

Herbal Formulations in the Management of Recurrent Aphthous Stomatitis: A Comprehensive Review

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ABSTRACT

Recurrent Aphthous Stomatitis (RAS) is a frequent oral health issue marked by frequent ulcers. Traditional treatments such as corticosteroids and antimicrobial mouthwashes commonly offered short-term benefits but carried possible adverse reactions, necessitating the search for other remedies. Herbal remedies provided a holistic strategy by addressing immune system issues, microbial imbalances, and tissue inflammation. Aloe vera, green tea, and echinacea offer hope because of their anti-inflammatory, antimicrobial, and immunomodulatory properties. These natural treatments targeted the intricate pathophysiology of RAS effectively while causing few side effects, ultimately improving patient safety and adherence for extended periods. The study aims to tackle the root causes of illnesses while also enhancing overall health and well-being. As research progresses in this area, herbal blends could be a practical and efficient option for patients with recurring aphthous stomatitis. The active components functioned together to enhance treatment effectiveness, decrease doses, and mitigate the chances of developing drug resistance. Personalized herbal treatments, designed specifically for each patient's unique needs and symptoms, have produced increased satisfaction and effectiveness. The present review emphasized the importance of such herbal formulations to confirm their efficacy and safety. There is promising potential for herbal formulations in RAS treatment to provide a safe, natural, and convenient alternative to traditional therapies. Improved cooperation between conventional healers and contemporary researchers could enhance the comprehension and application of these treatments.

Keywords: Antimicrobials, Anti-inflammatory, Herbal Extracts, Immunomodulatory, Oral Ulcers.

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INTRODUCTION

Recurrent Aphthous Stomatitis (RAS) is a prevalent and frequently uncomfortable condition marked by the recurring occurrence of sores in the mouth lining. Usually, these sores are circular or oval-shaped with a yellow or greyish bottom and a red halo. Approximately 20% of the overall population is impacted by RAS, with a greater occurrence among teenagers and young adults.^[1] Although not deadly, RAS greatly impacts quality of life by causing pain and making it difficult to eat, speak, and maintain oral hygiene.^[2] The precise cause of RAS is not fully understood, but it is believed to result from a combination of genetic, immunological, and environmental factors. Factors like stress, hormonal changes, lack of certain nutrients, and specific foods have been suggested as triggers.^[3,4] The repetitive and unexpected occurrence of RAS leads to significant discomfort and adverse effects on daily life and overall health.

Traditional therapies for RAS mainly focus on alleviating symptoms instead of providing a permanent solution. Some of the treatments consist of corticosteroids, antimicrobial mouthwashes, and pain relievers. In severe situations, systemic treatments like oral corticosteroids and immunomodulators are used.^[5,6] Nevertheless, typical treatments frequently provide short-term alleviation and come with potential side effects that restrict their extended usage.^[7] Moreover, the absence of a universally successful treatment frequently causes frustration for both patients and healthcare providers.^[8]

Due to the restrictions of traditional therapies, there has been an increasing fascination with alternative and complementary treatments for RAS. Herbal preparations, especially, have attracted interest because of their potential effectiveness and reduced risk of side effects.^[9,10] For many years, traditional medicinal plants and their bioactive components have been utilized in different cultures to heal oral ulcers and other health issues. Recent scientific research has started to confirm the effectiveness of these natural remedies, showing positive outcomes in treating RAS.^[11,12] Plant-based substances like aloe vera, licorice, and chamomile, which have anti-inflammatory, antimicrobial, and



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wound-healing properties, are used in herbal remedies for RAS through topical and mouth rinse applications. For example, aloe vera gel has been proven to decrease pain and speed up healing in patients with RAS, while licorice extract shows notable anti-ulcer properties.^[13] In addition, intricate herbal blends containing various plant extracts are being created to improve treatment results. The growing curiosity in herbal and alternative remedies for RAS reflects a larger movement towards integrative healthcare, which seeks to blend traditional medical approaches with natural therapies supported by evidence. This comprehensive method aims to tackle the root causes of illnesses while also enhancing overall health and well-being. As research progresses in this area, herbal blends could be a practical and efficient option for patients with recurring aphthous stomatitis.

PATHOPHYSIOLOGY OF RAS

The painful mouth ulcers that reoccur are a hallmark of a multifactorial illness called RAS, has a complicated etiology that combines immunological response, microbial, and genetic predispositions.

Genetic predisposition

A substantial amount of data points to the involvement of genetic factors in the pathophysiology of RAS. Research has indicated that there may be a hereditary component to RAS, as those with a family history of the disorder are more likely to develop it. Certain genetic indicators, including specific forms of HLA (Human Leukocyte Antigen), have been linked to a higher risk of RAS. For instance, a higher incidence of RAS has been associated with the presence of HLA-B12, HLA-B51, and HLA-Cw7. It is believed that these genetic markers affect how the immune system reacts to mucosal damage or microbial stimuli, which in turn promotes the formation of ulcers.^[1]

Immune response

One important factor in the development of RAS is the immune system. It is widely acknowledged that RAS is a specific kind of immunological response mediated by T cells. More specifically, patients with RAS have been found to have an imbalance between pro- and anti-inflammatory cytokines. Tumor Necrosis Factor-Alpha (TNF- α), Interleukin-2 (IL-2), and Interferon-Gamma (IFN- γ) are examples of pro-inflammatory cytokines with elevated levels that contribute to inflammation; conversely, Interleukin-10 (IL-10) and other anti-inflammatory cytokines may not have sufficient levels to counteract this response. Due to this imbalance, the immune system reacts inappropriately, damaging mucosa and causing ulcers. The beneficial effects of immunomodulatory medications, such as systemic prednisone, which lowers inflammation, and montelukast, which blocks leukotriene pathways, in the treatment of RAS, further support the role of immunological dysregulation.^[4,5]

Microbial factors

Microorganisms play a crucial role in the development of Recurrent Aphthous Stomatitis (RAS). While no single pathogen has been identified as the exclusive culprit, imbalances in the oral microbiota, known as dysbiosis, can lead to immune reactions and inflammation, resulting in the development of distinctive oral ulcers in RAS. Streptococcus species, particularly Streptococcus mutans and Streptococcus sanguinis, are often present in the mouth and bind to oral mucosal surfaces, leading to inflammation and causing ulcers. Additionally, bacterial toxins such as Lipopolysaccharides (LPS) from gram-negative bacteria trigger Toll-like Receptors (TLRs) on immune cells, leading to the production of pro-inflammatory cytokines and chemokines, intensifying inflammation. Fungal infections, specifically from Candida species like Candida albicans, also play a role in the development of RAS. Fungal overgrowth, which is commonly linked to weakened immune systems or the use of antibiotics, worsens mucosal inflammation and in turn worsens oral ulcers. Secondary bacterial and fungal infections make RAS more complicated, leading to longer healing periods and exacerbating symptoms, either because of mucosal damage from initial ulceration or opportunistic infections in those with weakened immune systems.^[4] Therefore, the imbalance of microorganisms and disruption of microbial balance in the mouth are important factors in starting and worsening inflammation that results in the development of oral ulcers in RAS. Additional study on how microbial communities and host immune responses interact is crucial for comprehending the complex causes of RAS and developing specific treatment approaches.

CLINICAL FEATURES

Painful mouth sores are a hallmark of Recurrent Aphthous Stomatitis (RAS), which has a substantial negative impact on the quality of life for those who have it. These sores are usually found on non-keratinized mucosal surfaces such the inner cheek, tongue, and soft palate. They normally appear as circular or oval-shaped lesions with a yellowish or greyish foundation and a red border. Early warning indicators, like as burning or tingling feelings, may appear before ulcers occur.

RAS is divided into three primary subgroups based on the degree of ulceration, which can vary greatly:

Minor RAS

With 70-85% of all cases having this appearance, it is the most prevalent. It appears as tiny, oval, or spherical lesions encircled by an erythematous halo and covered in a pseudomembrane that is greyish-white in color. Usually, 1-5 smaller than 1 cm in diameter ulcers are seen in each minor RAS episode. These episodes are self-limiting and go away without causing any lasting damage after 4-14 days.

Table 1: Herbal Formulations for Recurrent Aphthous Stomatitis (RAS) and Their Mechanisms of Action.

Herbal formulations	Parts used	Active compounds	Activity or mechanism of action	Types of studies in which they have been used	Clinical studies and outcomes
Aloe vera	Gel from leaves	Aloin, Emodin	Anti-inflammatory, Wound healing	Clinical trials, <i>in vitro</i> studies	Several clinical studies have demonstrated the efficacy of Aloe Vera in reducing pain and accelerating healing of RAS lesions. ^[20]
Green tea (<i>Camellia sinensis</i>)	Leaves	Catechins, Polyphenols	Antioxidant, Antimicrobial	Clinical trials, <i>in vitro</i> studies	Green tea has shown promise in RAS treatment, with its antioxidant and antimicrobial properties contributing to symptom relief and lesion healing. ^[22]
Echinacea	Roots, aerial parts	Alkamides, Polysaccharides	Immune modulation, Anti-inflammatory	Clinical trials, <i>in vitro</i> studies	Clinical trials evaluating Echinacea's effectiveness in RAS management have reported mixed results, warranting further investigation. ^[19]
<i>Chrysanthemum morifolium</i>	Flowers	Terpenoids, Flavonoids	Antifungal, Anti-inflammatory	Clinical trials, <i>in vitro</i> studies	Research on <i>Chrysanthemum morifolium</i> suggests its potential in RAS treatment, particularly due to its antifungal and anti-inflammatory actions. ^[23]
Mangosteen (<i>Garcinia mangostana</i>)	Pericarp	α -Mangostin	Wound healing, Anti-inflammatory	Clinical trials, <i>in vitro</i> studies	Formulation enhancements involving Mangosteen extract have shown promising results in improving wound healing and reducing inflammation associated with RAS. ^[3]
<i>Persea americana</i> Mill (avocado)	Leaves, fruits	Flavonoids, Polyphenols	Anti-inflammatory, Antimicrobial, Wound healing	<i>In vitro</i> studies	<i>In vitro</i> studies have demonstrated the anti-inflammatory and antimicrobial properties of <i>Persea americana</i> Mill extract, suggesting its potential in RAS management. ^[9,18]
<i>Abrus precatorius</i> (saga)	Seeds	Abrin, Alkaloids	Anti-inflammatory, Analgesic	<i>In vitro</i> studies	<i>Abrus precatorius</i> Linn. Extract has shown anti-inflammatory and analgesic effects <i>in vitro</i> , indicating its potential for RAS treatment. ^[12]
<i>Averrhoa bilimbi</i> L (<i>Belimbing wuluh</i>)	Fruit, leaves	Flavonoids, Polyphenols	Anti-inflammatory, Antioxidant, Antimicrobial	<i>In vitro</i> studies	<i>Averrhoa bilimbi</i> L. extract has demonstrated anti-inflammatory, antioxidant, and antimicrobial properties <i>in vitro</i> , suggesting its usefulness in RAS management. ^[10]

Herbal formulations	Parts used	Active compounds	Activity or mechanism of action	Types of studies in which they have been used	Clinical studies and outcomes
<i>Psidium guajava</i> L. (guava)	Leaves, fruit	Tannins, flavonoids	Antimicrobial, Anti-inflammatory, Wound healing	<i>In vitro</i> studies	<i>Psidium guajava</i> L. extract has exhibited antimicrobial, anti-inflammatory, and wound healing effects <i>in vitro</i> , indicating its potential for RAS treatment. ^[12]
<i>Curcuma longa</i> (turmeric)	Rhizomes	Curcuminoids	Anti-inflammatory, Antioxidant, Wound healing	<i>In vitro</i> studies	<i>Curcuma longa</i> extract, particularly curcuminoids, has shown anti-inflammatory, antioxidant, and wound healing properties <i>in vitro</i> , suggesting its potential for RAS management. ^[12,16]
<i>Kaempferia galanga</i> Linn. (<i>Galangal rhizome</i>)	Rhizomes	Kaempferol, Galangin	Anti-inflammatory, Antimicrobial, Wound healing	<i>In vitro</i> studies	<i>Kaempferia galanga</i> Linn. extract has demonstrated anti-inflammatory, antimicrobial, and wound healing effects <i>in vitro</i> , suggesting its potential for RAS treatment. ^[13]
<i>Citrus hystrix</i> DC (<i>Kaffir lime</i>)	Leaves			<i>In vitro</i> studies	<i>Citrus hystrix</i> DC extract has shown antimicrobial, anti-inflammatory, and analgesic effects <i>in vitro</i> , indicating its potential for RAS management. ^[12]

Major RAS

Roughly 10% of all cases have this, the most severe form of the illness. This subtype is characterized by larger than 1 cm ulcers that typically affect the lips, soft palate, and pharynx. The patient's quality of life is greatly impacted by the lesions, which can linger for more than six weeks and leave scars.

Herpetiform RAS

This subtype, which makes up 1-10% of all cases, is distinguished by painful, deep, and frequent outbreaks of tiny ulcers. Aphthae, which are 2-3 mm in size, can develop up to 100 at a time. These ulcers often combine to create larger, unevenly contoured ulcerations. Compared to the other clinical subgroups of the disease, herpetiform RAS is more common in older people and women.

RAS can make it difficult to eat, speak, and practice good oral hygiene. Because it recurs, it can exacerbate oral pain and psychological suffering. To reduce symptoms and enhance general health, an accurate diagnosis and appropriate therapy are crucial. Pain is usually minimized, healing is encouraged, and recurrence is avoided with a customized regimen of topical and systemic therapy.^[14]

HERBAL FORMULATIONS FOR RAS

Herbal remedies are becoming more acknowledged as effective treatment choices for dealing with Recurrent Aphthous Stomatitis (RAS), presenting benefits compared to traditional treatments. These natural treatments use plant-based compounds with anti-inflammatory, antimicrobial, and immunomodulatory properties to target the complex RAS pathophysiology. Herbal treatments have a lower risk of side effects than synthetic medications, which helps to ensure patient safety and adherence to long-term treatment. Moreover, herbal remedies offer a comprehensive strategy for maintaining oral health by addressing root causes of issues in the body's immune system. Herbal formulations with customized treatment choices and the possibility of combined effects among bioactive compounds are beneficial in aiding oral health interventions for managing RAS.

Advantages of herbal formulations

Herbal remedies have various benefits compared to conventional treatments for dealing with Recurrent Aphthous Stomatitis (RAS). Firstly, natural remedies have a lower risk of negative effects in comparison to artificial drugs.^[2,5,15] Although corticosteroids and immunomodulatory drugs have the potential for systemic side effects when used for an extended period, herbal formulations

typically have bioactive compounds that are safer, minimizing the risk of negative reactions and encouraging continued use.^[8,16,17] Moreover, herbal remedies offer a comprehensive method for oral care by tackling root imbalances in the body's defences and enhancing overall health. Instead of just addressing individual symptoms, herbal blends focus on various aspects of RAS pathophysiology like immune dysregulation, microbial overgrowth, and tissue inflammation. This comprehensive strategy follows the beliefs of integrative medicine by highlighting how the mind, body, and environment are all interconnected in managing health and illness.^[4,12,18]

Personalized therapy with herbal formulations

Another important benefit of herbal remedies for RAS is that they can offer customized treatment options that are specially designed to meet the unique needs and preferences of each patient. With a wide variety of plants to choose from, medical professionals can pick herbal mixtures depending on their patients' individual symptoms, health backgrounds, and healing objectives. This customized method boosts treatment effectiveness and patient contentment while minimizing the chances of treatment resistance and relapse.^[12,19,20] Moreover, combinations of natural ingredients could work together in a way that increases the effectiveness of the treatment through different actions. Herbal medicines, as opposed to synthetic drugs that target one specific area, typically have a combination of phytochemicals that work together to affect different biological pathways related to RAS development. This collaboration could lead to improved effectiveness, lower doses, and reduced chance of drug resistance, making herbal remedies important supplements to oral health treatments.^[8,14,21]

The treatment of recurring aphthous stomatitis usually requires a combined method, and herbal formulations have shown potential as helpful additions to traditional treatments. Table 1 provides a summary of various popular herbal mixtures used to treat RAS, emphasizing the components used, active ingredients, actions, types of research, and clinical trials and results. Aloe vera, green tea, echinacea, and other natural treatments contain active ingredients with proven anti-inflammatory, antimicrobial, and wound-healing qualities that can target the root cause of RAS and relieve its symptoms. It is essential for healthcare providers and individuals looking for alternative treatments for RAS to comprehend the features and effectiveness of these herbal formulations. This knowledge allows for informed decision-making and personalized therapeutic interventions.

Herbal formulations and their efficacy in RAS treatment

Traditional and natural treatments have been investigated for their effectiveness in controlling RAS because of their believed safety and possible healing advantages. Herbal blends like aloe vera, green tea, echinacea, and mangosteen have demonstrated hopeful outcomes in alleviating pain, reducing inflammation,

Table 2: Herbs with reported phytoconstituents for RAS.^[16,25]

Common name	Scientific name and family	Flavonoids and tannins
Guava leaves	<i>Psidium guajava</i> Myrtaceae	Flavonoids and tannins
Indian cherry leaves	<i>Cordiadihotoma</i> Boraginaceae	Alkaloids, flavonoids, and amino acids
Liquorice	<i>Glycyrrhia glabra</i> L. Leguminoseae	Saponin, flavonoid, liquirtin, isoliquirtin and liquiritigenin
Turmeric	<i>Curcuma longa</i> Zingiberaceae	curcumin, dimethoxy curcumin, and bisdemethoxycurcumin
Pomegranate flowers	<i>Punica m</i> L. <i>Punicaceae</i>	Polyphenols, ethyl brevilincolcarboxylate and triterpenes oleanolic acid
Betel leaves	<i>Piper betle</i> L. <i>Piperaceae</i>	Alkaloids, tannins, and steroids
Aloe vera	<i>Aloe barbadensis</i> Miller Liliaceae	Amino acids, anthraquinones, enzymes, minerals, vitamins, ligninssaponins, and sterols
Capsicum	<i>Capsicum annum</i> L. Solanaceae	Capsaicin, paprika oleoresin, and dihydrocapsaicin
Indian Mulberry	<i>Morinda citrifolia</i> Linn. Rubiaceae	Anthraquinones, flavonoids and phenolics

and speeding up the healing process of RAS lesions. The bioactive compounds in these herbal remedies have anti-inflammatory, antioxidant, and antimicrobial properties that are essential in relieving symptoms of RAS. Evidence from clinical trials and research studies supports the effectiveness of these herbal treatments.^[3,19,20,22] Incorporating herbal formulations in managing RAS provides a natural option or supplement to traditional treatments, giving patients more choices to ease discomfort and support oral health (Tables 2-5).

Comparative efficacy of herbal and conventional treatments

The effectiveness of herbal and conventional treatments for Recurrent Aphthous Stomatitis (RAS) must be compared to comprehend the advantages and disadvantages of each approach to treating this prevalent oral mucosal ailment (Table 6). Herbal medicines provide safe, natural alternatives to conventional treatments, which frequently involve topical corticosteroids, analgesics, and antibacterial agents. Clinicians and patients can make well-informed judgments regarding treatment alternatives

Table 3: Herbal formulations for RAS: evidence from *in vitro* and clinical studies.

Herbal formulations	Parts used	Active compounds	Type of studies	Clinical outcomes	Reference number
Amlexanox	Oral adhesive		Clinical trials	Demonstrated effectiveness in reducing pain and lesion size in RAS treatment	[26]
Montelukast	Systemic		Clinical trials	Showed comparative therapeutic effects in unresponsive RAS cases.	[5]
Green Tea	Leaves	Catechins, Polyphenols	Clinical trials, <i>in vitro</i>	Exhibited antioxidant and antimicrobial properties, aiding in RAS symptom relief.	[14,22]
Aloe Vera	Gel from leaves	Aloin, Emodin	Clinical trials, <i>in vitro</i>	Efficacy in reducing pain and accelerating healing of RAS lesions	[20]
<i>Persea americana</i> Mill	Leaves, Fruit	Flavonoids, Polyphenols	<i>In vitro</i> studies	Demonstrated anti-inflammatory and antimicrobial properties, potential for RAS management	[9,18]
<i>Abrus precatorius</i> Linn.	Seeds	Abrin, Alkaloids	<i>In vitro</i> studies	Shown anti-inflammatory and analgesic effects, indicating potential for RAS treatment	[24]
<i>Averrhoa bilimbi</i> L.	Fruit, Leaves	Flavonoids, Polyphenols	<i>In vitro</i> studies	Demonstrated anti-inflammatory, antioxidant, and antimicrobial properties, usefulness in RAS management.	[10]
<i>Psidium guajava</i> L.	Leaves, Fruit	Tannins, Flavonoids	<i>In vitro</i> studies	Exhibited antimicrobial, anti-inflammatory, and wound healing effects, potential for RAS treatment	[10]
<i>Curcuma longa</i>	Rhizomes	Curcuminoids	<i>In vitro</i> studies	Shown anti-inflammatory, antioxidant, and wound healing properties, potential for RAS management.	[16]
<i>Kaempferia galanga</i> Linn.	Rhizomes	Kaempferol, Galangin	<i>In vitro</i> studies	Demonstrated anti-inflammatory, antimicrobial, and wound healing effects, potential for RAS treatment	[13]
<i>Citrus hystrix</i> DC	Leaves	Limonene, Citral	<i>In vitro</i> studies	Exhibited antimicrobial, anti-inflammatory, and analgesic effects, potential for RAS management	[25]

Table 4: Herbal formulations published within the period from 2020 to 2024.

Sl. No.	Author	Herbs	Formulation
1	Bandana K <i>et al.</i> , (2020) ^[27]	guava leaves and liquorice roots	polyherbal oral gel
2	Sing R <i>et al.</i> , (2020) ^[28]	guava leaves and Turmeric rhizomes	oral gel
3	Jain NK <i>et al.</i> , (2020) ^[29]	guava leaves, betel leaves and licorice extract	aqueous gel
4	Upadhye K <i>et al.</i> , (2021) ^[30]	aloe, neem and tulsi	poly herbal gel
5	Bakhshi M <i>et al.</i> , (2022) ^[31]	Curcumin (<i>Curcumin longa</i>)	1% Curcumin nanomicelle gel, 2% Curcumin gel

Table 5: Herbal formulations and their efficacy in RAS treatment.

Herbal formulations	Efficacy in RAS treatment	Mechanism of action
Aloe Vera	Aloe vera is well-known for its anti-inflammatory and wound-healing qualities. Aloe vera gel has been demonstrated to greatly alleviate pain and expedite healing of RAS lesions. A clinical investigation indicated a considerable decrease in lesion size and pain levels among participants. ^[20]	Anti-inflammatory and wound healing properties
Green Tea (<i>Camellia sinensis</i>)	Catechins and polyphenols found in green tea have potent antibacterial and antioxidant qualities. These substances work by lowering inflammation and encouraging healing to lessen the symptoms of RAS. Green tea extracts have been shown in studies to be an effective way to lessen the severity and duration of RAS lesions. ^[22]	Antioxidant and antimicrobial
Echinacea	Echinacea has been shown to be useful in healing mild oral aphthous ulcers and is frequently used to strengthen the immune system. According to a study, echinacea greatly decreased pain and accelerated ulcer healing. ^[19]	Immunomodulatory effects
<i>Chrysanthemum morifolium</i>	<i>Chrysanthemum morifolium</i> has been investigated for its ability to cure RAS. It is frequently used in traditional medicine for its antifungal qualities. Significant antifungal effects are displayed by the various terpenoids found in the roots, which are helpful in treating RAS by lowering secondary infections and promoting quicker recovery. ^[23]	Antifungal activities reduce secondary infections
Mangosteen (<i>Garcinia mangostana</i>)	RAS has been effectively treated with mangosteen. Promising outcomes have been shown in the reduction of inflammation and promotion of faster healing in RAS lesions through the complexation of 2-hydroxypropyl- β -cyclodextrin with α -manganostin to boost its wound healing abilities in hydrogel formulation. ^[3]	Anti-inflammatory properties
<i>Persea americana</i> (Avocado)	Due to their high flavonoid and polyphenol content, the fruit and leaves have antibacterial and anti-inflammatory qualities. These imply that avocado may help control RAS by lowering inflammation and avoiding subsequent infections. ^[9,18]	Flavonoids and polyphenols provide anti-inflammatory and antimicrobial effects
<i>Averrhoa bilimbi</i>	<i>Abrus precatorius</i> is well-known for having abrin and other alkaloids in its seeds, which have been shown to have analgesic and anti-inflammatory properties <i>in vitro</i> . These characteristics suggest that it may be used to treat RAS by lowering the pain and inflammation brought on by the illness. ^[24]	Alkaloids provide anti-inflammatory and analgesic effects
Curcumin	Curcumin, which is derived from turmeric, possesses strong anti-inflammatory and antioxidant characteristics. Research has demonstrated that curcumin, in a variety of forms, including nanomicelle gels, can successfully lessen discomfort and hasten the healing process for RAS lesions. Nanomicelle gel was proven to be more effective than other types in clinical research. ^[31,32]	Anti-inflammatory and antioxidant
Liquorice (<i>Glycyrrhiza glabra</i>)	Liquorice root extract has a reputation for being calming and anti-inflammatory. Licorice extract-based formulations have been used to treat oral ulcers, including RAS, by lowering inflammation and pain. Licorice combined with other herbs in herbal gels is a good way to treat the symptoms of RAS. ^[27,29,33]	Anti-inflammatory and reduces inflammation

Table 6: Comparative efficacy of herbal formulations and conventional treatments for RAS.

Factors	Herbal treatment	Conventional treatment
Efficacy	It has been shown that aloe vera, green tea, echinacea, and curcumin are highly effective at easing pain and hastening the healing process. ^[3,19,20,22]	The following medications can help reduce ulcer size and pain: amlexanox, systemic prednisone, topical corticosteroids, chlorhexidine, and sucralfate. ^[4-6,15,26,34]
Outcome	Herbal remedies frequently result in decreased inflammation, accelerated healing, and defence against recurrent infections. ^[9,23,35]	In acute situations, conventional therapies are often favoured because they provide faster ulcer clearance and immediate pain relief. ^[4,5,26]
Patient satisfaction	High levels of patient satisfaction because of the natural origin and less adverse effects. ^[19,20,22]	High satisfaction owing to prompt recovery, notwithstanding the potential side effects of certain therapies, such as oral candidiasis brought on by steroids. ^[5,6]
Patient compliance	Generally positive because of their natural source and lower negative effects, yet some herbal medicines need to be applied frequently. ^[19,20,36]	High adherence to treatments that offer immediate relief; however, negative effects from long-term steroid use may lower adherence. ^[5,6]
Cost	Generally less expensive because a lot of herbs can be found naturally or bought cheaply. ^[9,10,24]	Increased expenses because of the usage of prescription drugs and their requirement. ^[5,26]
Side effects	Few side effects; allergies may occur in certain people. ^[19,20]	Mucosal irritation, steroid systemic effects, and potential antimicrobial resistance are examples of potential adverse effects. ^[4,5]
Availability	Accessible: a large variety of herbs are available at health food stores or can be grown at home. ^[9,10,24]	Needs access to a pharmacy and a prescription; availability varies based on healthcare system. ^[6,26]
Mechanism of action	Healing and inflammation reduction are facilitated by anti-inflammatory, antioxidant, and antibacterial qualities. ^[3,20,22,23]	The pathophysiology of ulcers is directly targeted by anti-inflammatory, immunosuppressive, and barrier-forming characteristics. ^[4,5,15]
Long-term use	Appropriate for patients experiencing recurrences frequently, safe for extended use with low side effects. ^[3,19]	The use of steroids and antibiotics can be restricted due to negative effects and resistance that can arise from prolonged use. ^[5,6]

by evaluating aspects like efficacy, safety, cost-effectiveness, patient satisfaction, and long-term results. With the aim of optimizing patient care and enhancing oral health outcomes, this comparative analysis provides valuable insights into the various RAS management approaches.

CONCLUSION

The current review emphasizes the importance of assessing herbal formulas for treating Recurrent Aphthous Stomatitis (RAS), providing a detailed summary of their effectiveness, actions, and advantages over traditional treatments. At present, herbal treatments like Aloe vera, green tea, Echinacea, and more show potential in alleviating pain, inflammation, and speeding up healing for RAS sores, backed by clinical research and historical usage. The current situation reflects an increasing fascination with herbal remedies because of their natural source, minimal side effects, and comprehensive approach to wellness. Nevertheless, these treatments require additional validation through thorough, top-notch clinical trials to determine their effectiveness and

safety. The future looks bright for herbal formulations, as more research is being done to identify bioactive compounds and understand how they work for therapy. The benefits of herbal remedies include their easy availability, affordability, and lower chance of negative effects, which make them attractive options in addition to or in place of standard treatments. Nevertheless, challenges like differences in strength, absence of uniformity, and insufficient regulatory supervision need to be tackled to guarantee their safe and efficient utilization. Future suggestions highlight the importance of thorough clinical studies to establish consistent doses, formulations, and treatment procedures. Improving the strength of evidence with randomized controlled trials will aid in the incorporation of herbal remedies into conventional medical care. Moreover, promoting partnerships between conventional healers and contemporary researchers can improve comprehension and utilization of these therapies. In the end, the outlook is positive for herbal formulations in treating RAS as they could provide safe and effective alternatives to traditional treatments that are also convenient for patient.

ABBREVIATIONS

RAS: Recurrent Aphthous stomatitis; **HLA:** Human Leukocyte Antigen; **TNF- α :** Tumor Necrosis Factor-Alpha; **IL-2:** Interleukin-2; **IFN- γ :** Interferon-Gamma; **IL-10:** Interleukin-10; **LPS:** Lipopolysaccharides; **TLRs:** Toll-Like Receptors.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

SUMMARY

Recurrent Aphthous Stomatitis (RAS) is a prevalent, painful oral mucosal condition. While conventional treatments such as corticosteroids, antimicrobial agents, and analgesics are commonly used, they often provide only temporary relief and are associated with side effects when used long-term. As a result, there is a growing interest in alternative therapies, particularly herbal formulations, for safer and more holistic management. This review evaluates the efficacy, mechanisms of action, and clinical outcomes of various herbal remedies including aloe vera, green tea, echinacea, curcumin, mangosteen, and others. These botanicals exhibit anti-inflammatory, antimicrobial, antioxidant, and immunomodulatory properties, making them promising agents for treating RAS. The review presents evidence from *in vitro* and clinical studies, emphasizing how these natural compounds reduce pain, accelerate healing, and help prevent recurrence. Additionally, the review compares herbal and conventional therapies in terms of efficacy, safety, cost, patient compliance, and long-term use. Herbal remedies are shown to be effective, affordable, and better tolerated, with fewer side effects, thus improving patient satisfaction and adherence. The review advocates for further clinical validation and supports the integration of herbal medicine into conventional treatment protocols for RAS management.

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