

## COMPREHENSIVE PHYTOCHEMICAL CHARACTERIZATION AND BIOACTIVITY PROFILE OF ETHANOLIC LEAF EXTRACT OF *Dracaena trifasciata* (Prain) Mabb.



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### ABSTRACT

*Dracaena trifasciata* (Prain), commonly known as snake plant, has been traditionally used in ethnomedicine. This study provides a comprehensive, multi-technique analysis of its ethanolic leaf extract. Phytochemical screening revealed abundant flavonoids, tannins, saponins, and steroids. Gas Chromatography-Mass Spectrometry (GC-MS) analysis identified 31 bioactive compounds, with methyl-10,11-octadecadienoate (16.96%), Phenol,4,4'-thiobis[2,6-dimethyl-] (16.96%), and 2,3,7,8-Tetramethoxy-5H-dibenzo[a,d]cyclohepten-10(11H)-one (16.64%) as major constituents. Fourier Transform Infrared (FT-IR) spectroscopy confirmed key functional groups, including alcohols, amines, and alkenes. Elemental and vitamin analysis revealed a notably high Vitamin E content (41.24 µg/mL). The extract exhibited significant, dose-dependent in vitro antioxidant activity, with a DPPH radical scavenging IC<sub>50</sub> of 295.4 µg/mL and a ferric reducing power of 850.2 µM Fe(II)/g. Antimicrobial evaluation demonstrated broad-spectrum efficacy against Gram-positive (*Staphylococcus aureus*, *Bacillus spp.*) and Gram-negative (*Escherichia coli*, *Salmonella spp.*) bacteria, with *Salmonella spp.* showing the highest susceptibility (25 mm inhibition zone at 1 mg/mL). The rich phytochemical profile, particularly the electron-donating phenolic constituents, also suggests potential for novel interdisciplinary applications such as green corrosion inhibition. This integrated characterisation provides a robust scientific foundation for further pharmacological and industrial development of *D. trifasciata*.

**KEYWORDS:** *Dracaena trifasciata*, GC-MS, FT-IR, Antioxidant activity, Antimicrobial activity, Phytochemical analysis.

### INTRODUCTION

Oxidative stress and antimicrobial resistance (AMR) are two critical global health challenges (Liguori *et al.*, 2018; WHO, 2014). The search for safe, effective, and multi-target therapeutic agents has renewed interest in plant-derived bioactive compounds (Fabricant and Farnsworth, 2001). Plant secondary metabolites like flavonoids, phenolics, and saponins are known for their potent antioxidant and antimicrobial properties (Cowan, 1999; Alara *et al.*, 2021). *Dracaena trifasciata* (formerly *Sansevieria trifasciata*), a perennial plant of the *Asparagaceae* family, is widely used in traditional medicine for treating wounds, inflammation, and infections (Igwe *et al.*, 2021). While previous studies have indicated bioactivity in *Dracaena* species, a comprehensive phytochemical profile of *D. trifasciata* linked to specific antioxidant and antimicrobial activities using integrated analytical techniques is lacking. This study aims to bridge this gap by employing a consolidated analytical approach—including GC-MS, FT-IR, and elemental analysis—to provide a detailed phytochemical characterisation of *D. trifasciata* ethanolic leaf extract. Furthermore, it quantitatively evaluates the extract's antioxidant (DPPH, FRAP) and antimicrobial

activities, correlating the chemical profile with observed bioactivities. The findings validate traditional uses and propose novel applications based on the chemical properties of the identified constituents.

### MATERIALS AND METHODS

#### Research Design

An experimental design was used for the in vitro analysis of phytochemicals and bioactivities. All protocols were standardized and conducted in triplicate.

#### Sample Collection and Preparation

Fresh *Dracaena trifasciata* leaves were collected from Uyo, Nigeria. The plant was authenticated by a taxonomist at the University of Uyo (Herbarium Voucher Number: UUH4323). Leaves were washed, cut, sun-dried for three weeks, and pulverised into a fine powder.

#### Extraction Procedure

Powdered leaf materials (200 g) were subjected to cold maceration with 95% ethanol (1000 mL) for 120 hours in the dark at 25-28°C. The mixture was filtered, and the filtrate was concentrated using solar evaporation to yield a dark green, semi-solid extract. The percentage yield

was calculated as 6.25%. While this method was suitable for this initial study, future work should employ rotary evaporation under reduced pressure to minimise potential photo-degradation of labile compounds.

### Phytochemical Analysis

**Qualitative Screening: Preliminary screening for alkaloids, flavonoids, tannins, saponins, and steroids was performed using standard procedures (Sofowora, 1993; Trease and Evans, 2002).**

### Quantitative Analysis:

**Total Phenolic Content (TPC):** Determined using the Folin-Ciocalteu method (Siddhuraju and Becker, 2003). Absorbance was measured at 765 nm. Results were expressed as mg gallic acid equivalent per gram of extract (mg GAE/g). The gallic acid standard curve was linear ( $R^2 = 0.998$ ) in the range of 0-100  $\mu\text{g/mL}$ .

**Total Flavonoid Content (TFC):** Estimated using aluminium chloride colorimetry (Zhishen *et al.*, 1999). Absorbance was measured at 510 nm. Results were expressed as mg quercetin equivalent per gram of extract (mg QE/g). The quercetin standard curve was linear ( $R^2 = 0.997$ ) in the range of 0-100  $\mu\text{g/mL}$ .

### Advanced Analytical Techniques

**GC-MS Analysis:** Analysis was performed on an Agilent 8860 GC/5977B MSD system equipped with a DB-5MS column (30 m  $\times$  0.25 mm, 0.25  $\mu\text{m}$  film). Helium was the carrier gas (1 mL/min). The oven temperature was programmed: 55°C (0.4 min), ramp to 200°C at 25°C/min, then to 280°C at 8°C/min, finally to 300°C at 25°C/min (hold 2 min). Identification of compounds was based on comparison of mass spectra with the NIST 17 library and confirmed using calculated retention indices relative to a homologous series of n-alkanes (C8-C40). Results are reported as relative peak area percentages.

**FT-IR Spectroscopy:** The extract was mixed with dry KBr and pressed into a pellet. Spectra were recorded on a PerkinElmer spectrometer in the range of 4000-400  $\text{cm}^{-1}$  at a resolution of 4  $\text{cm}^{-1}$ .

**Elemental and Vitamin Analysis:** Mineral elements (Cr, Mn, Pb, Zn, Cu, Mg, Ni) were quantified using Atomic Absorption Spectroscopy (AAS) following APHA 3500 series methods. Vitamin C was determined by spectrophotometry using the AOAC 967.21 method, and Vitamin E ( $\alpha$ -tocopherol) was estimated spectrophotometrically following the AOAC 2012.09 principle.

### Antioxidant Assays

**DPPH Radical Scavenging Assay:** The method of Shekhar and Anju (2015) was used. Various

concentrations of extract (20-180  $\mu\text{g/mL}$ ) were mixed with 0.1 mM DPPH in methanol. After 30 min in the dark, absorbance was measured at 517 nm. Percentage inhibition was calculated, and the  $\text{IC}_{50}$  value (concentration providing 50% inhibition) was determined from the dose-response curve. Ascorbic acid was the standard.

**Ferric Reducing Antioxidant Power (FRAP) Assay:** The reducing power was assessed using the Oyaizu (1986) method. Extract samples were mixed with phosphate buffer and potassium ferricyanide, incubated at 50°C, followed by the addition of trichloroacetic acid and ferric chloride. Absorbance was measured at 700 nm. Results were expressed as absorbance and also converted to  $\mu\text{M}$  Fe(II) equivalent per gram of extract using a  $\text{FeSO}_4$  standard curve.

### Antimicrobial Assay

Antimicrobial activity was evaluated against *Staphylococcus aureus*, *Escherichia coli*, *Bacillus spp.*, and *Salmonella spp.* using the agar well diffusion method (Asuquo *et al.*, 2022). Bacterial suspensions (0.5 McFarland) were swabbed on nutrient agar plates. Wells (6 mm) were filled with extract solutions (1, 0.5, 0.25, 0.125 mg/mL). Ciprofloxacin (10  $\mu\text{g}$ ) was used as a positive control. Plates were incubated at 37°C for 24 h, and zones of inhibition (mm) were measured. For a complete assessment of antimicrobial potency, future studies should determine the Minimum Inhibitory Concentration (MIC).

### Statistical Analysis

All experiments were performed in triplicate. Data are presented as mean  $\pm$  standard deviation (SD). Statistical analysis was performed using one-way ANOVA followed by post-hoc tests in GraphPad Prism ( $p < 0.05$  considered significant).

## RESULTS

### Extraction Yield

The ethanolic extraction yielded 12.5 g of a dark green, semi-solid extract from 200 g of dried powder, corresponding to a yield of 6.25%. This yield is within the typical range reported for polar solvent extractions of *Dracaena* species.

### Phytochemical Composition

**Qualitative and Quantitative Screening:** The extract tested positive for flavonoids, tannins, saponins, and steroids. Alkaloids were not detected (Table 1). The TPC was  $85.2 \pm 2.3$  mg GAE/g, and the TFC was  $62.7 \pm 1.8$  mg QE/g, indicating a high concentration of these antioxidant compounds.

**GC-MS Analysis:** GC-MS analysis tentatively identified 31 compounds (Table 2, Figure 1), dominated by fatty acid esters and phenolic compounds. The major constituents were methyl-10,11-octadecadienoate (16.96%), Phenol,4,4'-thiobis[2,6-dimethyl-] (16.96%), and 2,3,7,8-Tetramethoxy-5H-dibenzo[a,d]cyclohepten-10(11H)-one (16.64%). Notable bioactive compounds included 3',4',5,7-Tetramethoxyflavone (1.43%) and an alkaloid derivative, 2,4-Diamino-5-[3-methoxy-4,5-methylenedioxybenzyl]pyrimidine (3.72%).

**FT-IR Spectroscopy:** The FT-IR spectrum (Figure 2) revealed characteristic functional groups. Key absorptions included a broad band at ~3270 cm<sup>-1</sup> (O-H/N-H stretch), a sharp peak at 2925 cm<sup>-1</sup> (C-H stretch), a strong peak at 1640 cm<sup>-1</sup> (C=C stretch), and bands between 1000-1300 cm<sup>-1</sup> (C-O stretches of alcohols, esters, and phenolics). The peak at 2117 cm<sup>-1</sup> was assigned to C≡C stretching vibrations.

Table 1: Phytochemical Profile of the Crude Ethanolic Extract of *Dracaena trifasciata*

| Phytochemical | Test                               | Observation                           | Inference                |
|---------------|------------------------------------|---------------------------------------|--------------------------|
| Flavonoids    | Flavonoid test                     | Yellow colour indication              | Flavonoids Present       |
|               | Sodium Hydroxide test              |                                       |                          |
|               | Alkaline test                      |                                       |                          |
| Tannin        | Ferric Chloride Test for Phenolics | Blue-black colour                     | Tannin confirmed present |
|               | Acetic Acid Test                   |                                       |                          |
| Saponin       | Frothing Test                      | Persistent Froth                      | Saponins present         |
| Steroids      | Liebermann-Burchard test           | Royal blue at the addition of Toluene | Steroids present         |

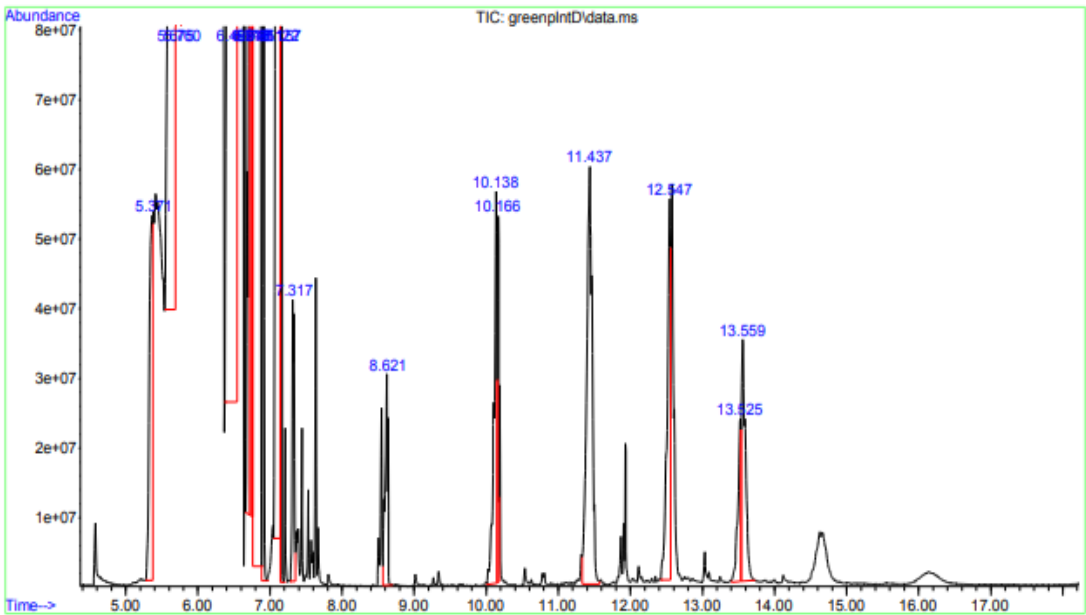


Figure 1: GC-MS Chromatogram of green *Dracaena trifasciata*

Table 2. GC-MS analysis of ethanol extract of green *Dracaena trifasciata* (Prain)

| S/N | COMPOUND                                                   | % (PEAK AREA) | CHEMICAL GROUP              |
|-----|------------------------------------------------------------|---------------|-----------------------------|
| 1   | Heptadecanoic acid                                         | 3.184         | Fatty acid                  |
| 2   | Heptadecanoic acid, 3-(acetyloxy)-16-methyl-, methyl ester | 3.184         | Fatty acid ester derivative |
| 3   | 3',4',5,7-Tetramethoxyflavone                              | 1.428         | Flavonoid                   |
| 4   | Heptadecanoic acid, 9-methyl-, methyl ester                | 12.549        | Fatty acid ester            |
| 5   | Heptadecanoic acid, 16-methyl-, methyl ester               | 12.549        | Fatty acid ester            |
| 6   | Isopropyl myristate                                        | 9.078         | Fatty acid ester            |
| 7   | Phenol, 4,4'-thiobis[2,6-dimethyl-                         | 16.959        | Phenolic                    |

|    |                                                                     |                   |         |                             |
|----|---------------------------------------------------------------------|-------------------|---------|-----------------------------|
| 8  | 2,4-Diamino<br>methylenedioxybenzyl]pyrimidine                      | 5-[3-methoxy-4,5- | 3.715   | Alkaloid                    |
| 9  | Cyclohexanol, 4-sec-butyl                                           |                   | 5.334   | Alcohol                     |
| 10 | Cyclohexanol, 2-(1-methylpropyl)-                                   |                   | 5.334   | Alcohol                     |
| 11 | Methyl 10,11-octadecadienoate                                       |                   | 16.959  | Fatty acid derivative       |
| 12 | 10-Octadecynoic acid, methyl ester                                  |                   | 16.959  | Fatty acid ester            |
| 13 | 4H-1-Benzopyran-4-one, 3-hydroxy-5,7-dimethoxy-2-(4-methoxyphenyl)- |                   | 1.240   | Flavonoid                   |
| 14 | 2,3,7,8-Tetramethoxy-5H-dibenzo[a,d]cyclohepten-10(11H)- one        |                   | 16.64 4 | Flavonoid                   |
| 15 | 2,6-Dimethoxyphenol, pentafluoropropionate                          |                   | 4.845   | Phenolic                    |
| 16 | 3,4-Dimethoxyphenol, pentafluoropropionate                          |                   | 4.845   | Phenolic                    |
| 17 | Nonane                                                              |                   | 0.574   | Terpene                     |
| 18 | 2-Bromononane                                                       |                   | 0.593   | Terpene                     |
| 19 | 5-Iodo-nonane                                                       |                   | 0.0001  | Terpene                     |
| 20 | Hexane, 2,4-dimethyl-                                               |                   | 1.144   | Terpene                     |
| 21 | Benzoic acid, 2-ethoxy-, ethyl ester                                |                   | 0.449   | Fatty acid ester derivative |
| 22 | Trimethyl pentadecane-1,7,15-tricarboxylate                         |                   | 2.465   | Fatty acid ester            |
| 23 | Trimethyl tetradecane-1,6,14-tricarboxylate                         |                   | 2.465   | Fatty acid ester            |
| 24 | Nonadecanoic acid, 18-oxo-, methyl ester                            |                   | 1.354   | Fatty acid ester            |
| 25 | Methyl 15-acetoxyhexadecanoate                                      |                   | 0.500   | Fatty acid ester            |
| 26 | 3-Pentanol, 3-ethyl-                                                |                   | 0.0001  | Alcohol                     |
| 27 | 9,12-Octadecadienoic acid (Z,Z)-                                    |                   | 0.0001  | Fatty acid                  |
| 28 | iso-Propyl 9-.cis.,11-.trans.-octadecadienoate                      |                   | 0.0001  | Fatty acid ester            |
| 29 | Isopropyl linoleate                                                 |                   | 0.0001  | Fatty acid ester            |
| 30 | Tridecanoic acid, 3-hydroxy-, ethyl ester                           |                   | 0.0001  | Fatty acid ester            |
| 31 | Dodecanoic acid, 3-hydroxy-, ethyl ester                            |                   | 0.0001  | Fatty acid ester            |

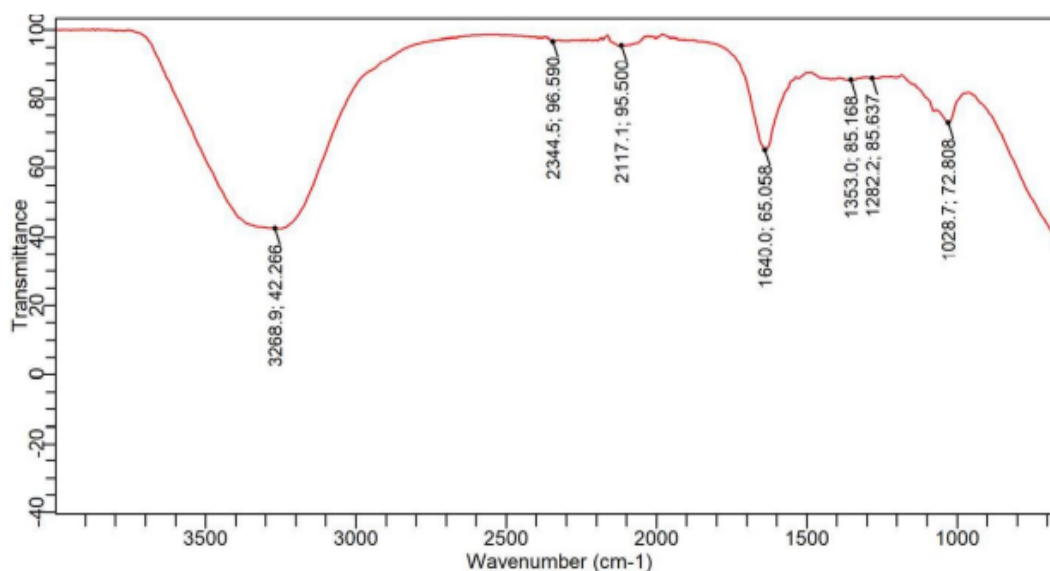


Figure 2: FT-IR spectrum of green *Dracaena trifasciata* (Prain)

Elemental and Vitamin Composition: The analysis (Table 3) showed the extract contained essential minerals, with manganese (1.98 mg/L) being the most abundant.

Notably, the Vitamin E ( $\alpha$ -tocopherol) content was remarkably high at 41.24  $\mu$ g/mL.

#### Antioxidant Activity

**DPPH Radical Scavenging:** The extract exhibited concentration-dependent radical scavenging activity (Table 4). The IC<sub>50</sub> value was calculated to be 295.4 ± 8.2 µg/mL. Ascorbic acid, used as a standard, showed significantly higher activity with an IC<sub>50</sub> of 12.7 ± 0.5 µg/mL.

**FRAP Assay:** The reducing power of the extract increased linearly with concentration (Table 4). At 180 µg/mL, the reducing power was equivalent to 850.2 ± 15.3 µM Fe(II)/g of extract, demonstrating substantial electron-donating capacity.

#### Antimicrobial Activity

The antimicrobial efficacy of *D. trifasciata* extract was assessed by determining the zones of inhibition (mm)

against four test organisms at four serial dilutions (1 mg/mL, 0.5 mg/mL, 0.25 mg/mL, and 0.125 mg/mL). The activity index (AI), calculated as the ratio of the extract's inhibition zone to that of a standard antibiotic (see Table 7.1), is reported alongside each measurement to normalise and compare potency. As summarised in Table 5, the extract demonstrated concentration-dependent activity, with the highest inhibitory effects observed at 1 mg/mL. Notably, against *Salmonella spp.*, the extract exceeded the standard antibiotic's activity (AI = 1.25), while for *E. coli* and *Bacillus spp.*, bactericidal effects diminished at the lowest concentration (0.125 mg/mL), with no detectable inhibition (AI = 0.00).

Table 3: FT-IR analysis of green *Dracaena trifasciata*

| Peak Number | Wavenumber (cm <sup>-1</sup> ) | Intensity | Type of vibration  | Molecule/Functional group responsible |
|-------------|--------------------------------|-----------|--------------------|---------------------------------------|
| 1           | 1028.74524                     | 72.80840  | Strong C=O bend    | Alkene                                |
| 2a          | 1282.20422                     | 85.63672  | Strong C-N stretch | Amine                                 |
| 2b          | 1282.20422                     | 85.63672  | Strong C-O stretch | Aromatic ester                        |
| 3a          | 1353.02363                     | 85.16811  | Strong C-N stretch | Aromatic amine                        |
| 3b          | 1353.02363                     | 85.16811  | Strong C-H bend    | Alkane                                |
| 4           | 1640.02865                     | 65.05757  | Strong C=C stretch | Alkene                                |
| 5           | 2117.12789                     | 95.50029  | Strong O-H stretch | Carboxylic acid                       |
| 6           | 2344.49550                     | 96.58978  | Strong O=C=O       | Carbon dioxide                        |
| 7a          | 3268.87528                     | 42.26594  | Medium O-H stretch | Alcohol                               |
| 7b          | 3268.87528                     | 42.26594  | Medium N-H stretch | Aliphatic primary amine               |

Note: Vitamin C and E were quantified using an HPLC method

Table 4: AAS analysis of green *Dracaena trifasciata*

| PARAMETER | METHOD        | CONCENTRATION |
|-----------|---------------|---------------|
| Chromium  | APHA 3500 -Cr | 0.400 (mg/L)  |
| Manganese | APHA 3500 -Mn | 1.982 (mg/L)  |
| Lead      | APHA 3500 -Pb | 0.011 (mg/L)  |
| Zinc      | APHA 3500 -Zn | 0.426 (mg/L)  |
| Copper    | APHA 3500 -Cu | 0.023 (mg/L)  |
| Magnesium | APHA 3500 -Mg | 0.260 (mg/L)  |
| Nickel    | APHA 3500 -Ni | 0.001 (mg/L)  |
| Vitamin C | AOAC 967.21   | 7.61 (mg/ml)  |
| Vitamin E | AOAC 2012.09  | 41.24 (mg/ml) |

Table 5: Antimicrobial activity of *Dracaena trifasciata* extract at varying concentrations

| Test organisms               | 1 mg/ml |      | 0.5 mg/ml |      | 0.25 mg/ml |      | 0.125 mg/ml |      |
|------------------------------|---------|------|-----------|------|------------|------|-------------|------|
|                              | mm      | AI   | mm        | AI   | mm         | AI   | mm          | AI   |
| <i>Staphylococcus aureus</i> | 20      | 1.00 | 18        | 0.90 | 13         | 0.65 | 10          | 0.50 |
| <i>Escherichia coli</i>      | 20      | 1.00 | 15        | 0.75 | 10         | 0.50 | 0           | 0.00 |
| <i>Bacillus spp.</i>         | 15      | 0.50 | 15        | 0.50 | 10         | 0.33 | 0           | 0.00 |
| <i>Salmonella spp.</i>       | 25      | 1.25 | 20        | 1.00 | 10         | 0.50 | 10          | 0.50 |

Note: AI means activity index with respect to the zone of inhibition of Ciprofloxacin as the standard antibiotic "0" indicates no inhibition zone detected.

## DISCUSSION

This integrated study provides a detailed phytochemical and bioactivity profile of *D. trifasciata*. The high TPC and TFC directly correlate with the significant antioxidant activity observed, which operates via hydrogen-atom donation (DPPH assay) and electron-transfer (FRAP assay) mechanisms. The identified compounds, particularly the methoxylated flavonoid (3',4',5,7-Tetramethoxyflavone) and sulfur-containing phenol, are likely key contributors due to their known redox properties (De Souza *et al.*, 2018). The remarkable Vitamin E content (41.24 µg/mL) is a significant finding, as this lipophilic antioxidant can synergise with hydrophilic phenolics to provide comprehensive protection against oxidative stress. The antimicrobial activity of *Dracaena trifasciata* extract demonstrates a concentration-dependent and organism-specific profile, consistent with established principles of antimicrobial pharmacodynamics (Lambert, 2002). Notably, the extract exhibited superior potency against *Salmonella spp.*, with an Activity Index (AI) exceeding 1.0 at the highest concentration. While broad initial activity was observed, a sharp decline in efficacy against *E. coli* and *Bacillus spp.* at lower concentrations reveals a critical potency threshold, likely indicating the minimum inhibitory concentration (MIC) lies between 0.25 and 0.125 mg/mL for these organisms and underscoring the permeability challenges posed by Gram-negative cell envelopes (Breijyeh *et al.*, 2020).

These findings align with and extend previous research on the genus. The significant activity against *Salmonella* supports ethnobotanical uses and corroborates studies attributing such effects to bioactive compounds like steroidal saponins found in related species (Mohan *et al.*, 2013; Mboosso *et al.*, 2013). However, variations in potency—such as the more rapid loss of activity against *E. coli* compared to some literature (Alshehri, 2022)—highlight the significant influence of plant chemotype and extraction methodology on the resultant phytochemical profile. This confirms the plant's antimicrobial potential while precisely defining its spectrum and limitations, thereby justifying targeted future research into the isolation and mechanistic action of its specific active constituents. The presence of fatty acid esters and phenolics suggests a multi-target antimicrobial mechanism involving membrane disruption and protein binding. The GC-MS profile, which reveals major constituents not previously emphasised in *D. trifasciata*, advances phytochemical knowledge of this species. The FT-IR analysis confirmed the presence of functional groups consistent with the

identified compound classes. A notable implication arising from the rich phenolic profile and strong electron-donating capacity (FRAP) is the potential for interdisciplinary applications. The heteroatom-rich phenolic compounds could act as adsorbates on metal surfaces, suggesting a testable hypothesis for the use of *D. trifasciata* extracts as environmentally benign, green corrosion inhibitors—an avenue for future materials science research (Verma *et al.*, 2020).

## CONCLUSION

This study conclusively demonstrates that *Dracaena trifasciata* is a rich source of diverse bioactive compounds, including phenolics, flavonoids, fatty acid esters, and a high concentration of Vitamin E. The extract possesses significant, dose-dependent antioxidant and broad-spectrum antimicrobial activities, providing a scientific basis for its traditional uses. The comprehensive chemical dataset also opens new possibilities for its application in nutraceutical development and, potentially, in green industrial chemistry. Further research should focus on isolating the active principles, conducting in vivo studies, and exploring the proposed corrosion inhibition potential.

## RECOMMENDATIONS

- i. Undertake bioassay-guided fractionation to isolate and characterize the most active antioxidant and antimicrobial compounds.
- ii. Perform in vivo toxicity and efficacy studies to validate pharmacological potential.
- iii. Determine the Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) for a precise antimicrobial assessment.
- iv. Experimentally evaluate the extract's performance as a green corrosion inhibitor using electrochemical methods.
- v. Develop standardized extraction and quality control protocols based on the identified marker compounds for potential product development.

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