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Formulation and evaluation of Buccoadhesive compacts of Lacidipine

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ABSTRACT

The aim of the present study is to formulate and evaluate buccoadhesive compacts of Lacidipine. Compacts were prepared with different grades of polymers like HPMC, Carbopol and Ethyl cellulose by direct compression technique. Compacts were evaluated for weight uniformity, thickness, surface pH, mucoadhesive strength, *in vitro* residence time and *in vitro* release. Physicochemical properties and content uniformity were found well within limits. FTIR studies showed no evidence on interaction between drug, polymers and other excipients. Surface pH and swelling index was found in the range of 6.42 to 6.80 and 44.83 – 97.87 %. F_2 formulation showed controlled drug release of 90.42% in 8h and selected as optimized formulation. Optimized compacts were not dislodged within 8h. *In vivo* mucoadhesion studies showed that compacts were retained for more than 8h. Mucoadhesive force was found in the range of 3.47 to 5.82 N. Stability studies has been be performed for 3 months on the optimized formulation concluded that there were no significant changes in drug content and *in vitro* dissolution characteristics than initial results. The results indicate that suitable compact of lacidipine HCl with *in vivo* residence time and control release could be formulated for commercial scale.

Introduction

Buccal delivery of drugs provides an attractive alternative to the oral route of drug administration, particularly in overcoming deficiencies associated with the latter mode of dosing [1]. Several research groups have been working on the development of pharmaceutical buccoadhesives in the form of tablets, patches, multi-layered systems, disks, micro-spheres, creams and hydrogel systems, as an alternative to conventional orally administered dosage forms [2-4].

Amongst the various routes of drug delivery, the oral route is most preferred by patient and the clinician alike because of the significant attention to their presystemic metabolism or any instability in the acidic environment associated with the oral environment. Consequently, other absorptive mucosa, are considered as potential site for drug administration, rich blood supply, lower enzymatic activity of saliva, better patient acceptance are some other prominent meritorious visage of buccoadhesive systems [5-6].

Oral mucosal drug delivery offers many benefits, such as selective release of drugs at their respective binding sites, ease of administration and removal of the dosage form, low enzyme activity, reduction of first-pass metabolism in the liver as well as the ability to control the release due to its composition of hydrophilic excipients [7-9].

Bioadhesion is a characteristic that some natural or synthetic macro-molecules present when they adhere to biological tissue, where weight molecular conformation, crosslink density, load, ionizing properties, as well as the concentration of the polymer used, are all determining factors for the bioadhesion to occur[10]. In general, this process involves three stages: moistening, interpenetration and muco-polymer mechanical interaction [11-12].

Mucosa of the buccal area has a smooth and relatively immobile surface, which is suitable for placement of a retentive system [13]. Buccal delivery offers efficient drug delivery since the mucosal surface is washed with 0.5 to 2 liters/day of saliva, avoids first-pass metabolism of the drug, avoids degradation in the stomach (from acid or from gastric enzymes) and subjects the drug to a milder enzyme milieu [14]. In this study Carbopol 934P have been used as mucoadhesive agent.

Carbopol polymers are high molecular weight, crosslinked, acrylic acid-based polymers. All of the carbopol polymers have the same acrylic acid backbone. The main differences are related to the presence of a comonomer and the crosslink density. With very minor adjustments in the crosslink density and comonomer level, a large number of polymers have been engineered to provide specific application properties without substantially changing the gross molecular structure [15].

Successful buccal drug delivery using buccal adhesive system requires at least three of the following (a) a bioadhesive to retain the system in the oral cavity and maximize the intimacy of contact with mucosa (b) a vehicle the release the drug at an appropriate rate under the conditions prevailing in the mouth and (c) strategies for overcoming the low permeability of the oral mucosa. Buccal adhesive drug delivery stem promote the residence time and act as controlled release dosage forms [16].

Lacidipine HCl is a calcium channel blocker developed for oral administration and used in the treatment of hypertension and atherosclerosis. The drug is administered orally in a dose of 2– 6 mg daily as its hydrochloride salt, reducing significantly the diastolic blood pressure. After oral administration, lacidipine HCl is completely and erratically absorbed from the gastrointestinal tract. Bioavailability is reduced to approximately 10% because of extensive first pass metabolism to inactive metabolites. These pharmacokinetic parameters make lacidipine HCl a suitable candidate for buccal delivery [17].

The objective of present investigation was to formulate and evaluate buccal mucoadhesive controlled release tablets of lacidipine HClusing carbopol 934P, different viscosity grades of hydroxypropyl methylcellulose (HPMC) individually and their combination. Effect of polymer type, proportion and

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combination was studied on drug release rate, release mechanism and mucoadhesive strength of the prepared formulations.

Materials and Methods:

Materials

Lacidipine HCl(Gift sample from Macloids-Daman), HPMC 4KM, (Gift sample from Apotex Labs Pvt Ltd-Bangalore and Colorcon Pvt. Ltd. Madgoa, Goa), HPMC 15KM and HPMC 100KM (Gift sample from Apotex Labs Pvt Ltd-Bangalore and Colorcon Pvt. Ltd. Madgoa, Goa), Carbopol 934P(Gift sample from Remedex pharma Pvt. Ltd. Bangalore/ Corel Pharma, Ahmedabad), Ethyl Cellulose(Colorcon Pvt. Ltd. Madgoa, Goa).

Preparation of buccoadhesive compacts of lacidipine:

Buccoadhesive compacts of lacidipine HCl were formulated as reported in Table 1. The tablet contains two layers i.e. core layer and backing layer. Core layer was prepared by transferring specified quantity of lactose, MCC pH 102, mannitol, carbopol 934P and HPMC to the mortar and pestle and mixed well. Lacidipine HCl was added to the above mixture and mixed well. Then specified quantity of magnesium stearate was added to the above mixture and mixed well. From the above directly compressible mixture specified of powder was transferred to 8mm die cavity of compression machine and compressed. Then add specified quantity of the backing layer powder containing ethyl cellulose, magnesium stearate and color above the core layer compact and compressed.

Pre-compressional parameters Buccoadhesive compacts of Lacidipine.

Moisture content:

Moisture content was measured by using IR moisture analyzer [18].

Carr's index (or) % compressibility (I): It indicates granules flow properties. It was expressed in percentage and given by

$$I = (TD - BD) \times 100/TD$$

Where, TD and BD are tapped density and bulk density respectively [19].

Hausner's ratio: Hausner's ratio was an indirect index of ease of powder flow. It was calculated by the following formula.

$$\text{Hausner's ratio} = TD / BD$$

Where, TD and BD are tapped density and bulk density respectively [19].

Angle of Repose (θ):

The granules blend was allowed to flow through the funnel freely on to the surface. The diameter and height of the granules cone were measured and angle of repose was calculated using the following equation.

$$\tan \theta = h/r$$

Where, h and r are the height and radius of the powder cone [20].

Physicochemical characterization of Formulations:

For each batch, 20 compacts were weighed (Electrolab, India) for assessing weight variation. Thickness and diameter of compacts were determined using vernier calipers. Hardness of the compacts was determined using monsonto hardness tester. Hardness of the compacts was recorded as the maximum force required (kg/cm^2) to break the compacts [21]. Friability was determined by subjecting 20 compacts to falling shocks in friabilator (Electrolab, India) for 4 min at 25 rpm [22]. Drug content study was carried out separately by taking 10 compacts from each formulation and crushed in mortar and pestle. Weigh 5 mg equivalent weight of powder and dissolve in phosphate buffer 6.8. The sample was analyzed using UV-Visible spectrophotometer (Shimadzu 1601 Model) at 244.5nm [23].

Surface pH studies

The designed compacts were first allowed to swell by keeping compacts in contact with 1 ml of distilled water (pH 6.8) for 2 h in petridishes. The surface pH was measured by bringing glass electrode of pH meter in contact with the surface of tablets and allowing it to equilibrate for 1 min. The surface pH of the compacts was determined in order to investigate the possibility of any discomfort in oral cavity as acidic or alkaline pH may lead to irritation [24].

Swelling studies

The swelling rate of compacts was evaluated using 1% w/w agar gel plate. For each formulation, 3 compacts were weighed using analytical balance and the weight was noted as ($W_{1)}$. The compacts were placed with core layer facing the gel surface in 3 separate petri dishes containing 5 ml of 1% w/w agar gel. Which were placed in an incubator at 37 ± 1 °C. Compacts were removed at regular intervals of 0.5, 1, 2, 4 and 6 h, excess water on the surface was carefully removed using filter paper and swollen compacts were weighed and noted as ($W_{2)}$. Swelling index was calculated by using the formula [25].

$$\% \text{ Swelling index} = (W_2 - W_1) \times 100 / W_1$$

***In vitro* Bioadhesion studies:**

The apparatus used for *in vitro* bioadhesion studies is shown in Fig 1. *In vitro* bioadhesion studies were carried out using rabbit buccal mucosa and modified two armed balance. The beaker on one side of the balance was counter balanced by using suitable weights on the other side. The compact was fixed to the tissue holder with cyanoacrylate adhesive. A circular piece of sheep buccal mucosa was fixed to the tissue holder with cyanoacrylate adhesive and was immersed in tyrode solution and the temperature was maintained at 37±1˚C. Then the compact was placed on the buccal mucosa by using a preload of 50gms and kept it aside for 5 min to facilitate adhesion bonding. After preloading time, the preload was removed and the water was allowed to flow into the beaker kept on the other side of the balance at the flow rate of 1 drop/sec until the compact detaches from the buccal mucosa. The weight required to detach the compact from the buccal mucosa was noted. The force of adhesion is calculated by using the following formula[26]

Force of adhesion (N) = **(**Mucoadhesive strength X 9.81)/100

Fig 1. Modified two armed balance

Stability studies in human saliva

Stability studies will be performed in normal human saliva using the optimized formulation (F_2) selected based on the results of swelling, release, and bioadhesive force studies. The human saliva (5ml) will be collected from humans (aged 18-55) and filtered. compacts will be placed in separate petri dishes containing 5 ml of human saliva and placed in a temperature-controlled oven for 6 h at 37°C ± 0.2°C. At regular time intervals (0, 1, 2, 3 and 6 h), the compact was examined for change in color, shape, thickness, swelling and pH content of the compact [27].

***Ex vivo* residence time**

Ex vivo residence time of the compacts were determined by using a locally modified disintegration apparatus. 800ml of pH 6.8 phosphate buffer solution was used as disintigration medium. Sheep buccal mucosa was fixed to the surface of the glass slab by using feviquick , and a mucoadhesive core side of each compact was wetted with 1 drop of pH 6.8 phosphate buffer and hydrated surface was brought in contact with the mucosal membrane by applying a little pressure with a fingertip for 30 seconds. The glass slab was vertically fixed to the apparatus and allowed to move up and down so that the tablet was completely immersed in the buffer solution at the lowest point and was out at the highest point. The time necessary for compete erosion or detachment of the tablet from mucosal surface were recorded [27].

***In vitro* release studies**

In vitro release study of compacts of Lacidipine HCl for all the formulations were carried out using USP XXIV dissolution apparatus with rotating basket method at 37 ± 0.5°C and 50 rpm. Study was conducted in triplicate. 900ml of pH 6.8 phosphate buffer was used as dissolution medium. Aliquot samples (5ml) were withdrawn at predetermined time intervals and replaced with fresh dissolution medium. The samples were filtered through whatman filter paper number 42. The samples were analyzed using Shimadzu UV-Visible spectrophotometer 1601 at 244.5nm[27].

***In vivo* mucoadhesion test**

Six New Zealand rabbits were selected for the study. I.M. injections of ketamine (35 mg/Kg) and xylazine (3 mg/Kg) are used to anesthetize the rabbits. To observe the in vivo mucoadhesive performance, compacts without drug were prepared. The dummy compact was placed on the buccal mucosa between the cheek and gingiva in the region of the upper canine and gently pressed onto the mucosa for about 30 s. The compact and associated buccal mucosa area was observed for a period necessary for the compact to detach was recorded. The observations were made by lifting the upper lip. Either complete erosion or dislodgement of the compact would indicate the adhesion period. In addition the animals were also observed for irritancy, redness, dryness of mouth, salivation and colour of the mucosa[27].

Stability studies

Studies of the formulated compacts (optimized formulation) were carried out at 40 ± 2°C(75 ± 5% RH) and 25 ± 2°C(60 ± 5% RH) for three months to investigate the influence of temperature and RH on the drug content, bioadhesion strength and *in vitro* drug release[28].

Results and Discussion

Compacts of enalaprill maleate were prepared by using various ratios such as 1:0, 1:1 & 0:1 of Carbopol 934P, HPMC 4KM, HPMC 15KM, HPMC 100KM by direct compression method was studied for precompressional characteristics. The results of angle of repose, carr's index, hausners's ratio and moisture content were shown in Table 2. The angle of repose and carr's index was found to be between 26.86-29.97 °θ and 10.55-14.94 % respectively. Hausner's ratio was found in the ratio of 11.12 to 1.18 %. Moisture content was found to be between of 3.30 – 4.12 %. All the formulations showed good blend properties for direct compression.

FT-IR studies showed no evidence on interactions between drug, polymers, and excipients.

Prepared compacts were then evaluated for various physical properties weight variation, hardness, thickness, friability and all the observations are summarized in Table 3.

From the above observations it was concluded weight variation, hardness, thickness, diameter and friability of tablets were lying within IP limit.

The maximum and minimum drug content for all formulations was found to be 99.31 – 99.95 %. The results were found within pharmacopoeia limits.

Swelling studies for the prepared buccoadhesive compacts

Swelling index data was reported in Fig 2. F_8 showed least swelling index whereas F_3 showed highest swelling index. The swelling index was found in the range of 44.83 – 97.87 %. It is evident from the above data, that the compacts containing carbopol 934P alone showed higher swelling index than compared to compacts containing HPMC.

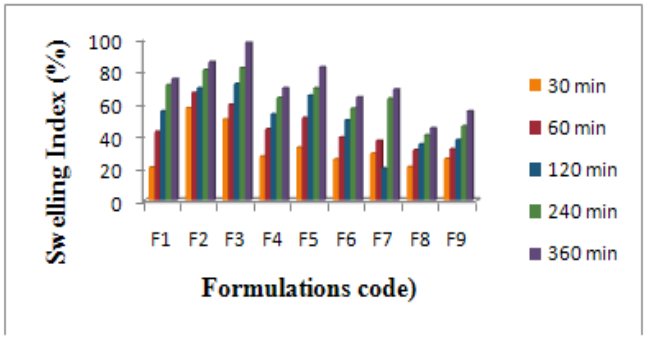

Fig. 2: Swelling index profile lacidipine HCl compacts (F_1-F_9)

It was concluded that there is no significant difference in the swelling index, when the individual polymers are compared.

Surface pH studies

Surface pH of all the formulation was found to be 5.9 to 6.4 and shown in Fig 3. These results reveal that all the formulation provide an acceptable pH in the range of salivary pH (5.5 to 7.0). It was also observed that they did not produce any local irritation to the mucosal surface, more over there is no significant difference in the pH among the formulations.

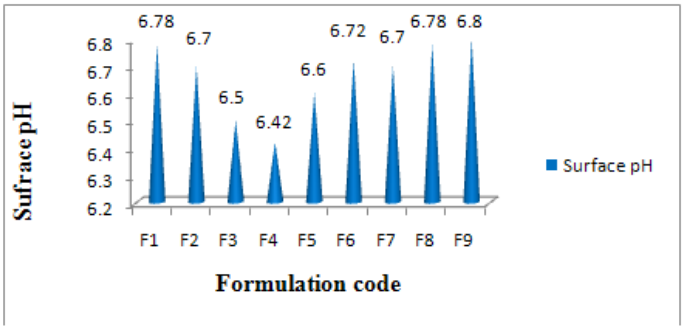

Fig 3. Surface pH of lacidipine HCl compacts (F_1-F_9)

***In vitro* Mucoadhesion studies**

All the observations of bioadhesion force are shown in Fig 4. Bioadhesive strength and bioadhesion force was observed in the range of 35.33 – 56.33 gm and 3.47 -5.82 N. The highest adhesion force and highest strength of the mucoadhesive bond was observed with the formulation F_9, whereas showed F_1 showed least bioadhisive strength. It is evident from the above data, that the compacts containing Carbopol 934P & HPMC showed higher bioadhisive strength than compared to compacts containing Carbopol 934P & HPMC alone. The bioadhesive characters were found to be affected by the nature and proportions of the bioadhesive polymers used in the formulations. In all the formulations, as the polymer mixture concentration increased, the mucoadhesion was increased. The order of bioadhesion of polymers used in the preparation can be given as HPMC 4KM < Carbopol 934.

Table 1. Formulation of buccoadhesive compacts of lacidipine HCl(F_1- F_9)

Sl. No.	Ingredients	Formulations								
		F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9
Core layer										
1.	Lacidipine	5	5	5	5	5	5	5	5	5
2.	HPMC 4KM	0	15	30	-	-	-	-	-	-
3.	HPMC 15KM	-	-	-	0	15	30	-	-	-
4.	HPMC 100KM	-	-	-	-	-	-	0	15	30
5.	Carbopol 934P	30	15	0	30	15	0	30	15	0
6.	MCC	44	44	44	44	44	44	44	44	44
7.	Mannitol	25	25	25	25	25	25	25	25	25
8.	Lactose	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5
9.	Magnesium stearate	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Backing layer										
1.	Ethylcellulose	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5
2.	Colouring agent	1	1	1	1	1	1	1	1	1
3.	Magnesium stearate	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Table 2. Precompressional parameters compacts of lacidipine HCl.

Formulation code	Angle of repose* (°θ) ± SD	Carr's index* (%) ± SD	Hausner's ratio* (%) ± SD	Moisture content* (%) ± SD
F_1	29.67 ± 0.43	11.69 ± 0.22	1.13 ± 0.00	4.05 ± 0.02
F_2	26.86 ± 0.14	14.94 ± 1.40	1.18 ± 0.02	4.12 ± 0.02
F_3	28.70 ± 0.29	13.34 ± 0.31	1.15 ± 0.00	4.00 ± 0.00
F_4	29.82 ± 0.14	11.79 ± 3.16	1.13 ± 0.04	3.85 ± 0.02
F_5	29.54 ± 0.14	10.60 ± 0.37	1.12± 0.00	4.00 ± 0.00
F_6	29.97 ± 0.13	10.55 ± 2.82	1.12 ± 0.04	3.33 ± 0.03
F_7	29.54 ± 0.28	13.79 ± 1.78	1.16 ± 0.00	3.83 ± 0.02
F_8	29.96 ± 0.42	13.45 ± 1.32	1.16 ± 0.02	3.30 ± 0.00
F_9	29.81 ± 0.61	13.19 ± 0.20	1.15 ± 0.00	4.07 ± 0.02

*Average of 6 determinations, SD= Standard deviation

Table 3. Physical characteristics of lacidipine HCl compacts.

Formulation code	Weight variation* (mg) ± SD	Hardness$^{\#}$ (Kg/cm^2) ± SD	Thickness$^{\#}$ (mm) ± SD	Diameter$^{\#}$ (mm) ± SD	Friability^{x} (%)	Drug Content$^{¤}$ (%)* ± SD
F_1	199.30 ± 1.02	6.00 ± 0.00	3.50 ± 0.00	8.00 ±0.00	0.05	99.79 ± 0.08
F_2	199.65 ± 0.51	6.00 ± 0.31	3.54 ± 0.03	8.00 ±0.00	0.25	99.95 ± 0.08
F_3	199.9 ± 0.52	6.52 ±0.04	3.48± 0.02	8.00 ± 0.00	0.17	99.87 ± 0.11
F_4	200.00 ± 0.42	6.54 ± 0.03	3.50 ±0.00	8.00 ± 0.00	0.25	99.63 ± 0.11
F_5	199.65 ± 0.51	6.50 ± 0.02	3.56 ± 0.03	8.00 ± 0.00	0.25	99.71± 0.15
F_6	200.00 ± 0.57	6.50 ± 0.00	3.48 ±0.04	8.00 ± 0.00	0.28	99.55 ± 0.20
F_7	199.98 ± 0.55	6.54 ± 0.03	3.50 ±0.00	8.00 ± 0.00	0.13	99.31 ± 0.31
F_8	199.75 ± 0.00	6.52 ± 0.02	3.46 ±0.05	8.00 ± 0.00	0.18	99.58 ± 0.15
F_9	195.75 ± 0.72	6.46 ± 0.03	3.46 ±0.03	8.00 ±0.00	0.43	99.55 ± 0.20

Average of 20, 5$^{\#}$, 10^{x}, 3$^{¤}$ determinations, SD= Standard deviation

Table 4.Stability studies in human saliva of lacidipine HCl compacts (F_2)

Formulation code	Color*	Shape*	Thickness(mm)* ± SD	Swelling Index (%)* ± SD	Surface pH* ± SD
F_2	No change (Translucent & clear)	No change (Round)	3.5 ± 0.0	349.3 ± 0.63	6.8 ± 0.0

*Average of 6 determinations, SD= Standard deviation

Table 5. *In vivo* mucoadhesion profile of buccoadhesive compacts of lacidipine HCl

Formulation code	In-vivo mucoadhesion time* (min)
F_2	571.67 ± 1.57

*Average of 6 determinations, SD= Standard deviation

Table 6. Response of rabbits for lacidipine HCl compacts (F_2)

SL. No.	Criteria	Rabbits Response (%)
1.	Irritation	
	a. None	100
	b. Slight	-
	c. Moderate	-
	d. Severe	-
2.	Color	
	a. None	100
	b. Slight	-
	c. Moderate	-
	d. Severe	-
3.	Redness of buccal mucosa	
	a. None	100
	b. Slight	-
	c. Moderate	-
	d. Severe	-
4.	Dryness of mouth	
	a. None	100
	b. Slight	-
	c. Moderate	-
	d. Severe	-
5.	Salivation	
	a. None	100
	b. Slight	-
	c. Moderate	-
	d. Severe	-
6.	Dislodgement	
	a. No	100
	b. Yes	-

*Average of 6 determinations, SD= Standard deviation

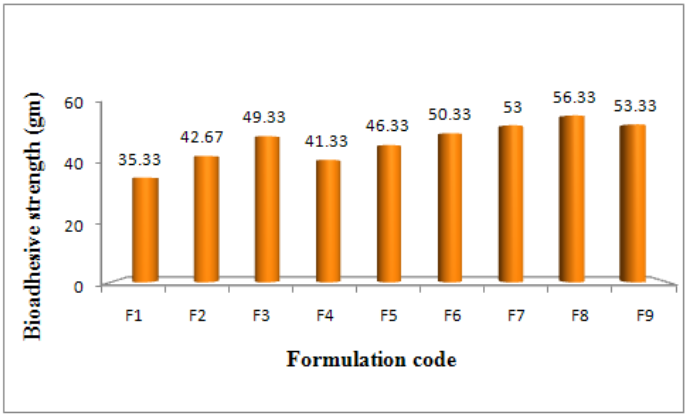

Fig 4. Bioadhision force of lacidipine HCl compacts (F_1-F_9)

Buccal tablets formulated with a mixture of Carbopol 934 and HPMC 100 KM showed comparatively higher bioadhesion than that of Carbopol 934P and HPMC K4M. Very strong mucoadhesion could damage the epithelial lining of the buccal mucosa. Bioadhesive strength exhibited by the formulation F2 tablets can be considered satisfactory for maintaining them in the oral cavity for 12hrs. However there is increase in the Bioadhisive strength was found, when the concentration of HPMC is increased.

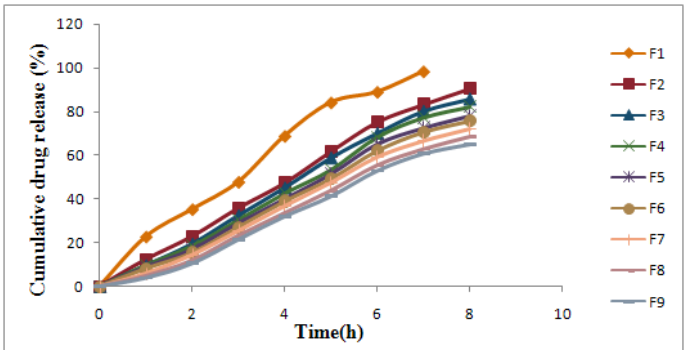

Fig. 5: Cumulative percentage of drug release profile of lacidipine HCl compacts (F_1-F_9)

***In vitro* release studies**

In vitro percentage drug release was found in the range of 64.78 – 98.53 % and results were shown in Fig 5. It has been revealed that the amount of polymer blend has the significant effect on the drug release profile. The drug release from the formulations decreased with increase in the amount of polymer

blend added in each formulation. The release of drug from polymer blend matrix takes place after complete swelling of the polymer blend and as the amount of polymer blend in the formulation increase the time required to swell also increase thereby decrease in the drug release.

It was concluded that formulation F2 was considered as optimized formulation based on the release rate data.

From the kinetic studies, it was observed that n value lies between 0.5 to 1.0. Hence all the formulations exhibiting a non-fickian release behavior controlled by a combination of both diffusion and chain relaxation mechanism. Results of kinetic data showed that the release rate from all formulations well fitted in square root 't' kinetics.

***Ex vivo* residence time**

The *Ex vivo* residence time was determined by using specially designed disintegration apparatus. The *Ex vivo* residence time was found in the range of 465.00 – 658.33 min and shown in Fig 6. Formulation F_9 showed higher residence time of 658.33 min compared to all formulations. As the concentration of HPMC increased, the residence time also increased. This examination reveals that the mucoadhesive capacity of polymers used in formulations. The results showed that the mixture of carbopol 934 and HPMC K4M containing group formulations showed better bioadhesion than carbopol 934P and HPMC alone. From the results it was concluded that F_2 formulations as best formulation because the compact was detached from buccal mucosa after 8 h.

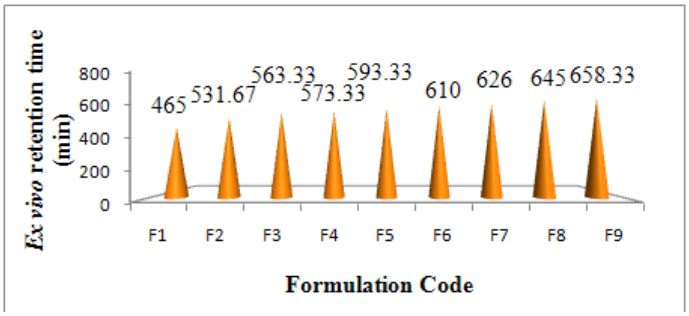

Fig. 6: *Ex vivo* retention time of lacidipine HCl compacts (F_1-F_9)

Stability studies in human saliva

The information obtained from stability studies performed in human saliva would be more accurate to mimic the stability of drug and device in the oral cavity in vivo. Hence, the formulation stability studies were performed only on the optimized formulation (F_2), and obtained data are presented in Table 4. The compacts did not exhibit change in color or shape, suggesting the satisfactory stability of the drug and device in the human saliva. In theory, if the drug is instable in human saliva, its color would change. Physical properties of the compacts such as thickness and diameter increased slightly owing to swelling of the system in human saliva. But compacts did not collapse in the artificial saliva until the end of the study, confirming the sufficient strength of the compacts. It was observed that there is no significant change in the pH.

***In vitro* permeation studies**

The release rate of optimized formulation (F_2) was found after 8 hours was 88.00 ± 0.17. It the results were showed that there is no much significant change in the release rate.

***In vivo* mucoadhesion study**

The results were summarized in Table 5 and Table 6. The *in vivo* mucoadhesion studies was carried out only for optimized formulation (F_2) by using six rabbits and showed mucoadhesion time of 571.67 min**.**

From the studies there is no changes in color, irritancy, redness, concentration of saliva and dryness of mouth were observed and it was concluded that there was no change in

Stability studies

From the stability studies, it was revealed that there are no significance changes in drug content, bioadhesive strength and *in vitro* release studies

***In vivo* mucoadhesion study**

The results were summarized in Table 5 and Table 6. The *in vivo* mucoadhesion time was determined by using rabbits of Formulation F_9 showed 9 h 20 min**.** It was revealed that there are no changes in color, irritancy, redness and dryness of mouth was found in rabbits. It was found that there are no changes in the concentration of salivation.

Conclusion:

It can be concluded that the designed compacts of lacidipine HCl can overcome the disadvantage of poor and erratic oral bioavailability of lacidipine HCl with currently marketed formulations. The compacts has potential to be an effective sustained release system over a long period of time for the lacidipine HCl. The type and each polymer in polymer blend used and type of diluents are fundamental factors that can affect the drug release and also the physicochemical properties of compacts. This increased and predictable availability of lacidipine HCl from designed formulations may result in substantial dose reduction, bypass the extensive hepatic first-pass metabolism and to improve the bioavailability of enalpril maleate through buccal mucosa.

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