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FORMULATION AND EVALUATION OF MUCOADHESIVE BUCCAL FILM OF CURCUMIN EXTRACT FROM *CURCUMA LONGA* USING POLYMERIC BLEND FOR ENHANCED SYSTEMIC DELIVERY

Mansi Shukla*[1], Prof. (Dr.) Pankaj Kumar Sharma[2], Prof. (Dr.) Jaya Sharma[3], Ravisha Mathur[4], Ms. Shaifali Sharma[5]

[1]Research Scholar, Apex Institute of Pharmaceutical Sciences, Apex University, Jaipur, Rajasthan, India.
[2]Dean, Apex Institute of Pharmaceutical Sciences, Apex University, Jaipur, Rajasthan, India.
[3]Principal, Institute of Pharmaceutical Sciences, Apex University, Jaipur, Rajasthan, India.
[4]Assistant Professor, Apex Institute of Pharmaceutical Sciences, Apex University, Jaipur, Rajasthan, India.
[5]Associate Professor, Apex Institute of Pharmaceutical Sciences, Apex University, Jaipur, Rajasthan, India.

***Corresponding Author: Mansi Shukla**

Research Scholar, Apex Institute of Pharmaceutical Sciences, Apex University, Jaipur, Rajasthan, India.

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ABSTRACT

Curcumin, the principal bioactive constituent of *Curcuma longa*, possesses significant anti-inflammatory, antioxidant, antimicrobial, and anticancer activities. However, its therapeutic effectiveness is limited by poor aqueous solubility and low oral bioavailability. The present study aimed to formulate and evaluate mucoadhesive buccal films containing curcumin extract using a polymeric blend for enhanced systemic delivery. Curcumin extract was obtained from turmeric powder by ethanolic extraction and incorporated into buccal films prepared by the solvent casting method. Gelatin and sodium alginate were employed as film-forming and mucoadhesive polymers, while starch served as a supporting polymer and glycerin as a plasticizer. Three formulations (F1, F2, and F3) were developed by varying polymer and plasticizer concentrations. The prepared films were evaluated for physical appearance, surface texture, flexibility, folding endurance, peelability, and hydration behaviour. Approximately 0.50 g of curcumin extract was obtained from 25 g of turmeric powder. Among all formulations, F3 containing 20 mg curcumin extract, 600 mg gelatin, 100 mg sodium alginate, 100 mg starch, and 0.4 mL glycerin demonstrated superior properties, including smooth translucent appearance, good peelability, non-sticky texture, folding endurance greater than 30 folds, and satisfactory hydration behavior. The study demonstrated that polymer concentration and plasticizer content significantly influenced film characteristics. The optimized formulation exhibited promising potential as a mucoadhesive buccal drug delivery system for curcumin.

KEYWORDS: Curcumin, Buccal Film, Mucoadhesive Drug Delivery System, Gelatin, Sodium Alginate, Solvent Casting Method.

1. INTRODUCTION

Curcumin is a naturally occurring polyphenolic compound obtained from the rhizomes of *Curcuma longa* and is widely recognized for its antioxidant, anti-inflammatory, antimicrobial, and anticancer activities. Despite its remarkable therapeutic potential, curcumin exhibits poor aqueous solubility, low gastrointestinal absorption, rapid metabolism, and extensive first-pass hepatic elimination, resulting in poor systemic bioavailability.[1,20,43]

Buccal drug delivery systems have emerged as a promising alternative to conventional oral dosage forms because they provide direct access to systemic circulation through the buccal mucosa, thereby bypassing hepatic first-pass metabolism and improving bioavailability.[7,17,22,38] Mucoadhesive buccal films offer several advantages including ease of administration, improved patient compliance, prolonged residence time, controlled drug release, and reduced dosing frequency.[5,17,25]

Natural and semi-synthetic polymers have been extensively investigated for buccal film development. Gelatin exhibits excellent film-forming capability, flexibility, and biocompatibility, whereas sodium alginate contributes to hydration, swelling, and mucoadhesive properties.[18,21,26] Plasticizers such as glycerin improve elasticity and reduce brittleness of films by enhancing polymer chain mobility.[27]

The present investigation was undertaken to formulate and evaluate curcumin-loaded mucoadhesive buccal films using a polymeric blend of gelatin, sodium alginate, and starch prepared by the solvent casting method. The influence of polymer concentration and plasticizer content on film characteristics was also investigated.

2. MATERIALS AND METHODS

a. Materials

Turmeric powder (*Curcuma longa*), gelatin, sodium alginate, starch, glycerin, ethanol, and distilled water were used in the study. All chemicals and reagents employed were of analytical grade.

b. Extraction of Curcumin

Curcumin extract was obtained by ethanolic extraction. Twenty-five grams of turmeric powder was dispersed in approximately 100 mL ethanol and heated at 40–50°C with continuous stirring for 30–45 minutes. The mixture was filtered, and the filtrate was dried at room temperature followed by oven drying at 40°C. The dried extract was collected and stored in an airtight container. Approximately 0.50 g of curcumin extract was obtained.

c. Preparation of Buccal Films

Buccal films were prepared using the solvent casting technique. Gelatin and sodium alginate were dispersed in distilled water with continuous stirring and mild heating. Curcumin extract dissolved in ethanol was incorporated into the polymeric solution. Starch and glycerin were subsequently added, and the final mixture was poured into Petri dishes. The cast films were dried at 40–45°C for 6–7 hours and cut into 1 cm × 1 cm units.

d. Composition of Formulations

Table 1: Composition of Formulations.

Ingredient	F1	F2	F3
Curcumin Extract	10 mg	20 mg	20 mg
Gelatin	400 mg	200 mg	600 mg
Sodium Alginate	150 mg	100 mg	100 mg
Starch	100 mg	100 mg	100 mg
Glycerin	0.2 mL	0.2 mL	0.4 mL
Water	20 mL	20 mL	10 mL
Ethanol	2–3 mL	2–3 mL	2 mL

e. Evaluation of Buccal Films

Prepared films were evaluated for:

- Physical appearance
- Surface texture
- Flexibility
- Folding endurance
- Hydration/swelling behavior

3. RESULTS AND DISCUSSION

a. Extraction Yield

The ethanolic extraction process yielded approximately 0.50 g of curcumin extract from 25 g of turmeric powder. The obtained extract was dark brown in appearance with a slightly granular texture. The dark coloration may be attributed to the presence of curcuminoids together with other ethanol-soluble compounds naturally present in turmeric rhizomes. The extract was successfully incorporated into the prepared buccal film formulations without visible incompatibility. Ethanol was found suitable for extraction due to its ability to dissolve curcumin efficiently.[43]

Figure 1: Dried ethanolic extract obtained from curcuma longa.

b. Physical Appearance

Noticeable differences were observed among formulations. F1 produced uneven films with moderate stickiness, whereas F2 resulted in dark opaque and brittle films. F3 exhibited smooth translucent appearance with good peelability and flexibility.

The superior appearance of F3 may be attributed to higher gelatin concentration and optimized glycerin content, which improved film formation and structural integrity.[21,27]

Figure 2: Optimised mucoadhesive buccal film formation (F3) containing curcuminoid-rich ethanolic extract of *Curcuma longa*.

c. Surface Characteristics

Surface texture evaluation revealed that F1 was slightly rough and sticky, while F2 exhibited hard and brittle characteristics. F3 showed smooth, uniform, and non-sticky surface properties.

Improved surface texture in F3 indicated enhanced polymer interaction and better plasticization.

d. Folding Endurance

Folding endurance is an indicator of mechanical strength and flexibility.

F3 demonstrated significantly higher folding endurance due to increased gelatin concentration and glycerin content. Similar findings regarding the effect of plasticizers on film flexibility have been reported in previous studies.[27,35]

e. Hydration Behavior

Hydration behavior plays an important role in mucoadhesion and drug release.

F3 exhibited rapid hydration while maintaining structural integrity for a prolonged period. Sodium alginate contributed to water uptake, whereas gelatin provided matrix stability.[18,26]

f. Comparative Evaluation

Among all formulations, F3 demonstrated the best overall performance. Increased gelatin concentration enhanced mechanical strength, while glycerin improved flexibility and peelability. Reduction in water content also contributed to formation of a denser polymeric matrix.

The results clearly indicated that polymer concentration and plasticizer content significantly influence physicochemical and mechanical properties of buccal films. Similar observations have been reported for mucoadhesive buccal film formulations in previous studies.[17,25,36]

Table 2: Comparative Evaluation of Buccal Film Formulations.

Parameter	F1	F2	F3
Appearance	Uneven	Dark opaque	Smooth translucent
Peelability	Difficult	Poor	Good
Flexibility	Low	Very low	Good
Stickiness	Moderate	Low	Non-sticky
Folding Endurance	5–8	3–5	>30
Hydration Behavior	Softened slowly	Fragile	Rapid softening with controlled erosion
Surface Texture	Slightly rough	Brittle	Smooth
Mechanical Strength	Moderate	Poor	Good
Overall Performance	Acceptable	Unsatisfactory	Best formulation

4. CONCLUSION

The present study successfully developed and evaluated curcumin-loaded mucoadhesive buccal films using a polymeric blend of gelatin, sodium alginate, and starch. Curcumin extract was successfully isolated from *Curcuma longa* and incorporated into buccal films prepared by solvent casting. The prepared formulations exhibited varying physicochemical and mechanical characteristics depending on polymer and plasticizer concentration.

Among all formulations, F3 demonstrated superior appearance, flexibility, peelability, folding endurance, and hydration behavior. The optimized formulation contained 20 mg curcumin extract, 600 mg gelatin, 100 mg sodium alginate, 100 mg starch, and 0.4 mL glycerin. The study established the feasibility of developing curcumin-loaded mucoadhesive buccal films as a potential alternative delivery system for enhanced systemic delivery of curcumin.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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