FORMULATION AND EVALUATION OF SUGAR-FREE ORAL DISSOLVING FILMS OF TENELIGLIPTIN HBR FOR DIABETIC PATIENTS

Sakshi Londhe [1*], Rutuja Khote [1], Ashwini Kamble [2].
[1]B Pharm. Student, Shri Ganpati Institute of Pharmaceutical Sciences and Research, Tembhurni, 413211.
[2]Assistant Professor, Shri Ganpati Institute of Pharmaceutical Sciences and Research, Tembhurni, 413211.

Abstract : Diabetes mellitus is a chronic metabolic disorder requiring long-term pharmacotherapy and strict adherence to medication. Oral dissolving films (ODFs) have emerged as a promising dosage form due to their convenience, rapid disintegration, and ease of administration. The present study aimed to formulate and evaluate sugar-free oral dissolving films containing Teneligliptin hydrobromide for diabetic patients. Films were prepared by the solvent-casting technique using polyvinyl alcohol (PVA) and starch as film-forming polymers, glycerin as a plasticizer, sodium starch glycolate as a disintegrating agent, stevia as a natural sugar-free sweetener, citric acid as a saliva-stimulating agent, peppermint flavour as a taste-masking component, and turmeric as a natural colouring agent. The prepared films were assessed for physical appearance, thickness, folding endurance, surface pH, drug content uniformity, disintegration time. The optimized formulation showed satisfactory mechanical strength, uniform drug distribution, acceptable surface pH, rapid disintegration, and efficient drug release. More drug was released within a short period, indicating the suitability of the developed system for rapid drug delivery. The study demonstrates that sugar-free Teneligliptin ODFs may serve as a patient-friendly alternative to conventional tablets for diabetic individuals.

IndexTerms - Teneligliptin hydrobromide, oral dissolving film, diabetes mellitus, sugar-free formulation, stevia, solvent casting.

Introduction[12456]

Diabetes mellitus is one of the most prevalent chronic diseases worldwide and is characterized by persistent hyperglycaemia resulting from impaired insulin secretion, insulin resistance, or both. The increasing incidence of type 2 diabetes has created a demand for dosage forms that enhance treatment adherence and patient comfort.

Teneligliptin hydrobromide is a dipeptidyl peptidase-4 inhibitor widely prescribed for the management of type 2 diabetes mellitus. It improves glycaemic control by increasing endogenous incretin activity, thereby enhancing insulin secretion and reducing glucagon release.

Although tablets remain the most common dosage form for Teneligliptin administration, some patients experience difficulty swallowing conventional oral medications. Oral dissolving films represent an advanced drug delivery platform designed to rapidly hydrate and dissolve upon contact with saliva. Such films offer advantages including ease of administration without water, accurate dosing, improved patient acceptance, portability, and rapid onset of drug release.

Oral dissolving films are thin polymeric films that rapidly dissolve when placed on the tongue without the need for water. These dosage forms are particularly useful for pediatric, geriatric, bedridden, and dysphagic patients.

- **Types of Diabetes Mellitus:**

1. Type-1 Diabetes Mellitus.
2. Type-2 Diabetes Mellitus.

1. Type-1 DM:

Type-1 DM is Characterized by autoimmune destruction of pancreatic beta cells leading to insulin deficiency.

Requires insulin therapy.

2. **Type-2 DM:**

Type-2 DM is Characterized by insulin resistance and relative insulin deficiency. It is the most prevalent form of diabetes.

DRUG PROFILE[45]

Name: Teneligliptin Hydrobromide

Category: Antidiabetic agent

Class: DPP-4 inhibitor

Mechanism of Action:

Teneligliptin inhibits the DPP-4 enzyme responsible for degradation of incretin hormones. Increased incretin levels stimulate insulin release and suppress glucagon secretion, leading to improved glycaemic control.

Dose: 20 mg

Solubility: Freely soluble in water

Materials and Methods[6]

Materials: optimized formula for 1 film

Sr.No.	Ingredients	Quantity	Roles
1.	Teneligliptin HBr	20mg	Anti-diabetic agent
2.	PVA	58.3mg	Film forming polymer
3.	Starch	12.5mg	Natural supporting polymer
4.	Glycerin	0.5ml	Plasticizer
5.	Stevia	4.1mg	Natural sweetener
6.	Sodium Starch Glycolate	2.5mg	Super-disintegrant
7.	Citric Acid	1mg	Saliva stimulating agent
8.	Peppermint Flavour	q.s	Flavouring agent
9.	Turmeric colour	q.s	Colouring agent
10.	Distilled water	q.s	vehicle

Table-1: Materials used

Method of preparation[6]

The oral dissolving films were prepared using the solvent-casting method.

Procedure:

1. **Step-I : Preparation of polymer solution:**

Weigh the given quantity of the PVA(Polyvinyl Alcohol). Take 10-15 ml of water and dissolve the weighed polymer into the water until clear solution is obtained.

(PVA is not soluble in water at room temperature, so it need to dissolved at higher temperature approximately 70-80°C with continuous stirring for 15-30 mins.)

Also, dissolve the starch in 2-3 ml water with continuous stirring.

Mix both the solutions.

The combination of PVA and starch gives balanced film properties with strength, flexibility and fast disintegration.

2. **Step-II: Preparation of drug solution:**

Weigh accurately the given quantity of the drug and dissolve in small quantity of water with continuous stirring.

Mix the drug solution in the solution of polymer until clear solution is obtained at room temperature that is 25-30°C.

3. **Step-III: Addition of excipients:**

Add the remaining excipients subsequently in the polymer solution:

- Glycerin.
- Stevia.
- Sodium Starch Glycolate.
- Citric Acid.
- Peppermint Flavour.
- Turmeric colour.

Let all the excipients mix with continuous stirring until homogenous solution is formed.

4. **Step-IV: Sonication:**

After the formation of homogenous solution, keep the solution in the ultrasonicator for about 10-15 min to remove all the bubbles from the solution and obtain the smooth film.

5. **Step-V: Casting:**

Pour the final solution in the petri plate(8cm) and spread it uniformly.

Make sure no bubbles should be present.

6. **Step-VI: Drying:**

Dry the solution in hot air oven for 3-4 hrs at 45-50°C of 24hrs at room temperature to get the film.

7. **Step-VII: Cutting:**

Remove the film carefully from the petri plate and cut it into 2×2 cm strips.

Each strip should contain 20mg of drug.

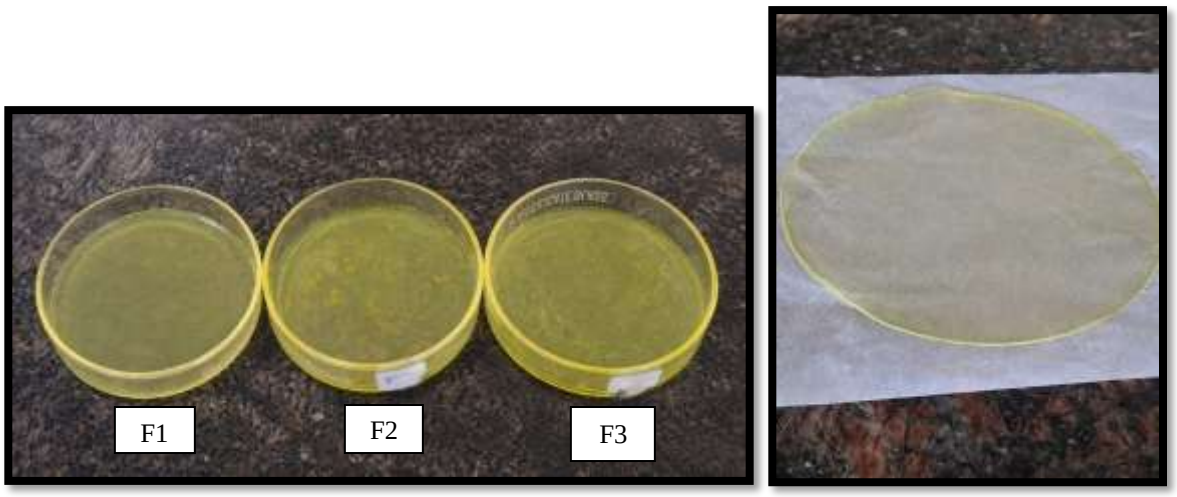


Fig. 1: Formulated film

Evaluation Parameters[678]

- **Pre-formulation study:**
  1. Organoleptic properties.
  2. Melting point determination.
  3. Calibration curve of Teneligliptin.
  4. Flow property.
- **Post-formulation study:**
  1. Appearance.
  2. Thickness.
  3. Folding Endurance.
  4. Surface pH.
  5. Disintegration Time.
  6. Drug content.

Pre-formulation study[67]

1. Organoleptic properties:

Sr. No.	Tests	observations
1.	Colour	White
2.	Odour	Odourless
3.	Taste	Bitter

Table-2: Organoleptic properties

2. Melting point determination:

Melting point of Teneligliptin HBr was measured by the common method.

Sr. No.	Melting point
1.	201°C

Table-3: Melting Point

3. Calibration curve of Teneligliptin HBr[78]

For the calibration curve of Teneligliptin HBr, the drug is dissolved in the suitable solvent to make the stock solution. Then different dilutions were made with concentration of- 5, 10, 15, 20, 25 µg/ml.

The wavelength is then checked were the drug is absorbed maximum.

Observation: Teneligliptin HBr is maximum absorbed at 241.6nm.

Sr. No.	Concentration (µg/ml)	Absorbance at 241.6nm
1.	5	0.160
2.	10	0.224
3.	15	0.295
4.	20	0.401
5.	25.	0.516

Table-4: Calibration curve

- **Post-formulation study:**

1. Appearance:

Films were visually examined for transparency, smoothness, flexibility, and stickiness.

Observation:

1.	Colour	Light yellow
2.	Shape	Square
3.	Size	2*2
4.	Smoothness	Smooth
5.	Transparency	Transparent
6.	Flexibility	Flexible
7.	Stickiness	Non-sticky

Table -5: Appearance of Film

2. Thickness[6]

The thickness of film was measured by using Vernier Caliper.

To record the thickness, the measurement is recorded at different positions (5 positions- 4 corners and 1 center), and mean is calculated.

- **For F1 batch:**

Thickness of 5 positions:

(Centre- T1, Top right- T2, Top left- T3, Bottom right- T4, Bottom left- T5)

T1	0.18mm
T2	0.17mm
T3	0.18mm
T4	0.16mm
T5	0.17mm

Mean= T1+T2+T3+T4+T5/5
=0.18+0.17+0.18+0.16+0.17/5
=0.86/5
=0.17mm

- **For F2 batch:**

T1	0.20mm
T2	0.21mm
T3	0.19mm
T4	0.21mm
T5	0.19mm

Mean=T1+T2+T3+T4+T5/5

=0.20+0.21+0.19+0.21+0.19/5

=1/5

=0.2mm

- **For F3 batch:**

T1	0.26mm
T2	0.24mm
T3	0.25mm
T4	0.26mm
T5	0.26mm

Mean= T1+T2+T3+T4+T5/5

= 0.26+0.24+0.25+0.26+0.26/5

= 1.27/5

= 0.25mm

Sr. No.	Formulations	Thickness (mm)
1.	F1	0.17
2.	F2	0.20
3.	F3	0.25

Table-6: Thickness of Films

3. Folding endurance:

Folding endurance was determined by folding the film at the same place until it broke.

The number of folds at the same place without breaking is the value of folding endurance.

Sr. No.	Formulations	Folding endurance
1.	F1	122
2.	F2	140
3.	F3	158

Table-7: Folding endurance of Films

4. Surface pH:

The pH of the film was measured by a digital pH meter.

The film was dissolved in 10ml of water and the electrode was placed in it and the pH was measured.

Sr. No.	Formulations	Surface pH
1.	F1	6.04
2.	F2	6.54
3.	F3	6.6

Table-8: Surface pH of Films

5. Disintegration Time (DT):

The disintegration time was measured by placing the film into the petri dish that contains the water.

The time of breakdown is the time when film starts to disintegrate.

This time is recorded.

Sr. No.	formulations	Disintegration Time (sec)
1.	F1	55
2.	F2	48
3.	F3	40

Table-9: DT of Films

6. Drug content (%):

The drug content was measured by dissolving the film in suitable solvent and measuring the absorbance at 241.6 nm using UV spectrophotometer.

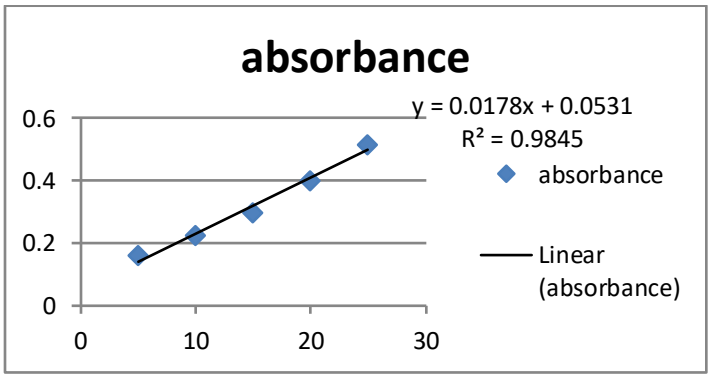
The absorbance we have got for 3 batches are:

Sr. No.	Formulations	Absorbance
1.	F1	0.365
2.	F2	0.370
3.	F3	0.391

Table-10: Absorbance of Film solution

Based on above data we can calculate the drug content by the equation.

The equation is obtained from the data of absorbance obtained from calibration curve.



The equation we get:

Y= mX + c

Where,

Y= absorbance

m = slope

X = concentration

c= intercept

Y= 0.017x + 0.053

- **For F1 batch:**

First calculate the concentration.

Absorbance is- 0.365

∴ X = 0.365-0.053/ 0.017

= 0.312/ 0.017

= 18.35

Now calculate the total drug content.

∴ Total drug (mg)= X × volume of sample(ml)× dilution factor/ 1000

= 18.35 mg

Drug content (%) = [actual drug amount (mg)/ theoretical dose (mg)] *100

= 18.35/20 *100

= 91.7%

- **For F2 batch:**

Absorbance- 0.370

X= 0.370- 0.053/ 0.017

= 0.317/0.017

= 18.64

Total drug (mg) = 18.64mg

∴Drug content (%) = 18.64/20 *100

= 93.2%

- **For F3 batch:**

Absorbance- 0.391

X= 0.391-0.053/ 0.017

= 0.338/0.017

= 19.88

Now,

Total drug (mg) = 19.88mg

∴ Drug content (%) = 19.88/20 * 100

= 99.4%

Sr. No	Formulations	Drug content (%)
1.	F1	91.7%
2.	F2	93.2%
3.	F3	99.4%

Table-11: Drug content of Films

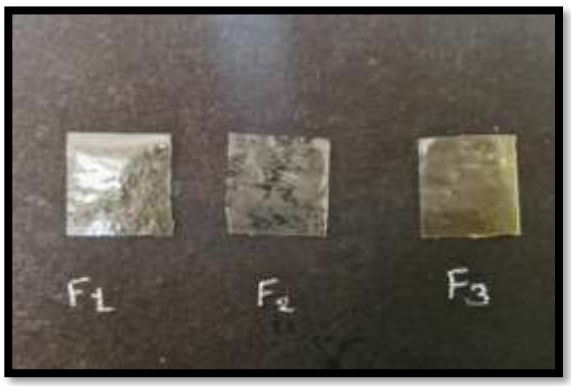


Fig. 2: Batch wise films

Result:

Sr. No.	Tests	F1	F2	F3
1.	Thickness (mm)	0.17	0.20	0.25
2.	Folding endurance	122	140	158
3.	Surface pH	6.04	6.54	6.6
4.	Disintegration Time (sec)	55	48	40
5.	Drug content (%)	91.7%	93.2%	99.4%

From the above all data of evaluation tests, the F3 batch shows the best results with better thickness, folding endurance, pH, disintegration time and drug content.

So, F3 batch is the optimized batch.

Conclusion:

The present study successfully formulated and evaluated sugar-free oral dissolving films of Teneligliptin Hydrobromide for diabetic patients.

The prepared films showed satisfactory physicochemical characteristics, rapid disintegration, high drug content uniformity, and pH. Among all formulations, F3 demonstrated optimum performance with faster disintegration and higher drug content.

The use of stevia made the formulation suitable for diabetic patients without compromising taste. Therefore, sugar-free oral dissolving films of Teneligliptin HBr can serve as a promising alternative to conventional oral dosage forms.

References:

1) Sapra A, Bhandari P. Diabetes. [Updated 2023 Jun 21]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK551501/
2) Bala R, Pawar P, Khanna S, Arora S. Orally dissolving strips: A new approach to oral drug delivery system. Int J Pharm Investig. 2013 Apr;3(2):67-76. doi: 10.4103/2230-973X.114897. PMID: 24015378; PMCID: PMC3757902.
3) Arya A, Chandra A, Sharma V, Pathak K. Fast dissolving oral films: an innovative drug delivery system and dosage form. International Journal of ChemTech Research.
4) Kishimoto M. Teneligliptin: a DPP-4 inhibitor for the treatment of type 2 diabetes. Diabetes Metab Syndr Obes. 2013 May 6;6:187-95. doi: 10.2147/DMSO.S35682. PMID: 23671395; PMCID: PMC3650886.
5) Indian pharmacopoeia.
6) Ghurghure S, Attar S, Sumit . Teneligliptin hydrobromide hydrate mouth dissolving strip: Formulation and evaluation [Internet]. ***Int J Pharm Chem Anal***. 2024 [cited 2026 Jun 08];11(2):164-170. Available from: https://doi.org/10.18231/j.ijpca.2024.023
7) Vishnu C. Shinde, Kiran B. Aher, Girija B. Bhavar, Sachin J. Kakad and Sanjay R. Chaudhari Development and validation of UV spectrophotometric method and high performance thin layer chromatographic (HPTLC) method for estimation of teneligliptin hydrobromide in pharmaceutical preparation Der Pharmacia Lettre, 2016, 8 (8):291-301 (http://scholarsresearchlibrary.com/archive.html)
8) Kshirsagar, S. & Mane, S. & Hanchate, Y. & Katte, Samartha & Kulkarni, K.. (2018). UV Spectrophotometric Method Development and Validation for Determination of Teneligliptin Hydrobromide Hydrate in API and in Pharmaceutical Dosage Form. International Journal for Pharmaceutical Research Scholars. 7. 19-27. 10.31638/IJPRS.V7.I1.00008.
9) Patil, P.C.; Shrivastava S.K.; Vaidehi S.; Ashwini P.; —Oral fast dissolving drug delivery system: A modern approach for patient compliance‖. International journal of drug regulatory affairs, 2014; 02(02): 49-60.

10) Muhammad I, Subahdar R, Qadir Q, Jabeen M, Khan F. Orally disintegrating films: A modern expansion in drug delivery system. Saudi Pharm J. 2016;24(5):537–46.

11) Ghodake, P.P.; Karande, K.M.; Osmani, R.A.; Bhosale, R.R.; Harkare, B.R.; ―Mouth Dissolving Films: Innovative Vehicle for Oral Drug Delivery‖, International journal of pharma research and review, 2013; 02(10): 41-47.