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A REVIEW: THERAPEUTIC ROLE OF CYMBOPOGON CITRATUS IN WOUND HEALING

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Abstract

Cymbopogon citratus, commonly known as lemongrass, is a widely used medicinal plant in traditional systems of medicine. Renowned for its aromatic and therapeutic properties, it has gained significant attention in recent years for its role in wound healing. The bioactive compounds present in Cymbopogon citratus, such as citral, geraniol, myrcene, and flavonoids, exhibit diverse pharmacological activities, including anti-inflammatory, antimicrobial, antioxidant, and analgesic effects. These properties are crucial in the various phases of wound healing, namely hemostasis, inflammation, proliferation, and remodeling. This review aims to comprehensively analyze the phytoconstituents of Cymbopogon citratus, its pharmacological activities, mechanisms involved in wound repair, and its potential as a therapeutic agent in modern wound management. Furthermore, the review highlights recent in vitro, in vivo, and clinical studies supporting its efficacy, and identifies research gaps that need to be addressed for its standardization and clinical validation.

Keywords: Cymbopogon citratus, Lemongrass, Wound healing, Phytoconstituents, Herbal medicine, Anti-inflammatory, Antioxidant

1. Introduction

Wound healing is a complex and dynamic biological process that involves a series of well-orchestrated cellular and molecular events aimed at restoring the integrity of injured tissue. Chronic wounds, delayed healing, and infections continue to be significant global healthcare concerns, often leading to increased morbidity and healthcare costs [1,2]. In this context, herbal medicines have garnered growing attention due to their effectiveness, low toxicity, and cost-efficiency in wound management. Among various medicinal plants, *Cymbopogon citratus* (DC.) Stapf, commonly known as lemongrass and a member of the Poaceae family, has shown notable promise [3,4]. It is a tall, perennial grass with narrow, aromatic leaves, native to India and Southeast Asia, and widely cultivated in tropical and subtropical regions. Traditionally, lemongrass has been used to treat skin infections, inflammation, and minor wounds, which has prompted increased scientific interest in its therapeutic potential. The

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plant is especially valued for its essential oil, which is rich in citral—a bioactive compound known for its lemon-like aroma and a wide range of pharmacological actions, including antimicrobial, anti-inflammatory, and antioxidant properties [5,6]. These features collectively support the role of *Cymbopogon citratus* as a promising natural agent in enhancing wound healing and tissue regeneration.

2. Objective The objective of this review is to explore the phytochemical composition and therapeutic mechanisms of *Cymbopogon citratus* in wound healing. It aims to highlight its potential as a natural, safe, and effective alternative in wound management.

3. Phytochemical Constituents of *Cymbopogon citratus* and Their Role in Wound Healing

The wound healing efficacy of *Cymbopogon citratus* is primarily due to its rich phytochemical profile. The essential oil contains citral, a key compound with potent antimicrobial and anti-inflammatory properties [7]. Myrcene helps relieve pain and inflammation, while geraniol and linalool act as antioxidants and protect wounds from microbial invasion. Flavonoids and phenolic acids reduce oxidative stress and promote tissue regeneration. Additionally, tannins support wound contraction and inhibit microbial growth [8]. Together, these constituents contribute to different stages of wound healing hemostasis, inflammation, proliferation, and remodeling—making *C. citratus* a promising herb for herbal formulations [9].

Table 1: Phytoconstituents of *Cymbopogon citratus* and Their Wound Healing Roles [8,9]

Sr. No.	Phytochemical	Pharmacological Activity	Role in Wound Healing
1	Citral (neral & geranial)	Antimicrobial, Anti-inflammatory	Reduces infection and inflammation
2	Myrcene	Analgesic, Anti-inflammatory	Alleviates pain and swelling
3	Geraniol	Antioxidant, Antimicrobial	Enhances cell protection and microbial defense
4	Linalool	Antioxidant, Sedative	Promotes cell healing and reduces stress
5	Flavonoids & Phenolic Acids	Antioxidant, Anti-inflammatory	Reduce oxidative damage, aid tissue repair
6	Tannins	Astringent, Antimicrobial	Promotes tissue contraction and healing

4. Pharmacological Activities Relevant to Wound Healing

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- **Antioxidant Activity**: Lemongrass extracts scavenge free radicals and protect tissues from oxidative stress, which is crucial in the inflammatory and proliferative phases of wound healing [10].
- **Anti-inflammatory Activity**: It reduces the production of pro-inflammatory cytokines (e.g., TNF-α, IL-6), helping to control inflammation and expedite healing [11].
- **Antimicrobial Activity**: Essential oils of C. citratus show broad-spectrum antimicrobial action against bacteria and fungi, thereby preventing wound infections.
- **Analgesic Effects**: The essential oil alleviates pain associated with wounds, enhancing patient comfort [12].

Table 2: Pharmacological Activities connected to Wound Healing [10-12]

Sr. No.	Pharmacological Activity	Mechanism of Action	Relevance to Wound Healing
1	**Antioxidant Activity**	Scavenges free radicals, increases antioxidant enzymes	Protects tissues from oxidative stress during the inflammatory and proliferative phases of wound healing.
2	**Anti-inflammatory Activity**	Reduces pro-inflammatory cytokines (TNF-α, IL-6)	Helps control inflammation, reducing swelling and promoting faster healing.
3	**Antimicrobial Activity**	Broad-spectrum antimicrobial action against bacteria and fungi	Prevents wound infections, creating a cleaner environment for healing.
4	**Analgesic Effects**	Relieves pain via essential oil components	Alleviates pain, improving patient comfort during the healing process.

5. Mechanisms of Wound Healing Action Cymbopogon citratus aids wound healing through multiple mechanisms:

Cymbopogon citratus (lemongrass) aids wound healing through several vital mechanisms that contribute to the overall repair and regeneration of tissue:

- **Enhancing Collagen Synthesis and Fibroblast Proliferation**: Collagen is a critical structural protein for wound healing, providing strength and structure to the newly

formed tissue. *Cymbopogon citratus* promotes the synthesis of collagen by stimulating fibroblasts, which are responsible for collagen production. This helps in the formation of a strong extracellular matrix, necessary for tissue repair and wound closure [13].

- **Promoting Angiogenesis and Epithelialization**: Angiogenesis is the process of new blood vessel formation, essential for supplying nutrients and oxygen to the wound site. *Cymbopogon citratus* aids angiogenesis, enhancing tissue oxygenation and nutrient delivery. Additionally, it promotes epithelialization, which is the regeneration of the skin or mucosal layers over the wound. This process helps seal the wound surface and prevents further infection [14].
- **Reducing Inflammation and Microbial Burden at the Wound Site**: Chronic inflammation can delay wound healing, while excessive microbial load can lead to infections. *Cymbopogon citratus* has potent anti-inflammatory and antimicrobial properties, reducing pro-inflammatory cytokines such as TNF-α and IL-6, thereby controlling the inflammatory response. The antimicrobial action helps reduce the microbial burden at the wound site, creating a conducive environment for healing [13].
- **Stimulating Antioxidant Enzyme Activities**: The wound healing process generates oxidative stress, which can damage cells and slow recovery. *Cymbopogon citratus* stimulates the activity of key antioxidant enzymes like superoxide dismutase (SOD), catalase, and glutathione peroxidase. These enzymes help neutralize reactive oxygen species (ROS), reducing oxidative damage to cells and promoting faster healing [15].

6. Preclinical Evidence, Formulations, and Safety of *Cymbopogon citratus* in Wound Healing: Preclinical and clinical evidence supports the wound healing potential of *Cymbopogon citratus* (lemongrass), showing benefits in wound contraction, re-epithelialization, and infection reduction. Animal studies demonstrate significant improvements in wound healing with topical formulations like lemongrass oil or extract gels. While clinical trials are limited, early human studies suggest promise, requiring further placebo-controlled trials [16]. Lemongrass is used in various topical formulations, including gels, creams, and ointments, often combined with other herbal ingredients for enhanced effects. It offers antimicrobial, anti-inflammatory, and antioxidant benefits, making it suitable for chronic wounds. Though generally safe, high concentrations may cause dermal irritation, and further studies are needed to evaluate its long-term safety and drug interactions [17].

7. Research Gaps and Future Prospects

- Lack of standardized extracts with defined active constituents
- Need for large-scale human clinical trials
- Limited data on chronic toxicity and herb-drug interactions
- Need for novel delivery systems to improve bioavailability

8. Conclusion Cymbopogon citratus is a promising medicinal plant with notable wound healing properties owing to its rich phytochemistry and multifaceted pharmacological activities. Despite promising preclinical data, clinical translation remains limited due to inadequate standardization and insufficient clinical trials. Future research should focus on elucidating its mechanisms of action, optimizing formulations, and conducting extensive clinical evaluations to establish it as a reliable agent in wound management.

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