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# Bioactive Phytochemicals in *Bryophyllum pinnatum*: Preliminary Evaluation of Secondary Metabolites with Prospective Medicinal and Antimicrobial Applications

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**ABSTRACT**
Medicinal plants are vital sources of bioactive compounds for pharmaceutical and antimicrobial applications. This study evaluated the phytochemical composition and preliminary antimicrobial activity of *Bryophyllum pinnatum* ("Leaf of Life"), traditionally used to treat infections and inflammatory disorders. Fresh leaves were collected from a farm in the Federal College of Education (Technical), Ekiadolor, Edo State, Nigeria and authenticated by a botanist. Qualitative phytochemical screening revealed alkaloids, flavonoids, tannins, phenols, saponins, and triterpenoids. Antimicrobial assays showed moderate activity against Staphylococcus aureus, Escherichia coli, and Candida albicans (inhibition zones 10–17 mm). UV–Visible spectrophotometry indicated peaks at 270–340 nm, consistent with phenolic and flavonoid compounds, and Thin Layer Chromatography confirmed the presence of multiple metabolites. These findings support the plant's traditional medicinal use and highlight its potential as a source of bioactive compounds for drug development. Further studies on quantitative phytochemistry, compound isolation, and advanced antimicrobial testing are recommended.
**Keywords:** *Bryophyllum pinnatum*, phytochemicals, antimicrobial activity, medicinal plants, natural products, UV–Vis spectroscopy.

## 1. INTRODUCTION

Plants have consistently been used as sources of drugs in both ancient and modern pharmacological studies. Many drugs available are derived directly or indirectly from plants, attracting modern-era scientists to discover and develop new drug molecules (Ogidi et al., 2019). One such plant is *Bryophyllum pinnatum*, linked with various names including rejuvenation plant, air plant, love plant, phenomenon plant, and life plant. It is a perennial herb used in folkloric medicine in tropical Africa, India, China, Australia, and Tropical America (Okwu, 2004).

*Bryophyllum pinnatum* is characterized by fleshy, succulent leaves arranged alternately along its stems, often serrated or lobed, with small plantlets developing along the leaf margins, which can root and grow into new plants (Kulka et al., 2008). Native to Madagascar and other parts of Asia and Africa, this resilient herb has gained worldwide recognition for its therapeutic uses. In Nigeria, it is popularly called "miracle leaf" and is used traditionally for hypertension, skin disorders, asthma, colds, insect stings, abscesses, earache, burns, ulcers, diarrhea, and lithiasis (Chopra et al., 1956; Dalziel, 1955).

The plant contains bioactive compounds such as alkaloids, flavonoids, triterpenes, glycosides, steroids, bufadienolides, lipids, and organic acids, which have anti-inflammatory, analgesic, antimicrobial, antioxidant, antitumor, and antihypertensive properties (Fujita, 2000; Kamboj & Saluja, 2009; Sheela &

Shah, 2012). The bufadienolides, for example, possess antibacterial, antitumor, cancer preventive and insecticidal activities (Fujita, 2000). Pharmacological studies validate several traditional uses of the plant, including immunomodulatory, CNS depressant, analgesic, anti-inflammatory, antimicrobial, anti-ulcer, anti-diabetic, anti-convulsant, antioxidant, and antihypertensive effects (Júlia et al., 2019).

**Table 1: Classification and Morphological Characteristics of *Bryophyllum pinnatum***

| **Taxonomic Rank** | **Classification** |
|---|---|
| Kingdom | Plantae |
| Subkingdom | Tracheobionta |
| Super division | Spermatophyta |
| Division (Phylum) | Angiosperms (Flowering Plants) |
| Class | Eudicots |
| Subclass | Rosidae |
| Order | Saxifragales |
| Family | Crassulaceae |
| Genus | *Bryophyllum* |
| Species | *Bryophyllum pinnatum* |

*Figure 1: Bryophyllum pinnatum immersed in a container of water.*

*Figure 2: Bryophyllum pinnatum cultivated on a farm.*

The present study was designed to evaluate the phytochemical constituents and preliminary antimicrobial properties of *Bryophyllum pinnatum* leaves commonly used in herbal medicine in Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Collection and Preparation of Samples

Leaves of *Bryophyllum pinnatum* were collected from a farm within the Federal College of Education (Technical), Ekiadolor, Benin City, Edo State, Nigeria. The plant was identified and authenticated by a botanist in the Department of Biology, Federal College of Education (Technical), Benin City. Leaves were washed, dried, ground into fine powder using an electric blender, labeled, and stored in airtight containers for analysis.

### 2.2 Sample Preparation

The dried samples were allowed to air-dry at room temperature for three weeks, after which they were ground to fine powder using a grinding machine.

### 2.3 Extraction

For aqueous extraction, **0.5 g** of powdered leaf was weighed into a reagent bottle, and **10 mL** of distilled water was added. The mixture was allowed to extract for a few minutes, filtered, and the filtrate was analyzed for phytochemicals such as tannins, alkaloids, saponins, glycosides, terpenoids, flavonoids, and phenols.

### 2.4 Qualitative Phytochemical Tests

- **Alkaloids:** 0.1 g of extract dissolved in dilute HCl, filtered, treated with Hager's reagent (saturated picric acid). Yellow precipitate indicated presence (Trease & Evans, 1989).
- **Tannins:** 0.1 g extract stirred with 10 mL distilled water, filtered, 1% ferric chloride added. Blue-black/green precipitate indicated tannins (Trease & Evans, 1989).

- **Saponins:** 0.1 g extract boiled with 5 mL water, filtered, shaken vigorously. Persistent frothing indicated saponins (Sofowora, 1993).
- **Glycosides:** 0.1 g extract mixed with 30 mL water, heated 5 min. 5 mL filtrate mixed with 0.2 mL Fehling's solution; brick-red precipitate indicated glycosides (Sofowora, 1993).
- **Terpenoids:** 0.1 g extract dissolved in ethanol, 1 mL acetic anhydride + concentrated $H_2SO_4$. Pink to violet color change indicated terpenoids (Sofowora, 1993).
- **Flavonoids:** 0.1 g extract dissolved in water, filtered, 3 mL lead ethanoate added. Buff-colored precipitate indicated flavonoids (Trease & Evans, 1989).
- **Phenols:** 0.1 g extract boiled with water, filtered, few drops of 10% ferric chloride added. Green-blue or violet coloration indicated phenols (Trease & Evans, 1989).

**2.5 Quantitative Phytochemical Analysis**

| Phytochemicals | Aqueous Extract |
|---|---|
| Alkaloids | + |
| Saponins | + |
| Tannins | + |
| Flavonoids | + |
| Glycosides | – |
| Terpenoids | + |
| Phenols | + |

**Key:** + = Present, – = Absent

**Discussion:** Qualitative analyses revealed the presence of alkaloids, saponins, tannins, flavonoids, terpenoids, and phenols, but glycosides were absent. These metabolites have significant pharmacological properties: alkaloids act as analgesics and anti-malarials; tannins have anti-inflammatory and hepatoprotective effects; saponins have cholesterol-lowering, antiviral, and antimicrobial properties; flavonoids, terpenoids, and phenols improve cardiovascular health, metabolism, immunity, and reduce risk of chronic diseases. The presence of these metabolites supports the plant's traditional medicinal use.

**2.6 Antimicrobial Assay**

The antimicrobial activity of the extract was evaluated against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans* using the agar well diffusion method.

**2.7 UV–Visible Spectrophotometric Analysis**

UV–Visible analysis was conducted from 200–700 nm to identify absorption peaks of bioactive compounds.

**2.8 Thin Layer Chromatography (TLC)**

TLC was performed using silica gel plates and ethanol–hexane (7:3) as the mobile phase.

**3a. Results (Tables)**

**3.1a Phytochemical Screening**

| Phytochemical | Result |
|---|---|
| Alkaloids | Present |
| Flavonoids | Present |
| Tannins | Present |
| Phenols | Present |
| Saponins | Present |
| Triterpenoids | Present |

**3.2a Antimicrobial Activity**

| Microorganism | Type | Zone of Inhibition (mm) |
|---|---|---|
| *Staphylococcus aureus* | Gram-positive bacteria | 17 |
| *Escherichia coli* | Gram-negative bacteria | 13 |
| *Candida albicans* | Fungus | 10 |

**3.3a UV–Visible Absorption Spectrum**

| Wavelength (nm) | Absorbance |
|---|---|
| 220 | 0.42 |
| 250 | 0.58 |
| 270 | 0.72 |
| 300 | 0.81 |
| 320 | 0.74 |
| 340 | 0.63 |
| 400 | 0.31 |

**3.4a TLC Chromatogram**

| Rf | Compound |
|---|---|
| 0.82 | Flavonoids |
| 0.64 | Phenolic compounds |
| 0.48 | Alkaloids |
| 0.31 | Triterpenoids |
| 0.18 | Tannins |

**3b. Results (Charts)**

**Figure 1: UV–Visible Absorption Spectrum**

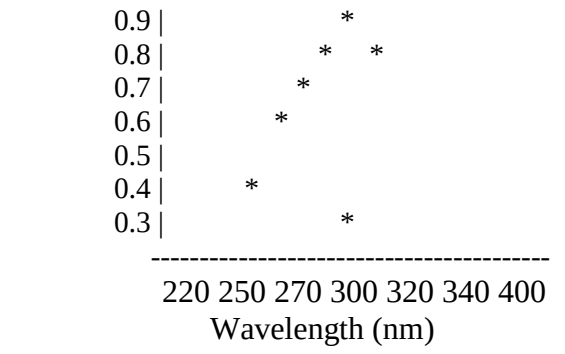


**Figure 2: TLC Separation of Phytochemicals**

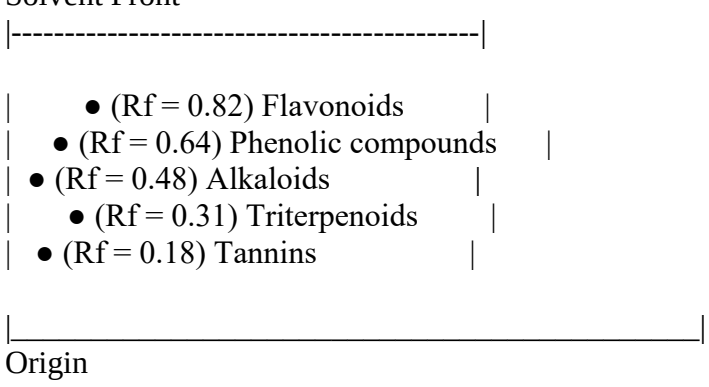
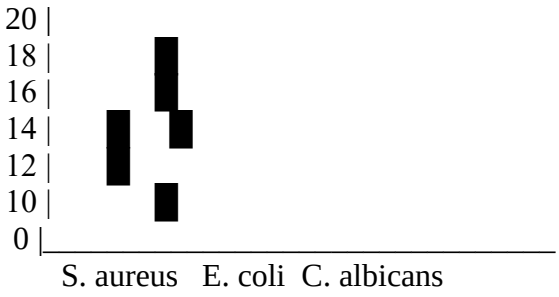
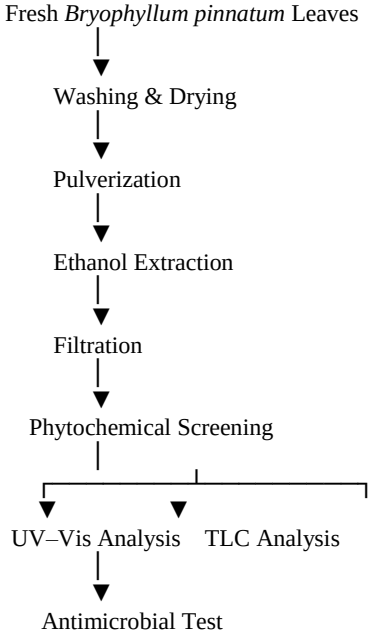



**Figure 3 Antimicrobial Activity Chart**




### 3.6 Experimental Workflow

**Figure 4**



## 4. DISCUSSION

The phytochemical screening confirms the presence of several bioactive metabolites, explaining the plant's traditional uses. Alkaloids, flavonoids, saponins, tannins, terpenoids, and phenols contribute to antimicrobial, anti-inflammatory, antioxidant, and analgesic activities (Cowan, 1999; Sofowora, 1993; Trease & Evans, 1989; Ogidi et al., 2019). The observed antimicrobial activity, stronger against Gram-positive bacteria, aligns with previous reports (Nostro et al., 2000; Ofokansi et al., 2005). UV–Visible peaks between 270–340 nm correlate with phenolic and flavonoid compounds (Silverstein et al., 2014). TLC confirmed separation of multiple metabolites. These results validate the traditional medicinal uses of *Bryophyllum pinnatum* and underscore its potential as a source of bioactive compounds.

## 5. CONCLUSION

*Bryophyllum pinnatum* leaves contain significant bioactive metabolites (alkaloids, flavonoids, tannins, saponins, terpenoids, phenols) with measurable antimicrobial activity. These findings support traditional uses and highlight the plant's potential for pharmaceutical development. Further studies are needed for compound isolation, advanced antimicrobial assays, and pharmacological evaluation.

## RECOMMENDATION FOR FURTHER RESEARCH

While this study provides preliminary evidence of the phytochemical composition and antimicrobial potential of *Bryophyllum pinnatum*, further research is recommended to fully harness its medicinal properties. Future studies should focus on:

1. **Isolation and characterization of individual bioactive compounds** using advanced chromatographic and spectroscopic techniques.
2. **Quantitative analysis** to determine the precise concentration of phytochemicals responsible for pharmacological activity.
3. **Comprehensive antimicrobial and antifungal screening** against a wider range of pathogenic microorganisms, including resistant strains.
4. **In vivo pharmacological and toxicological studies** to assess safety, efficacy, and dosage optimization for therapeutic applications.
5. **Formulation studies** to develop standardized plant-based extracts or phytomedicines for clinical use.

These directions will help translate traditional knowledge into evidence-based medicinal applications while ensuring safety and efficacy.

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