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# FORMULATION, DEVELOPMENT AND EVALUATION OF MUCOADHESIVE TABLET OF DILTIAZEM USING NATURAL POLYMER

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**A B S T R A C T :**

One of the most often used drug delivery methods for addressing the bioavailability issues of medications that suffer significant first-pass metabolism when taken orally is mucoadhesive. Diltiazem was chosen as a model medication for study due to its appropriate characteristics, such as its 4.5-hour half-life, optimal partition coefficient, and molecular weight, which allow it to be administered orally. Diltiazem hydrochloride compound Because carbopol has good mucoadhesive properties, it was employed as the principal polymer to make mucoadhesive buccal tablets. Secondary polymers such as HPMC, SCMC, sodium alginate, and guar-gum were also used.

Formulations with different polymer concentrations were created. It was investigated how drug release was affected by subsequent polymer loading. The formulations underwent testing for both in vitro swelling and in vitro drug release. In 8 hours, Formulation FD4 demonstrated a maximum release of 83.23%. Carbopol has adequate bioadhesive qualities. For the buccal administration of diltiazem, formulation FD4, which used an HPMC and carbopol polymer (1:2) ratio, demonstrated notable bioadhesive qualities with an ideal release profile. When compared to natural polymers, all synthetic polymers have good bioadhesive qualities.

**Keywords**: Muco adhesive Tablet, , Diltiazem, novel drug delivery system, trans dermal drug delivery system, mouth dissolving tablet.

## Introduction

Drug delivery system research is essential to enhancing the security and effectiveness of existing therapies. The oral route is the most popular way to provide drugs systemically, although it has drawbacks such erratic absorption, gastrointestinal intolerance, drug breakdown in the gastrointestinal tract, and limited bioavailability due to presystemic metabolism. The only proven method that gets around the majority of these drawbacks is the parenteral route. [1–3]. For systemic medication delivery, transmucosal routes—such as the nasal, rectal, vaginal, ocular, and oral cavities—offer a number of benefits over peroral administration. Bypassing the first pass effect and avoiding metabolism or degradation in the harsh environment of the gastrointestinal system are possible outcomes of these methods. Because of its high permeability and abundant vasculature, the nasal mucosa has been thoroughly studied for systemic medication administration. However, the effectiveness of medication delivery through the nasal mucosa may be impacted by possible irritation, permanent damage to the ciliary activity, and significant intra- and inter-subject variance in mucus production. [4-5]

The buccal or sublingual route is typically used for oral transmucosal medication administration. Although the sublingual mucosa's characteristics allow for a quick initiation of action, tongue motion and continual salivary washing cause disruptions and a lack of smooth muscle expanse. Compared to sublingual methods, buccal mucosa has several benefits, including improved blood flow, permeability, and adhesion to the mouth cavity. [6-7]. A calcium channel blocker, diltiazem hydrochloride has been used to treat a number of cardiovascular conditions, most notably systemic hypertension and angina pectoris. It is quickly removed and has a brief biological half-life of around three to four hours. Diltiazem hydrochloride has a 40% oral bioavailability. Diltiazem hydrochloride buccal tablets were created in the current investigation utilising either natural or synthetic polymers. Consequently, an effort will be made to formulate.

Therefore, we intend to create mucoadhesive buccal tablets of Diltiazem hydrochloride in order to increase its bioavailability, effectiveness, and reduce the negative effects that come with oral administration. [8–10]

## Material and Methods

**Apparatus and chemicals:** Diltiazem hydrocloride by Cipla Pithampur., Carbopol-934, Sodium alginate, Magnesium Stearate, Talc, Sodium

hydroxide, Sodium hydroxide by S.D.Fine chemicals Ltd, Mumbai, Guar gum by Merck Specialties Pvt Ltd, Mumbai.

***Methods: Preparation mucoadhesive tablet by direct compression method.***

Diltiazem hydrochloride mucoadhesive tablets were made by the direct compression technique utilising the mucoadhesive polymers HPMC K4M, Carbopol-934, sodium alginate, and Sod. CMC. Every component, including the medication, polymer, and excipients, was precisely weighed in accordance with the batch formula (Table 1). In an inflated polyethylene bag, the medication and all of the ingredients—aside from lubricants—were combined in ascending weight order and manually blended for ten minutes. Lubricant was added after the materials had been evenly combined, and it was stirred for two more minutes. To create a buccal tablet, the produced mix of each formulation was crushed using a 7.0mm punch based on their weights on a single stroke tablet punching machine with a turret speed of 2 rpm and a pressure of 0.5 tonnes.

**Table 1: Formulation table of diltiazem hydrochloride mucoadhesive buccal tablets.**

| **Ingredients** | **FD1** | **FD2** | **FD3** | **FD4** | **FD5** | **FD6** | **FD7** | **FD8** | **FD9** | **FD10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Diltiazem Hydrochloride | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Carbopol | 20 | 40 | 20 | 40 | 20 | 40 | 20 | 40 | 20 | 40 |
| HPMC | --- | --- | 40 | 20 | --- | --- | --- | --- | --- | --- |
| Na CMC | --- | --- | --- | --- | 40 | 20 | --- | --- | --- | --- |
| Sodium Alginate | --- | --- | --- | --- | --- | --- | 40 | 20 | --- | --- |
| Guar gum | --- | --- | --- | --- | --- | --- | --- | --- | 40 | 20 |
| Mannitol | 95 | 75 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 |
| Mg. Stearate | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Talc | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

## Experimental work

### *3.1 Preformulation Studies*

The study of a medical ingredient's physical and chemical properties, both alone and in conjunction with excipients, is known as preformulation. Preformulation studies aim to identify the physicochemical properties and excipients that may affect the manufacturing process, formulation design, and pharmacokinetic-biopharmaceutical aspects of the final product.

### *3.2 UV and FTIR Spectroscopy*

Using an FTIR spectrometer, the drug-polymer and polymer-polymer interactions were investigated. After mixing two percent (w/w) of the material with potassium bromide, a disc formed. IR spectroscopy was used to record the distinctive peaks.

### *3.3 Evaluation of Mucoadhesive tablet of Diltiazem*

#### 3.3.1 Hardness test

For tablets to survive the mechanical shocks of handling during production, packing, and shipping, they need to have a specific level of strength, hardness, and resistance to friability. The Monsanto Hardness tester was used to measure the tablets' hardness. Kg/cm2 is the unit of measurement. From each formulation, three tablets were chosen at random, and the mean and standard deviation were determined.

#### 3.3.2 Friability test

When tablet surfaces are exposed to mechanical shock or attrition, they may sustain damage and/or exhibit signs of lamination or fracture. Using the Roche Friabilator, the tablet's friability was assessed in accordance with the IP friability method. The percentage (%) is used to express it. Twenty pills were put into the friabilator after being first weighed (W initial). The friabilator was run up to 100 revolutions or at 25 rpm for 4 minutes. Once more, the pills were weighed (W final).

#### 3.3.3 Thickness and Diameter

Using a screw gauge/vernier calliper, the diameter and thickness of tablets from each formulation were measured in millimetres.

**3.3.4 Drug Content uniformity**

Each formulation's five crushed tablets were weighed, extracted using 20 millilitres of phosphate buffer (pH 6.4), and centrifuged for 10 minutes at 4000 rpm. The supernatant was then analysed after being diluted with buffer so that the theoretical concentration matched the standard concentration. A spectrophotometer set at 237 nm was used to analyse the resultant solutions.

**3.3.5 PH Study**

Since an acidic or alkaline pH might cause irritation, the tablets' surface pH was measured to look into the probability of any oral cavity discomfort. For this, a composite glass electrode is employed. For two hours at room temperature, the tablet is left in contact with five millilitres of phosphate buffer (pH 6.8) to allow it to swell. By touching the electrode to the tablet's surface and letting it equilibrate for a minute, the pH may be determined.

**3.3.6 Sweling Index**

After being individually weighed (W1), the tablets of each formulation were put on Petri plates with 2% Agar gel. The tablets were taken out of the Petri plates at regular intervals of 1, 2, 3, 4, 5, 6, 7, and 8 hours, and any extra water was carefully wiped out with filter paper. The swelling index of each formulation was determined using this method after the enlarged pills were reweighed (W2). The following formula is used to determine the swelling index: swelling index = 100 (W2-W1) / W1. where W1 is the tablet's initial weight.

W2 = Tablet's final weight.

**3.3.7 Dissolution Studies**

The USP dissolving equipment II (Coply Scientific, England) was used to dissolve the buccoadhesive tablets in 500 millilitres of phosphate buffer (pH 6.8) at 37 ± 0.5°C and 50 rpm. Five millilitres of samples were taken out at the proper intervals, and to keep the volume constant, an equivalent volume of medium was added. After the samples were properly diluted and passed through a 0.45 µm millipore filter, the quantity of diltiazem HCl released was measured spectrophotometrically at 237 nm, and the release data were assessed kinetically.

**3.3.8 Residence In vitro**

The buccal tablet's in vitro residence time was established by use of a locally customised USP disintegration device. 800 millilitres of phosphate buffer pH 6.8 kept at 370 made up the medium. A 3-cm-long piece of sheep buccal mucosa was adhered to a glass slab. Phosphate buffer pH 6.8 was used to hydrate the tablet surface, which was subsequently brought into contact with the mucosal membrane. At its lowest position, the glass slab that was mounted vertically to the tablet was fully submerged in the buffer solution, and at its highest point, it was out. It was noted how long it took for the tablet to completely erode or separate from the mucosal surface.

## Result and discussion

### FT-IR Spectroscopy

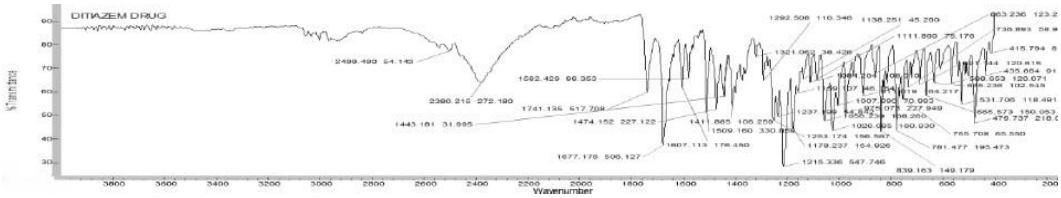


**Figure 1 FTIR of pure Drug**

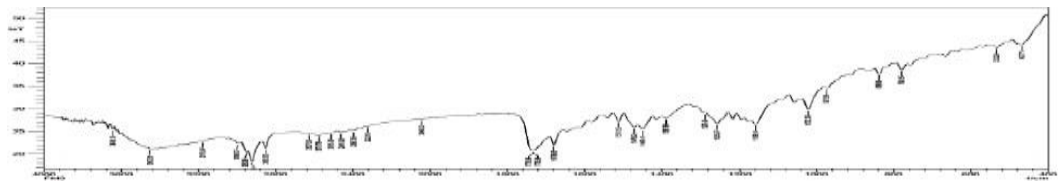

**Figure: 2 FTIR Spectrums of FD1 (Diltiazem HCl + Carbopol).**

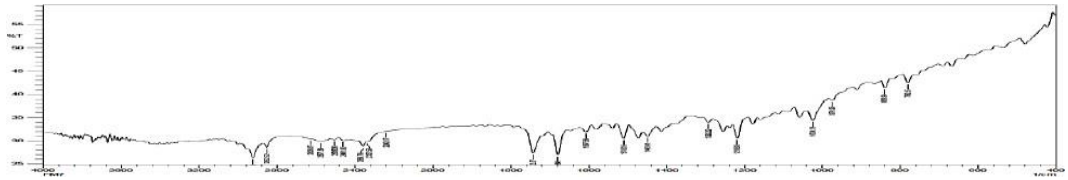

**Figure 3; FTIR Spectrums of FD3 (Diltiazem HCl + HPMC).**

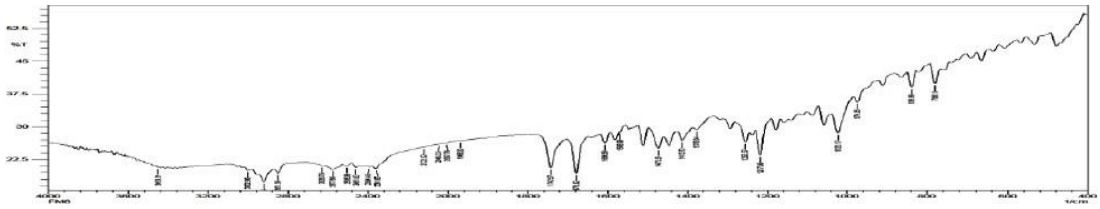

**Figure 4; FTIR Spectrums of FD3 (Diltiazem HCl + NA CMC).**

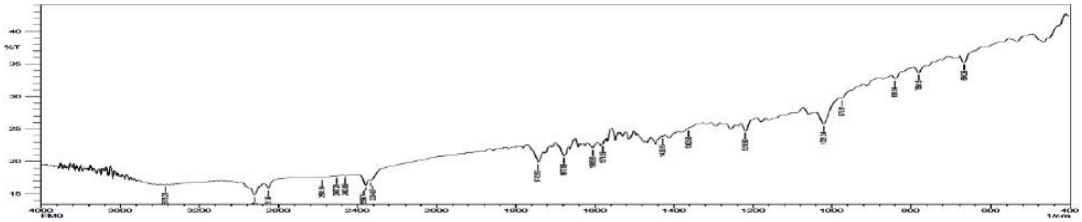

**Figure 5: FTIR Spectrums of FD5 (Diltiazem HCl + Sodium Alginate).**

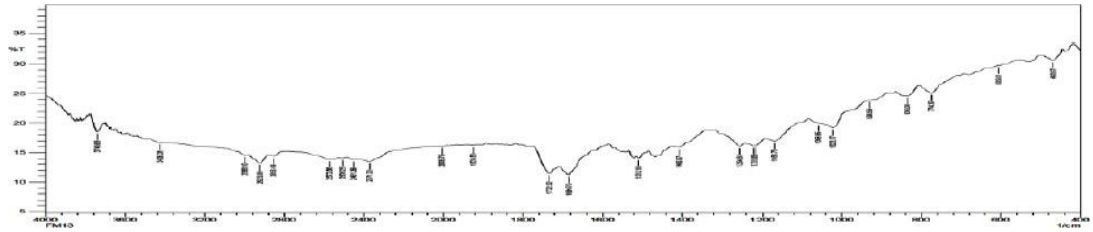

**Figure 6: FTIR Spectrums of FD9 (Diltiazem HCl + Guar gum).**

**Table 2: FTIR Peaks of diltiazem Hydrochloride and Excipients.**

| Formulation code | Composition | Peak for diltiazem hydrochloride | | | | |
|---|---|---|---|---|---|---|
| | | Aromatic C-H Stretch | O-CH3 C-H stretch (cm-1) | Amine HCl N-H stretch (cm-1) | Acetate C=O stretch (cm-1) | Lactam C=O stretch (cm-1) |
| | Diltiazem HCl | 3057.27 | 2837.38 | 239.81 | 1743.71 | 1681.98 |
| FD1 | Diltiazem HCl + Carbopol | 3000.07 | 2852.52 | 2322.13 | 1730.99 | 1679.88 |
| FD3 | Diltiazem HCl + HPMC | 3047.43 | 2852.52 | 2358.78 | 1722.52 | 1607.56 |
| FD5 | Diltiazem HCl + Na CMC | 3453.31 | 2851.32 | 2361.67 | 1742.57 | 1678.92 |
| FD7 | Diltiazem HCl + Sod alginate | 3375.20 | 2851.56 | 2334.57 | 1743.53 | 1677.95 |
| FD9 | Diltiazem HCl + Guar gum | 3426.31 | 2853.49 | 2371.32 | 1732.82 | 1684.70 |

**Table 3: Physical parameters of various diltiazem hydrochloride mucoadhesive tablets.**

| Formulation Code | Weight (mg) | Thickness (mm) | Hardness ($kg/cm^2$) | Friability |
|---|---|---|---|---|
| FD1 | 150.033±0.018 | 2.82±0.068 | 4.67±0.058 | 0.48±0.014 |
| FD2 | 149.700±0.100 | 2.84±0.020 | 4.63±0.055 | 0.37±0.004 |
| FD3 | 150.00±0.200 | 2.88±0.005 | 5.84±0.100 | 0.46±0.005 |

| | | | | |
|---|---|---|---|---|
| FD4 | 150.033±0.077 | 2.85±0.017 | 5.67±0.115 | 0.45±0.011 |
| FD5 | 149.700±0.090 | 2.87±0.005 | 5.54±0.100 | 0.38±0.001 |
| FD6 | 150.633±0.205 | 2.87±0.038 | 5.51±0.058 | 0.26±0.012 |
| FD7 | 150.667±0.154 | 2.81±0.055 | 5.43±0.100 | 0.31±0.005 |
| FD8 | 149.867±0.043 | 2.87±0.058 | 5.75±0.100 | 0.35±0.015 |
| FD9 | 150.430±0.082 | 2.83±0.058 | 5.95±0.100 | 0.45±0.01 |
| FD10 | 150.289±0.145 | 2.80±0.049 | 5.34±0.115 | 0.33±0.01 |

**Table 4: Swelling index data of mucoadhesive tablets of diltiazem hydrochloride**

| **Time (h)** | **Percentage weight change** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **FD1** | **FD2** | **FD3** | **FD4** | **FD5** | **FD6** | **FD7** | **FD8** | **FD9** | **FD10** |
| 1 | 18.90±0.60 | 21.06±0.05 | 34.25±0.11 | 39.87±0.21 | 18.19±0.10 | 23.99±0.70 | 34.21±0.05 | 38.15±0.25 | 31.15±0.25 | 29.01±0.15 |
| 2 | 19.14±0.40 | 24.21±0.02 | 41.21±0.64 | 48.91±0.86 | 26.75±0.15 | 30.15±0.17 | 42.65±0.18 | 47.98±0.91 | 41.48±0.91 | 36.60±0.03 |
| 3 | 24.95±0.78 | 28.42±0.09 | 53.62±0.71 | 60.52±0.61 | 32.26±0.02 | 34.10±0.45 | 51.14±0.49 | 53.18±0.83 | 53.08±0.83 | 51.02±0.20 |
| 4 | 27.28±0.32 | 32.68±0.04 | 66.38±0.08 | 75.38±0.28 | 35.68±0.15 | 38.60±0.57 | 56.22±0.27 | 58.23±0.57 | 58.40±0.57 | 56.46±0.12 |
| 5 | 31.43±0.14 | 37.24±0.04 | 74.97±0.25 | 79.17±0.16 | 36.84±0.21 | 41.93±0.49 | 61.29±0.09 | 62.62±0.72 | 62.64±0.72 | 69.41±0.18 |
| 6 | 34.05±0.65 | 40.21±0.78 | 81.47±0.34 | 86.07±0.15 | 41.24±0.68 | 44.84±0.54 | 68.92±0.45 | 65.83±0.24 | 65.83±0.24 | 74.21±0.04 |
| 7 | 36.07±0.54 | 48.57±0.95 | 84.81±0.31 | 88.31±0.07 | 43.24±0.15 | 46.84±0.69 | 71.22±0.31 | 68.56±0.47 | 68.06±0.47 | 77.61±0.31 |
| 8 | 38.06±0.23 | 55.79±0.05 | 88.12±0.02 | 91.87±0.21 | 45.22±0.20 | 48.99±0.70 | 72.65±0.17 | 74.56±0.25 | 71.15±0.25 | 80.31±16 |

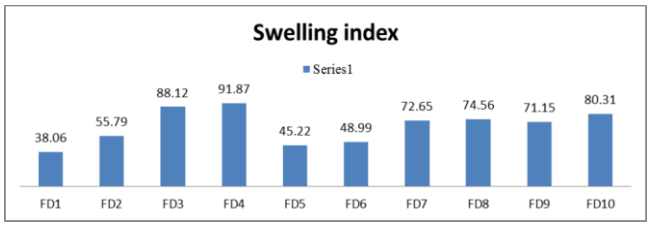


**Figure 8: Swelling index of diltiazem hydrochloride from mucoadhesive tablets.**

**Table 5: Result of Surface pH, Mucoadhesiv Strength, In vitro Residence Time**

| **Formulation Code** | **Surface pH ± SD** | **Mucoadhesive strength (g) ± SD** | ***In Vitro Residence* (Hrs) ± SD** | ***Drug content*** |
|---|---|---|---|---|
| FD1 | 6.62±0.154 | 3.22±0.085 | 2.21±0.050 | 99.96±0.010 |
| FD2 | 6.72±0.115 | 3.50±0.121 | 2.22±0.025 | 99.22±0.065 |
| FD3 | 6.77±0.157 | 4.33±0.115 | 5.26±0.133 | 99.35±0.016 |
| FD4 | 6.64±0.258 | 4.76±0.042 | 5.55±0.072 | 98.28±0.030 |
| FD5 | 6.52±0.155 | 4.30±0.110 | 4.10±0.503 | 100.12±0.012 |
| FD6 | 6.60±0.040 | 4.63±0.055 | 3.64±0.036 | 98.47±0.013 |
| FD7 | 6.71±0.023 | 3.08±0.110 | 3.90±0.309 | 99.77±0.026 |
| FD8 | 6.75±0.121 | 3.15±0.042 | 2.92±0.375 | 99.06±0.035 |
| FD9 | 6.76±0.021 | 3.60±0.100 | 4.47±0.031 | 98.56±0.014 |

| | | | | |
|---|---|---|---|---|
| FD10 | 6.90±0.101 | 3.90±0.050 | 4.49±0.062 | 99.23±0.023 |

**Table 6: In vitro release data of Diltiazem hydrochloride from mucoadhesive buccal tablets at pH 6.8.**

| Time (h) | *In vitro* release at pH 6.8 (n=3, Mean±SD) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FD1 | FD2 | FD3 | FD4 | FD5 | FD6 | FD7 | FD8 | FD9 | FD10 |
| 1 | 18.10±1.09 | 20.53±0.25 | 32.43±0.21 | 38.77±0.35 | 17.32±0.99 | 16.04±0.08 | 17.43±0.16 | 18.71±0.26 | 15.98±0.44 | 17.00±0.33 |
| 2 | 26.44±1.07 | 25.35±1.56 | 38.74±0.65 | 45.07±1.35 | 27.05±0.25 | 26.42±1.18 | 24.14±2.22 | 22.42±0.29 | 30.41±0.38 | 33.05±0.99 |
| 3 | 34.60±0.54 | 33.63±0.25 | 46.55±0.91 | 49.09±2.36 | 36.45±1.77 | 35.22±1.13 | 30.24±0.33 | 31.47±0.72 | 42.94±0.24 | 44.07±0.25 |
| 4 | 46.20±0.25 | 43.91±1.10 | 50.61±0.27 | 51.65±1.07 | 38.32±3.45 | 40.18±0.18 | 45.79±0.18 | 46.57±2.38 | 50.09±1.95 | 49.82±0.34 |
| 5 | 55.72±0.91 | 53.96±0.24 | 57.34±1.77 | 59.50±0.44 | 48.60±1.18 | 50.22±0.55 | 48.38±1.98 | 46.09±3.45 | 54.72±1.07 | 56.35±1.02 |
| 6 | 62.10±0.08 | 60.33±3.45 | 65.85±1.19 | 68.88±0.24 | 58.63±0.52 | 59.52±1.96 | 52.12±3.20 | 51.01±0.32 | 60.36±1.96 | 62.75±0.44 |
| 7 | 65.40±0.44 | 64.38±0.21 | 70.31±1.11 | 73.17±0.21 | 60.18±2.51 | 61.40±0.44 | 55.83±1.96 | 53.24±0.18 | 66.48±0.79 | 68.24±0.30 |
| 8 | 68.22±0.33 | 67.30±0.24 | 78.77±0.24 | 83.23±1.10 | 63.95±0.91 | 65.86±0.79 | 66.72±1.34 | 68.10±0.40 | 72.51±0.34 | 75.40±1.07 |

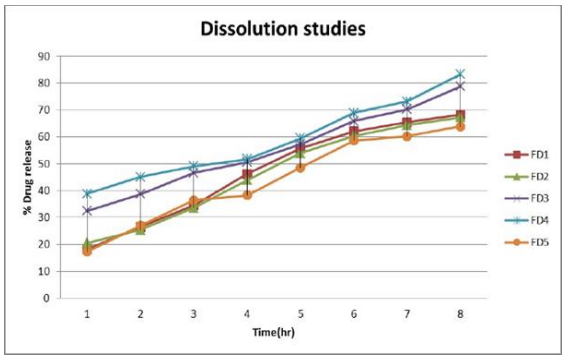


**Figure 9: Drug Release of Mucoadhesive tablet formulation FD1-FD5.**

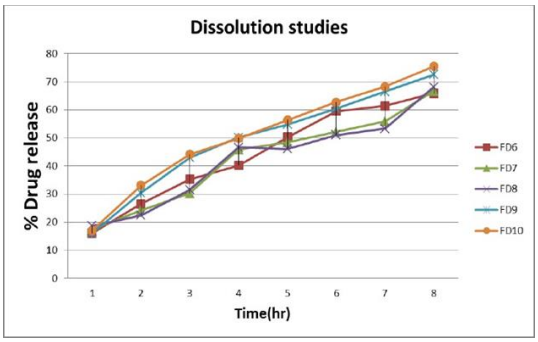


**Figure 10: Drug Release of Mucoadhesive tablet formulation FD6-FD10**

**Table 7: Regressional analysis of the in vitro release data according to various release kinetic models.**

| Formulation code | Zero order | First order | Higuchi | Korsmeyer-Peppas | | Hixon-Crowell | Erosion |
|---|---|---|---|---|---|---|---|
| | $r^2$ | $r^2$ | $r^2$ | $r^2$ | n | $r^2$ | $r^2$ |
| FD1 | 0.996 | -0.725 | 0.998 | 0.998 | 0.829 | 0.910 | -0.910 |
| FD2 | 0.982 | -0.817 | 0.995 | 0.994 | 0.803 | 0.987 | -0.987 |
| FD3 | 0.995 | -0.788 | 0.998 | 0.998 | 0.809 | 0.975 | -0.975 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FD4 | 0.996 | -0.914 | 0.992 | 0.995 | 0.712 | 0.996 | -0.996 |
| FD5 | 0.995 | -0.925 | 0.990 | 0.991 | 0.724 | 0.997 | -0.997 |
| FD6 | 0.996 | -0.915 | 0.985 | 0.981 | 0.757 | 0.996 | -0.996 |
| FD7 | 0.996 | -0.802 | 0.997 | 0.999 | 0.907 | 0.971 | -0.971 |
| FD8 | 0.988 | -0.849 | 0.996 | 0.995 | 0.953 | 0.980 | -0.980 |
| FD9 | 0.999 | -0.827 | 0.994 | 0.999 | 0.955 | 0.971 | -0.971 |
| FD10 | 0.985 | -0.874 | 0.998 | 0.994 | 0.840 | 0.994 | -0.994 |
| FD11 | 0.979 | -0.922 | 0.995 | 0.992 | 0.865 | 0.998 | -0.998 |
| FD12 | 0.982 | -0.926 | 0.937 | 0.993 | 0.907 | 0.997 | -0.997 |

**Table 8: Short term stability study data of mucoadhesive buccal tablets of Diltiazem hydrochloride.**

| Duration (Month) | Parameter studied | Formulation Code | | | |
|---|---|---|---|---|---|
| | | **FD4** | **FD6** | **FD8** | **FD10** |
| 0 | Drug content | 98.28 | 98.47 | 99.06 | 99.23 |
| | Surface pH | 6.64 | 6.60 | 6.75 | 6.90 |
| | % Drug release | 83.23 | 65.86 | 68.10 | 75.40 |
| 1 | Drug content | 97.20 | 98.40 | 99.01 | 99.16 |
| | Surface pH | 6.62 | 6.61 | 6.72 | 6.88 |
| | % Drug release | 83.20 | 65.68 | 67.75 | 75.33 |
| 2 | Drug content | 97.14 | 97.39 | 99.02 | 99.10 |
| | Surface pH | 6.60 | 6.90 | 6.85 | 6.77 |
| | % Drug release | 83.12 | 65.52 | 67.40 | 75.25 |
| 3 | Drug content | 96.15 | 96.38 | 98.90 | 99.06 |
| | Surface pH | 6.59 | 6.81 | 6.76 | 6.75 |
| | % Drug release | 83.04 | 65.35 | 67.34 | 74.68 |

## Discussion

Carbapol-934, sodium carboxymethyl cellulose (SCMC), hydroxy propyl methyl cellulose (HPMC), sodium alginate, and guar-gum were used as mucoadhesive polymers to create mucoadhesive buccal tablets of Diltiazem hydrochloride. Ten formulations with different polymer concentrations were created. When FTIR spectroscopy was utilised to examine the drug-polymer interaction for a specific drug combination with various polymers (fig. 2 to 7 and table 2), it was found that Diltiazem HCl was in its free form and that neither drug-polymer nor polymer-polymer interactions occurred during formulation development. The tablets' thickness, hardness, friability, drug content homogeneity, and surface pH were assessed; the findings are shown in Tables 3, 4, and 5. The drug content ranged from 98.47% to 100.12%, indicating consistent drug mixing. All of the buccal tablets had surface pH values between 6.5 and 6.9, which is closer to salivary pH (6.5 to 7.5). This indicates that using the manufactured buccal tablets is safe and won't cause any discomfort or irritation to the mucosa. The findings of the swelling investigation of prepared buccal tablets in 2% agar gel are shown in Table 4/Fig. 8 as a percentage weight change over time.

In formulations F3 to F10, the release of Diltiazem hydrochloride was extended from 6 to 8 hours by the use of secondary polymers such as HPMC, Sod CMC, sodium alginate, and guar gum in addition to carbopol as primary polymers. Because HPMC has a hydrophilic gel-forming matrix that was utilised as a release suppressor, the buccal tablets containing HPMC demonstrated a maximum release of 83% to 78%. The gel's viscosity and the development of a gel layer with a longer diffusional path both increase with the concentration of the polymer. The results showed that the drug release in formulations reduced linearly with an increase in the carbopol content. As the concentrations of carbopol and HPMC rose, so did the bioadhesion force and oedema.

Guar gum, sodium alginate, Sod CMC, and HPMC are some of the secondary polymers that prolong the drug release for up to eight hours. The release of Diltiazem hydrochloride is considerably ($p > 0.05$) impacted by the increase in carbopol concentration in all tablet forms.

To determine the drug release mechanism and kinetics of drug release from the buccal tablets, the in vitro release data was submitted to zero order,

first order, Higuchi, Korsemeyer-Peppas, Hixon crowell, and erosion models. Table 7 provides a summary of the regressional study with correlation coefficient "r2" value for several kinetic models.

A strong "r2" value and good linearity were noted using the Korsemeyer-Peppas model. The release mechanism is defined by the value of the release exponent "n," which is computed as a slope. Because hydrophilic polymers have a larger affinity for water, the drug release was thought to follow non-fickian anomalous diffusion, as shown by the value of "n" determined for all tablet formulations being >0.5 and <1.0.

## Conclusion

The formulation and assessment of Diltiazem hydrochloride mucoadhesive buccal tablets revealed that there was no danger of mucosal irritation and that the tablets exhibited satisfactory swelling for up to eight hours in 2.0% Agar gel. Diltiazem hydrochloride's in vitro release was prolonged by 6–8 hours, and it was prolonged by Carbopol, HPMC K4M, sodium alginate, guar gum, and Sod CMC. The increase in carbopol had a considerable impact on the in vitro release, which followed zero order kinetics. The tablets had a satisfactory mucoadhesive strength of 3.08 g to 4.76 g and a good residence duration of 2.21 to 5.55 hours. The mucoadhesive strength was increased by the inclusion of secondary polymers such as sodium alginate, guar gum, HPMC K4M, and Sod CMC. The stability of the manufactured mucoadhesive buccal tablets suggests that they may be used to better treat inflammatory and autoimmune diseases. The work raises the possibility of doing pharmacokinetic and pharmacodynamic research.

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