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Formulation And Assessment Of An Herbal Gel Containing Cymbopogon Citratus For Wound Healing

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ABSTRACT

Wound healing is a complex physiological process that can be impaired by infections and inflammation. Conventional therapies often pose risks such as side effects and antimicrobial resistance. In this study, an herbal gel formulation containing *Cymbopogon citratus* (lemongrass) extract was developed and evaluated for its wound healing potential. The ethanolic extract of *Cymbopogon citratus* leaves was obtained using Soxhlet extraction and subjected to phytochemical screening, which confirmed the presence of alkaloids, flavonoids, tannins, terpenoids, saponins, and glycosides. Antioxidant activity was assessed by DPPH assay, showing significant radical scavenging potential with an IC_{50} of 72.5 µg/mL. Three gel formulations containing 1%, 2%, and 3% extract were prepared using Carbopol 940 as the base. Evaluation parameters including pH, viscosity, spreadability, stability, and antimicrobial activity revealed that the 3% formulation demonstrated the best overall characteristics. The study concludes that *Cymbopogon citratus* gel holds promise as a natural, effective, and stable topical agent for wound healing applications.

Keywords: *Cymbopogon citratus, Lemongrass, Herbal gel, Wound healing, Antioxidant activity, DPPH assay, Phytochemical screening, Topical formulation, Carbopol 940, Natural antimicrobials*

1. INTRODUCTION

Wound healing is a vital process in medical care, as improper management can lead to complications such as infections, delayed recovery, and scarring. Conventional wound treatments often involve antibiotics and synthetic agents, which may cause side effects and contribute to antimicrobial resistance[1]. As a result, there is growing interest in herbal alternatives that are safer, cost-effective, and therapeutically beneficial. Herbal gels, in particular, offer an ideal medium for topical delivery due to their non-greasy texture, ability to maintain a moist environment, and sustained release of active compounds[2,3]. *Cymbopogon citratus* (lemongrass) is a medicinal plant renowned for its antimicrobial, anti-inflammatory, and antioxidant properties, attributed to bioactive constituents such as citronellal, geraniol, and flavonoids[4]. These properties make lemongrass a promising candidate for promoting wound healing, reducing infection, and enhancing tissue regeneration. When formulated into a gel, it ensures better adherence, ease of application, and visibility of the wound site[5].

OBJECTIVES : This study aims to formulate an herbal gel containing *Cymbopogon citratus* extract and evaluate its phytochemical content, antioxidant and antimicrobial properties, physicochemical characteristics, and stability. The goal is to develop a safe, effective, and stable herbal gel for wound healing applications.

PLANT PROFILE OF *CYMBOPOGON CITRATUS* (LEMONGRASS): *Cymbopogon citratus*, commonly known as lemongrass, is a tropical grass native to Southeast Asia, widely recognized for its medicinal and aromatic properties. It grows in dense clumps with long, narrow, lemon-scented leaves and thrives in warm, well-drained environments. The plant's leaves and essential oil are rich in bioactive compounds like citral, citronellol, geraniol, and linalool, which contribute to its antimicrobial, anti-inflammatory, antioxidant, and analgesic effects. Lemongrass is traditionally used for wound healing, infection prevention, and digestive support. Its essential oil, mainly extracted from the leaves, plays a vital role in topical applications due to its therapeutic efficacy in promoting skin regeneration and reducing microbial load[4,5].

2. MATERIAL AND METHODS

Plant collection: Fresh leaves of *Cymbopogon citratus* were collected from the herbal garden of Career Point University, Kota.

Materials: Dried *Cymbopogon citratus* (lemongrass) leaves were sourced from the herbal garden of Career Point University, Kota. Solvents and reagents included ethanol (95%), methanol, distilled water, DPPH, ferric chloride, Mayer's and Wagner's reagents, and ascorbic acid. Gel excipients used were Carbopol 940, glycerin, triethanolamine, methylparaben, and propylene glycol. Microbial strains (*S. aureus, E. coli, P. aeruginosa, C. albicans*) were cultured on MHA and SDA. Equipment included a UV-Vis spectrophotometer, viscometer, pH meter, incubator, and standard glassware.

Methods

1. **Plant Collection and Processing**: Fresh lemongrass leaves were cleaned, shade-dried for 7–10 days, powdered, and stored in airtight containers[2,6].
2. **Extraction**: 100 g of the powdered leaves underwent Soxhlet extraction using 95% ethanol for 6–8 hours. The extract was filtered and concentrated under reduced pressure at 40–50°C, then stored for further use[7,8].
3. **Phytochemical Screening**: Standard qualitative tests were performed to detect alkaloids, flavonoids, phenolics, tannins, terpenoids, saponins, and glycosides using reagents like Wagner's, Dragendorff's, $FeCl_3$, and sulfuric acid[8-10].
4. **Antioxidant Activity**: DPPH assay was used to assess radical scavenging activity. Various concentrations of the extract were tested and compared with ascorbic acid, with absorbance measured at 517 nm to determine % inhibition and IC_{50}[11,12].
5. **Gel Formulation**: A 1% Carbopol 940 gel base was prepared with glycerin, preservatives, and triethanolamine for pH adjustment. The ethanolic extract was incorporated with continuous stirring until a uniform gel was formed[12,13].
6. **Evaluation Parameters**: The formulated gel was tested for pH, viscosity, spread-ability, stability, and microbial activity against selected strains using the agar well diffusion method[14-16].

3. RESULTS

1. Plant Collection and Processing

Fresh *Cymbopogon citratus* leaves were successfully shade-dried for 7 days, resulting in a crisp, brittle texture suitable for grinding. The final powdered mass was greenish-brown and had a characteristic lemon-like aroma. Yield after drying was approximately 30–35% w/w of fresh weight.

2. Extraction

Soxhlet extraction of 100 g powdered leaves yielded 2.95 g of a dark greenish-brown ethanolic extract, giving a 2.95% w/w extractive yield. The extract was semi-solid at room temperature and showed good solubility in ethanol and DMSO.

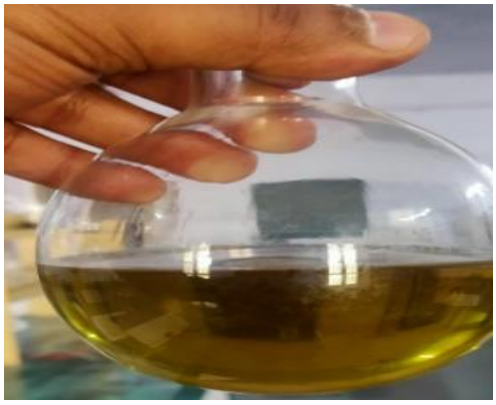

Figure 1: Obtained extract from soxhlation

3. Phytochemical Screening: Qualitative phytochemical analysis of the ethanolic extract revealed the presence of:

- Alkaloids (positive with Dragendorff's and Wagner's reagents)
- Flavonoids (positive via lead acetate and alkaline reagent test)
- Phenolics (positive with $FeCl_3$ test)

- Tannins (positive with gelatin and $FeCl_3$ tests)
- Terpenoids (positive via Salkowski's test)
- Saponins (froth test positive)
- Glycosides (positive via Keller–Killiani test)

Figure 2: Phytochemical evaluation of the extract

Table 1: Phytochemical screening *Cymbopogon citratus*

Sr. No.	Phytochemical Component	Test Used	Observation	Result
1	Alkaloids	Wagner's & Dragendorff's Tests	Reddish-brown precipitate, orange precipitate	Positive
2	Flavonoids	Shinoda's Test & Alkaline Reagent	Red/pink color, yellow color turning colourless	Positive
3	Phenolics	Ferric Chloride Test	Green/blue color	Positive
4	Tannins	Lead Acetate & Ferric Chloride Test	White precipitate, Green/black color	Positive
5	Terpenoids	Salkowski & Liebermann-Burchard Test	Reddish-brown layer, Blue-green color	Positive
6	Saponins	Foam Test	Persistent foam	Positive

These findings confirm the presence of bioactive secondary metabolites known for antioxidant and antimicrobial properties.

4. Antioxidant Activity

The antioxidant activity of *Cymbopogon citratus* ethanolic extract was evaluated using the DPPH radical scavenging assay. Various concentrations of the extract were tested for their ability to scavenge DPPH radicals, and the results were compared with the standard antioxidant, ascorbic acid. The percentage of inhibition and IC_{50} values were calculated, with lower IC_{50} values indicating stronger antioxidant potential.

Table 2: Antioxidant activity of *Cymbopogon citratus* ethanolic extract

Sr. No.	Concentration (µg/mL)	Absorbance at 517 nm	% Inhibition	IC_{50} (µg/mL)	Remarks
1	10	0.452	10.5		Moderate activity
2	20	0.423	15.7		Moderate activity
3	30	0.395	20.3		Moderate activity

4	40	0.371	26.1		Moderate activity
5	50	0.342	32.8		Moderate activity
6	60	0.316	39.3		Moderate activity
7	70	0.289	46.2		High activity
8	80	0.261	53.1		High activity
9	90	0.234	60.0		High activity
10	100	0.213	65.4	72.5	Highest activity

The IC_{50} value indicates the concentration required to achieve 50% inhibition of DPPH radicals. For comparison, the IC_{50} value of ascorbic acid was found to be 35 µg/mL, confirming that *Cymbopogon citratus* extract exhibits notable antioxidant activity, especially at higher concentrations.

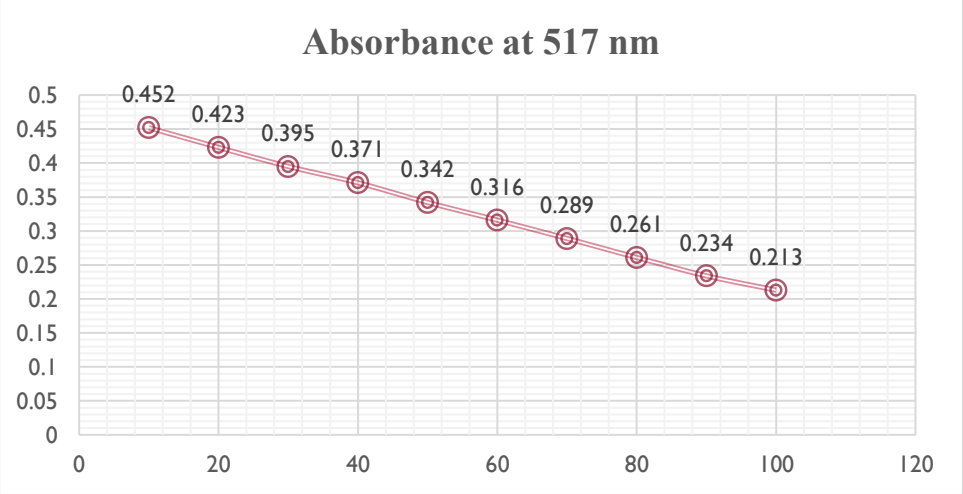

Chart 1: UV absorption at various concentrations

5. Gel Formulation

A uniform herbal gel was successfully prepared with the ethanolic extract of *Cymbopogon citratus*. The gel had a smooth texture, light green color, and lemon-like fragrance. No phase separation or clumping was observed during preparation.

Tabel 3: Gel formulations containing *Cymbopogon citratus*

Sr. No.	Ingredients	Formulation 1 (1% Extract)	Formulation 2 (2% Extract)	Formulation 3 (3% Extract)
1	Cymbopogon citratus Extract	1%	2%	3%
2	Carbopol 940	1.0%	1.0%	1.0%
3	Glycerin	5.0%	5.0%	5.0%
4	Methylparaben	0.2%	0.2%	0.2%
5	Triethanolamine	q.s. (to adjust pH 6.0–6.5)	q.s. (to adjust pH 6.0–6.5)	q.s. (to adjust pH 6.0–6.5)
6	Distilled Water	q.s. to 100%	q.s. to 100%	q.s. to 100%

6. Evaluation Parameters of Herbal Gel Formulations

Formulation F3 (3% extract) showed the best overall performance in terms of spreadability and viscosity, while Formulation F1 (1% extract) had the lowest viscosity and spreadability. Formulation F2 (2% extract) showed intermediate properties. All formulations exhibited similar homogeneity, appearance, and rheological behavior, making them suitable for topical use.

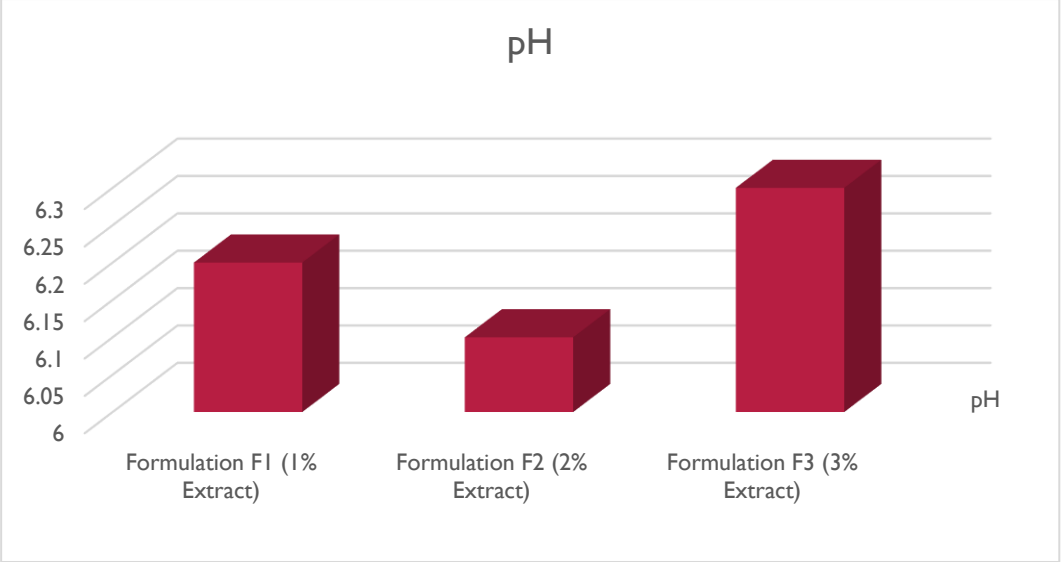

Chart 2: pH determination of *Cymbopogon citratus* Gel Formulations

Table 4: Comparative Evaluation of Herbal Gel Formulations

Sr. No.	Parameter	Formulation F1 (1% Extract)	Formulation F2 (2% Extract)	Formulation F3 (3% Extract)
1	Appearance	Smooth, translucent, lemon-like fragrance	Smooth, translucent, lemon-like fragrance	Smooth, translucent, lemon-like fragrance
2	pH	6.2	6.1	6.3
3	Viscosity (cps)	1800	2200	2500
4	Spreadability (sec)	25 sec	20 sec	18 sec
5	Homogeneity	Homogeneous, no lumps or phase separation	Homogeneous, no lumps or phase separation	Homogeneous, no lumps or phase separation
6	Rheological Behavior	Pseudoplastic, shear thinning	Pseudoplastic, shear thinning	Pseudoplastic, shear thinning

Formulation F3 (3% extract) showed the best overall performance in terms of spreadability and viscosity, while Formulation F1 (1% extract) had the lowest viscosity and spreadability. Formulation F2 (2% extract) showed intermediate properties. All formulations exhibited similar homogeneity, appearance, and rheological behavior, making them suitable for topical use.

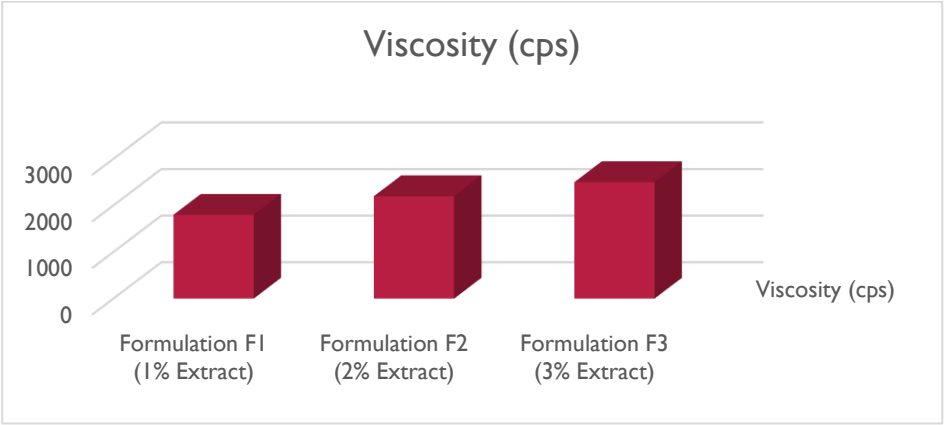

Chart 3: Viscosity of *Cymbopogon citratus* Gel Formulations (F1,F2,F3)

Antimicrobial Activity : The herbal gel exhibited dose-dependent antimicrobial activity. F3 (3% extract) showed the highest zones of inhibition against all tested strains, with 18 mm for *S. aureus* and 17 mm for *C. albicans*, indicating significant antimicrobial efficacy. No activity was observed with the negative control.

Table 5: Antimicrobial Activity of Cymbopogon citratus Gel (Zone of Inhibition in mm)

Microorganism	MTCC No.	F1 (1%)	F2 (2%)	F3 (3%)	Std. Control	Neg. Control
Staphylococcus aureus	96	12	15	18	21.5	0
Escherichia coli	443	10	13	15	19.8	0
Pseudomonas aeruginosa	741	8	10	13	17.6	0
Candida albicans	227	11	14	17	18.3	0

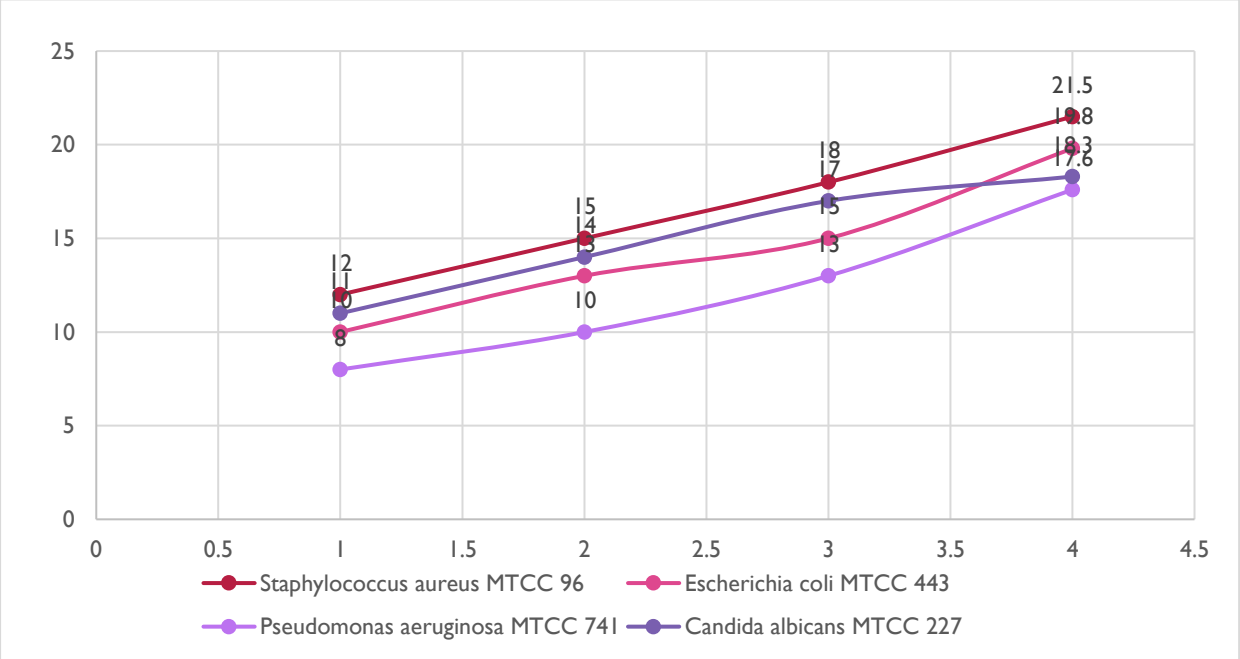

Chart 4: Antimicrobial Activity of Formulations ZOI comparison

Stability testing: Stability testing of the Cymbopogon citratus herbal gel over 90 days showed no significant changes in pH, viscosity, spreadability, or appearance under room, refrigerated, and elevated temperatures. The gel remained homogenous with no phase separation or unpleasant odor. These results confirm the formulation's physical and chemical stability, maintaining its therapeutic integrity and aesthetic appeal throughout the storage period.

4. DISCUSSION

The present study demonstrated that *Cymbopogon citratus* possesses significant phytochemical constituents, including flavonoids and tannins, which are known for their antioxidant and antimicrobial properties. The DPPH assay confirmed strong radical scavenging activity, supporting its potential role in accelerating wound healing. Among the formulated gels, the 3% extract gel exhibited optimal pH, viscosity, and spreadability, ensuring better patient compliance and effective application. Its antimicrobial effect further highlights the utility of lemongrass extract in preventing infection at wound sites. The formulation remained stable over the evaluation period, suggesting its suitability for long-term topical use in wound management.

5. CONCLUSION

The study concludes that an herbal gel containing *Cymbopogon citratus* extract is a promising natural formulation for wound healing. The 3% extract gel showed excellent physicochemical properties, stability, and biological activity. Its antioxidant and antimicrobial effects support its potential as an effective, safe, and economical alternative to synthetic topical agents. Further in vivo studies and clinical trials are recommended to validate its therapeutic efficacy and commercial applicability in wound care formulations.

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