World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Design and characterization of fast dissolving buccal film of imipramine HCL

Rajani B K *, P. Ashok kumar and Suresh V Kulkarni

Sree Siddaganga College of Pharmacy, B.H. Road, Tumkur-572102, Karnataka, India.

World Journal of Advanced Research and Reviews, 2022, 16(02), 258–270

Publication history: Received on 11 September 2022; revised on 17 October 2022; accepted on 20 October 2022

Article DOI: https://doi.org/10.30574/wjarr.2022.16.2.1044

Abstract

In depressed individuals, Imipramine exerts a positive effect on mood. TCAs are potent inhibitors of serotonin and norepinephrine reuptake. Imipramine hydrochloride having variable bioavailability i.e. ranging from 29-77% due to first pass metabolism, peak plasma concentration is usually attained 2-6 hours. Absorption is unaffected by food. It is freely soluble in water. The objective of this research work is to improve the bioavailability of the drug and fast the onset of action to decrease the depressant activity. The Buccal bioavailability of Imipramine HCL is only 29-77% for this reason drug can be administered into Buccal mucosa using mucoadhesive film. It can be made fast drug release and directly enter into blood circulation through Buccal mucosa and increase the drug bioavailability. Fast dissolving Buccal films were prepared by solvent casting method using various polymers like hydroxyl propyl methyl cellulose E15, PVP, PVA and sodium saccharin, plasticizer and vanillin as flavouring agent. Dissolution profile as studied in USP dissolution apparatus type 1 using pH 6.8 simulated saliva. The influence of variable like polymer type and concentration on Imipramine HCL release profile was studied. The formulation was optimized on the basis of various evaluation parameters like drug content and in vitro drug release. Formulation F3 successfully fast the release of drug within 8 minutes. The IR Spectra revealed the absence of interaction between drug and selected polymer, results of stability studies were as per ICH guide lines and results indicated that the selected formulation was stable.

Keywords: Imipramine HCL; HPMC E 15; PVP; PVA; Citric acid; Solvent casting method

1. Introduction

Orally fast-dissolving film is new drug delivery system forth oral delivery of the drugs. It was developed on the basis of technology of the transdermal patch. The delivery system consists of a very thin oral strip, which is simply placed on the patient's tongue or any oral mucosal tissue, instantly wet by saliva the film rapidly hydrates adheres onto the site of application. It then rapidly disintegrates and dissolves to release the medication for oral mucosal.[1]

These are solid dosage forms, which disintegrate or dissolve within 1 minute when placed in the mouth without drinking water. This technology has been used for local action, rapid release products. The oral films are formulated using polymers, plasticizer, flavors, colors and sweeteners. This review describes about the formulation methodology, evaluation parameters and the future aspects of fast dissolving films.[2]

Fast dissolving drug delivery systems were first developed in the late 1970s as an alternative to tablets, capsules, and syrups for pediatric and geriatric patients who experience difficulties in swallowing. The novel technology of oral fast-dispersing dosage forms is known as fast dissolve, rapid dissolve, rapid melt and quick disintegrating tablets. However, the function and concept of all these dosage forms are similar. These dosage forms possess certain specific advantages like no need of water for disintegration, accurate dosing, rapid onset of action, ease of handling, ease of transportability, pleasant taste and improved patient compliance.[3]

* Corresponding author: Rajani B K
Sree Siddaganga College of Pharmacy, B.H. Road, Tumkur-572102, Karnataka, India.

Buccal fast dissolving films which allow a rapidly dissolving drug to absorb directly into systemic circulation through the buccal mucosa. These kinds of dosage forms are also convenient for children, elderly patients, with swallowing difficulties and in the absence of potable liquids. Rapid dissolution and absorption of drugs which may produce rapid onset of action. Increased bioavailability particulars in case of insoluble and hydrophobic drugs due to rapid dissolution. Different film forming materials, film modifiers and polyhydric alcohols were assessed for enhancing the synthesis of quick dissolving films.[4]

Depression is a state of low mood and aversion to activity that can have a negative effect on a person's thoughts, behavior, feelings, world view and physical well-being. Depressed people may feel sad, anxious, empty, hopeless, worried, helpless, worthless, guilty, irritable, hurt or restless. They may lose interest in activities that once were pleasurable, experience loss of appetite or overeating have problems concentrating remembering details or making decisions and may contemplate or attempt suicide. Insomnia, excessive sleeping, fatigue, loss of energy, or aches, pains or digestive problems that are resistant to treatment may also be present.[5]

Antidepressants are medications that can help relieve symptoms of depression, social anxiety disorder, seasonal affective disorder, and dysthymia, or mild chronic depression, as well as other conditions. They aim to correct chemical imbalances of neurotransmitters in the brain that are believed to be responsible for changes in mood and behavior. Imipramine, the prototypical tricyclic antidepressant (TCA), is a dibenzazepine-derivative TCA. TCAs are structurally similar to phenothiazines. They contain a tricyclic ring system with an alkyl amine substituent on the central ring. In non-depressed individuals, imipramine does not affect mood or arousal, but may cause sedation. In depressed individuals, imipramine exerts a positive effect on mood. It binds the sodium-dependent serotonin transporter and sodium-dependent norepinephrine transporter reducing the reuptake of norepinephrine and serotonin by neurons. Depression has been linked to a lack of stimulation of the post-synaptic neuron by norepinephrine and serotonin.[6]

Imipramine is a tricyclic antidepressant with general pharmacological properties similar to those of structurally related tricyclic antidepressant drugs such as amitriptyline and doxepin. A tertiary amine, imipramine inhibits the reuptake of serotonin more so than most secondary amine tricyclic, meaning that it blocks the reuptake of neurotransmitters serotonin and noradrenaline almost equally.

Imipramine hydrochloride having variable bioavailability i.e. ranging from 29-77% due to first pass metabolism, peak plasma concentration is usually attained 2-6 hours. Absorption is unaffected by food. It is freely soluble in water.[7]

2. Material and methods

2.1. Material

Imipramine HCL Hydroxypropyl methyl cellulose (HPMCE15), Polyvinyl alcohol (PVA), Polyvinyl pyrrolidone (PVP) used as polymer From Yarrow chemicals Mumbai. propylene glycol used as plasticizer. Citric acid used as a saliva stimulating agent. Sodium saccharine as sweetening agent and vanillin used as a flavoring agent from SD Fine chem Limited. All the reagents were analytical grade.

2.2. Methods

The Strips are preferably formulated using the solvent casting method. The required quantity of polymer was added in small quantities and mixed well to dissolve in distilled water. Small quantity of drug is dissolved in the above solution. Add plasticizers to the above solution and mixed well. Solution was then casted on Petri dish and kept in hot air oven for drying at 40 ℃. After drying Strips were removed with the help of sharp blade and kept in desiccator for 24 hrs. Then cut into pieces of the desired shape and size.

2.3. Standard curve of Imipramine HCL

From the Imipramine HCL standard stock solution (100 µg/ml), appropriate aliquots were taken into different volumetric flasks and made up to 10 ml with simulated saliva solution (pH 6.8), so as to get drug concentrations of 5 to 30 µg/ml. The absorbencies of these drug solutions were estimated at λ max 251 nm by using Shimadzu UV/visible Spectrophotometer against simulated saliva pH 6.8 as blank. This procedure was performed in triplicate to validate the calibration curve. The Standard calibration curve Yields a straight line,

2.4. Drugs-polymer interaction study by FT-IR spectrophotometer

An FT-IR spectroscopy study has been carried out separately to check the compatibility between the drug (Imipramine HCL) and the polymers (HPMC E15, PVP , PVA) used for the preparation of Drug and polymers.

2.5. Formulation of fast dissolving Oral Strips

From the preliminary physical observation of the strips prepared the best compositions were used for the incorporation of Imipramine HCL. Solvent casting Imipramine HCL is dissolved, then polymers are added (PVA, PVP, and HPMC E15), propylene glycol (plasticizer) was added and stirred to form a homogeneous solution. Finally Citric acid and Sodium saccharin vanillin are added and stirred to form a homogeneous mixture. The solution was casted in a mould 6×8 cm (length and width).Then kept in hot air oven at 60 ºC for 24 hours. The film thus formed was cut into size of 2×2 cm square strips. The prepared square thin orals strips were packed using single pouches, blister card with multiple units, multiple-unit dispenser, and continues roll dispenser aluminum pouch and stored in desiccator.

Table 1 Composition of different formulation of Imipramine HCL fast dissolving oral strips

Formulation	Polymer and its composition (mg)				Plasticizer (mL) Glycol	Citric acid(mg)	Sodium saccharin (mg)	Vanillin (mg)	D. water (mL)
	IM	HPMC E15	PVPK30	PVA					
F1	10	350			0.1	60	2	2	10
F2	10	400			0.1	60	2	2	10
F3	10	450			0.1	60	2	2	10
F4	10		200		0.1	60	2	2	10
F5	10		250		0.1	60	2	2	10
F6	10		300		0.1	60	2	2	10
F7	10			200	0.1	60	2	2	10
F8	10			250	0.1	60	2	2	10
F9	10			300	0.1	60	2	2	10

2.6. Evaluation of Imipramine HCL fast dissolving oral strips

2.6.1. Physical appearance and surface texture of Strips

This parameter was checked simply with visual inspection of strips and evaluation of texture by feel or touch.

2.6.2. Weight uniformity of Strips

Three Strips of the size 2×2 cm were weighed individually using digital balance and the average weights were calculated.

2.6.3. Thickness of Strips

Thickness of the strips was measured using screw gauge with a least count of 0.01mm at different spots of the strips. The thickness was measured at three different spots of the strips and average was taken.

2.6.4. Folding endurance of Strips

The flexibility of strips can be measured quantitatively in terms of what is known as folding endurance. Folding endurance of the strips was determined by repeatedly folding a small strip of the strips (approximately 2x2 cm) at the same place till it broke. The number of times strips could be folded at the same place, without breaking gives the value of folding endurance.

2.6.5. Drug content uniformity of strips

The strips were tested for drug content uniformity by UV Spectrophotometric method. Strips of 2×2 cm size were cut from three different places from the casted strips. Each film was placed in 100 mL volumetric flask and dissolved in simulated saliva pH 6.8 and 2 mL is taken and diluted with water up to 10 ml. The absorbance of the solution was

measured at λ max 251 nm using UV/ visible spectrophotometer (Shimadzu, japan). The percentage drug content was determined.

2.6.6. In vitro drug release

The release rate of Imipramine HCL fast dissolving oral strips was determined by using the 250 mL beaker placed on magnetic stirrer and adds magnetic beads into the beaker. The RPM of the magnetic bead was maintained at 50 RPM. The film with 2×2 cm was placed in the 100 mL of 6.8 pH simulated saliva as dissolution medium, and temperature was maintained at 37 °C. From this dissolution medium, 2 mL of the sample solution was withdrawn at different time intervals. The samples were filtered through Whatman filter paper and absorbance was determined 251nm using double beam UV- Visible spectrophotometer.

2.6.7. Permeation study

The prepared fast dissolving Buccal strips are placed in the Franz diffusion cell on the upper membrane of the (donor compartment) and the receptor compartment contain a simulated saliva (10 ml) it can be contact with the permeation membrane washed and soaked with phosphate buffer 6.8 upper side of the donor compartment contain a film attach the film of length and width (2×2) cm it contains 1 mg of drug. And the receptor compartment it contain a simulated saliva and magnetic bead and this diffusion compartment placed in the magnetic stirrer the drug permeation start through the dialysis membrane and enter in to the receptor compartment the drug to be enter in the receptor compartment and this solution taken 2 ml every 5 minutes up to 45 minutes and maintain the sink condition by replace the 2ml of simulated saliva in to the receptor Compartment and this every interval taken samples analysed by (Shimadzu) UV-visible spectrophotometer.

2.6.8. Stability studies

The purpose of stability testing is to provide evidence on how the quality of a drug substance or drug product varies with time under the influence of a variety of environmental factors. To assess the drug and formulation stability, stability studies were done as per ICH guidelines. The formulated fast dissolving oral strips were wrapped in aluminium foil and stored at 45 ± 0.5 ºC for period of twelve weeks. After the periods of three-month strips were tested for appearance, drug content and *in vitro* drug release.

2.7. Determination of λ max of Imipramine HCL using simulated saliva buffer pH 6.8

Accurately weighed quantity of 100 mg of Imipramine HCL was taken in 100 ml volumetric flask a made up to 100 ml using phosphate buffer of pH 6.8

Scanning*:* Drug solution of Imipramine HCL in pH 6.8 was scanned using UV spectrophotometer between the ranges of 200 – 400nm. The lambda max of Imipramine HCL was found to be 251nm.

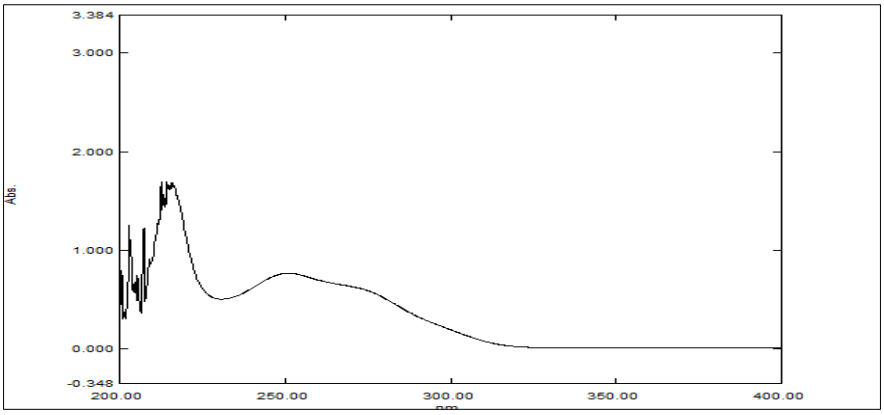

Figure 1 Determination of λ max of Imipramine HCL using simulated saliva buffer pH 6.8

2.7.1. Calibration curve of Imipramine HCL in simulated saliva pH 6.8

Imipramine in simulated saliva pH 6.8 showed good linearity (R^2 =0.9997) as the concentration range 5-30 µg/mL at λ max 251 nm with slope =0.0328

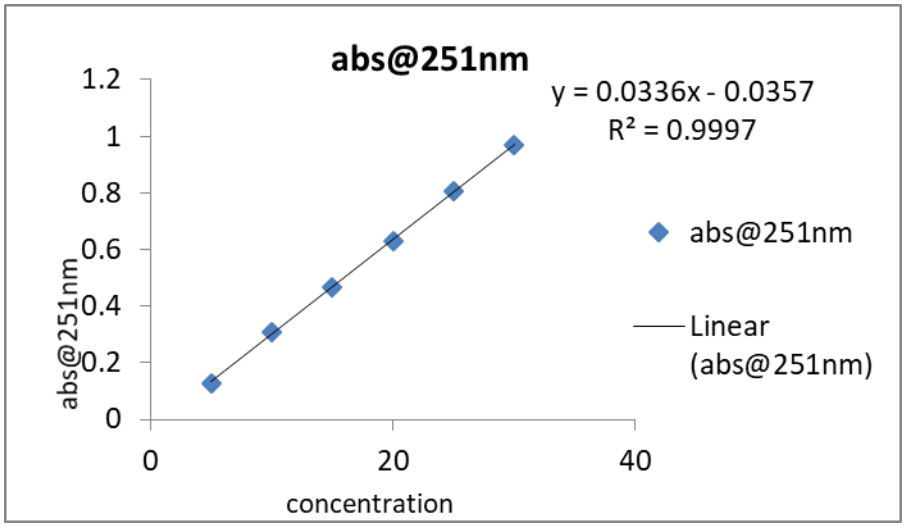

Figure 2 The Standard graph of Imipramine HCL using simulated salivary buffer of pH 6.8

3. Results and discussion

3.1. Drugs-polymer interaction study by FT-IR spectrophotometer

An FT-IR spectroscopy study has been carried out separately to check the compatibility between the drug (Imipramine HCL) and the polymers (HPMC E15, PVP , PVA) used for the preparation of Drug and polymers. The FT-IR was performed for drug, polymers, and physical mixture of drug and polymers. The spectra obtained from FT-IR spectroscopy study at wave number from 4000 to 500 cm^{-1} are shown below.

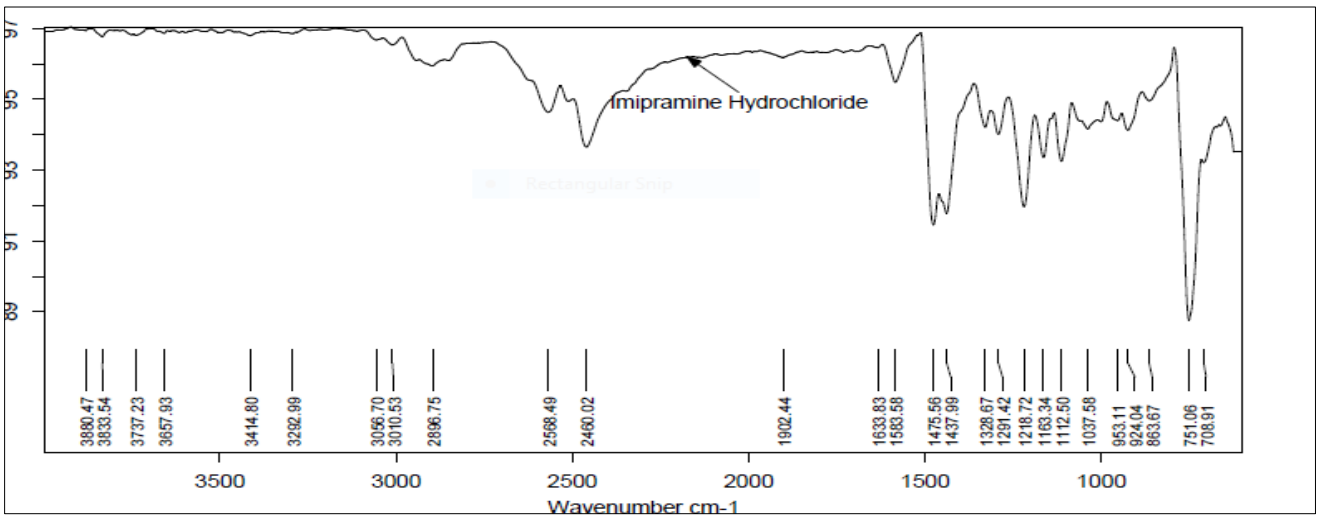

Figure 3 The FTIR Spectrum of pure Imipramine HCL

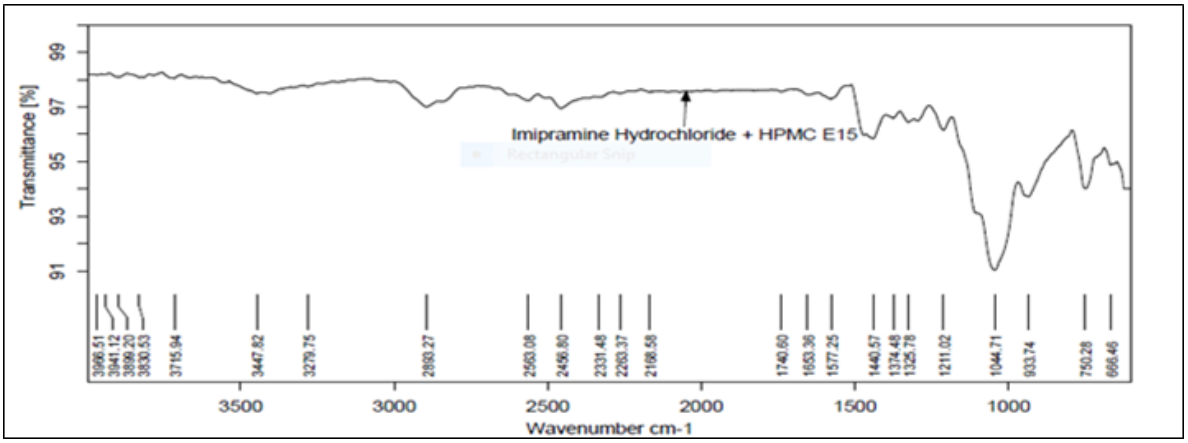

Figure 4 The FTIR spectrum of Imipramine HCL+HPMC E15

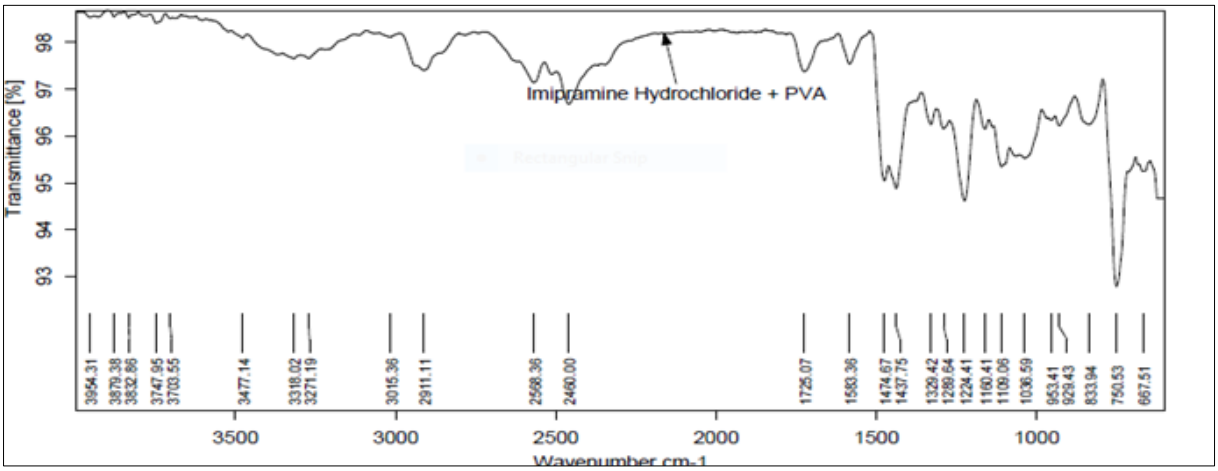

Figure 5 The FTIR Spectrum of Imipramine HCL +PVA

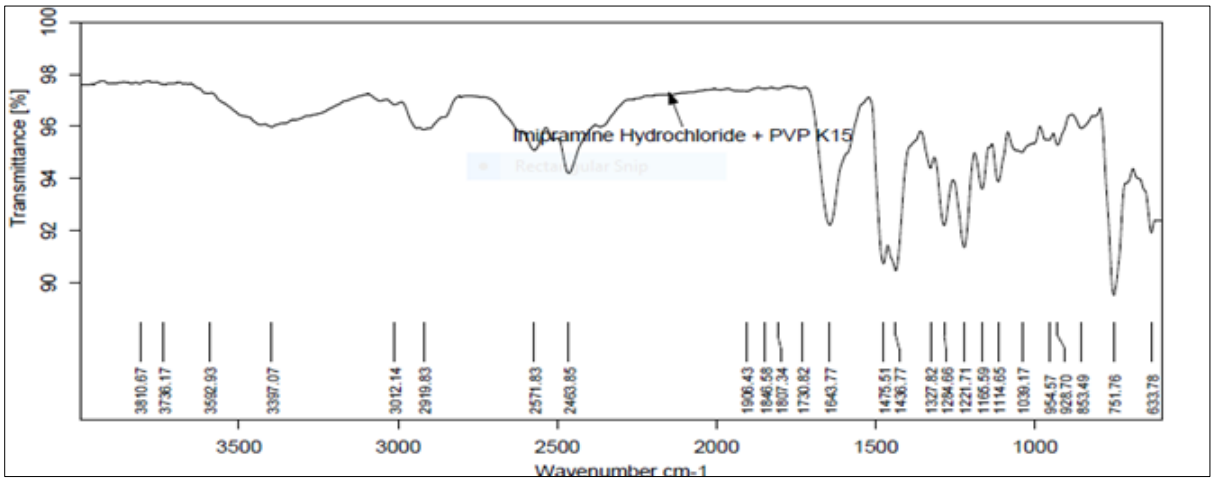

Figure 6 The FTIR Spectrum of Imipramine HCL+PVP

Table 2 Interpretation of FTIR Spectrum of above figures

SI.NO	Name of the Compound	Wave number (cm^{-1})	Functional group
1	IMIPRAMINE HCL	3396.03 2909.09 2666.11 1593.88 1487.81	CH stretch (ar) C-H stretch C-O stretch (ali) C-N stretch C= C stretch C-O stretch
2	IM: HPMC E15 (1:1)	3396.03 2909.09 2666.11 1593.88 1487.81	CH stretch (ar) C-H stretch C-O stretch (ali) C-N stretch C= C stretch C-O stretch
3	IM: PVP K30 (1:1)	3396.03 2909.09 2666.11 1593.88 1487.81	CH stretch (ar) C-H stretch C-O stretch (ali) C-N stretch C= C stretch C-O stretch
4	IM: PVA (1:1)	3396.03 2909.09 2666.11 1593.88 1487.81	CH stretch (ar) C-H stretch C-O stretch (ali) C-N stretch C= C stretch C-O stretch

Table 3 Weight uniformity of various Imipramine HCL fast dissolving oral Strips

Formulation code	Weight of Strips (mg)			Average weight (mg)±SD
	I	II	III	
F1	42.51	44.5	45.09	44.00±2.033
F2	45.50	46.5	44.08	45.33±1.366
F3	50.25	48.5	49.5	49.44±1.362
F4	47.50	46.5	47.2	46.40±1.153
F5	49.21	53.0	52.1	52.36±1.484
F6	52.21	50.0	51.18	51.36±1.484
F7	43.50	41.0	42.16	42.20±0.818
F8	48.00	46.1	45.1	46.06±1.050
F9	51.80	48.2	49.85	49.80±1.802

All the absorption peaks of Imipramine HCL were retained in the physical mixtures of Imipramine HCL with various excipients. The spectra of physical mixture did not show the shift of vibration bands of Imipramine HCL. It indicated that there was no any chemical interaction between the drug and excipients.

3.2. Results of Thickness uniformity

Table 4 Thickness uniformity of various Imipramine HCL fast dissolving oral Strips

Formulation code	Thickness of strips (mm)			Average thickness (mm)±SD
	I	II	III	
F1	0.12	0.14	0.16	0.15±0.020
F2	0.17	0.19	0.20	0.18±0.005
F3	0.23	0.19	0.18	0.18±0.062
F4	0.13	0.15	0.18	0.15±0.025
F5	0.22	0.22	0.25	0.23±0.017
F6	0.23	0.24	0.28	0.26±0.017
F7	0.22	0.24	0.21	0.22±0.015
F8	0.23	0.20	0.21	0.21±0.016
F9	0.21	0.22	0.21	0.21±0.015

Table 5 Folding endurance of various Imipramine HCL fast dissolving oral strips

Formulation code	Folding endurance of strips			Average Folding endurance (mm)±SD
	I	II	III	
F1	345	343	344	344.00±1.52
F2	346	346	348	346.66±1.52
F3	350	352	351	351.00±1.03
F4	315	314	308	312.33±1.15
F5	351	357	351	353.00±1.52
F6	354	357	355	355.00±1.52
F7	310	310	312	310.66±1.15
F8	315	318	320	317.66±2.51
F9	322	323	320	321.66±2.31

Table 6 Disintegration study of various Imipramine HCL fast dissolving oral strips

Formulations code	Disintegration time (sec)			Average disintegration time(sec)±SD
	I	II	III	
F1	37	37	36	36.0±1.15
F2	41	44	44	42.0±1.15
F3	45	47	46	46.0±1.00
F4	39	32	34	35.0±1.00
F5	48	50	50	49.3±1.15
F6	58	52	54	54.3±1.15
F7	38	33	34	35.0±1.00
F8	48	50	48	48.6±1.15
F9	50	52	50	50.6±1.15

Table 7 Drug content uniformity of various Imipramine HCL fast dissolving Oral Strips

Formulation Code	% Drug Content
F1	95.7±0.24
F2	96±0.15
F3	98±0.26
F4	95±0.12
F5	98±0.17
F6	96±0.22
F7	91±0.18
F8	97±0.34
F9	91±0.25

Table 8 *In -vitro* release data of various Imipramine HCL fast dissolving Oral Strips

Time (min)	Cumulative % Drug release				
	F1	F2	F3	F4	F5
2	33.10	22.50	20.80	36.03	32.22
4	46.25	35.40	33.01	49.21	49.18
6	54.44	52.8	79.54	57.78	57.59
8	81.67	85.40	96.92	60.49	69.25
10	85.06	90.10	-	77.98	78.68
12	91.66	94.85	-	85.45	83.94
14	-	-	-	88.43	86.52
16	-	-	-	-	-
18	-	-	-	-	-
20	-	-	-	-	-

3.3. Results of *In -vitro* drug release study (F6-F9)

Table 9 *In- vitro* release data of various Imipramine HCL fast dissolving oral Strips

Time (min)	% Cumulative drug release			
	F6	F7	F8	F9
2	43.30	22.35	23.86	12.64
4	47.50	32.46	30.45	20.01
6	54.00	41.47	40.82	27.64
8	66.60	49.57	49.92	36.16
10	68.35	55.24	53.48	45.54
12	77.96	62.36	60.04	53.30
14	82.00	65.50	67.25	59.52
16	-	71.58	74.34	65.43
18	-	75.01	80.52	68.18
20	-	81.65	81.35	72.36

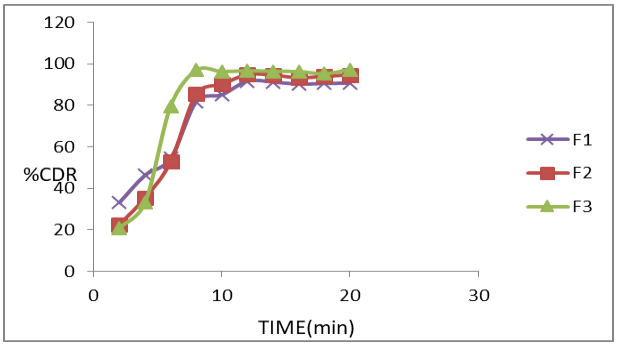

Figure 7 *In-vitro* drug release profile of formulations F1-F3

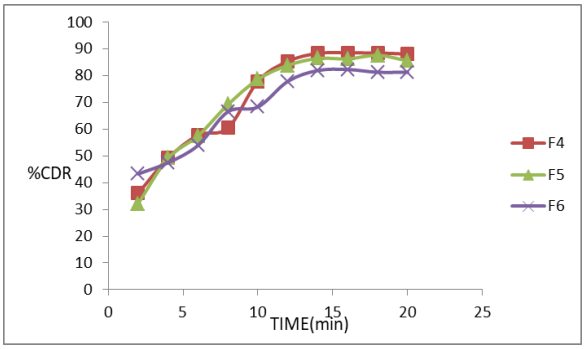

Figure 8 *In-vitro* drug release profile of formulations F4-F6

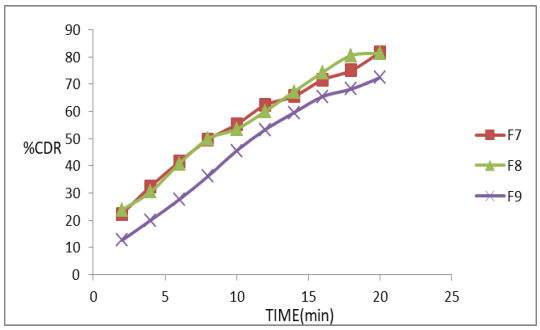

Figure 9 *In-vitro* drug release profile of formulations F7-F9

3.4. Results of drug permeation study (F1-F9)

Table 10 Drug permeation study data of various Imipramine HCL fast dissolving Oral Strips

Time (min)	Permeation study				
	F1	F2	F3	F4	F5
5	42.45	35.4	40.82	37.6	42.69
10	48.04	40.16	46.52	44.52	50.16
15	52.56	50.36	54.25	49.37	62.04
20	59.21	59.6.6	61.30	56.25	74.86
25	64.58	63.52	62.64	66.67	88.62
30	72.63	69.35	74.12	72.28	93.26
35	80.37	75.93	79.24	83.04	-
40	-	81.71	83.63	86.48	-
45	-	-	-	89.34	-

Table 11 Drug permeation study data of various Imipramine HCL fast dissolving oral Strips

Time (min)	Permeation study			
	F6	F7	F8	F9
5	26.65	35.92	39.48	31.8
10	44.16	45.72	45.93	45.98
15	65.08	53.85	53.88	58.04
20	78.85	60.74	61.92	65.16
25	85.6	65.74	69.08	69.54
30	90.23	72.15	75.10	81.82
35	-	85.62	83.24	84.79
40	-	89.02	85.25	85.78
45	-	-		87.26

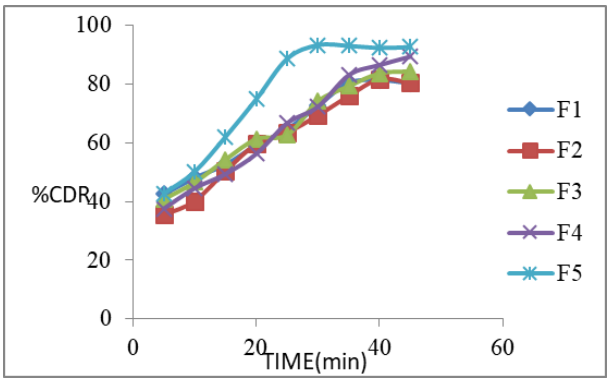

Figure 10 *In-vitro* permeation profiles of F1-F5

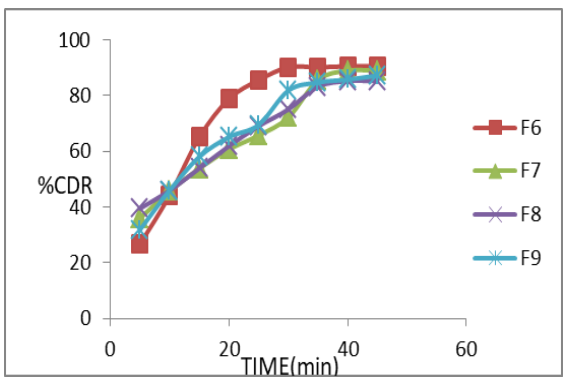

Figure 11 *In-vitro* permeation profiles of F1-F5

3.5. Stability studies:

Finally based on the thickness uniformity, weight uniformity, drug content uniformity, disintegration study, permeation study and in vitro drug release study confirmed that F3 was the best formulation. For this strips drug content uniformity and stability studies were carried out.

The formulated Strips F3 were stored at 40 ± 0.5 ºC in hot air oven, over period of three month. At the end of three month strips were tested for drug content and *in-vitro* release profiles. Stability studies were conducted as per ICH guidelines. Samples were taken at 30days intervals for drug content and *in-vitro* release estimation. The drug content and *in-vitro* release results were suggesting that there was no significant change in drug content and *in-vitro* drug release.

Table 12 Drug content data of stability study of formulation F3

SL.NO	Trial no.	1st day	After 4 weeks	After 8weeks	After 12 weeks
1	I	95.59	95.87	95.64	95.86
2	II	95.81	95.70	95.67	95.72
3	III	95.84	95.84	95.82	95.83
4	Mean	95.84±0.35	95.80±0.48	95.71±0.48	95.78±0.23

Table 13 Drug content data of stability study of formulation F3

SL.NO	Trial no.	1st day	After 4 weeks	After 8weeks	After 12 weeks
1	I	95.59	95.87	95.64	95.86
2	II	95.81	95.70	95.67	95.72
3	III	95.84	95.84	95.82	95.83
4	Mean	95.84±0.35	95.80±0.48	95.71±0.48	95.78±0.23

4. Conclusion

From the present research work that is “Formulation and evaluation of Imipramine HCL fast dissolving oral Strips” for Anti-depressant the following point were concluded

- In the Beginning Blank polymeric strips were prepared by solvent casting technique using HPMC E15, PVP, PVA, the concentration of polymer was varied and the best formulations were chosen for incorporating the drug.
- The prepared strips were evaluated for following parameters like physical appearance and surface texture, weight uniformity, thickness of strips, folding endurance and drug content uniformity, disintegration, permeation study, drug excipients interaction studies, *in vitro* drug release and short-term stability studies.
- All the formulation showed acceptable quality control property formulation F3 having polymer concentration HPMC E15 gave better drug release rate over period of 8 minutes thus formulation F3 was found to be the most promising formulation on the basis of acceptable evaluation property and the *In-vitro* drug release rate of 96.92%. Based on the FTIR studies appear to be no possibility of interaction between the Imipramine HCL and polymers of other excipients used in the strips.
- Stability studies were conducted for the optimized formulation as per ICH guidelines for a period of 90 days which revealed that the formulation was stable. The result suggests that the developed fast release strips of Imipramine HCL could perform the better than conventional dosage form leading to improved efficacy and better patient compliance.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

References

[1] Bhyan B, Jangra S, Kaur M, Singh H. Orally fast dissolving films: innovations in formulation and technology. Int J Pharm Sci Rev Res 2011; 9(2): 9-15.

[2] Mandeep K, Rana AC, Nimrata S. Fast Dissolving Films: An Innovative Drug Delivery System. Int. J. Pharm. Res. & Allied Sci 2013; 2(1); 14-27.

[3] Ravneet K, Rajni B. Formulation and evaluation of Ivabradine hydrochloride fast dissolving film. J Pharm Res 2012; 5 (6): 3327-30.

[4] Dinge A, Nagarsenker M. Formulation and evaluation of fast dissolving films for delivery of triclosan to the oral cavity. Aaps Pharmscitech 2008; 9(2): 349-56.

[5] Ketul P, Patel K, Patel M, Patel N. Fast dissolving films: a novel approach to oral drug delivery. Int J Pharm Pract 2013; 4(2): 655-61.

[6] Tomar A, Sharma K, Chauhan NS, Mittal A, Bajaj U. Formulation and evaluation of fast dissolving oral film of dicyclomine as potential route of buccal delivery. Int. J. Drug Dev. Res 2012; 4(2) : 408-17.

[7] Kunte S, Tandale P. Fast dissolving strips: A novel approach for the delivery of Verapamil. J Pharm Bioallied Sci 2010; 2(4): 325-8.

[8] Available from : https://go.drugbank.com/drugs/DB00458

[9] Pokale P, Khade P, Bhosale A. Design, Development and Evaluation of Fast Dissolving Buccal Film of Norethisterone Int. J. Curr. Pharm. Res 2019; 9(4): 3365-77.

[10] Maheswari KM, Devineni PK, Deekonda S, Shaik S, Uppala NP, Nalluri BN. Development and evaluation of mouth dissolving films of amlodipine besylate for enhanced therapeutic efficacy. J Pharm 2014; 2014: 1-8.

[11] Joshi P, Patel H, Patel V, Panchal R. Formulation development and evaluation of mouth dissolving film of domperidone. J Pharm Bioallied Sci 2012; 4(1): S108-9.

[12] Pooja RD, Sayyad FJ. Design, development and evaluation of Oxcarbazepine loaded fast dissolving oral film. Int J Drug Dev Res 2018; 10(3): 7-19.

[13] Deepthi A, Reddy BV, Navaneetha K. Formulation and evaluation of fast dissolving oral films of zolmitriptan. Am. J. Adv. Drug Deliv 2014; (2): 153-63.

[14] Bhikshapathi DV, Madhuri VD, Rajesham VV, Suthakaran R. Preparation and evaluation of fast dissolving oral film containing naratriptan Hcl. Am J Pharm Tech Res 2014; 4(2) : 799-812.

[15] Aditya D, Mangal N. Formulation and evaluation of fast dissolving films for the delivery of Triclosan to the oral cavity. AAPS Pharm Sci Tech 2008; 9(2): 349-56.