Development and evaluation of *Dracaena trifasciata* hydrogel: A multifunctional approach for topical therapeutic formulations

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ABSTRACT

Dracaena trifasciata is a widely used ornamental plant that possesses an array of bioactive compounds contributing to its potent antibacterial, anti-inflammatory, antipyretic, analgesic and anti-diabetic properties. The current research involved extracting bioactive compounds from D. trifasciata employing ethanolic and methanolic solvents, followed by the evaluation of their phytochemical profiles and antioxidant activities. These extracts were then used to develop hydrogel formulations F1, F2, and F3, each containing ethanolic extract, methanolic extract, and a combination of both, respectively. These formulations were examined for their spreadability, pH levels, physical stability, and extrudability. The antibacterial activity of these formulations was subsequently tested against pathogens to determine their potential use as topical agent. The ethanolic and methanolic extracts of D. trifasciata revealed the presence of various bioactive compounds and demonstrated significant antioxidant activity. The formulations exhibited ideal physicochemical properties, including pH, spreadability, extrudability, and physical stability. They also exhibited significant antibacterial activity against P. aeruginosa, S. pyogenes, E. coli which validates their potential as effective and reliable topical agents.

***Keywords**:* Antioxidant, *Dracaena trifasciata*, hydrogel, phytochemicals, topical formulation.

INTRODUCTION

Dracaena trifasciata, commonly referred to as the 'snake plant,' is a perennial evergreen herbaceous species utilized for its therapeutic properties in managing inflammatory conditions, snakebites, otalgia, edema, furuncles, and febrile illnesses (Teponno *et al.*, 2016). *Dracaena trifasciata*stands out as one of the most recommended species for enhancing indoor air quality due to its exceptional capacity to purify air by efficiently removing pollutants such as nitrogen oxides, formaldehyde, xylene, and toluene, facilitated by its Crassulacean Acid Metabolism (CAM) adaptation(Umoh *et al.*, 2020; Kaur and Mudgal, 2021). The robust, lustrous, and lengthy natural fibers found in the leaves of this plant were traditionally utilized for crafting bowstrings and fishing lines, owing to their exceptional strength and durability, and is currently being explored for applications in the automotive industry as a reinforcement material in polyester composite manufacturing (Widyasanti*et al.*, 2020; Myint and Swe, 2019). Their phytochemical profile is characterized by a wide range of compounds, including steroidal alkaloids, sterols, flavonoids, and anthraquinones, many of which have demonstrated promising pharmacological properties supporting its traditional medicinal

application in treating various health conditions. Additionally, several studies suggest that certain attributes of snake plants may have the potential to address issues related to antimicrobial resistance (Kaur *et al.,* 2023).

Tissue damage is a common occurrence in daily life, often resulting from factors such as surgeries, burns, skin diseases, and other traumatic events. Injuries such as surgeries, burns, and skin diseases can cause significant tissue damage, resulting in the loss of essential protective mechanisms and the subsequent formation of a wound (Chi *et al.,* 2020). Wounds can be classified as acute or chronic, wherein acute wounds typically heal quickly, while the chronic wounds have a prolonged healing process, often lasting one to three months or more (Liu *et al.,* 2022). Wound healing is a complex biological phenomenon involving sequential stages of inflammation, proliferation, and remodeling, all of which are essential for the efficient repair and closure of injured tissues and wounds (Ruseva *et al*., 2020; Gavel *et al.,* 2020). The delayed healing of chronic wounds is frequently attributed to microbial colonization within the wound bed, impeding the normal healing process. Effective management of chronic wounds is crucial to prevent complications such as amputation, sepsis, and death (Liu *et al.,* 2022). Traditional textile dressings, despite being cost-efficient, do not possess effective anti-infective properties, tend to be dry, and often adhere to wounds, thus compromising the wound healing process (Liu *et al.,* 2021).

Hydrogels are three-dimensional network structure, formed by crosslinked polymer chains through physical or covalent bonds. The unique three-dimensional network structure of hydrogels enables them to exhibit remarkable water absorption and retention properties (Liu *et al.,* 2022). The substantial water content of hydrogels effectively maintains a moist wound environment, which is crucial for reducing the risk of scar formation as well as providing a cooling effect and minimizing tissue adherence, thereby reducing patient discomfort (Sun *et al.,* 2020; Kumar and Kaur 2020).The remarkable swelling capacity of hydrogels enables them to absorb a substantial amount of exudate, thus ensuring an effective wound management (Singh and Kumar 2020). Additionally, the high porosity of hydrogels facilitates the transmission of oxygen, promoting tissue oxygenation and enhancing wound healing (Stubbe *et al.,* 2019). Hydrogels are typically prepared from both synthetic polymers, such as carbomer (Carbopol) and carboxy methylcellulose, and natural polymers, like xanthan gum and guar gum. Synthetic polymers are preferred more often, with carbomer being the most widely used due to its excellent physical and rheological properties (Jain *et al.,* 2016).

The study involved the extraction of *Dracaena trifasciata* phytoconstituents using ethanol and methanol as solvents. The resultant crude extracts were subsequently analysed for their phytochemical composition. These extracts were then incorporated into hydrogels, with Carbopol 940 serving as the primary polymer matrix. The formulated hydrogels underwent a series of evaluations to assess their physicochemical properties and were ultimately tested for their antibacterial efficacy against wound pathogens, including *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli*, and *Streptococcus pyogenes*.

MATERIALS AND METHODS

Materials

Folin–Ciocalteus's reagent and 1, 1-diphenyl-2- picrylhydrazyl (DPPH) were obtained from Merck pvt ltd. Potassium dichromate, gallic acid (= GA), ascorbic acid (AA), $AlCl_3$, H_2SO_4, Nitric acid, NaOH, quercetin (QU), DMSO, EDTA, Diclofenac-Na, sodium nitrous, tween-80 and $FeCl_3$ were obtained from the Hi media Chemicals pvt ltd.

Sample collection and preparation

The aerial parts of *D. Trifasciata* leaves with

horizontal bands of light green with yellow margins were collected from Peelamedu region of Coimbatore district, Tamil Nadu, India. The leaves were extensively washed with distilled water to ensure the removal of all surface impurities and subsequently shade dried for 7 days. The cleaned leaves were cut into small pieces and subsequently subjected to thermal drying in a hot air oven at 120°C for 3 hrs. The dried leaves material was mechanically ground into a uniform coarse powder, ensuring homogeneity and stored in airtight containers for further use.

Sample extraction

About 450 g of the dried pulverized material was placed in an amber-colored glass container and soaked separately with 1600 mL of ethanol and methanol. The sealed containers were kept at room temperature for 7 days, with intermittent shaking and stirring. After the extraction period, the mixtures were filtered through a piece of clean white cotton, followed by Whatman No. 1 filter paper. The filtrate was allowed to evaporate at room temperature and the crude extract was reconstituted in dimethyl sulfoxide (DMSO) for subsequent analysis (Hossain *et al.,* 2016).

$$\text{Extraction efficiency (\%)} = \frac{\text{Final dry weight}}{\text{Initial dry weight}} \times 100$$

Phytochemical analysis

The extracts were subjected to a thorough phytochemical screening to identify the presence of an array of bioactive compounds such as f tannins, alkaloids, saponins, flavonoids, terpenoids, anthraquinones, glycosides, steroids, reducing sugars, amino acids and phenolic compounds (Gul *et al.,* 2017; De Silva *et al.,* 2017).

Estimation of antioxidant content Total phenolics content

For the quantification of total phenolics, 0.1 ml of the extract was dissolved in 0.4 ml of methanol and then combined with 2.5 ml of Folin–Ciocalteu reagent. The solution was kept at 25 °C for 3 to 5 min to facilitate the reaction. Subsequently, 0.8 ml of sodium hydrogen carbonate solution (75 g/l) was added to the reaction mixture. The reaction mixture was incubated at 25 °C for 60 minutes to ensure, followed by absorbance measurement at 765 nm using a UV-Vis Spectrophotometer (Shimadzu).The phenolic content of the extracts was then calculated and expressed as gallic acid equivalents (GAEs) (Yuniarsih *et al.,* 2023).

Total flavonoid content

To determine the total flavonoid content 0.1 ml of the extract was mixed with 2.4 ml of methanol, 0.1 ml of a 10% aluminum chloride solution, 0.1 ml of 1M sodium carbonate, and 2.3 ml of distilled water.Following a 30min incubation at 25 °C, the solutions absorbance was measured at 432 nm using a UV-Vis spectrophotometer, with the results expressed in terms of quercetin equivalents (QEs)

Determination of antioxidant activity DPPH assay

The DPPH assay involved the preparation of a 0.1 mM DPPH solution in ethanol.160 µL of this solution was added to 40 µL of sample solutions at various concentrations, diluted in methanol. The samples were incubated for 25 min at room temperature, and the absorbance values were subsequently measured at 517 nm. The DPPH radical scavenging activity was calculated, and the results were expressed as IC_{50} (mg/mL), which corresponds to the concentration at which 50
% inhibition was observed.

$$\text{DPPH scavenging effect (\%)} = \frac{Ac - As}{Ac} \times 100$$

Wherein, Ac corresponds to the absorbance of control, while As denotes to the absorbance of sample. The antioxidant activity was compared using ascorbic acid as the standard reference

(Recheke*t al.*, 2021).

ABTS assay

The ABTS cation radical scavenging activity was evaluated via spectrophotometric analysis. ABTS radicals were formed by reacting 2.45 mM potassium persulfate with a 7 mM ABTS solution, which was incubated in the dark at room temperature for 12 hrs.This solution was subsequently diluted with ethanol to achieve an absorbance of 0.700 at 734 nm.For the assay, 160 µL of the ABTS solution was added to 40 µL of sample solutions diluted in methanol at various concentrations in a 96-well plate.The following equation was used to determine the scavenging potential of ABTS radicals

$$\text{ABTS scavenging effect (\%)} = \frac{\text{Ac} - \text{As}}{\text{Ac}} \times 100$$

where Ac refers to the absorbance of control; As refers to the absorbance of sample. Trolox served as the reference standard for comparative analysis of antioxidant activity (Rechek *et al.*, 2021).

Ferric reducing power assay

The reaction setup involved mixing 40 µl of phosphate buffer (pH 6.6) with 50 µL of 1% (w/v) potassium ferricyanide. Subsequently, 10 µl of plant extract, at varying concentrations (200, 100, 50, 25, and 12.5 µg/ml), was added. The solution was then incubated for 20 min at 50 °C to facilitate the reaction. Subsequently, the reaction mixture was treated with 50 ml of 10% trichloroacetic acid (TCA), 40 ml of deionized water, and 10 µl of 0.1% ferric chloride ($FeCl_3$). The absorbance was then measured at 700 nm, where an increase in absorbance denoted enhanced ferric reducing power (FRP). The results, expressed as A0.50, denoted the concentration necessary to attain an absorbance of 0.500. Catechin served as the standard for comparison (Recheke*t al.*, 2021).

Formulation of hydrogel

To formulate the hydrogels, was dispersed in 5 ml of sterilized water and stirred continuously at 500 rpm for 4 hours. Subsequently, 0.1 % of the *D. trifasciata* leaf crude extract was incorporated and stirred for another 2 hours. The formulation process included the addition of
0.02 g each of propyl paraben and methyl paraben. This was followed by the addition of 0.8 ml of glycerine and 0.5 ml of oleic acid. The final volume was adjusted to 10 ml with distilled water. The prepared samples were then equilibrated at room temperature for 24 hours prior to undergoing evaluation tests. Three formulations were developed: one containing ethanolic extract (F1), one with methanolic extract (F2), and a combination of both extracts (F3). A formulation lacking *D. Trifasciata* extract served as the control (Table 1) (Chirayath*et al.*, 2019).

Evaluation of hydrogel formulation

Organoleptic analysis

The organoleptic properties of the newly formulated topical gel, encompassing its appearance, homogeneity, washability, consistency, phase separation, and odor, were systematically evaluated through visual inspection. The assessment of homogeneity and texture was conducted by positioning samples between the thumb and index finger, ensuring a comprehensive evaluation. The stability of the gel formulation was examined by subjecting it to centrifugation at 5000 rpm for 30 minutes, monitoring for any phase separation, creaming, or cracking phenomena. Concurrently, the immediate skin feel, encompassing parameters such as stiffness, grittiness, and greasiness, was assessed to ensure the formulation's overall sensory and physical integrity (Alam *et al.*, 2023).

Spreadability

The spreadability of the innovative topical

gels was quantitatively assessed by placing 0.5 g samples between glass plates, each with a predetermined weight of 100 g, and allowed to remain undisturbed for 10 min. The spreading area was measured using the formula

$$\text{Spreadability (S)} = M \times \frac{L}{T}$$

Wherein, M is the weight that is placed on the upper slide, L is the length of the glass slide and T represents the time duration (Garg *et al.*, 2002).

Physical stability

The physical stability of the novel topical gel formulation was investigated under a range of storage conditions ($40 \pm 2°C$, $30 \pm 2°C$, and $25 \pm 2°C$) over a 28-day period. T This investigation evaluated the stability and performance of the product, with careful documentation of any shifts in appearance, color, homogeneity, phase separation, and uniformity within the packaging tube to ensure comprehensive quality assessment (Alam *et al.*, 2023).

pH

The pH measurement of the gel was carried out with a digital pH meter. A 2 g gel sample was mixed in distilled water until a homogeneous suspension was formed. The suspension volume was adjusted to 40 mL, and the pH of the resulting solution was measured (Singh *et al.*, 2013).

Extrudability

The extrudability test involved filling capped collapsible aluminum tubes with the gel formulations, followed by precise weighing. The tubes were clamped between two glass slides and subjected to a 500 g weight placed on the top slide. After removing the cap, the extruded gel was collected and weighed to calculate the extrusion percentage, providing insights into the gel's behavior under mechanical stress (Mohan *et al.*, 2020).

Determination of antibacterial activity

The antibacterial efficacy of the hydrogel formulations was assessed against *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, and *Streptococcus pyogenes* using the agar well diffusion method. Bacterial cultures were grown overnight and diluted to achieve an optical density of 0.5 at 600 nm. Subsequently, 100 µl of these standardized bacterial suspensions were uniformly spread onto LB agar plates. Agar wells, 8 mm in diameter, were then created using a sterile agar well cutter to facilitate the introduction of the hydrogel formulations. Each well was loaded with 100 µl of the respective hydrogel formulations (F1, F2, F3, and Control) in 100 µl of DMSO. The plates were incubated at 37°C for 24 hours in an upright position. The zones of bacterial growth inhibition surrounding the wells were measured to determine the antimicrobial effectiveness of the hydrogel formulations (Chirayath *et al.*, 2019)

RESULTS AND DISCUSSION

Sample extraction

The extraction of *D. trifasciata* leaves using ethanol and methanol solvents yielded 15.45% and 11.12% respectively. The higher yield from methanol extraction implies that the bioactive compounds in the snake plant exhibit a polarity similar to that of methanol, demonstrating a better affinity of these phytoconstituents for methanol compared to ethanol (Marjoni*et al.*, 2023).

Phytochemical analysis

The phytochemical screening results of the alcoholic (ethanolic) and methanolic extracts from
D. trifasciata leaves, as detailed in Table 2, confirm the presence of polyphenols, flavonoids, saponins, alkaloids, steroids, glycosides, reducing sugars, and amino acids in both extracts. Additionally, the ethanolic

extract showed the presence of tannins and anthraquinones, while the methanolic extract revealed triterpenoids. These findings are consistent with those reported in previous studies (Umoh *et al.,* 2020; Oomariyah and van Dijk, 2022; Oboho *et al.,* 2024; Sarjani*et al.,* 2021). Phytochemicals are characterized by a wide array of potential activities that can be applied to various beneficial uses. Compounds such as cardiac glycosides, flavonoids, triterpenoids, alkaloids, phenols, and saponins imparts strong anti-inflammatory properties to these compounds (Oboho *et al.,* 2024). Additionally, the presence of alkaloids, saponins, terpenoids, steroids, glycosides, and tannins collectively enhance their antibacterial potential (Gul *et al.,* 2017). Furthermore, different flavonoid structures are associated with antifungal, antiviral, and antibacterial properties (Berame *et al.,* 2017).

Estimation of antioxidant content Total

phenolics content

The quantification of total phenolic content in the ethanolic and methanolic extracts of *D. trifasciata* leaves was assessed using a gallic acid standard curve. The phenolic content was determined to be 13.84 mg GAE/g of extract for the ethanolic extract and 9.65 mg GAE/g of extract for the methanolic extract (Fig 1a). The antioxidant activity of the extracts is attributed to their phenolic components, which exhibit a well-established positive correlation with antioxidant activity due to the hydroxyl groups' scavenging ability Jain *et al*. (2016). The hydroxyl groups can donate hydrogen atoms to free radicals, thus enabling phenolic compounds to mitigate the free radical's effects (Sarjani*et al.,* 2021).

Total flavonoid content

The total flavonoid content in the *D. trifasciata* leaf extracts was quantified, yielding 8.17 mg QE/g from the ethanol and 6.27 mg QE/g in the methanol (Fig 1b). The antioxidative activity is facilitated through the inhibition of cyclooxygenase and lipoxygenase enzymes, which reduces prostaglandin and leukotriene levels, disrupts the arachidonic acid pathway, and decreases capillary permeability (Oboho *et al.,* 2024). Flavonoids demonstrate antibacterial activity by disrupting bacterial cell membrane integrity (Dewatisari *et al.,*, 2021), in addition to exhibiting antifungal and antiviral properties (Umoh *et al.,* 2020). Moreover, flavonoids are known to possess antiseptic, anti-inflammatory, and anticancer effects (Febriani *et al.,* 2019).

Determination of antioxidant activity

A single assay is often insufficient to evaluate the total antioxidant potential, since different mechanisms play a role in the neutralization of free radicals. Consequently, the antioxidant efficacy of the *D. trifasciata* extract was subjected to three different assessment methods with the results illustrated in Fig 2.

DPPH assay

The DPPH radical scavenging assay indicated that the ethanolic extract of *D. trifasciata* achieved a 45 % antioxidant activity, while the methanolic extract displayed a 37 % antioxidant potential (Fig 2a). The data demonstrated a dose-dependent enhancement in free radical inhibition, with higher concentrations yielding greater inhibition percentages. The ethanolic extracts of *D. trifasciata* leaves demonstrated DPPH scavenging rates of 45 %, 37 %, 25 %, 16.5
%, 11 %, and 6 % at corresponding concentrations of 200, 100, 50, 25, 12.5, and 6.25 µg/ml. Meanwhile, the methanolic extracts achieved scavenging rates of 37 %, 29.5 %, 20.5 %, 12.5 %,
8.5 %, and 3.5 % at the same concentrations. The IC_{50} values for DPPH scavenging by the ethanolic and methanolic extracts were determined to be 331.45 µg/ml and 1586.3 µg/ml, respectively.Earlier investigations have reported diverse IC50 values for *D. trifasciata*leaf extracts, with results

showing 285.602 µg/ml(Lontoc *et al*, 2018) 119.04 µg/mL (Shidhaye*et al.*, 2024), 48.77 µg/ml(Siddique*et al.*, 2014), and 2.19 µg/ml(Dewatisari*et al.*, 2024).

ABTS assay

The ABTS radical scavenging assay results revealed that the ethanolic extract of *D. trifasciata* exhibited a 63 % antioxidant activity, whereas the methanolic extract showed a 53.5 % antioxidant potential (Fig 2b). The data illustrated a dose-dependent increase in free radical inhibition, with higher extract concentrations resulting in higher inhibition percentages. The ethanolic extracts showed ABTS scavenging rates of 63 %, 48.5 %, 37 %, 23 %, 17 %, and 7.5
% at concentrations of 200, 100, 50, 25, 12.5, and 6.25 µg/ml, respectively. Concurrently, the methanolic extracts achieved scavenging rates of 53.5 %, 37 %, 24 %, 17.5 %, 13.5 %, and 6 % at the same concentrations. The IC_{50} values for the ethanolic and methanolic extracts were established as 105.56 µg/ml and 176.20 µg/ml, respectively.

Ferric reducing power assay

The FRAP assay results for *D. trifasciata* leaf extracts, as shown in Fig 2c, reveal that the ethanolic extract possesses a significantly higher reducing power than the methanolic extract. The ethanolic extract had a reducing potential of 14.66 µg/ml, while the methanolic extract was at 26.71 µg/ml, with catechin as a standard showing 1.78 µg/ml at $A_{0.5}$. This assay evaluates the reducing power of compounds based on their ability to donate hydrogen atoms or electrons.The FRAP assay underscores the importance of hydrogen atom and electron donation capabilities in the antioxidant activity of these extracts. The high reducing power is due to the presence of hydrogen atom donors, as well as methoxy, keto, triterpenes, and acid groups in the plant extracts, which enhance their reducing potential and effectiveness as antioxidants (Shukla *et al.*, 2015).

Formulation of hydrogel

The formulation development employed pharmaceutical-grade constituents, adhering to the composition framework detailed in Table 1. The gelling agents incorporated include Carbopol 940, alongside preservatives such as Propyl paraben and Methyl paraben. The active ingredients were the ethanolic and methanolic extracts of *D. trifasciata* leaves, with oleic acid serving as a solubilizing agent and glycerin as a humectant.

Evaluation of hydrogel formulation

Organoleptic properties

The physicochemical properties of the novel topical gels were thoroughly evaluated, with specific focus on parameters such as appearance, phase separation, consistency, washability, odor, and immediate skin feel, as detailed comprehensively in Table 3. The prepared gel formulations varied in color from pale green to white for F1, F2, and F3, with the control formulation distinctly white. All formulations were grit and lump-free, exhibiting an opaque appearance. The gels applied smoothly, confirming their uniformity and washability, with no discernible odor.

Spreadability

The spreadability test results for the formulations are presented in Fig 3a. The results indicated that all the formulations fulfilled the requirements for good spreading efficiency. The evaluation revealed that formulation F3 possessed the highest spreadabilityat 8.86 g.cm. This was followed by formulation F1 with a spreadability of 8 g.cm, F2 with 7.18 g.cm, and the control with 7 g.cm. The ability of the newly developed gel formulation to distribute uniformly over the skin surface is a distinct characteristic, highlighting its excellent spreadability. Effective spreadability is paramount for topical formulations to ensure patient compliance. A

gel is deemed effective when it requires minimal time to disperse across the skin surface (Garg *et al.,* 2002).

Physical stability

The physical stability of the newly formulated gel was systematically evaluated at various time intervals to detect any signs of destabilization. The tubes were placed between two glass slides and were clamped on which a weight of 500 gm was placed over the slides and then the cap was removed. The results, as detailed in Table 4, confirm that the topical gel maintained its stability under the specified conditions throughout the assessment period.

pH

Ensuring an appropriate pH level is crucial for topical preparations to prevent skin irritation and scaling, with the ideal range being 4.5–6.5 (Yuniarsih*et al.,* 2023). The pH values for the developed formulations were 6.05 for F1, 6.76 for F2, 6.47 for F3, and 4.45 for the control, as depicted in Fig. 3b.These values demonstrate that all formulations comply with the required pH standards.

Extrudability

Extrudability analysis is performed to quantify the force necessary to expel the formulation from a filled tube. Gels exhibiting high consistency may resist extrusion from their tubes, whereas those with lower viscosity may flow too swiftly; hence, an appropriate consistency is necessary for optimal extrusion. Ensuring efficient extrusion of the gel from the tube is critical for ease of application and patient compliance. The values of extrudability of different formulations are 93
% for F1, 91.5 % for F2, 92 % for F3 and 87 for control, as represented in Fig. 3c. Gel formulations with extrudability rates over 90% are categorized as excellent, while those with rates at 80% are rated as good and those at 70% are considered as fair.

Determination of antibacterial activity

The hydrogel formulation F3 exhibited robust antibacterial efficacy, with inhibition zones measuring 20 mm, 12 mm, and 10 mm against *P. aeruginosa*, *S. pyogenes*, and *E. coli*, respectively (Table 5). Additionally, the F2 formulation too displayed considerable activity against *P. aeruginosa* and *E. coli*, presenting inhibition zones of 17 mm and 13 mm, respectively. In contrast, formulation F1 displayed a more selective antibacterial activity, showing significant efficacy only against *P. aeruginosa* with a 15 mm zone of inhibition. The classification of antibacterial potency based on the zone of inhibition is crucial for evaluating the efficacy of developed antimicrobial agents. A zone of inhibition $\geq$ 20 mm signifies a very strong level of antibacterial activity. Zones that fall within the range of 10 to 20 mm are classified as having strong activity, while those between 5 and 10 mm exhibit moderate activity (Hudzicki*et al.*, 2016).

The significant antibacterial activity observed in *D. trifasciata* extract gel formulations underscores the presence of a complex array of bioactive compounds. The broad-spectrum antimicrobial activity can be attributed to a synergistic effect of various phytochemicals present in the extract, including alkaloids, saponins, terpenoids, steroids, glycosides, tannins, acids, fats, and oils, all of which enhance the formulation's therapeutic potential (Akindele *et al.*, 2015; Andhare*et al.*, 2012). The antibacterial properties of ethanolic extracts from *D. trifasciata* leaves stem from their rich composition of bioactive molecules. These extracts show substantial potential as a natural antibacterial and antiseptic agent highlighting their potential for inclusion in natural therapeutic applications (Buyun*et al.*, 2018; Tkachenko *et al.*, 2017). The methanolic leaf extract of *D. trifasciata* demonstrates significant antibacterial activity, primarily due to its active phytochemical constituents, including saponins, phenols, and flavonoids (Febriani*et al.*, 2019).

CONCLUSION

The phytochemical analysis of *Dracaena trifasciata* leaf extracts confirmed the presence of various secondary metabolites, including alkaloids, flavonoids, and saponins, highlighting its pharmacological relevance and supporting its traditional medicinal applications. Quantitative assessments revealed significant antioxidant activity, demonstrating the extracts' potential in mitigating oxidative stress-related diseases and promoting cellular health. The formulation of Carbopol-based hydrogels incorporating these extracts resulted in optimal homogeneity, consistency, extrudability, and spreadability. Additionally, agar plate diffusion assays validated the effective release of bioactive compounds from the hydrogels, showcasing substantial antibacterial activity against *S. pyogenes*, *E. coli*, and *P. aeruginosa*. These findings position *D. trifasciata* extracts as promising candidates for topical therapeutic applications in cosmetic science.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1: Composition for hydrogel formulation with *D. trifasciata*

INGREDIENTS	F1	F2	F3	CONTROL
D.trifasciata Ethanolic extract	-	0.1 g	0.05 g	-
D.trifasciata methanolic extract	0.1 g	-	0.05 g	-
Carbopol 940	0.15 g	0.15 g	0.15 g	0.15 g
Propylparaben	0.02 g	0.02 g	0.02 g	0.02 g
Methylparaben	0.02 g	0.02 g	0.02 g	0.02 g
Glycerine	0.8 ml	0.8 ml	0.8 ml	0.8 ml
Oleicacid	0.5 ml	0.5 ml	0.5 ml	0.5 ml
Sterile H2O (Make upto)	10 ml	10 ml	10 ml	10 ml

Table 2: Phytochemical investigation of *D. trifasciata* leaf extracts

S. No	Phytochemical analyzed	Ethanolic extract	Methanolic extract	S. N	Phytochemical analyzed	Ethanolic e xtract	Methanolic extr
1.	Polyphenols	+	+	7.	Steroids	+	+
2.	Tanins	+	-	8.	Anthraquinone	+	-
3.	Flavonoids	+	+	9.	Glycosides	+	+
4.	Saponins	+	+	10.	Reducingsugars	+	+
5.	Alkaloids	+	+	11.	Amino acids	+	+
6.	Triterpenoids	-	+				

"+"indicates presence of the compound

"-"indicates absence of the compound

Table 3: Organoleptic characterization of novel topical gel formulation

Parameters	**Observation**			
	F1	**F2**	**F3**	**Control**
Appearance	Opaque	Opaque	Opaque	Opaque
Color	Pale green to white	Pale green to white	Pale green to white	White
Homogeneity	Homogenous	Homogenous	Homogenous	Homogenous
Consistency	Good	Good	Good	Good
Phase separation	No	No	No	No
Washability	Washable	Washable	Washable	Washable
Odor	No	No	No	No
Texture	Smooth	Smooth	Smooth	Smooth
Grittiness	No	No	No	No

Table 4: Physical stability examination of the developed formulations

Day/Condition	40 ±2°C					30 ±2°C					25 ±2°C				
	F1														
	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN
0	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
7	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
14	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
21	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
28	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
	F2														
	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN
0	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
7	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
14	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
21	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
28	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
	F3														
	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN
0	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
7	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
14	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
21	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
28	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes	Translucent	Y/NC	No	Yes	Yes
	Control														
	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN	PA	CL	PS	HM	UN
0	Translucent	W/NC	No	Yes	Yes	Translucent	W/NC	No	Yes	Yes	Translucent	W/NC	No	Yes	Yes
7	Translucent	W/NC	No	Yes	Yes	Translucent	W/NC	No	Yes	Yes	Translucent	W/NC	No	Yes	Yes
14	Translucent	B/C	No	Yes	Yes	Translucent	W/NC	No	Yes	Yes	Translucent	W/NC	No	Yes	Yes
21	Translucent	B/C	No	Yes	Yes	Translucent	B/C	No	Yes	Yes	Translucent	W/NC	No	Yes	Yes
28	Translucent	B/C	No	Yes	Yes	Translucent	B/C	No	Yes	Yes	Translucent	B/C	No	Yes	Yes

***PA-Physical appearance, CL–Color, PS-Phase separation, HM-Homogeneity, UN-Uniformity**

****Y/NC-Yellow and No change incolor, W/NC-White and change incolor, B/C-Brown and change in color**

Table 5: Zone of inhibition of the developed formulations

S. No	Formulation	*S. pyogenes*	*S. aureus*	*E. coli*	*P. aeruginosa*
		Zone of inhibition(mm)			
1.	F1	2	3	1	15
2.	F2	1	5	13	17
3.	F3	12	4	10	20
4.	Control	1	1	NA	NA

NA-No zone formation was observed

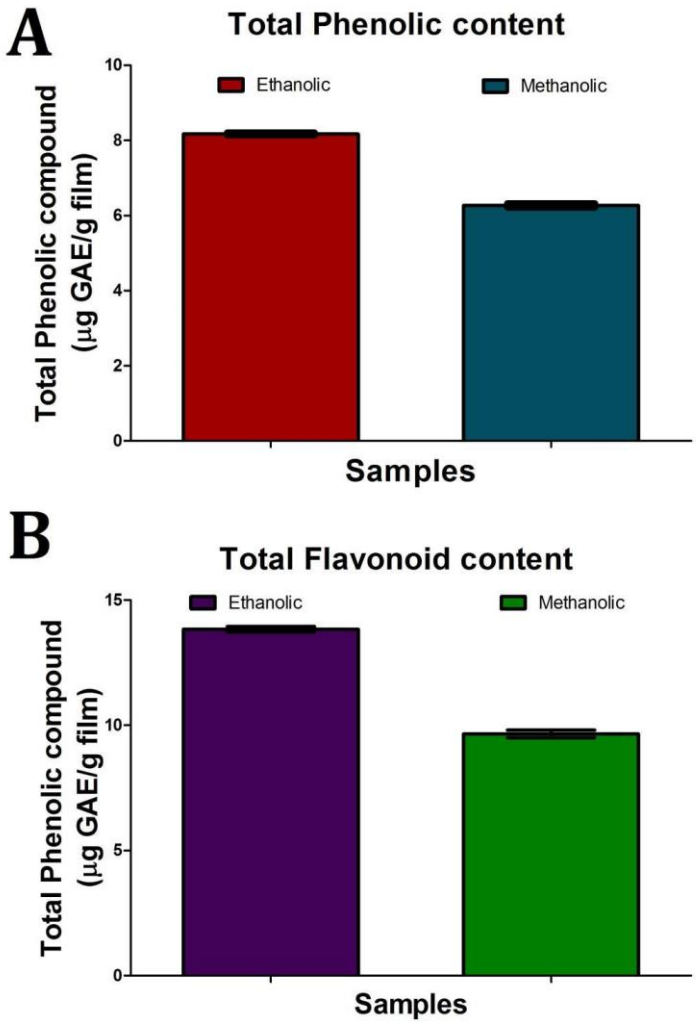

Fig 1: Estimation of antioxidant content in *D. trifasciata* leaf extracts. A. Estimation of total phenolic content in ethanolic and methanolic extracts of *D. trifasciata* leaves**. B.** Estimation of total flavonoid content in ethanolic and methanolic extracts of *D. trifasciata* leaves.

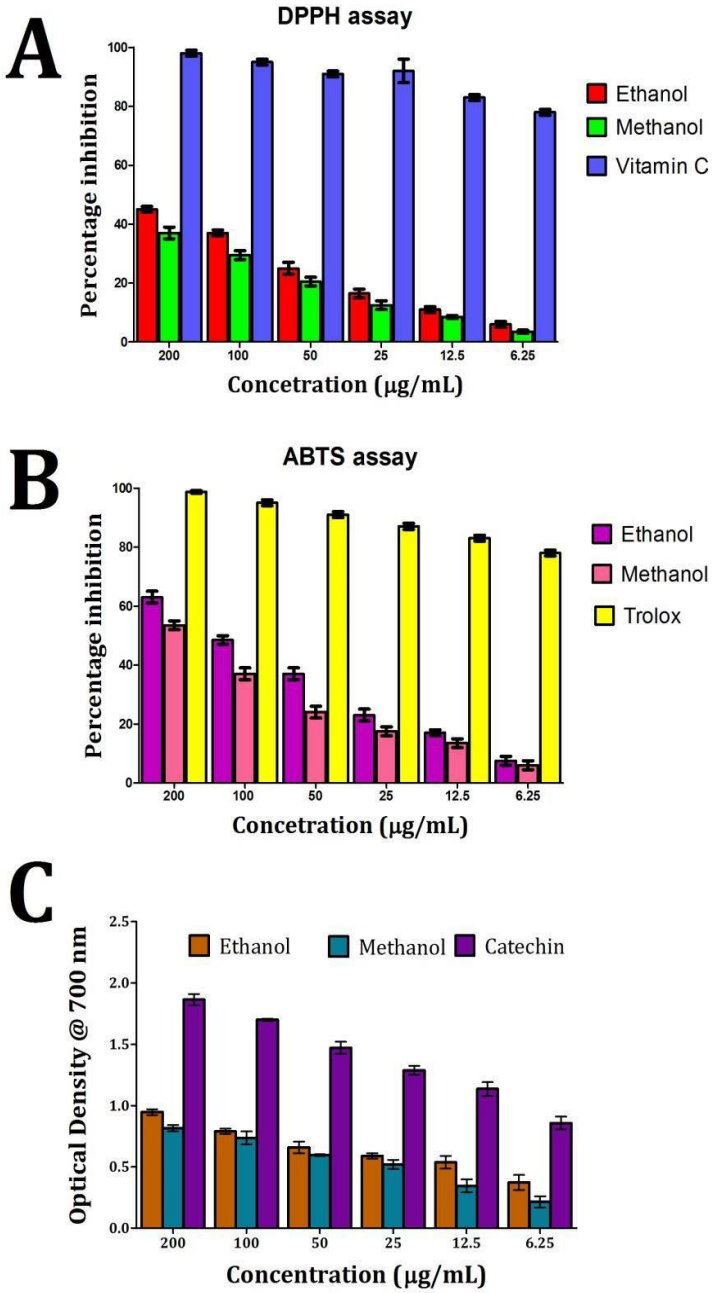

Fig 2: Assessment of antioxidant activity in *D. trifasciata* leaf extracts. A. Evaluation of DPPH radical scavenging activity in *D. trifasciata* extracts, **B.** Analysis of ABTS radical cation scavenging activity in *D. trifasciata* extracts and **C.** Estimation of ferric reducing power of *D. trifasciata* leaf extracts.

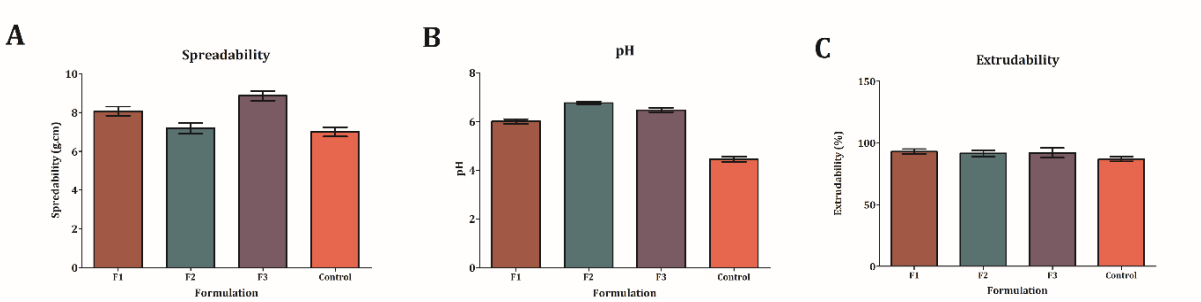

Fig 3: Characterization of hydrogels formulated with *D. trifasciata* leaf extracts. A. Assessment of spreadability of the hydrogel formulation, **B.** pH analysis of the hydrogel formulation and C. Evaluation of extrudability of the hydrogel formulation.