

A Review On: MUCOADHESIVE FILM FOR ORAL ANTIBACTERIAL THERAPY USING SESBANIA GRANDIFLORA

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ABSTRACT

Oral infections are associated with complex microbial communities and may contribute to dental caries, periodontal disease and other oral inflammatory conditions. Conventional antibacterial dosage forms may have limitations for localized therapy because salivary flow, swallowing and oral movements can reduce residence time at the target site. Mucoadhesive oral films are thin polymeric dosage forms designed to maintain contact with the oral mucosa and may provide a useful platform for localized delivery. *Sesbania grandiflora* (L.) Poir., commonly known as agati, is a medicinal plant of the family Fabaceae. Different parts of the plant have been investigated for phytochemical constituents and biological activities, including antibacterial and antioxidant effects. Published studies have reported antibacterial activity from extracts of *S. grandiflora* leaves, flowers and bark, although activity varies with plant part, extraction method, concentration and test organism. This review discusses the botanical and phytochemical profile of *S. grandiflora*, its reported pharmacological and antibacterial activities, principles of mucoadhesive oral films, formulation components, solvent-casting preparation, evaluation parameters, research gaps and future prospects. Particular emphasis is placed on the potential use of a standardized *S. grandiflora* leaf extract in a mucoadhesive oral film for local antibacterial application. Available evidence supports further formulation research, but it does not by itself establish clinical efficacy. Standardization, formulation optimization, antibacterial testing against relevant oral pathogens, mucosal safety, stability and subsequent in-vivo and clinical studies are required.

Keywords: *Sesbania grandiflora*, mucoadhesive film, oral antibacterial therapy, buccal drug delivery, herbal drug delivery, phytochemicals, antibacterial activity.

1. INTRODUCTION

The oral cavity contains a diverse microbial community that normally exists in a dynamic ecological balance. Changes in the local environment and microbial composition can contribute to oral diseases including dental caries, gingival inflammation and periodontal disease. For local antibacterial therapy, maintaining adequate exposure of an active substance at the oral mucosal surface is an important formulation objective. Conventional oral dosage forms may be removed from the oral cavity by saliva, swallowing and mechanical movements. Buccal and other mucoadhesive delivery systems are therefore investigated to prolong residence at the site of application. Mucoadhesive systems can provide close contact between a dosage form and mucosal tissue, potentially improving local exposure and reducing premature removal. Mucoadhesive films are particularly attractive because they are thin, flexible and can be prepared using different film-forming polymers. They can be designed for local delivery and may offer acceptable administration compared with larger solid dosage forms. The performance of a film depends on polymer selection, plasticizer concentration, extract properties, mechanical strength, hydration, adhesion and the physiological conditions of the oral cavity. Natural products are important sources of structurally diverse phytochemicals. **Sesbania grandiflora** has a history of traditional use and has been investigated for several biological activities. The antibacterial findings reported for different plant parts provide a rationale for further investigation of standardized leaf extracts in pharmaceutical delivery systems. However, antibacterial activity observed in vitro should not be interpreted as proof of clinical effectiveness.[5,6,7]

2. ORAL INFECTIONS AND NEED FOR LOCAL ANTIBACTERIAL DELIVERY

The oral cavity is continuously exposed to microorganisms from saliva, food and the environment. Disease can occur when microbial interactions and host factors become unfavorable. Local antibacterial delivery aims to expose the target site to an effective concentration of an antibacterial substance while minimizing unnecessary systemic exposure. A localized mucoadhesive system may remain at the application site longer than a conventional liquid or rapidly swallowed preparation. This can be useful when the therapeutic objective is local action. Nevertheless, eating, drinking, salivary flow and tongue movement can influence residence time, so formulation design must account for these physiological factors.[5,6]

3. MUCOADHESIVE DRUG DELIVERY SYSTEM

Mucoadhesion is the adhesion of a material to a mucosal surface. In pharmaceutical systems, mucoadhesive polymers are used to prolong the residence of a formulation on mucosal tissue. The mechanisms proposed for mucoadhesion include wetting, interpenetration of polymer and mucus chains, hydrogen bonding, electrostatic interactions and other secondary interactions. For oral delivery, the buccal mucosa is accessible and can be used for local or systemic drug delivery. For local antibacterial therapy, the desired outcome is prolonged contact of the active material with the oral mucosa. A successful system must balance adequate adhesion with patient comfort and should not cause unacceptable irritation.[5,6,7,8]

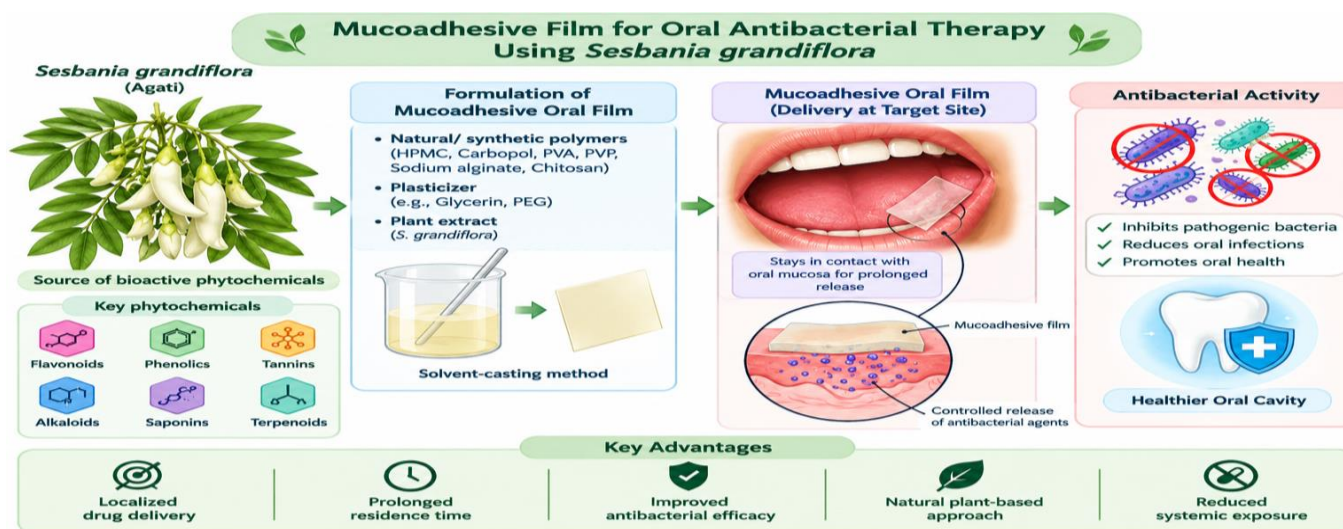


Fig 3.1: Mucoadhesive Oral Film

4. MUCOADHESIVE ORAL FILMS

Mucoadhesive oral films are thin polymeric sheets containing an active ingredient or standardized herbal extract with suitable excipients. Film properties can be adjusted by changing polymer type and concentration, plasticizer level, solids content, drying conditions and other formulation variables. Solvent casting is a commonly used laboratory-scale approach. A polymer is dissolved or dispersed in a suitable solvent system, the active material and excipients are incorporated, the mixture is cast onto a defined surface and then dried under controlled conditions. The dried film is removed and cut into uniform units. Advantages may include ease of administration, flexibility, portability and the possibility of localized delivery. Limitations include sensitivity to moisture, possible changes in mechanical properties during storage, taste or mouthfeel issues, and loss of adhesion due to saliva and oral movements[5,6,7,8].

5. SESBANIA GRANDIFLORA

Sesbania grandiflora (L.) Poir. belongs to the family Fabaceae and is commonly known as agati or agathi. It is a tropical and subtropical plant used traditionally as food and medicine. Different plant parts, including leaves, flowers and bark, have been investigated for their phytochemical and pharmacological properties.[9,10]

Classification	Details
Kingdom	Plantae
Family	Fabaceae
Genus	Sesbania

Species	* <i>Sesbania grandiflora</i> * (L.) Poir.
Common name	Agati / Agathi

6. PHYTOCHEMICAL CONSTITUENTS

Phytochemical investigations of **S. grandiflora** have reported several classes of secondary metabolites, including flavonoids, phenolic compounds, tannins, alkaloids, saponins, terpenoids, steroids and glycosides. The qualitative and quantitative profile can vary with plant part, geographic source, maturity, extraction solvent and analytical method.

Phytochemical class	Examples/reporting	Potential relevance
Flavonoids	Quercetin, kaempferol and related flavonoids	Antioxidant and potential antimicrobial relevance
Phenolics	Phenolic acids and related compounds	Antioxidant and biological activity
Tannins	Reported in phytochemical screening	Possible antimicrobial/astringent contribution
Saponins	Reported in some extracts	Potential biological activity
Alkaloids	Reported in leaf/other extracts	Pharmacological relevance
Terpenoids/steroids	Reported in phytochemical investigations	Potential biological contribution
Glycosides	Reported in extracts	Potential pharmacological contribution

Quercetin and gallic acid are compounds of interest in the literature on *S. grandiflora*, but the evidence should be interpreted carefully. A compound reported in one plant part or extract should not automatically be described as the principal active antibacterial constituent of the leaves. For a leaf-film formulation, marker selection should be supported by leaf-specific analytical data.[9,10,11,12]

7. PHARMACOLOGICAL ACTIVITIES

7.1 Antibacterial activity

Experimental studies have reported antibacterial activity from *S. grandiflora* extracts. Activity has been observed with different plant parts and extraction methods, demonstrating biological potential but also substantial variability between preparations.

7.2 Antioxidant activity

Phenolic and flavonoid constituents may contribute to antioxidant activity reported for *S. grandiflora*. Antioxidant assay results are supportive pharmacological evidence but do not by themselves establish clinical benefit in oral disease.

7.3 Anti-inflammatory activity

Investigations of *S. grandiflora* have reported anti-inflammatory effects in experimental models. This is relevant to oral-health research because bacterial infection and inflammation may occur together.

7.4 Wound-healing potential

Experimental and traditional use reports have explored wound-healing properties. Dedicated oral mucosal studies are required before therapeutic claims are made. [9,10,11]

8. ANTIBACTERIAL ACTIVITY OF SESBANIA GRANDIFLORA

Anantaworasakul, Klayraung and Okonogi reported antibacterial activity of *S. grandiflora* extracts and found notable activity in tested stem-bark fractions. China and colleagues reported activity of a flower polyphenolic extract against several bacterial species, including *Staphylococcus aureus*, *Escherichia coli*, *Salmonella Typhi* and *Vibrio cholerae*. Other studies have investigated leaf extracts and reported antibacterial activity in vitro.

These findings provide a rationale for additional work but also show why plant part and extraction conditions must be specified. A result obtained from bark or flower extract cannot be assumed to predict the activity of a standardized leaf extract in a mucoadhesive film.[1,2,3,4]

Study	Plant part	Approach	Main finding
Anantaworasakul et al., 2011	Different parts; notable stem-bark fractions	Extracts/fractions and antibacterial testing	Antibacterial activity reported
China et al., 2012	Flowers	Polyphenol extract	Activity against several tested pathogens
Packiyalakshmi et al., 2016	Leaves	Solvent extracts	In-vitro antibacterial activity reported
Abubakar et al., 2015	Leaves and stem	Aqueous/ethanolic extracts	Activity against selected clinical isolates

9. FORMULATION COMPONENTS OF MUCOADHESIVE FILM

9.1 Film-forming and mucoadhesive polymers

Polymers provide the structural matrix of the film and influence thickness, flexibility, swelling, adhesion and release. Commonly investigated materials include hydroxypropyl methylcellulose (HPMC), hydroxypropyl cellulose, sodium carboxymethyl cellulose, Carbopol, polyvinyl alcohol, polyvinylpyrrolidone, sodium alginate and chitosan.

9.2 Plasticizers

Plasticizers such as glycerol, propylene glycol and polyethylene glycol can improve flexibility and reduce brittleness. Their concentration must be optimized because excessive plasticizer can change mechanical strength, moisture uptake and release behavior.

9.3 Other excipients

Depending on the formulation, sweeteners, flavouring agents, saliva-stimulating agents, pH modifiers and solubilizers may be considered. Compatibility with the herbal extract must be evaluated.[5,6,7,8]

10. PREPARATION BY SOLVENT-CASTING METHOD

1. The selected polymer is accurately weighed and hydrated or dissolved in a suitable solvent system.
2. The standardized *S. grandiflora* leaf extract is prepared separately and incorporated into the polymeric solution.
3. Plasticizer and other required excipients are added with controlled stirring.
4. The formulation is mixed until a homogeneous solution or dispersion is obtained and allowed to stand to remove air bubbles.
5. The solution is cast onto a suitable, accurately measured surface.
6. The cast film is dried under controlled conditions.
7. The dried film is removed carefully and cut into uniform units.
8. Prepared films are packed in moisture-protective packaging and stored until evaluation.[5,6,7]

11. EVALUATION PARAMETERS

Parameter	Purpose
Appearance	Colour, transparency/opacity, smoothness and defects
Thickness	Uniformity of film thickness
Weight variation	Unit-to-unit uniformity
Folding endurance	Flexibility and resistance to repeated folding
Surface pH	Compatibility with oral mucosa
Moisture content	Physical stability and mechanical behavior
Swelling index	Hydration and swelling behavior
Extract/marker content	Uniformity of active material
Tensile strength	Mechanical strength
% Elongation	Flexibility/stretchability

Mucoadhesive strength	Force required to detach film from mucosa
In-vitro residence time	Duration of adhesion in a suitable model
In-vitro release	Release profile of extract/marker
Antibacterial activity	Activity against selected microorganisms
Stability study	Changes during storage

[5,6,7]

12. POTENTIAL APPLICATION IN ORAL ANTIBACTERIAL THERAPY

The proposed system combines a plant-derived antibacterial candidate with a localized mucoadhesive delivery platform. A standardized leaf extract could potentially be incorporated into a thin film that remains in contact with oral mucosa and releases its marker compounds or active constituents over a defined period. This concept should be considered a formulation research hypothesis rather than an established therapy. The actual performance of the formulation will depend on extract composition, dose, polymer characteristics, release rate, adhesion, local tolerability and antibacterial activity against relevant oral microorganisms.[1,3,4,5]

13. RESEARCH GAP

Published work demonstrates that *S. grandiflora* has been investigated for phytochemistry and biological activity, including antibacterial effects, while independent pharmaceutical research has established the feasibility of mucoadhesive buccal films. However, the evidence is fragmented across plant parts, extraction procedures, solvents, test organisms and experimental models. A specific research gap therefore remains in the systematic development and evaluation of a standardized *S. grandiflora* leaf-extract mucoadhesive oral film intended for potential local antibacterial application. Key needs include leaf authentication, extract standardization, marker-compound quantification, polymer/excipient optimization, antibacterial testing against relevant oral pathogens, mucosal safety assessment and stability studies.

1. Authentication and standardization of the plant material.
2. Optimization and reproducibility of the extraction process.
3. Identification and quantification of suitable chemical markers.
4. Selection and optimization of film-forming and mucoadhesive polymers.
5. Evaluation of extract–excipient compatibility.
6. Optimization of mechanical, swelling and mucoadhesive properties.
7. Testing against relevant oral pathogens and, where appropriate, biofilms.
8. Mucosal irritation and safety assessment.
9. Long-term and accelerated stability studies.
10. Further in-vivo and appropriately designed clinical studies.[1,2,3,4,5,9]

14. FUTURE PERSPECTIVES

Future studies may focus on standardized extraction, chemical fingerprinting, marker-based quality control and systematic formulation optimization using Design of Experiments. Antibiofilm testing against clinically relevant oral microorganisms may provide additional information beyond simple zone-of-inhibition assays. Mucosal safety, pharmacokinetic/local exposure studies where appropriate, stability and in-vivo evaluation should precede any clinical claims. Advanced film designs, including multilayer systems and controlled-release approaches, may also be explored. The ultimate objective should be a reproducible, stable, patient-acceptable formulation supported by appropriate pharmaceutical, microbiological and safety evidence.[5,8,9]

15. CONCLUSION

Sesbania grandiflora is a medicinal plant with reported phytochemical diversity and several biological activities, including in-vitro antibacterial activity. Mucoadhesive oral films offer a potentially useful platform for localized delivery because they can provide intimate

contact with oral mucosa and can be engineered through polymer selection and formulation optimization. The available literature provides a scientific rationale for investigating standardized *S. grandiflora* leaf extract in a mucoadhesive oral film, but it does not establish clinical efficacy of such a formulation. Future research should therefore concentrate on extract standardization, formulation development, physicochemical and mucoadhesive evaluation, antibacterial and antibiofilm testing, mucosal safety, stability, and subsequent in-vivo and clinical investigations.[1,5,9,10]

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