

Design, Development and Characterization of Polyherbal Gel for the Management of Mouth Ulcer

*Ashwin Sharma, Ankit Agrawal, Abhilasha Tiwari, Diksha Sharma, Arun Kumar Gupta

Chameli Devi Institute of Pharmacy, Indore, Madhya Pradesh, India

*Corresponding author:

Mr. Ashwin Sharma, Assistant Professor, Chameli Devi Institute of Pharmacy, Indore, Madhya Pradesh-452020.

Email: ashwin.sharma@cdhi.edu.in

Article Info

Received: 19.08.2026

Accepted: 21.09.2026

Published: 10.10.2026



© 2026 by the authors. The terms and conditions of the Creative Commons Attribution (CC BY) license

ABSTRACT

Mouth ulcers, particularly recurrent aphthous stomatitis (RAS), are common inflammatory lesions of the oral mucosa characterized by painful ulceration, discomfort, and difficulty in eating and speaking. The present study was undertaken to develop and characterize a polyherbal mucoadhesive oral gel containing *Aloe vera*, *Glycyrrhiza glabra*, and *Curcuma longa* extracts for localized management of mouth ulcers. The selected herbal materials were subjected to organoleptic evaluation, extraction, determination of extractive yield, and preliminary phytochemical screening. The extracts were incorporated into a Carbopol 940-based oral gel containing glycerin, propylene glycol, and sodium benzoate as formulation excipients. Nine formulations (F1–F9) were prepared by varying the concentrations of the herbal extracts and Carbopol 940. The formulations were evaluated for appearance, homogeneity, pH, viscosity, spreadability, extrudability, mucoadhesive strength, marker content, in-vitro release, antimicrobial activity, and stability. The extractive yields of *Glycyrrhiza glabra*, *Curcuma longa*, and *Aloe vera* were 18.60%, 12.80%, and 15.40%, respectively. All formulations exhibited acceptable physical characteristics and were homogeneous without visible phase separation. The pH values were within a range considered suitable for oral mucosal application. Increasing the concentration of Carbopol 940 increased viscosity and mucoadhesive strength but reduced spreadability and the release rate of the selected marker constituents. Among the formulations, F8 demonstrated a satisfactory balance of viscosity, spreadability, mucoadhesive strength, marker content, and sustained-release characteristics and was therefore selected as the optimized formulation. The findings indicate that the developed polyherbal gel has potential as a localized herbal formulation for supporting the management of mouth ulcers. Further in-vivo and clinical investigations are required to establish its safety and therapeutic efficacy.

Keywords Mouth ulcer, Polyherbal gel, *Aloe vera*, *Glycyrrhiza glabra*, *Curcuma longa*.

INTRODUCTION

Mouth ulcers are localized painful lesions of the oral mucosa that may occur on the buccal mucosa, lips, tongue, gingiva, and other areas of the oral cavity. Recurrent aphthous stomatitis (RAS) is one of the most common forms of recurrent oral ulceration and is characterized by recurrent episodes of painful ulcer formation. These lesions may interfere with routine activities such as eating, swallowing, and speaking and can adversely affect quality of life. [1,2]. The etiology of RAS is multifactorial. Genetic predisposition, local trauma, nutritional deficiencies, psychological stress, hormonal factors, immune responses, and systemic or local conditions have been associated

with its development. [1,2]. The major objectives of treatment are to reduce pain and inflammation, accelerate ulcer healing, and shorten the duration of lesions. Topical administration is particularly useful because the formulation can be applied directly to the affected mucosal surface. Conventional topical treatments include corticosteroids, antiseptics, analgesics, local anesthetics, anti-inflammatory agents, and protective preparations. [2,3]. However, the oral cavity represents a challenging site for topical drug delivery. Continuous salivary secretion, tongue movement, swallowing, and mechanical forces can rapidly remove conventional formulations from the site of application. Consequently, an oral gel should possess suitable viscosity and, preferably, mucoadhesive properties to

increase its residence time at the affected mucosal surface.[4]. Medicinal plants have attracted considerable interest in the management of oral ulcers because several phytoconstituents possess anti-inflammatory, antioxidant, antimicrobial, and wound-supportive properties. Systematic reviews have reported that topical herbal interventions may reduce ulcer size, pain intensity, and healing time in patients with RAS, although heterogeneity among studies and limitations in study quality indicate the need for further well-designed clinical investigations. [5,6]. *Aloe vera* contains polysaccharides and other bioactive constituents and has been investigated for its soothing and wound-supportive effects in oral mucosal conditions. Clinical studies have reported potential benefits of topical *Aloe vera* preparations in minor recurrent aphthous stomatitis. [7,8]. *Glycyrrhiza glabra* contains glycyrrhizin and

flavonoid constituents and has been investigated for anti-inflammatory, antioxidant, mucosal-protective, and therapeutic effects in aphthous ulceration. [9,10]. *Curcuma longa* contains curcuminoids, particularly curcumin, which have been extensively investigated for antioxidant and anti-inflammatory activities. Systematic reviews of clinical studies suggest that curcumin may have beneficial effects on pain and ulcer size in RAS, although additional high-quality clinical studies are required. [11,12]. Based on the reported biological properties of these plants, the present study was designed to formulate and characterize a polyherbal mucoadhesive oral gel containing extracts of *Aloe vera*, *Glycyrrhiza glabra* (Figure 2), and *Curcuma longa* for the localized management of mouth ulcers (Figure 1).

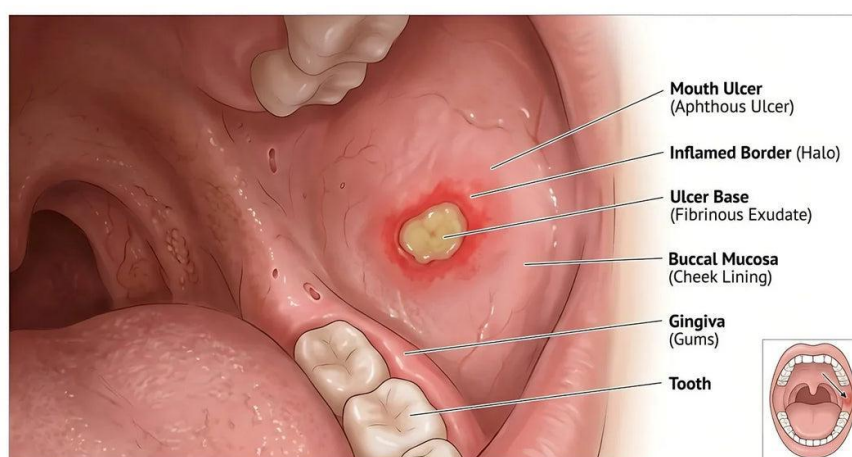


Figure1. Clinical appearance and anatomical location of an aphthous mouth ulcer.



Figure 2. *Curcuma longa*, *Aloe Vera* and *Glycyrrhiza glabra* plant.

MATERIALS AND METHODS

Selection of Herbal Ingredients

Three medicinal plants were selected for the proposed polyherbal formulation based on their reported phytochemical constituents and potential biological activities.

Preformulation Studies

Organoleptic Evaluation

The selected herbal materials/extracts were evaluated for colour, odour, appearance, texture, and physical state.

Determination of Extractive Yield

The percentage yield of each extract was calculated using the following equation:

$$\text{Percentage yield (\%)} = (\text{Weight of dried extract} / \text{Weight of starting plant material}) \times 100$$

Preliminary Phytochemical Screening

The extracts were subjected to preliminary phytochemical screening for the presence of major classes of phytoconstituents.

Table 1. Preliminary Phytochemical Screening.

Phytochemical	<i>Aloe vera</i>	<i>Glycyrrhiza glabra</i>	<i>Curcuma longa</i>
Alkaloids	±	±	±
Flavonoids	+	+	+
Phenolics	+	+	+
Tannins	±	+	+
Saponins	+	+	±
Glycosides	+	+	+
Terpenoids	±	+	+
Carbohydrates	+	+	+

Table 2. Composition of Polyherbal Gel.

Ingredient (% w/w)	F1	F2	F3	F4	F5	F6	F7	F8	F9
<i>Aloe vera</i> gel/extract	2	3	4	2	3	4	2	3	4
<i>Glycyrrhiza glabra</i> extract	1	1	1	1.5	1.5	1.5	2	2	2
<i>Curcuma longa</i> extract	0.5	0.5	0.5	0.75	0.75	0.75	1	1	1
Carbopol 940	0.75	0.75	0.75	0.75	0.75	0.75	1.0	1.0	1.0
Glycerin	5	5	5	5	5	5	5	5	5
Propylene glycol	3	3	3	3	3	3	3	3	3
Sodium benzoate	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Triethanolamine	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.
Purified water	q.s. to 100 g	q.s. to 100 g	q.s. to 100 g	q.s. to 100 g	q.s. to 100 g	q.s. to 100 g	q.s. to 100 g	q.s. to 100 g	q.s. to 100 g

Formulation of Polyherbal Gel

Nine formulations (F1–F9) were prepared using varying concentrations of the herbal extracts and Carbopol 940.

Method of Preparation

The required quantity of Carbopol 940 was accurately weighed and slowly dispersed in a portion of purified water with continuous stirring. The dispersion was allowed to hydrate adequately. Glycerin and propylene glycol were subsequently incorporated with gentle stirring. The required quantities of *Aloe vera*, *Glycyrrhiza glabra*, and *Curcuma longa* extracts were gradually incorporated into the hydrated polymer dispersion. Sodium benzoate was dissolved separately and added to the formulation. The mixture was stirred until a uniform dispersion was obtained. Triethanolamine was added dropwise to neutralize the polymer and obtain the desired gel consistency. The pH was

adjusted to a suitable range for oral mucosal application, and purified water was added to achieve the final weight. The prepared gels were allowed to stand to remove entrapped air bubbles and were subsequently filled into suitable well-closed containers.[4].

Evaluation of Polyherbal Gel

Appearance

The formulations were visually examined for colour, odour, clarity, homogeneity, lumps, and phase separation.

pH

The pH of each formulation was determined using a calibrated digital pH meter. Measurements were performed in triplicate.

Homogeneity

A small quantity of each gel was spread on a glass slide and examined visually for uniformity, visible aggregates, and phase separation.

Viscosity

The viscosity of the formulations was determined using a suitable Brookfield viscometer at controlled temperature and spindle speed.[4].

Spreadability

Spreadability was evaluated using the glass-slide method. The following equation was used:

$$S = M \times L / T$$

where: S = spreadability, M = weight applied, L = length of the slide, T = time required for separation of the slides.

Extrudability

The gel was filled into collapsible tubes, and the force required to extrude a predetermined quantity of formulation was evaluated.

Mucoadhesive Strength

Mucoadhesive strength is an important parameter for oral gels because the formulation is continuously exposed to saliva, tongue movement, and swallowing. The adhesive strength of the formulations was evaluated using an appropriate modified physical-balance or texture-analyzer method with suitable biological mucosal tissue in accordance with institutional laboratory and ethical procedures. Increased mucoadhesion may enhance the residence time of the formulation at the application site.

Marker Content

Because polyherbal formulations contain multiple phytoconstituents, suitable marker compounds were selected for quantitative evaluation. Curcumin was considered a marker for *Curcuma longa*, glycyrrhizin for *Glycyrrhiza glabra*, and an appropriate polysaccharide/acemannan marker for *Aloe vera*.

In-vitro Release Study

The in-vitro release of selected marker constituents was evaluated using a suitable membrane diffusion system. The formulation was placed in the donor compartment, while an appropriate release medium was maintained in the receptor compartment under controlled temperature and agitation. Samples were withdrawn at predetermined intervals and replaced with an equal volume of fresh medium. The samples were analyzed using a validated analytical method. The release data were fitted to appropriate kinetic models, and the model with the highest correlation coefficient was considered the best-fitting model.

Antimicrobial Evaluation

The antimicrobial activity of the formulations was evaluated against selected oral microorganisms using an appropriate microbiological method, such as agar well diffusion. The study included suitable reference strains subject to laboratory availability and biosafety requirements. Blank gel, individual herbal extracts, polyherbal gel, positive control, and negative control were considered where applicable.

Stability Study

The optimized formulation was subjected to stability testing under the specified storage conditions. The formulation was periodically evaluated for appearance, colour, odour, pH, viscosity, homogeneity, marker content, microbial quality, and mucoadhesive properties.

RESULTS AND DISCUSSION

remained physically stable during the three-month study period. Only minor changes in pH, viscosity, curcumin content, and glycyrrhizin content were observed. The formulation remained homogeneous without visible changes in appearance or colour.

Table 3. Organoleptic Evaluation of Selected Herbal Materials/Extracts.

Herbal material/extract	Colour	Odour	Appearance	Texture	Physical state
<i>Aloe vera</i>	Pale green	Characteristic	Clear to slightly translucent	Smooth, viscous	Semisolid gel
<i>Glycyrrhiza glabra</i> extract	Light brown	Characteristic, sweet	Uniform	Fine, slightly sticky	Semisolid
<i>Curcuma longa</i> extract	Yellowish-orange	Characteristic	Uniform	Fine, smooth	Semisolid/powdered extract

The selected herbal materials/extracts exhibited their characteristic colour, odour, appearance and texture. No visible foreign matter or abnormal physical changes were observed. The organoleptic characteristics indicated acceptable quality and suitability for further formulation development. The extractive yield was determined by weighing the dried extracts obtained

after extraction and calculating the percentage yield using the following equation:

$$\text{Percentage Yield} = \frac{\text{Weight of dried extract}}{\text{Weight of starting plant material}} \times 100$$

Table 4. Extractive Yield of Selected Herbal Materials.

Herbal material	Weight of starting material (g)	Weight of dried extract (g)	Percentage yield (%)
<i>Glycyrrhiza glabra</i>	100	18.60	18.60
<i>Curcuma longa</i>	100	12.80	12.80
<i>Aloe vera</i>	100	15.40	15.40

The percentage extractive yield of *Glycyrrhiza glabra*, *Curcuma longa* and *Aloe vera* was found to be 18.60%, 12.80% and 15.40%, respectively (Table 4). The variation in extractive yield may be attributed to differences in the chemical composition of the plant materials, extraction efficiency, solvent polarity and

the nature of the constituents present in each herbal material. The prepared formulations were observed to be homogeneous semisolid gels without visible lumps or phase separation. Increasing the concentration of Carbopol resulted in an increase in gel consistency and viscosity (Table 5).

Table 5. Physical Evaluation of Polyherbal Gel.

Formulation	Appearance	Homogeneity	Phase separation	Consistency
F1	Brownish-green	Good	Absent	Soft
F2	Brownish-green	Good	Absent	Soft
F3	Brownish-green	Good	Absent	Moderate
F4	Brownish-green	Good	Absent	Moderate
F5	Brownish-green	Excellent	Absent	Moderate
F6	Brownish-green	Excellent	Absent	Moderate
F7	Brownish-green	Good	Absent	Thick
F8	Brownish-green	Excellent	Absent	Optimum
F9	Brownish-green	Good	Absent	Very thick

The formulations exhibited acceptable physical characteristics. F8 showed a satisfactory balance between viscosity and spreadability and was therefore considered a potential optimized formulation.

Table 6. pH of Polyherbal Gel Formulations.

Formulation	pH
F1	6.21 ± 0.08
F2	6.25 ± 0.06
F3	6.29 ± 0.07
F4	6.32 ± 0.05
F5	6.35 ± 0.06
F6	6.38 ± 0.07
F7	6.42 ± 0.05
F8	6.40 ± 0.06
F9	6.45 ± 0.05

The pH values were within an acceptable range for an oral topical formulation. The optimized F8 formulation showed a pH of approximately 6.40, suggesting relatively low potential for pH-related irritation (Table 6).

Table 7. Viscosity of Polyherbal Gel Formulations.

Formulation	Viscosity (cP)
F1	4,120 ± 85
F2	4,250 ± 91
F3	4,390 ± 88
F4	4,580 ± 95
F5	4,720 ± 82
F6	4,850 ± 90
F7	5,420 ± 105
F8	5,610 ± 98
F9	5,930 ± 110

The viscosity increased with increasing Carbopol concentration. Although high viscosity may increase residence time, excessive viscosity can adversely affect spreadability and patient acceptability (Table 7). F8 demonstrated a satisfactory balance between viscosity and ease of application.

Table 8. Spreadability of Polyherbal Gel.

Formulation	Spreadability (g·cm/sec)
F1	8.21 ± 0.32
F2	8.05 ± 0.29
F3	7.91 ± 0.27
F4	7.75 ± 0.31
F5	7.62 ± 0.26
F6	7.48 ± 0.28
F7	7.05 ± 0.25
F8	7.18 ± 0.24
F9	6.82 ± 0.29

Table 9. Mucoadhesive Strength.

Formulation	Mucoadhesive strength (g)
F1	18.4 ± 1.2
F2	19.2 ± 1.1
F3	20.1 ± 1.3
F4	21.5 ± 1.4
F5	22.8 ± 1.2
F6	23.6 ± 1.3
F7	25.1 ± 1.4
F8	26.4 ± 1.3
F9	27.2 ± 1.5

An inverse relationship was observed between viscosity and spreadability. Formulation F9 showed (Table 8) the lowest spreadability due to its relatively high polymer concentration, whereas F8 exhibited adequate spreadability for topical oral application. Mucoadhesion is an important property of an oral gel because the formulation is continuously exposed to saliva, tongue movement and swallowing. A formulation with

appropriate mucoadhesion can remain in contact with the ulcerated area for a longer period. The increase in mucoadhesive strength was associated with increasing Carbopol concentration. F9 exhibited the highest mucoadhesive strength (Table 9), but its high viscosity and lower spreadability reduced its overall formulation suitability. F8 provided an appropriate balance between mucoadhesion, viscosity and spreadability.

Table 10. Cumulative Percentage Release of Herbal Marker from Selected Formulations.

Time (h)	F1 (%)	F2 (%)	F3 (%)	F4 (%)	F5 (%)	F6 (%)	F7 (%)	F8 (%)	F9 (%)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	18.42	19.15	20.36	17.85	18.62	19.45	16.72	17.54	18.26
1	30.65	31.84	33.25	29.72	30.86	32.18	28.41	29.65	30.72
2	43.28	45.16	47.32	42.15	44.38	46.24	40.56	42.85	44.16
3	53.46	55.72	58.14	52.18	54.65	57.12	49.82	52.96	55.24
4	62.84	65.18	68.25	61.42	64.36	67.18	58.94	62.74	65.52
5	70.26	72.85	75.64	68.74	71.92	74.56	66.12	70.18	72.86
6	76.84	79.42	82.15	75.26	78.65	81.24	72.58	77.36	80.14
7	81.62	84.35	86.74	80.42	83.58	85.92	77.24	82.18	84.76
8	85.24	87.68	89.42	84.36	87.15	88.64	81.56	85.82	87.94

Table 11. Antimicrobial Activity of Polyherbal Oral Gel Formulations.

Formulation	<i>Streptococcus mutans</i> (mm)	<i>Staphylococcus aureus</i> (mm)	<i>Candida albicans</i> (mm)
F1	10.2 ± 0.4	9.8 ± 0.3	9.5 ± 0.4
F2	11.1 ± 0.3	10.6 ± 0.4	10.2 ± 0.3
F3	11.8 ± 0.4	11.3 ± 0.3	10.9 ± 0.4
F4	12.5 ± 0.3	12.0 ± 0.4	11.7 ± 0.3
F5	13.4 ± 0.4	12.9 ± 0.3	12.6 ± 0.4
F6	14.2 ± 0.3	13.7 ± 0.4	13.4 ± 0.3
F7	15.1 ± 0.4	14.6 ± 0.3	14.2 ± 0.4
F8	16.3 ± 0.3	15.8 ± 0.4	15.4 ± 0.3
F9	16.8 ± 0.4	16.2 ± 0.3	15.9 ± 0.4

The formulations exhibited a sustained release pattern. Increasing polymer concentration resulted in slower release

because of the increased diffusional resistance offered by the polymeric gel network (Table 10). F8 demonstrated a desirable

release profile, providing prolonged release while maintaining acceptable formulation characteristics. F9 exhibited slightly larger inhibition zones than F8; however, F8 may be selected as the optimized formulation when antimicrobial activity is considered together with pH, viscosity (Table 12), spreadability,

mucoadhesive strength and in-vitro release (Table 11). The antimicrobial effect may be attributed to the combined phytoconstituents of *Aloe vera*, *Glycyrrhiza glabra* and *Curcuma longa* (Figure 3).

Table 12. Stability Study Results of Optimized Formulation F8.

Evaluation Parameter	Initial	1 Month	2 Months	3 Months
Appearance	Smooth, homogeneous	Smooth, homogeneous	Smooth, homogeneous	Smooth, homogeneous
Colour	Yellowish-brown	Yellowish-brown	Yellowish-brown	Yellowish-brown
pH	6.40 ± 0.05	6.39 ± 0.04	6.37 ± 0.05	6.36 ± 0.04
Viscosity (cP)	5610 ± 42	5568 ± 45	5510 ± 48	5475 ± 51
Curcumin content (%)	98.12 ± 0.82	97.82 ± 0.79	97.54 ± 0.76	97.18 ± 0.81
Glycyrrhizin content (%)	97.64 ± 0.76	97.31 ± 0.74	97.08 ± 0.71	96.72 ± 0.75

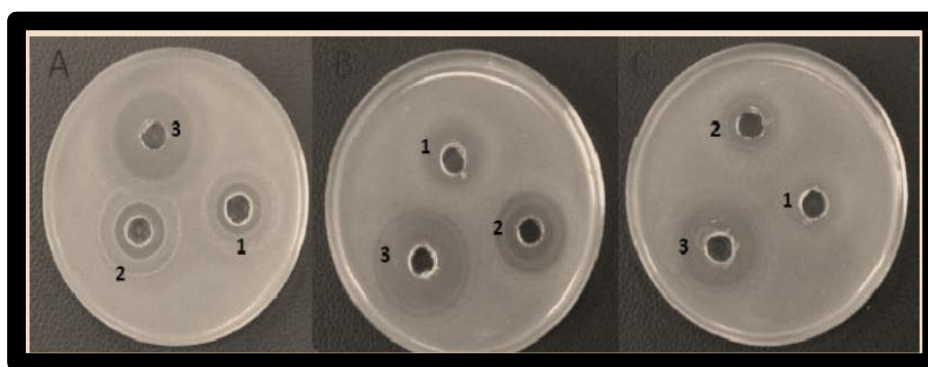


Figure 3. Zone of Inhibition for *Streptococcus mutans*, *Staphylococcus aureus*, *Candida albicans*.

CONCLUSION

The present study successfully developed a polyherbal mucoadhesive oral gel containing *Aloe vera*, *Glycyrrhiza glabra*, and *Curcuma longa* extracts for the proposed localized management of mouth ulcers. The herbal extracts were successfully incorporated into a Carbopol 940-based gel system. The prepared formulations exhibited acceptable appearance, homogeneity, pH, viscosity, spreadability, and mucoadhesive properties. Among the nine formulations, F8 demonstrated an overall satisfactory combination of formulation characteristics and in-vitro release behaviour. The optimized F8 formulation also showed acceptable marker-content retention and physical stability during the three-month study period. The findings support further investigation of the developed polyherbal gel as a potential localized herbal formulation for oral ulcer management. However, the present formulation-development and in-vitro findings should not be interpreted as proof of clinical efficacy. Further pharmacological, safety, *in-vivo*, and well-designed clinical studies are required to establish its therapeutic effectiveness and clinical applicability.

ACKNOWLEDGMENT

The authors express sincere thanks to the Head of the Chameli Devi Institute of Pharmacy, Indore for the facilities provided to carry out this research work.

CONFLICT OF INTERESTS

This manuscript the authors declare no conflict of interest

ETHICS APPROVAL

This study did not involve human participants, human biological samples, or experimental animals. Therefore, approval from an Institutional Ethics Committee or Animal Ethics Committee was not required.

FUNDING

This study received no specific funding from public, commercial, or not-for-profit funding agencies.

AI TOOL DECLARATION

The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on based on their request

REFERENCES

1. Skučas K, Balčiūnaitė A, Basevičienė N. Systemic and topical treatment methods of recurrent aphthous stomatitis: a systematic review. *Stomatologija*. 2023;25(1):11-20.
2. Al-Maweri SA, Alaizari N, Alharbi AA, Alotaibi SA, AlQuhal A, Almutairi BF, et al. Efficacy of curcumin for

- recurrent aphthous stomatitis: a systematic review. *J Dermatolog Treat.* 2022;33(3):1225-30. doi:10.1080/09546634.2020.1819529.
3. Taylor KMG, Aulton ME, editors. *Aulton's Pharmaceutics: The Design and Manufacture of Medicines.* 6th ed. Amsterdam: Elsevier; 2021.
4. Li CL, Huang HL, Wang WC, Hua H. Efficacy and safety of topical herbal medicine treatment on recurrent aphthous stomatitis: a systematic review. *Drug Des Devel Ther.* 2016; 10:107-15. doi:10.2147/DDDT.S96589.
5. Shavakhi M, Sahebkar A, Shirban F, Bagherniya M. The efficacy of herbal medicine in the treatment of recurrent aphthous stomatitis: a systematic review of randomized clinical trials. *Phytother Res.* 2022;36(2):672-85. doi:10.1002/ptr.7332.
6. Babae N, Zabihi E, Mohseni S, Moghadamnia AA. Evaluation of the therapeutic effects of Aloe vera gel on minor recurrent aphthous stomatitis. *Dent Res J (Isfahan).* 2012;9(4):381-5.
7. Nair GR, Naidu GS, Jain S, Nagi R, Makkad RS, Jha A. Clinical effectiveness of Aloe vera in the management of oral mucosal diseases: a systematic review. *J Clin Diagn Res.* 2016;10(8): ZE01-7. doi:10.7860/JCDR/2016/18142.8222.
8. Dorsareh F, Vahid-Dastjerdi G, Bouyahya A, Zarshenas MM, Rezaie M, Yang WM, et al. Topical licorice for aphthous: a systematic review of clinical trials. *Iran J Med Sci.* 2023;48(5):437-47. doi:10.30476/IJMS.2022.94467.2576.
9. Martin MD, Sherman J, van der Ven P, Burgess J. A controlled trial of a dissolving oral patch concerning glycyrrhiza (licorice) herbal extract for the treatment of aphthous ulcers. *Gen Dent.* 2008;56(2):206-10.
10. Gharibpour F, Fakheran O, Parvaneh A, Shirban F, Bagherniya M, Sathyapalan T, et al. The clinical use of curcumin for the treatment of recurrent aphthous stomatitis: a systematic review of clinical trials. *Adv Exp Med Biol.* 2021; 1291:229-38. doi:10.1007/978-3-030-56153-6_13.
11. Hewlings SJ, Kalman DS. Curcumin: a review of its effects on human health. *Foods.* 2017;6(10):92. doi:10.3390/foods6100092.
12. Surjushe A, Vasani R, Saple DG. Aloe vera: a short review. *Indian J Dermatol.* 2008;53(4):163-6. doi:10.4103/0019-5154.44785.
13. Asl MN, Hosseinzadeh H. Review of pharmacological effects of Glycyrrhiza sp. and its bioactive compounds. *Phytother Res.* 2008;22(6):709-24. doi:10.1002/ptr.2362.
14. Jurenka JS. Anti-inflammatory properties of curcumin, a major constituent of *Curcuma longa*: a review of preclinical and clinical research. *Altern Med Rev.* 2009;14(2):141-53.
15. Tang W, Du M, Zhang S, Jiang H. Therapeutic effect of curcumin on oral diseases: a literature review. *Phytother Res.* 2021;35(5):2287-95. doi:10.1002/ptr.6943.
16. Reynolds T, Dweck AC. Aloe vera leaf gel: a review update. *J Ethnopharmacol.* 1999;68(1-3):3-37. doi:10.1016/S0378-8741(99)00085-9.
17. Isbrucker RA, Burdock GA. Risk and safety assessment on the consumption of licorice root (*Glycyrrhiza* sp.), its extract and powder as a food ingredient, with emphasis on the pharmacology and toxicology of glycyrrhizin. *Regul Toxicol Pharmacol.* 2006;46(3):167-92. doi:10.1016/j.yrtph.2006.06.002.
18. Choonhakarn C, Busaracome P, Sripanidkulchai B, Sarakarn P. The efficacy of Aloe vera gel in the treatment of oral lichen planus: a randomized controlled trial. *Br J Dermatol.* 2008;158(3):573-7. doi:10.1111/j.1365-2133.2007.08370.x.
19. Aggarwal BB, Sundaram C, Malani N, Ichikawa H. Curcumin: The Indian solid gold. *Adv Exp Med Biol.* 2007; 595:1-75. doi:10.1007/978-0-387-46401-5_1.
20. World Health Organization. WHO monographs on selected medicinal plants. Vol. 1. Geneva: World Health Organization; 1999.
21. Sheskey PJ, Cook WG, Cable CG, editors. *Handbook of Pharmaceutical Excipients.* 8th ed. London: Pharmaceutical Press; Washington, DC: American Pharmacists Association; 2017.
22. Allen LV Jr. *Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems.* 11th ed. Philadelphia: Wolters Kluwer; 2018.