals	Composition (mg/kg)
Ca	4490.25 ± 0.13h
Mg	776.75 ± 0.54e
K	15500.0 ± 0.321
Na	29000.0 ± 0.00j
P	4322.27 ± 0.65g
Fe	1702.00 ± 1.21f
Mn	57.50 ± 0.83c
Zn	114.50 ± 1.10d
Cr	3.25 ± 0.76a
Co	25.25 ± 0.44b

Values are expressed as Mean ± SD (n= 3). Values with different superscripts down the column are significantly different ( $p < 0.05$ ).

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The result in figure 1 shows the FTIR spectrum of *Jatropha tanjorensis* leaf that reveals the functional groups present in the sample. The spectrum showcases several peaks, each corresponding to different molecular vibrations and functional groups. This includes O-H Stretching ( $3697.5\text{ cm}^{-1}$ ,  $3619.2\text{ cm}^{-1}$ ), C-H

Stretching ( $2851.4\text{ cm}^{-1}$ ,  $2918.6\text{ cm}^{-1}$ ), N-H Stretching ( $3272.8\text{ cm}^{-1}$ ), C=O Stretching ( $1733.2\text{ cm}^{-1}$ ), C=C Stretching ( $1635.8\text{ cm}^{-1}$ ), C-O Stretching ( $1237.5\text{ cm}^{-1}$ ,  $1013.8\text{ cm}^{-1}$ ), N-H Bending ( $1599.0\text{ cm}^{-1}$ ) and Aromatic C-H Bending ( $733.2\text{ cm}^{-1}$ ,  $701.5\text{ cm}^{-1}$ ).

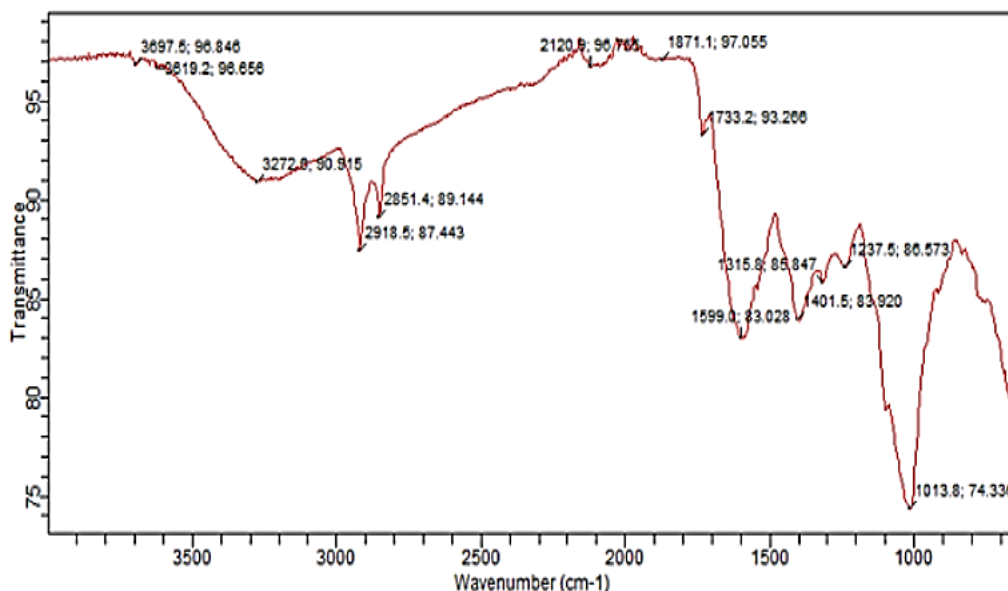


Figure 1: FTIR spectrum of *Jatropha tanjorensis* leaf

## DISCUSSION OF FINDINGS

The proximate analysis of *Jatropha tanjorensis* leaves provides valuable insights into their nutritional and potential industrial applications. The results reveal a composition with notable levels of moisture, protein, fat, fiber, ash, and carbohydrates. The moisture content of 8.67% is relatively low, which is advantageous for the preservation and storage of the leaves. Lower moisture content helps reduce the risk of microbial growth and spoilage, ensuring the leaves can be stored for longer periods without deterioration [6]. This makes *Jatropha tanjorensis* leaves suitable for various uses, including in dry formulations and products requiring stable ingredients.

The protein content of 5.25% is moderate, suggesting that the leaves can contribute to dietary protein intake. While not exceptionally high, this level is comparable to

other plant leaves used in animal feed and human consumption [19]. This protein content indicates potential applications in nutritional supplements and functional foods where moderate protein content is desirable. The significant crude fat content of 12.27% highlights the potential for oil extraction from *Jatropha tanjorensis* leaves. High-fat content is valuable for various industrial applications, including the production of biofuels and cosmetics [9]. The fat content in these leaves makes them a promising candidate for further exploration in bioenergy sectors and as a source of essential fatty acids. With 11.33% crude fiber, the leaves provide a considerable amount of dietary fiber, which is essential for promoting digestive health [5]. The fiber content suggests that the leaves could be utilized in functional foods and dietary supplements aimed at improving gastrointestinal health and managing conditions such as constipation.

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The ash content of 8.67% reflects the presence of minerals in the leaves. Mineral content is crucial for various physiological functions, including bone health and metabolic processes [10]. This level of ash indicates that *Jatropha tanjorensis* leaves can contribute to mineral intake in diets, potentially enhancing their nutritional profile. The carbohydrate content of 53.81% is the highest among the analyzed components, making the leaves a significant source of energy. This high carbohydrate content can be advantageous for energy-rich formulations and as an ingredient in various food products [11]. The energy density of the leaves supports their potential use in energy supplements and other applications where high carbohydrate content is beneficial.

The nutrient analysis of *Jatropha tanjorensis* leaves reveals a substantial presence of essential minerals. High concentrations of calcium (4490.25 mg/kg), potassium (15500.0 mg/kg), and sodium (29000.0 mg/kg) indicate the plant's potential as a significant source of these critical nutrients, which support bone health, cardiovascular function, and fluid balance [1]. The substantial levels of magnesium and phosphorus further enhance the nutritional profile, aligning with previous research that emphasizes the plant's health benefits [2]. The presence of iron at 1702.00 mg/kg highlights the plant's potential role in addressing iron deficiency, crucial for maintaining healthy red blood cells and overall energy levels [20].

The FTIR spectrum of *Jatropha tanjorensis* leaf indicates the presence of several key functional groups, each contributing to the plant's overall chemical composition and potential health benefits. The broad O-H stretching vibrations suggest a significant presence of hydroxyl groups, which are typical in phenolic compounds and alcohols. These compounds are well-known for their antioxidant properties, which can neutralize free radicals and reduce oxidative stress [8]. The presence of C-H stretching vibrations at around 2851.4  $\text{cm}^{-1}$  and 2918.6  $\text{cm}^{-1}$  indicates aliphatic hydrocarbons, which are common in essential oils and other bioactive compounds. The N-H stretching vibration at

3272.8  $\text{cm}^{-1}$  and bending vibration at 1599.0  $\text{cm}^{-1}$  imply the presence of amines or amides, compounds often associated with anti-inflammatory and antimicrobial activities [6].

The C=O stretching vibration at 1733.2  $\text{cm}^{-1}$  is indicative of carbonyl groups, suggesting the presence of aldehydes, ketones, or carboxylic acids, which are known for their various biological activities, including antimicrobial and anti-inflammatory properties. The C=C stretching vibrations at 1635.8  $\text{cm}^{-1}$  and aromatic C-H bending at 733.2  $\text{cm}^{-1}$  and 701.5  $\text{cm}^{-1}$  point towards the presence of aromatic compounds, likely contributing to the antioxidant activity of the leaf extract [5,13]. The C-O stretching vibrations at 1237.5  $\text{cm}^{-1}$  and 1013.8  $\text{cm}^{-1}$  suggest the presence of ethers and alcohols, further supporting the antioxidant potential of the leaf extract. The diverse functional groups identified in the FTIR spectrum align with previous studies that have demonstrated the presence of various bioactive compounds in *Jatropha tanjorensis* leaf, contributing to its medicinal properties [6].

## CONCLUSION

The proximate analysis of *Jatropha tanjorensis* leaves reveals a well-rounded nutritional profile with significant levels of protein, fat, fiber, and carbohydrates. The low moisture content is favorable for storage, while the high fat and carbohydrate contents suggest potential applications in biofuels and energy-rich food products. The moderate protein and substantial fiber content highlight the leaves' utility in dietary supplements and functional foods. Given these findings, *Jatropha tanjorensis* leaves present opportunities for further research into their use in nutritional and industrial applications.

This study also provides a detailed analysis of the mineral composition of *Jatropha tanjorensis* leaves, highlighting high levels of calcium, potassium, and iron that supports its potential use as a dietary supplement. The FTIR analysis of *Jatropha tanjorensis* leaf has revealed a complex mixture of functional groups, including hydroxyl, carbonyl, aliphatic, aromatic, and amine groups. These findings confirm the presence of various bioactive compounds that contribute to the



plant's antioxidant, anti-inflammatory, and antimicrobial properties. Future studies should focus on exploring the bioavailability of these nutrients, the health benefits of incorporating the leaves into various products as well as the therapeutic potentials of its bioactive compounds.

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