WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Development and Evaluation of Mucoadhesive Buccal film Containing Promethazine

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ABSTRACT:

The experimental study on the formulation and evaluation of polymeric buccal films utilizing hydroxypropyl cellulose and ethyl cellulose as polymers in various concentrations through solvent casting method provides a comprehensive exploration into the development of an efficient, patient-friendly drug delivery system. This study aimed to harness the unique properties of these biopolymers to create films that dissolve rapidly in the oral cavity, offering an alternative to conventional oral dosage forms, particularly beneficial for individuals with swallowing difficulties. Key findings from the study highlight that the choice of polymer and its concentration significantly influences the physical and mechanical properties of the polymeric buccal films. Initially at low concentrations hydroxypropyl cellulose and ethyl cellulose showed good mucoadhesive properties but poor mechanical properties but as the concentration of ethyl cellulose increases film showed excellent mechanical properties but mucoadhesive strength remains constant and no significant change was observed. Further with increase in HPC to 10% and ethyl cellulose to 3 % and 4 % the mucoadhesive properties has increased with optimal mechanical properties. However, F5 and F6 with 10% HPC and 1% and 2% ethyl cellulose respectively showed excellent mechanical properties but also excellent mucoadhesivity which is necessary attribute for buccal films.

Introduction:

1. **Buccal films:** The main reasons why films are a promising dosage form for buccal administration are their ease of administration, adaptability to achieve a local or systemic effect, mucoadhesion that allows for adequate absorption time, and small size and flexibility that enhance patient compliance. Regarding pharmaceutical drug products, the FDA classifies films into three categories (Jones, Ojewole et al. 2014):

   a) Film is a thin layer or coating.
   b) Extended release film: a medication delivery method that takes the shape of a film and releases the drug gradually over time to keep blood or target tissue at steady drug levels.
   c) Soluble films are thin coatings or layers that dissolve easily in liquid environments. These are sometimes referred to as orodispersible films (Buanz, Belaunde et al. 2015).

   Mucoadhesive preparations are designed to adhere to the mucosal epithelium in the oral cavity in order to stay there and allow for systemic drug absorption. Films are extremely thin polymeric matrices that are applied to the sublingual, buccal, or tongue mucosa. Saliva then hydrates the film, facilitating its dispersion, dissolution, swelling, and adherence to the administration site. The drug will be released for either a transmucosal absorption, gastrointestinal transit, or local effect, depending on the formulation and desired effect. In order to further regulate or alter drug release, films can also be created as mono- or multilayer systems (Silva, Borges et al. 2015). Compared to tablets and capsules, these dosage forms are advantageous for children and the elderly because they do not require swallowing in order to administer the medication. Moreover, compared to solutions and suspensions, mucoadhesive films can enable longer times of contact with the epithelium, leading to increased bioavailability. The potential hygroscopicity of films, their relatively low maximum dose (strong medications will be preferred), and the requirement to take taste and texture into account are the limitations of films as buccal dosage forms (Preis, Knop et al. 2014).

   4. Benefits of buccal films: Because buccal films are easy to handle and administer, patient compliance with them is higher. They are pharmacoeconomic and can be given by the patient themselves. Buccal films are a type of drug delivery that can be applied to the mucosal

cavity or the oral cavity. Buccal films work well for a wide range of medications. Buccal film was developed to increase the bioavailability of certain ingredients that have potential therapeutic uses. They are smaller in order to improve patient compliance. Since most drugs have an unpleasant taste, the drug is added to the buccal film in a way that masks its taste (Saygisever-Faikoglu, Faikoglu et al. 2022; Webster, Cater et al. 2022) .

Because buccal films have a larger surface area, the buccal cavity may experience rapid buccal film disintegration and dissolution. When a drug is administered sublingually or buccaly, it can have a greater effect on when the drug starts working, require less dosage, and have a higher safety and efficacy profile. Buccal films dissolve fairly quickly when compared to other conventional dosage forms, but they are also stable and long-lasting. Buccal films dosing accuracy is improved. Because buccal films are a spontaneous dosage form, they not only ensure that the correct medication is being administered but also have the potential to increase drug compliance. Due to the buccal film's ability to prevent the first pass effect, dosages are reduced, which reduces the likelihood of adverse effects from the molecules within. It becomes imperative to periodically verify if the drug's integrity or contents hold steady over time (Joshi, Akram et al. 2022; Wang, Jiang et al. 2022).

5. Cons of buccal films: Due to their hygroscopic nature, buccal films should only be stored in dry environments. Buccal films occasionally exhibit effervescent granule characteristics and can be delicate. Buccal films require unique packaging in order to preserve the product's stability and safety profile. It's possible to detect the drug's flavor, allergy, and tongue irritability. Certain unfavorable outcomes, such as tooth erosion and discolouration, may happen. A buccal film cannot be applied while the patient is drinking or talking at the same time. When a buccal film is inserted into the oral cavity, the drug concentration will be low because saliva will dilute the medication at the site of absorption. Saliva increases the absorption site's capacity to absorb the maximum amount of released and dissolved drug, increasing the likelihood that the drug will be swallowed and enter the gastrointestinal system (Lam, Cheung et al. 2020; Zaman, Hassan et al. 2021).

6. Applications of buccal films:

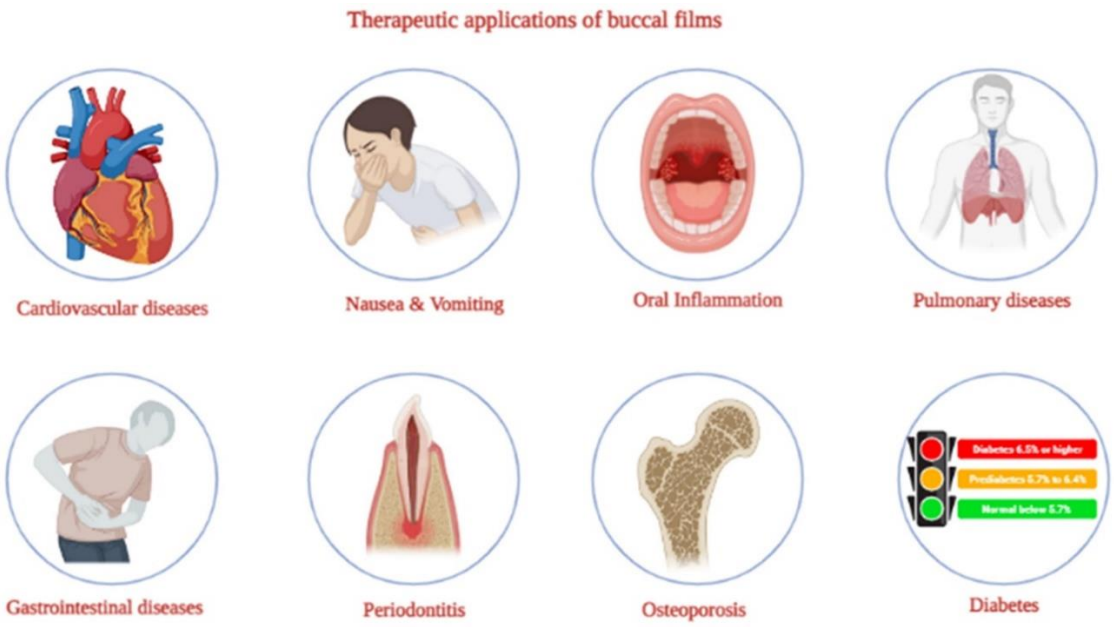

Figure 1: Therapeutic applications of buccal films (Faheem, Hameed et al. 2024)

Materials and Methods:

1. Preparation of buccal film:

The film was prepared using solvent casting method. Initially, hydroxypropyl cellulose (HPC) polymer was dissolved in water with constant stirring for about 10 mins. After addition of glycerine, plastisizer was added slowly along with constant stirring. The prepared solution was poured into the petriplates, placed on leveled surface. The mixture was allowed to dry slowly, by covering the petri plates by inverted funnel, so as to prepare the flexible film. The blank films prepared were then checked for any air entrapment through visual inspection (Nair, Shah et al. 2021).

Further ethyl cellulose with different ratios in combination with HPC were prepared by dissolving 200mg of ethyl cellulose in 10ml of ethanol and mixed well. 1ml of glycerine was added and mixed by using magnetic stirrer. The solution was kept aside for about an hour for removal of air bubbles entrapped if any. The solution was then poured into petri dish and dried overnight. The dried films were carefully removed and collected. Eight such different batches were prepared. By the application of little pressure for few minutes both the patches stick to each other. These patches were then cut into patches of 2x2cm^2 in dimensions and subjected to evaluation tests (Abdella, Afinjuomo et al. 2022, Shipp, Liu et al. 2022).

2. Selection of batches

The prepared batches were examined morphologically and other organoleptic properties were checked. All the batches were checked for color, homogeneity, transparency, smell, appearance and texture of the prepared buccal films. Out of these eight, only 5 batches were selected, based on air entrapment, any cracking, and /or ease of removal from petri dish (M. Farid and Ming Wen 2017, Abo-shady, Elkammar et al. 2020).

3. Preparation of promethazine containing mucoadhesive films

Promethazine, loaded mucoadhesive buccal films were prepared by solvent casting method. After mixing the polymer in ethanol, promethazine was added slowly and constantly. The mixture was stirred and plasticizer was added. Both glycerine and propylene glycol were used, forming an ideal flexible mucoadhesive film. The mixture was poured into petri-plates and were allowed to dry slowly using an inverted funnel method. The prepared films were carefully removed after drying and were stored safely (Pharm, Pharm et al. 2013, Daněk, Gajdziok et al. 2017).

4. Evaluation of prepared mucoadhesive films

Promethazine containing films were further characterized and evaluated for their efficacy, based on the following tests.

1.1 Uniformity of weight: The weight of the patches were evaluated using the digital weighing balance. 2x2 cm^2 of the prepared patches were taken, and were individually weighed. Average of three readings were taken, and results are calculated as mean and standard deviation (Sharma, Sharma et al. 2018).

1.2 Film thickness: Thickness is an important characteristic of orally disintegrating films as the thickness uniformity is directly related to the dose uniformity in each film. The thickness of each film was measured at six different points (n = 6) using micrometer screw gauge and the mean value was reported (Shemer, Amichai et al. 2008).

1.3 Folding endurance: The folding endurance is expressed as the number of folds (number of times the film is folded at the same place) required to break the specimen or to develop visible cracks. The number of times the patch could be folded at the same place without breaking gave the values of the folding endurance (Sharma, Yadav et al. 2022).

1.4 Surface pH test: The surface pH of the buccal patches was determined in order to investigate the possibility of any side effects in vivo. As an acidic or alkaline pH may cause irritation to the buccal mucosa, it was determined to keep the surface pH as close to neutral as possible. Buccoadhesive patches were left to swell by placing in required quantity of distilled water. The surface pH was measured by means of pH paper placed on the core surface of the swollen patch (Shao and Zhou 2020).

1.5 Content uniformity: One sheet of film from each formulation was dissolved in simulated salivary fluid at pH 6.8 in a flask of 30 ml and shaken for certain time to get homogenous solution. The permissible limits of the contents, as per USP standards are between 98-101%. The readings were taken in triplicate, and expressed as mean ± standard deviation. The drug content was calculated using a standard calibration curve of Promethazine HCl at wavelength 276 nm (Lerdsrimongkol, Tiyaboonchai et al. 2023).

1.6 Determination of % yield: After drying, the patches were removed from the petri dish and were weighed. The patches were calculated for % yield by using the formula (Gupta 2020, Lerdsrimongkol, Tiyaboonchai et al. 2023).

1.7 Density of the film: The density was calculated by using the values of mass, area and thickness of the patches by using the formulae:

1.8 Percentage elongation test:

When stress is applied, a strip sample stretches and this is referred to as strain. Strain is basically the deformation of strip divided by original dimension of the sample. Generally, elongation of strip increases as the plasticizer content increases.

It was calculated by following formula:

Percentage elongation = Increase in length of strip × 100 Initial length of strip

1.9 Swelling index: Buccal patches were weighed individually and the weight obtained is designated as W1. The patches were placed separately in distilled water and examined for any physical changes. At regular time intervals of 3 mins until 15 mins, the patches were removed from the water and excess surface water was removed carefully using the filter paper. The swollen patches were then reweighed and the weight obtained was noted as W2. The swelling index (SI) was calculated using the following formula (Alves, Rios et al. 2020).

1.10 Swelling Percentage (% S): A drug loaded films were placed in a thoroughly cleaned petridish and a graph paper was placed beneath the petridish, to measure the increase in area due to swelling of the film. Fifty ml of pH 6.8 phosphate buffer was poured into the petridish. An increase in the weight of the patch was noted in 15 min intervals for 60 min and the weight was calculated. The swelling percentage was calculated by using the following formula,

$$\%S = \frac{\mathrm{Xt} - \mathrm{X0}}{\mathrm{X0}} \times 100$$

Where, % S - swelling percentage, Xt - the weight of swollen film after time t, X0 -weight of film at zero time zero.

1.11 Moisture loss:

Percentage moisture loss10 was also carried to check the integrity of films at dry condition. Three 1cm diameter films was cut out and weighed accurately and kept in desiccator's containing fused anhydrous calcium chloride. After 72 hours the films were removed, weighed. Average percentage moisture loss of three films was found out.

Percentage moisture loss = Initial weight – Final weight X 100 Initial weight

1.12 Tensile strength: The tensile strength of the film was evaluated by using the push pull instrument. It consists of two load cell grip, the lower one was fixed and upper one was movable. Film strips with dimensions of 2×2 cm2 were fixed between these cell grips and force was gradually applied till the film brake.16 The break force was taken directly from the dial reading in gm (Suharyani, Fouad Abdelwahab Mohammed et al. 2021). It is calculated by equation:

Tensile strength = Break force/Area of film in cm^2.

The assay was determined by dissolving one film of dimension 2 cm × 2 cm containing 25 mg of promethazine HCl by homogenization in 100 ml of phosphate buffer pH 6.8 for 30 min with continuous shaking. From this, 10 ml was diluted to 50 ml with phosphate buffer pH 6.8. The absorbance was measured at 250 nm using an UV spectrometer (Göbel, da Silva et al. 2021).

1.13 In-vitro disintegration test: The experiments were carried out in triplicate for the films of all formulations and average values were recorded. The in vitro disintegration time is the time at which the film starts to break. The disintegration time was measured in a beaker containing 20 ml phosphate buffer pH 6.8. The time film starts to break was measured as disintegration time of film (Molania, Malekzadeh Shafaroudi et al. 2022).

1.14 In vitro release studies:

F6, F7 and F8 formulations were subjected to in vitro release studies in simulated saliva dissolution media. In vitro release studies in a simulated saliva medium are commonly performed to evaluate the release profile of drugs or formulations, such as oral dosage forms, under conditions that mimic the natural oral environment (Semalty, Semalty et al. 2008, Morales, McConville et al. 2011).

The drug release from developed films F6, F7 and F8 was evaluated by means of the paddle-over-disc method, utilizing a USP Type II apparatus (Electrolab TDC 50, Mumbai, India). Films were chosen from each batch, and each individual film having particular dimensions (2 cm × 2 cm) was held to a glass slide. The entire assembly was kept at the bottom of the dissolution vessel in such a manner that the drug-entrapped surface could release it toward the dissolution medium (900 mL of simulated saliva), set at a temperature of 37 ± 0.5 °C. The composition of simulated saliva utilized in the study consisted of 12 mM of potassium di hydrogen phosphate, 40 mM of sodium chloride and 1.5 mM of calcium chloride, and the pH was adjusted to 6.8 using sodium hydroxide. The paddle was rotated at 50 rpm and aliquot volumes of the samples were withdrawn, filtered using a syringe membrane filter having a pore size of 0.2 µm (Millipore, Bedford, MA, USA) and readily estimated by UV spectroscopy. The samples were taken at common

intervals of 5, 10, 15, 30, 60, and 120 minutes (Yehia, El-Gazayerly et al. 2009, Salehi and Boddohi 2017). The study was performed in triplicate with n=3 and the calculations were done to calculate cummulative amount released and was plotted against time. The statistical analysis was carried out by GraphPad Prism 6 (Graph-Pad Software, Inc., La Jolla, CA, USA). The difference in $p < 0.05$ was identified as statistical significance

Results and Discussion

Organoleptic properties of the films:

These properties include the visual appeal, taste, odor, and texture of the film, which collectively influence the overall patient experience. A well-designed buccal film should have an appealing appearance, a pleasant or neutral taste, an agreeable odor, and a smooth texture to ensure ease of administration and patient comfort (Nair, Kumria et al. 2013).

Taste masking is particularly important for Buccal films, as the rapid dissolution of the film in the oral cavity exposes the drug immediately to taste receptors. Bitter or unpleasant tastes must be masked using flavoring agents, sweeteners, or encapsulation techniques. Similarly, odors from active pharmaceutical ingredients or excipients can be neutralized or masked with suitable aromatic agents. The film's texture should be non-gritty and uniform to avoid discomfort during administration, which could otherwise lead to patient

In addition to these sensory attributes, the visual appeal of buccal films, including color and transparency, can also influence user acceptance. Bright, uniform colors and clear labeling enhance the product's appeal while ensuring ease of identification. Overall, optimizing the organoleptic properties of Buccal films is essential for enhancing patient adherence, particularly for formulations targeting populations with higher sensitivity to sensory experiences (Southward, Liu et al. 2025).

Evaluation of film thickness: Film thickness and appearance were recorded for all the developed batches. The thickness of thin films is a critical parameter, as it significantly influences many of the film's properties. Moreover, measuring film thickness is essential in various sectors of the pharmaceutical industry because it directly affects drug content uniformity. This study aims to ensure that all batches with the same formulation maintain uniform thickness, thereby validating consistency in both quality parameters and process parameters (Laoasoke, Choipang et al. 2024, Taha, ElSohly et al. 2024).

Table 5: Observation table for thickness observed in the polymeric films formed by HPC and ethylcellulose

SNO.	MAIN SCALE (MS) READING (in mm)	NO. OF DIVISIONS IN VERNIER SCALE (VC)	VFFS READING (NO. OF DIVISIONS * LC OF VS)	TOTAL READING (MS+VS) (in mm)
F1	0.2	2	1*0.1=0.2	0.4
F2	0.2	3	1*0.1=0.3	0.5
F3	0.2	3	2*0.1=0.3	0.5
F4	0.2	2	2*0.1=0.2	0.4
F5	0.2	3	2*0.1=0.3	0.5
F6	0.2	3	2*0.1=0.3	0.5
F7	0.2	2	2*0.1=0.2	0.4
F8	0.2	3	2*0.1=0.3	0.5
			Average	0.47 mm

Calculation:

$$Average\ thickness = \left(\frac{0.4 + 0.5 + 0.5}{3}\right) mm$$

The average thickness for all the batched developed form HPC and ethyl cellulose was calculated as 0.47 ± 0.03 mm. The low value of standard deviation ensures the consistency in the thickness between different batches (Jovanović, Tomić et al. 2021, Mady, Abulmeaty et al. 2021). Moreover, thickness was observed to be less than 0.5 mm which further ensures the potential film for mucoadhesive buccal film purpose as per literature. In several literature, the optimum thickness for various mucoadhesive buccal polymeric films was observed to be less than 0.5 mm which further confirms the developed films are ideal candidate for mucoadhesive buccal polymeric film. In several literature, the optimum thickness for various polymeric buccal films was observed to be less than 0.5 mm which further confirms the developed films are ideal candidate for polymeric buccal films (Tzanova, Hagesaether et al. 2021, Nair, Cabrera et al. 2023). Although, the thickness observed in F5, F6, F7 and F8 was too less as compared to films prepared by HPC at 5% in F1, F2, F3 and F4 which signifies better polymeric buccal film but there are certain drawbacks associated with very thin films i.e. low endurance and poor mechanical properties which may have impact in stability particularly associated with packaging, storage and transport. Hence, the developed films were further subjected to evaluation of film endurance so as to shortlist the better films for intended use (Abdella, Afinjuomo et al. 2022).

Selected formulations:

For polymeric buccal film: F6, F7 and F8 formulations were selected amongst the eight formulations made.Hence, further characterization studies were performed on the **F5, F6, F7 and F8.**

pH of the prepared films: The pH of buccal films influences their stability, drug release, and compatibility with the buccal mucosa. Buccal films are designed to deliver drugs directly through the mucosal tissues, which typically have a pH range of 5.5 to 7.4. To ensure optimal performance and minimize irritation, the pH of the film should ideally be within this range. A compatible pH ensures better drug absorption and reduces the risk of mucosal irritation or damage. Moreover, the pH can affect the solubility and ionization state of the drug, influencing its bioavailability (Protopapa, Siamidi et al. 2025).

Table 14: Observation table for pH test

Selected Formulations	Observation 1	Observation 2	Observation 3	Average
F5	6.23	6.20	6.15	**6.23**
F6	6.18	6.24	6.52	**6.35**
F7	6.56	6.48	6.61	**6.64**
F8	6.86	6.90	6.88	**6.71**

Evaluation of Folding endurance:

Folding endurance is a critical parameter in evaluating the mechanical properties of buccal films. It reflects the film's flexibility, durability, and resistance to mechanical stress during handling and application. The test involves repeatedly folding the film at the same point until it breaks or shows visible signs of cracking. A high folding endurance indicates a robust and flexible film capable of withstanding repeated folding without losing its integrity. This property is essential for ensuring the film's stability and usability in real-world applications (Kulazhenko and Butkevych 2023).

Table 8: Observation table for folding endurance

SELECTED FORMULATIONS	BATCHES MADE						AVERAGE
	O1	**O2**	**O3**	**O4**	**O5**	**O6**	
F5	65	68	67	69	71	70	**68**
F6	69	71	62	84	78	75	**73**
F7	250	244	257	229	267	289	**256**
F8	117	120	109	133	128	123	**122**

Folding endurance values typically range from 50 to 300 folds, depending on the formulation and intended use of the buccal film. A high folding endurance (e.g., >200 folds) is desirable for films designed for prolonged application, as it ensures the film remains intact during use. Low folding endurance may indicate brittleness or poor formulation and could lead to film breakage during handling or application.

Determination of weight of each formulation:

The weight uniformity of buccal films is a crucial parameter that reflects consistency in the manufacturing process and ensures uniform drug content and dosage accuracy. Variations in weight can directly influence the drug release profile, mechanical properties, and patient compliance. Uniform weight distribution across buccal films is typically achieved by maintaining consistent thickness during the casting or printing process. Factors such as polymer type, viscosity of the film-forming solution, drying conditions, and the precision of the casting equipment significantly impact weight uniformity. Deviations in weight could indicate issues like uneven spreading of the solution, air bubble entrapment, or improper drying, which may lead to suboptimal drug delivery. Hence, weight observation and standardization are critical quality control measures to ensure reproducibility, therapeutic efficacy, and safety of buccal films in clinical applications

Table: Weight of each film, with different polymer:

SELETED FORMULATIONS	BATCHES MADE						AVERAGE WEIGHT (mg)
	O1	**O2**	**O3**	**O4**	**O5**	**O6**	
F5	25	27	26	28	26	25	26.16
F6	34.6	36	36	34	35	34	34.9

F7	37	35.5	33	32.6	33.1	34	34.2
F8	38	39	36	35	33	34	35.8

Results of weight variation test:

The weight variation test is a critical quality control parameter for buccal films, ensuring uniformity in dosage and reproducibility during production. This test assesses the consistency in the weight of individual film samples within a batch, which directly correlates with the uniformity of drug content and overall product quality. Variations in weight can arise from factors such as inconsistent spreading of the film-forming solution, fluctuations in polymer concentration, drying conditions, or differences in film thickness during the manufacturing process (Nappinnai, Chandanbala et al. 2008)
To perform the test, multiple films are weighed individually, and the mean weight is calculated. The deviation of individual weights from the mean is evaluated to determine compliance with acceptable limits, as defined by regulatory guidelines. Excessive weight variation may lead to issues such as uneven drug distribution, altered dissolution profiles, or inconsistent therapeutic outcomes. Thus, achieving minimal weight variation is essential for ensuring the safety, efficacy, and reliability of buccal films, particularly in formulations designed for precise dosing and controlled drug delivery (Trastullo, Abruzzo et al. 2016, Ali, Sabati et al. 2017).

Table: Weight variation of each polymer:

SELETED FORMULATIONS	**BATCHES MADE**						**AVERAGE WEIGHT VARIATION (mg)**
	O1	**O2**	**O3**	**O4**	**O5**	**O6**	
F5	2.3	0.94	0.28	1.59	0.65	0.75	0.91
F6	1.68	0.94	0.28	1.59	0.65	0.75	1.05
F7	4.43	3.21	0.61	7.03	0.61	4.43	3.38
F8	0.86	3.15	3.15	2.57	0.28	2.57	2.09

Percentage elongation: The percentage elongation of buccal films reflects their flexibility and ability to withstand stretching without breaking. It is particularly important for ensuring that the films can adapt to the dynamic movements of the buccal mucosa, such as during speech and mastication. High percentage elongation indicates better flexibility, which is essential for user comfort and durability during application. This property is influenced by the composition of the film, including the type and concentration of polymers and plasticizers used. Excessive stiffness or brittleness, indicated by low elongation, can lead to cracking or failure during handling and use, whereas excessive elongation may compromise structural integrity. Thus, optimizing the percentage elongation is vital to achieving a balance between flexibility and mechanical strength for effective and reliable buccal drug delivery systems. The results are expressed in the following table.

Table 10: Observation table for percent elongation

Polymeric buccal film	**Original length (cm)**	**Final Length (cm)**	**Change in Length (Final Length -Initial length) (cm)**	**%Elongation**
F5	2	2.65	0.65	32.5%
F6	2	2.68	0.68	34%
F7	2	2.70	0.7	35%
F8	2	2.72	0.72	36%

Moisture Loss: Moisture loss in buccal films is an important parameter that influences their stability, mechanical properties, and drug release profile. Excessive moisture loss can lead to brittleness, cracking, and reduced flexibility of the films, compromising their ability to adhere to the buccal mucosa and deliver the drug effectively. On the other hand, inadequate moisture loss may result in films that are too soft or sticky, which could affect handling and patient comfort. Moisture loss is influenced by the composition of the film, including the type and proportion of hydrophilic and hydrophobic polymers, as well as the environmental conditions such as temperature and humidity during storage. Maintaining an optimal balance of moisture content is crucial for ensuring the long-term performance, integrity, and usability of buccal films in drug delivery systems.

Table 13: Observation table for Percent moisture loss

Oral dissolving film	**Initial weight(mg)**	**Final weight(mg)**	**Change in weight(mg)**	**Percent moisture loss (%)**
F5	115	113	2	1.7
F6	109	107.4	1.6	1.5

F7	25	24.17	0.84	3.32
F8	34.6	33.8	0.8	2.31

Disintegration test: The disintegration test of buccal films is a key evaluation parameter that measures the time required for the film to break down into smaller fragments or dissolve completely when in contact with a moist environment, such as saliva. This test is crucial for assessing the film's ability to release the drug effectively at the site of application. Factors such as polymer composition, film thickness, and the presence of plasticizers or other excipients significantly influence disintegration time. Films designed for fast drug release typically disintegrate quickly to allow rapid onset of action, while films intended for prolonged drug release are formulated to disintegrate more slowly. The test is often performed in simulated buccal conditions to ensure that the disintegration behavior mimics in vivo performance. An optimal disintegration time is essential to balance drug release kinetics, patient compliance, and therapeutic efficacy in buccal drug delivery systems.

Table 11: Observation table for disintegration test

Formulation no	**F5**	**F6**	**F7**	**F8**
Disintegration time	1 minute	1.5 minutes	2.5 minutes	5 minutes

The disintegration time of all the batches were within limits as per the official compendia's.

In vitro drug release study:

In vitro drug release studies are important to learn about the liberation of therapeutic actives from the film to the buccal mucosa and subsequent permeation through this biological membrane. Further, it is a well-known fact that drug delivery from a formulation is primarily dictated by the properties of the drugs and polymers. The effect of the polymer composition (HPC and ethyl cellulose) on the release of promethazine hydrochloride from films F6, F7 and F8 was determined and illustrated in Figure. It seemed the drug release was biphasic, as evidenced by a higher drug release rate in the initial two hours (the amount of drug released was 40–70%). This type of release profile is anticipated in buccal delivery, as greater drug release in the initial period will ensure adequate drug availability on the mucosal surface for absorption. It is also apparent from the profiles that drug release was relatively higher in film F6 and was nearly complete in 6 h. Followed by F7, the drug release decreased as F6 > F7 > F8, indicating the film composition influenced the promethazine release. The higher drug release observed with film F6 could be due to the presence of more HPC, wherein the drug release is usually due to swelling, which also supports the hydration data. Film F7 stood second, which has lower hydrophilic HPC than F6. The decrease in drug release may be due to the increased concentration of water insoluble polymer i.e. ethyl cellulose. As the concentration of ethyl cellulose was increased the drug release becomes slower and showed slow and prolonged drug release as observed in figure.

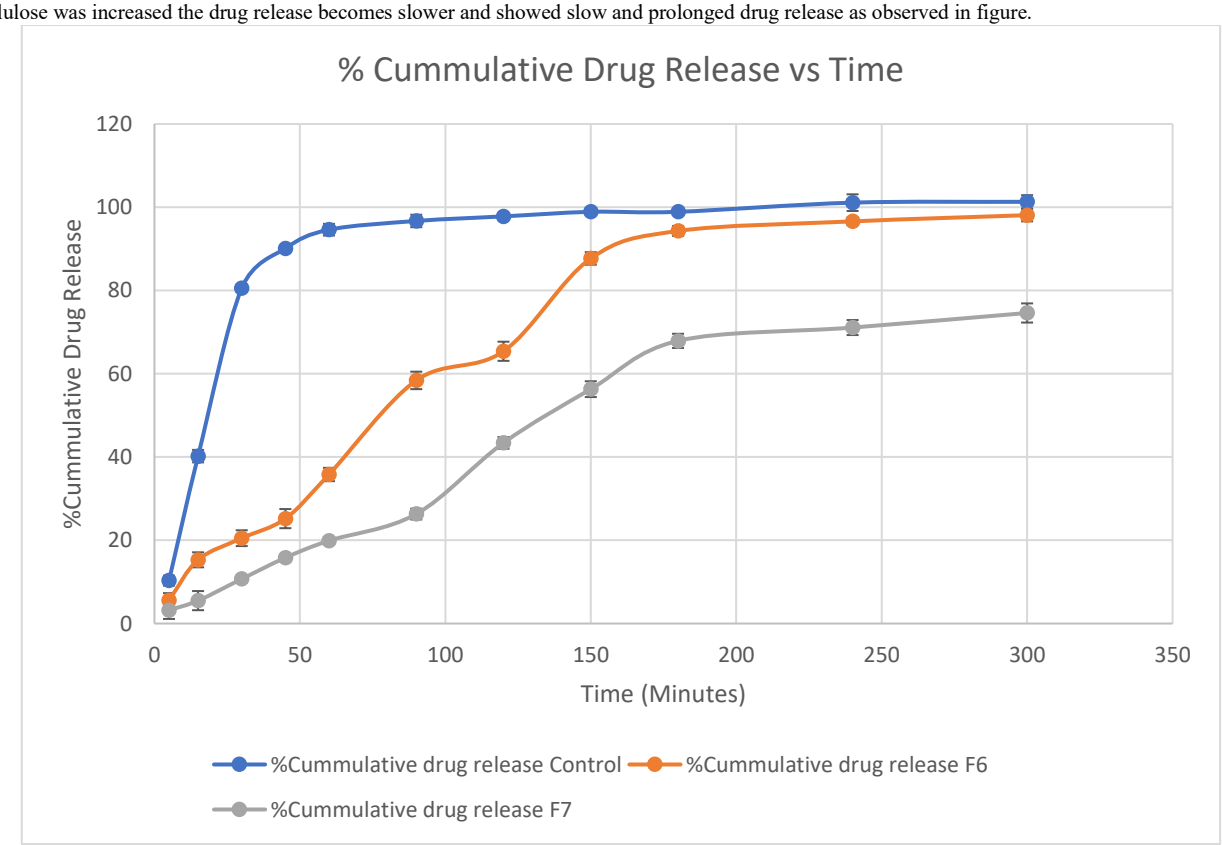

Figure: Graphical representation showing % Cummulative drug release vs time data for Control, F6, F7 and F8 formulations

SUMMARY AND CONCLUSION

The experimental study on the formulation and evaluation of polymeric buccal films utilizing hydroxypropyl cellulose and ethyl cellulose as polymers in various concentrations through solvent casting method provides a comprehensive exploration into the development of an efficient, patient-friendly drug delivery system. This study aimed to harness the unique properties of these biopolymers to create films that dissolve rapidly in the oral cavity, offering an alternative to conventional oral dosage forms, particularly beneficial for individuals with swallowing difficulties.

Key findings from the study highlight that the choice of polymer and its concentration significantly influences the physical and mechanical properties of the polymeric buccal films. Initially at low concentrations hydroxypropyl cellulose and ethyl cellulose showed good mucoadhesive properties but poor mechanical properties but as the concentration of ethyl cellulose increases film showed excellent mechanical properties but mucoadhesive strength remains constant and no significant change was observed. Further with increase in HPC to 10% and ethyl cellulose to 3 % and 4 % the mucoadhesive properties has increased with optimal mechanical properties. However, F5 and F6 with 10% HPC and 1% and 2% ethyl cellulose respectively showed excellent mechanical properties but also excellent mucoadhesivity which is necessary attribute for buccal films.

The evaluation of the films revealed that formulations with optimized concentrations of these polymers exhibited superior qualities in terms of tensile strength, elasticity, dissolution time, and uniformity of drug release. The study demonstrated that films with HPC and ethyl cellulose at high concentrations as polymers not only met the desired criteria for mucoadhesiveness and dissolution but also showed promising potential in improving the palatability and overall patient acceptance of the dosage form.

Furthermore, the research underscored the importance of a systematic formulation approach and thorough evaluation in the development of oral dissolving films. Solvent casting is a common formulation approach for preparing oral dissolving films (Buccal films). It involves dissolving a polymer matrix in a suitable solvent to form a homogeneous solution, which may include flavourings and other additives. The solution is then cast onto a flat surface and allowed to dry, resulting in a thin film. After drying, the film is peeled off and cut into individual doses. Buccal films offer rapid disintegration in the mouth without water, making them convenient for patients with swallowing difficulties. Solvent casting enables precise control over film characteristics and drug delivery properties, making it a versatile method for buccal film production.

In conclusion, this study provides valuable insights into the formulation and evaluation of polymeric buccal film. The findings suggest that these biopolymers, in carefully calibrated concentrations, offer a promising avenue for creating effective, patient-centric drug delivery systems. Future research could focus on exploring the clinical implications of these formulations, assessing their stability, safety, and efficacy in delivering various therapeutic agents. This work lays a solid foundation for advancing oral dissolving film technology, potentially enhancing medication adherence and providing a more agreeable treatment option for patients across diverse populations.

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