International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 07 July 2025
DOI: 10.47191/ijcsrr/V8-i7-69, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

Chamomile (*Matricaria Chamomilla* L.) as An Anti-Inflammatory Agent for Oral Mucosa: Mechanisms and Clinical Evidence

Pratiwi Soesilawati[1], Antonius Edwin Sutikno[2], Raniyah Shafiyah Adha[3]
[1]Department of Oral Biology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia
[2]Department of Prosthodontic, Faculty of Dentistry, Universitas Ciputra, Surabaya, Indonesia
[3]Undergraduate Student, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

ABSTRACT: *Matricaria chamomilla* L. commonly known as chamomile is a medicinal herb widely recognized for its potent anti-inflammatory, antioxidant, and antimicrobial properties. This narrative review synthesizes current evidence on the therapeutic potential of chamomile in managing oral mucosal inflammation, emphasizing its pharmacological mechanisms and clinical efficacy. Chamomile's major bioactive compounds including flavonoids such as apigenin and essential oils like chamazulene and α-bisabolol modulate key inflammatory pathways by inhibiting cyclooxygenase-2 (COX-2), suppress the production of proinflammatory cytokines (TNF-α, IL-1β, IL-6), and regulating NF-κB activity. These effects collectively reduce oxidative stress, inflammation, and microbial colonization in oral tissues. Clinical trials demonstrate chamomile's efficacy in reducing symptoms and accelerating healing in conditions such as oral mucositis, recurrent aphthous stomatitis, and gingivitis. Given its favourable safety profile and multi-targeted mechanisms, chamomile represents a promising natural adjunct or alternative in oral healthcare. Further standardized clinical research is warranted to optimize its therapeutic use.

KEYWORDS: Anti-inflammatory, Aphthous Stomatitis, Chamomile, Inflammation, *Matricaria chamomilla*, Oral Mucosa, Oral Mucositis.

INTRODUCTION

Inflammatory conditions of the oral mucosa present a considerable clinical challenge, often compromising patient comfort and impairing oral function [5,7]. *Matricaria chamomilla* L., commonly known as chamomile, is a plant frequently used in traditional medicine due to its proven anti-inflammatory properties and its ability to promote wound healing. Its pharmacological activity is largely attributed to its diverse array of bioactive constituents, particularly flavonoids and essential oils, which are known to influence key inflammatory pathways involved in oral mucosal conditions [9]. Despite the availability of conventional therapies, many are associated with undesirable side effects or limited therapeutic outcomes, thereby driving interest in plant-derived alternatives such as chamomile. This review provides a critical assessment of the current scientific evidence surrounding the therapeutic potential of chamomile in in addressing oral mucosal inflammation, highlighting its molecular mechanisms, clinical benefits, and future research prospects.

TAXONOMY AND BIOACTIVE COMPOUNDS OF *MATRICARIA CHAMOMILLA*

Matricaria chamomilla L., belonging to the Asteraceae family, is an annual herb characterized by spindle-shaped roots and distinct flower heads with yellow tubular and white ray florets [9]. The flowers serve as the main source of the plant's pharmacologically active essential oils particularly chamazulene and α-bisabolol which are largely responsible for its anti-inflammatory properties. In addition to these oils, chamomile contains several other bioactive constituents, including flavonoids such as saponins, tannins, luteolin, apigenin, and coumarins [6]. These compounds work synergistically to produce a wide spectrum of therapeutic effects, such as antioxidant, antimicrobial, analgesic, and anxiolytic properties [9]. Although it originates from temperate regions of Europe and western Asia, chamomile is now extensively cultivated in many parts of the world with suitable climatic conditions [1,9].

To obtain and preserve its active compounds, extraction methods such as steam distillation (for essential oils) and solvent extraction (for flavonoids and coumarins) are commonly employed. More advanced approaches, like supercritical CO_2 extraction, have been developed to improve both the yield and purity of the extracted substances [6,8].

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MECHANISMS OF ANTI-INFLAMMATORY ACTION IN ORAL MUCOSA

Chamomile's anti-inflammatory effects are primarily driven by its bioactive compounds, which suppress the expression of cyclooxygenase-2 (COX-2), thereby decreasing the production of prostaglandin E2 (PGE2)—one of the central mediators involved in vasodilation, edema, and pain during inflammation. By downregulating COX-2, chamomile effectively diminishes prostaglandin-mediated signaling within inflamed oral tissues, thereby alleviating local inflammatory responses [2,5]. Another key mechanism underlying chamomile's anti-inflammatory action is its ability to inhibit the activation of nuclear factor kappa B (NF-κB), which in turn reduces the expression of inducible nitric oxide synthase (iNOS) and proinflammatory cytokines such as TNF-α, IL-1β, and IL-6. This downregulation limits immune cell infiltration into the inflamed mucosa, reduces tissue injury, and facilitates mucosal healing [3].

Chamomile's bioactive constituents particularly flavonoids and sesquiterpenes also help prevent the degradation of the extracellular matrix by reducing the activity of neutrophil elastase and matrix metalloproteinase-9 (MMP-9), enzymes known to prolong inflammation and contribute to tissue destruction. By limiting the actions of these proteolytic enzymes, chamomile supports structural preservation and mitigates fibrosis in conditions such as oral ulcers [5]. Moreover, phenolic compounds present in chamomile possess strong antioxidant properties, neutralizing reactive oxygen species (ROS) that would otherwise exacerbate inflammation and cause epithelial damage. This antioxidant activity is particularly important in protecting mucosal cells during inflammatory insults, including chemotherapy-induced mucositis [10,13].

Chamomile also exhibits antimicrobial activity, largely due to its essential oils and flavonoids, which have been shown to be effective against various oral pathogens, including Staphylococcus aureus, Candida albicans, and Streptococcus mutans. By preventing secondary infections, chamomile further reduces inflammation and promotes mucosal recovery. Together, these mechanisms work synergistically to enhance epithelial repair, reduce oxidative and microbial burden, and alleviate key symptoms of oral mucosal inflammation such as swelling, ulceration, erythema, and pain [11].

CLINICAL EVIDENCE

Several clinical studies have explored chamomile's efficacy in oral mucosal conditions. Emerging clinical studies provide supportive evidence of chamomile's efficacy in treating various oral mucosal inflammatory conditions. Multiple randomized controlled trials have documented chamomile's effectiveness in lessening both the severity and duration of oral mucositis caused by chemotherapy or radiotherapy. Patients treated with chamomile mouthwash or topical gels experienced less pain, fewer ulcerations, and faster mucosal recovery compared to placebo controls [4]. The anti-inflammatory and antioxidant actions explained above account for these clinical improvements.

Chamomile has been shown to significantly decrease ulcer size and associated pain in patients with minor aphthous ulcers. A trial comparing chamomile extract to triamcinolone found the herb to be similarly effective, highlighting its potential as a natural alternative with fewer side effects. The suppression of inflammatory cytokines and microbial load contributes to these beneficial effects [5,7].

Chamomile containing mouth rinses and dentifrices have demonstrated reductions in gingival bleeding, plaque accumulation, and inflammatory markers in adults with gingivitis and chronic periodontitis [7]. These effects are attributed to inhibition of bacterial biofilms and attenuation of local inflammatory responses [10]. Overall, the clinical evidence supports chamomile's therapeutic use due to its effectiveness, safety, and ease of application in oral health care. Chamomile formulations including gels, mouthwashes, and topical applications, have consistently shown symptom alleviation and improved healing compared to placebo or standard treatment [4].

Table 1. Clinical outcome of chamomile in the management of oral inflammatory conditions

Condition	Outcomes
Oral mucositis	Reduced severity, pain relief, accelerated healing [4]
Recurrent aphthous stomatitis	Decreased ulcer size and pain [5,7]
Gingivitis and periodontitis	Reduced inflammation, plaque, and bleeding [7]

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SYNERGISTIC EFFECTS AND COMBINATION THERAPIES

Chamomile's flavonoids, terpenoids, and coumarins act synergistically to enhance anti-inflammatory efficacy by targeting multiple inflammatory pathways simultaneously [12]. This synergy leads to amplified inhibition of NF-κB signaling, reduced oxidative stress, and lower levels of key cytokines [14]. Combining chamomile with other herbal extracts (e.g., clove oil) has shown additive or synergistic benefits in reducing oral inflammation and microbial burden [11].

DISCUSSION

An increasing body of both preclinical and clinical research supports the anti-inflammatory potential of *Matricaria chamomilla* L. in managing oral mucosal inflammatory conditions. Its rich array of bioactive compounds particularly flavonoids, essential oils, and coumarins—acts on multiple molecular pathways involved in inflammation and tissue injury within the oral mucosa [6,9]. Chamomile exerts its effects primarily through the inhibition of cyclooxygenase-2 (COX-2), leading to decreased synthesis of proinflammatory prostaglandins that play a central role in mucosal inflammation [2,5]. Additionally, it suppresses the NF-κB signaling pathway, leading to decreased expression of key inflammatory mediators including TNF-α, IL-1β, and IL-6, as well as enzymes like inducible nitric oxide synthase (iNOS) and matrix metalloproteinases (MMPs). This dual action helps limit leukocyte infiltration and protects the extracellular matrix, thereby promoting tissue repair [3,5].

Its antioxidant activity further enhances mucosal protection by neutralizing reactive oxygen species (ROS), which contribute to oxidative stress and worsen epithelial injury, particularly in conditions such as chemotherapy-induced mucositis. Combined with its antimicrobial properties against common oral pathogens, chamomile offers a comprehensive therapeutic approach by addressing both the causes and effects of inflammation [10,13]. Clinical studies reinforce these mechanistic findings, reporting meaningful improvements in symptoms such as pain, erythema, ulceration, and gingival inflammation in conditions like oral mucositis, aphthous ulcers, and periodontal disease [11]. Chamomile has also shown a strong safety and tolerability profile, making it a promising natural alternative or adjunct to conventional

anti-inflammatory treatments [1].

Nonetheless, challenges remain due to clinical heterogeneity. Differences in the concentration of active ingredients, extraction techniques, formulations, and treatment regimens hinder direct comparisons and the development of standardized recommendations. Moreover, the majority of current clinical trials are constrained by limited sample sizes and brief study durations. To develop evidence-based recommendations for the use of chamomile in oral inflammatory conditions, larger and methodologically robust randomized controlled trials are urgently needed. Future research should also explore its pharmacokinetics, optimal delivery methods, and long-term safety.

Despite these gaps, current findings firmly support the multifaceted role of *Matricaria chamomilla* in modulating inflammation, oxidative stress, and microbial dysbiosis in the oral cavity, suggesting its practical value in clinical dentistry and oral medicine.

CONCLUSION

Matricaria chamomilla L. represents a promising natural anti-inflammatory agent for the management of oral mucosal inflammatory conditions, owing to its broad spectrum of bioactive constituents that act synergistically to regulate inflammatory pathways, reduce oxidative stress, and inhibit microbial activity. Its demonstrated ability to suppress COX-2 expression, downregulate proinflammatory cytokines, and prevent secondary infections underlies its therapeutic efficacy in conditions such as oral mucositis, recurrent aphthous stomatitis, and gingivitis. The herb's favorable safety profile, supported by an increasing body of clinical evidence, highlights its potential as a complementary or alternative therapeutic modality in oral healthcare. Nevertheless, to fully establish its clinical utility, further standardized trials employing well-defined formulations, dosages, and protocols are required. Such investigations will be crucial for determining optimal therapeutic applications and facilitating the integration of chamomile into evidence-based clinical practice for oral mucosal inflammation.

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Cite this Article: Soesilawati, P., Sutikno, A.E., Adha, R.S. (2025). Chamomile (Matricaria Chamomilla L.) as An Anti-Inflammatory Agent for Oral Mucosa: Mechanisms and Clinical Evidence. International Journal of Current Science Research and Review, 8(7), pp. 3797-3800. DOI: https://doi.org/10.47191/ijcsrr/V8-i7-69