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A Review on: Validation of Developed Analytical Methods for the Determination of Dapagliflozin and Teneligliptin in Pharmaceutical Dosage Forms

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ABSTRACT

SGLT-2 and DPP-4 is the class of anti-diabetic medicine also called gliflozin and gliptin respectively. Dapagliflozin and Teneligliptin are the SGLT-2 and DPP-4 classes inhibitors for the treatment of type II diabetes mellitus. The aim of this review is to focus on update of determination of Dapagliflozin and Teneligliptin in bulk and in pharmaceutical dosage forms using chromatographic and spectrophotometric methods. Dapagliflozin and Teneligliptin are estimated by UV, RP-HPLC, HPTLC, UPLC, RP-UHPLC methods. There are plenty of articles which have already been published describing analytical methods and method validation for the same. Most frequently used techniques such as spectrometric and liquid chromatographic methods are summarised in present review. Spectrometric methods for Dapagliflozin and Teneligliptin alone and in combination include parameters like λ max, solvent, matrix etc. and HPLC methods for Dapagliflozin and Teneligliptin alone and in combination including parameters like stationary phase, mobile phase combination, RF etc. This review also provides detailed information on separation conditions for Dapagliflozin and Teneligliptin alone, in the presence of combination with other drugs and in presence of its degradation products.

INTRODUCTION:

DAPAGLIFLOZIN:

Sodium-glucose cotransporter-2 (SGLT2) inhibitors are a relatively new class of antihyperglycaemic agents (AHAs) for the treatment of type 2 diabetes (T2D)[1,2,3] These agents reduce reabsorption of glucose in the kidneys and facilitate its excretion in the urine by inhibiting the high-capacity glucose transporter SGLT2 located in the proximal convoluted tubule, thereby lowering glucose levels independently of insulin action.[1,2]

Dapagliflozin is chemically known as (2S,3R,4R,5S,6R)-2-[4-(chloro-3- (4-ethoxybenzyl) phenyl]-6-(hydroxymethyl)tetrahydro-2H-pyran-3,4,5-triol, molecular formula $C_{21}H_{25}ClO_6$

With molecular weight 408.8 gm/mol.[4]

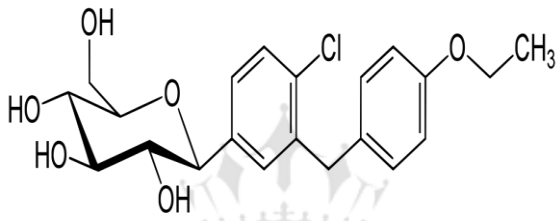

Figure 1: Structure of Dapagliflozin

TENELIGLIPTIN:

Dipeptidyl-peptidase-4 (DPP-4) inhibitors (or 'gliptins') represent a class of oral antihyperglycemic agents that block the inactivation of the "incretin" hormones, namely glucagon-like peptide-1 (GLP-1) and glucose-dependent insulinotropic polypeptide (GIP), and thus affect glucose control through several mechanisms, including enhancement of glucose-dependent insulin secretion. [5]

Teneligliptin is chemically known as {(2*S*,4*S*)-4-[4- (3-Methyl -1-phenyl - 1*H*-pyrazol-5-yl)-1-piperazinyl]-2-pyrrolidinyl}(1,3-thiazolidin-3-yl) methanone, molecular formula $C_{22}H_{30}N_6OS$ with molecular weight 426.6 gm/mol.[6]

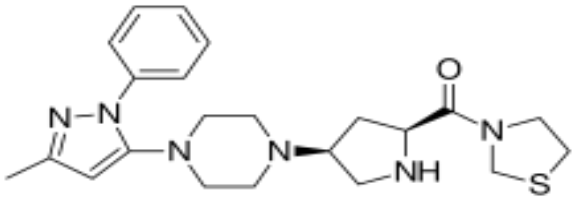

Figure 2: Structure of Teneligliptin

MECHANISM OF ACTION:

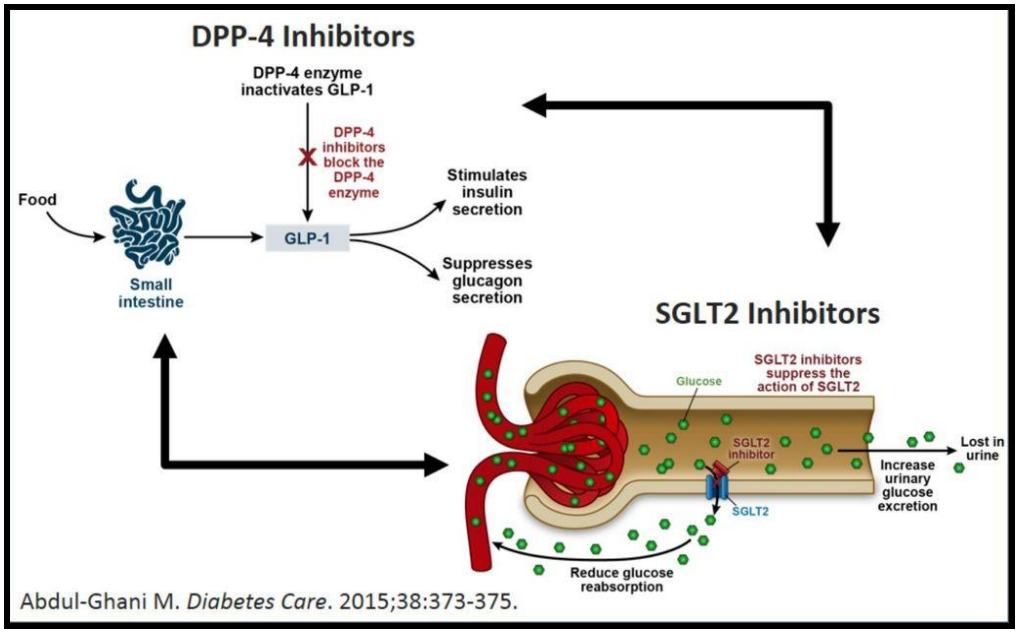

Figure 3: Mechanism of action DPP-4+SGLT2 Inhibitors [7]

SPECTROPHOTOMETRIC METHODS:

Table 1: Analytical method development and validation of spectrophotometric method for Dapagliflozin in alone

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Dapagliflozin	API and Tablet formulation	UV spectroscopic method	Solvent:Methanol Linearity: 0.5-2.5µg/ml r^2: 0.999 LOD: 0.0265µg/ml LOQ: 0.0804µg/ml	226 nm	8

Table 2: Analytical method development and validation of Spectrophotometric method for Dapagliflozin in combination

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Dapagliflozin & Teneligliptin HBr	Synthetic mixer	UV spectro-photometric method	Solvent: Distil water Linearity: 15-75 µg/ml LOD: Dapagliflozin: 0.7410 µg/ml Teneligliptin: 0.536 µg/ml LOQ: Dapagliflozin: 2.24 µg/ml Teneligliptin: 1.627 µg/ml	Dapagliflozin:223 nm Teneligliptin: 243 nm	9
2.	Dapagliflozin & Metformin HCl	Bulk and combined dosage formulation	UV-Visible spectroscopy method	Solvent:Water, Methanol, Acetonitrile Linearity: DAPA: 2-32µg/ml MET : 1-20µg/ml r^2: 0.999 LOD: DAPA: 0.0241µg/ml MET: 0.0293µg/ml LOQ: DAPA: 0.0732µg/ml MET: 0.0890µg/ml	Dapagliflozin: 222nm Metformin: 232 nm	10

HPLC Methods

Table 3: Analytical method development and validation of HPLC method for Dapagliflozin in alone

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Dapagliflozin	API & Tablet formulation	RP-HPLC	Column:ZORBAX C18 (250×4.6mm,5µm) Mobile phase: Phosphate buffer:Acetonitrile:Methanol (55:40:05v/v/v) Flow rate: 1 ml/min Linearity: 10-180µg/ml Retention time: 2.12±0.5min	225 nm	11
2.	Dapagliflozin	Tablet formulation	RP-HPLC	Column: C18 column Mobile phase: Acetonitrile: 0.1% Triethylamine (50:50v/v) Flow rate: 1 ml/min Linearity: 10-70µg/ml Retention time: 5.163min	224 nm	12
3.	Dapagliflozin	Raw and tablet formulation	RP-HPLC	Column: C18 column Mobile phase: Methanol:water(75:25v/v) Flow rate: 1 ml/min Linearity: 5- 25µg/ml Retention time: 3.1min	230 nm	13
4.	Dapagliflozin	API and tablet formulation	RP-HPLC	Column:C18(150×4.6mm,5µm) Mobile phase: Acetonitrile: Di-Potassium hydrogen phosphate (40:60v/v) Flow rate: 1 ml/min Linearity: 5- 150µg/ml Retention time: API (3.16min) Tablet (3.067 min)	222nm	14

Table 4: Analytical method development and validation of HPLC method for Dapagliflozin in combination

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Dapagliflozin & Metformin HCl	Bulk and combined formulation	RP-HPLC	Column: C18 (250mm x 4.6mm) Mobile phase: Water:Methanol (50:50v/v) Flow rate:5.1 ml/min Linearity: Dapagliflozin: 60-210µg/ml Metformin HCL: 2-7µg/ml Retention time: Dapagliflozin: 3.338min Metformin HCL: 2.178min	230 nm	15
2.	Dapagliflozin & Metformin	Tablet formulation	RP-HPLC	Column:C18 column (250 mm×4.6 mm, 5 µm) Mobile phase: Methanol:Water (75:25v/v) Flow rate: 1 ml/min Linearity: Dapagliflozin: 2-10 µg/ml Metformin**:** 100-500 µg/ml Retention time: Dapagliflozin**:** 5.099 min Metformin**:**2.165min	233 nm	16
3.	Dapagliflozin & Saxagliptin	Tablet formulation	RP-HPLC	Column: BDS C8 column (50mm x 4.6mm, 5µm) Mobile phase: Potassium dihydrogen phosphate :Acetonitrile (55:45v/v) Flow rate: 1 ml/min Linearity: Dapagliflozin**:** 25-150µg/ml Saxagliptin**:**12.5-75µg/ml Retention time:	210 nm	17

				Dapagliflozin**:** 2.266 min Saxagliptin: 2.805 min		
4.	Dapagliflozin & Metformin	Bulk and synthetic mixture	RP-HPLC	Column: C18(4.6 I.D. x 250mm,5 µm) Mobile phase: Acetonitrile : Water (75:25v/v) Flow rate:1 ml/min Linearity: Dapagliflozin**:** 20-100µg/ml Metformin **:** 10 -50 µg/ml Retention time: Dapagliflozin : 5.4 min Metformin: 5.4min	285 nm	18

HPTLC Method

Table 5: Analytical method development and validation of HPTLC method for Dapagliflozin alone

Sr No.	**Drug**	**Sample**	**Method**	**Description**	**Detection mode**	**RF**	**Ref No.**
1.	Dapagliflozin	Bulk and Tablet dosage form	HPTLC	HPTLC Plates: Merck precoated silica gel aluminium plate 60 F254 Mobile Phase: Chloroform: Methanol (9:1v/v)	223 nm	0.21±0.004	19

UPLC Method

Table 6: Analytical method development and validation of UPLC/PDA method for Dapagliflozin in combination

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref No.
1.	Dapagliflozin & Saxagliptin	Bulk & Pharmaceutical dosage form	UPLC/PDA	Column:HSS 100 × 2.1 mm, 1.8 m Mobile Phase: Phosphate buffer: Acetonitrile(50:50v/v) Flow rate: 0.3ml/min Linearity: Dapagliflozin: 2.5-15µg/ml Saxagliptin: 1.25-7.5µg/ml Retention time: Dapagliflozin:0.9 min Saxagliptin:1.119 min	260 nm	20

Teneligliptin

UV Methods

Table 7: Analytical method development and validation of spectrophotometric method for Teneligliptin in alone

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Teneligliptin	Tablet formulation	UV spectroscopic method	Solvant: Methanol Linearity: 10-50µg/ml r^2: 0.995 LOD: 2.25 µg/ml LOQ: 6.83µg/ml	246 nm	21

Table 8: Analytical method development and validation of spectrophotometric method for Teneligliptin in combination

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Remogliflozin Etabonate & Teneligliptin	Bulk and dosage form	UV spectroscopic method	Solvent: Methanol Linearity: Remogliflozin Etabonate: 5-25µg/ml Teneligliptin: 0.5-2.5µg/ml r^2: 0.995 LOD: Remogliflozin Etabonate: 0.0123µg/ml Teneligliptin: 0.0373µg/ml LOQ: Remogliflozin Etabonate: 0.0289µg/ml Teneligliptin: 0.0877µg/ml	Remogliflozin Etabonate: 233 nm Teneligliptin : 246 nm	22
2.	Teneligliptin HBr & Metformin HCl	Bulk and dosage form	UV visible spectrophotometric method	Solvant: Distilled water Linearity: Teneligliptin HBr:2-12 µg/ml Metformin HCl: 5 -55µg/ml r^2: 0.999	Teneligliptin HBr: 230 nm Metformin HCl: 245 nm	23

HPLC Methods

Table 9: Analytical method development and validation of HPLC method for Teneligliptin in alone

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Teneligliptin HBr	Dosage form	RP-HPLC	Column: C18 column Mobile phase: Phosphate buffer:Methanol (75: 25v/v) Flow rate: 1.2 ml/min Linearity: 80-120 µg/ml Retention time: 2.51 min	270 nm	24
2.	Teneligliptin	Tablet formulation	RP-HPLC	Column: C18 column (250mm x 4.6mm, 5µm) Mobile phase: Potassium dihydrogen phosphate:Acetonitrile (80:20 v/v) Flow rate:7.443 min Linearity: 500-3000 µg/ml Retention time: 7.443 min	242 nm	25
3.	Teneligliptin	Tablet formulation	RP-HPLC	Column: C18 analytical column (150 mm × 4.6 mm, 5.0 µm) Mobile phase: Acetonitrile, Water, and Trifluoroacetic acid (60:1940:2v/v) & Acetonitrile:Trifluoroacetic acid (2000:2v/v) Flow rate: 1.0 ml/min Linearity: 50-150µg/ml Retention time: 11.2 min	245 nm	26
4.	Teneligliptin	Bulk formulation	RP-HPLC	Column: C18 Mobile phase: Methanol: Phosphate buffer (70:30v/v) Flow rate: 0.8 ml/min Linearity: 10-50 µg/ml Retention time: 4.24 min	246 nm	27

Table 10: Analytical method development and validation of HPLC method for Teneligliptin in combination

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Remogliflozin Etabonate & Teneligliptin	Bulk and Dosage form	RP-HPLC	Column: Cosmosil C18 (250 mm × 4.6 mm, 5µm i.d.) Mobile Phase: Acetonitrile: Water (80:20 v/v) Flow rate: 1 ml/min Linearity: Remogliflozin Etabonate: 10-80 µg/ml Teneligliptin: 1-8 µg/ml Retention time: Remogliflozin Etabonate: 2.4 min Teneligliptin: 3.5 min	245 nm	28
2.	Teneligliptin & Metformin	Bulk and tablet dosage form	RP-HPLC	Column: C18 (250mm x 4.6mm 5.0 µm) Mobile phase: 0.1%orthophosphoric acid Buffer: Acetonitrile: Methanol (65:25:10 v/v/v) Flow rate: 1 ml/min Linearity: Teneligliptin: 5-30 µg/ml Metformin: 125-750 µg/ml Retention time: Teneligliptin: 2.842 min Metformin:2.017 min	254 nm	29
3.	Metformin &	Pharmaceutical	RP-	Column: C18 (250 mm	260 nm	30

	Teneligliptin	dosage form	HPLC	X 4.6 mm, 5µm) Mobile phase: 0.1% orthophosphoric acid Buffer: acetonitrile (65:35,v/v) Flow rate: 1 ml/min Linearity: Metformin: 125-750 µg/ml Teneligliptin: 5-30 µg/ml Retention time: Metformin: 2.517 min Teneligliptin: 3.687 min		
4.	Teneligliptin & Metformin	Pharmaceutical dosage form	RP-HPLC	Column: Cosmosil (C18, 250X4.6mm, 5µm) Mobile phase: Methanol : Water (50:50 v/v) Flow rate: 0.7 ml/min Linearity: Teneligliptin: 2-10µg/ml Metformin: 50-250 µg/ml Retention time: Teneligliptin: 2.45 min Metformin: 6.21 min	242 nm	31

Table 11: Analytical method development and validation of HPTLC method for Teneligliptin in combination

Sr No	Drug	Sample	Method	Description	Detection mode	RF	Ref No.
1.	Teneligliptin HBr & Metformin HCl	Bulk & Pharmaceutical formulation	HPTLC	HPTLC plate: pre-coated silica gel G60 F254 aluminium sheets 10×10 cm^2 Mobile phase: Methanol: Ammonium sulphate (0.5 w/v):Triethylamine (9:2.7:0.5 v/v/v)	237 nm	Teneligliptin HBr : 0.63 Metformin HCl: 0.19	32

Table 12: Analytical method development and validation of UHPLC method for Teneligliptin in combination

Sr No.	Drug	Sample	Method	Description	Detection mode	Ref no.
1.	Teneligliptin & Metformin	Fix dose combination	RP-UHPLC	Column: C18 (150 mm × 4.6 mm, 5 µm) Mobile phase: 50 mM potassium di-hydrogen phosphate, pH adjusted to 3.5±0.02 with orthophosphoric acid Flow rate: 0.7 ml/min Linearity: 20-100 µg/ml Retention time: Teneligliptin: 2.81 min Metformin: 1.71 min	233 nm	33

RATIONALE:

- The medications Dapagliflozin and Teneligliptin may be combined to treat Type 2 Diabetes Mellitus more effectively.

- Hence, there is a higher chance that Dapagliflozin and Teneligliptin will be used together in the near future.

- According to the literature review, different analytical techniques are documented for the analysis of each individual and combination drug of Dapagliflozin and Teneligliptin. These techniques include UV, HPLC, UPLC, UHPLC, and HPTLC.

- They are also accessible in combination with other drugs.

CONCLUSION:

Various methods for determination of Dapagliflozin and Teneligliptin have been reported. Some articles determine RP-HPLC methods were used to estimate Dapagliflozin and Teneligliptin. Some articles provide determination of Dapaliflozin and Teneligliptin alone or in combination with Metformin, Saxagliptin in pharmaceutical dosage forms. Research papers on UV, UPLC, HPTLC, and UHPLC are also reported methods in bulk and pharmaceutical dosage forms.

REFERENCES:

1. Hsia DS, Grove O, Cefalu WT. An update on sodium-glucose co-transporter-2 inhibitors for the treatment of diabetes mellitus. *Curr Opin Endocrinol Diabetes Obes.* 2017;24(1):73–79.
2. Wilding J, Fernando K, Milne N, et al. SGLT2 inhibitors in type 2 diabetes management: key evidence and implications for clinical practice. *Diabetes Ther.* 2018;9(5):1757–1773.
3. Scheen AJ. Pharmacodynamics, efficacy and safety of sodium-glucose co-transporter type 2 (SGLT2) inhibitors for the treatment of type 2 diabetes mellitus. *Drugs.* 2015;75(1):33–59.
4. https://pubchem.ncbi.nlm.nih.gov/compound/Dapagliflozin
5. Koliaki C., Doupis J. Incretin-based therapy: A powerful and promising weapon in the treatment of type 2 diabetes mellitus. *Diabetes Ther. Res. Treat. Educ. Diabetes Relat. Disord.* 2011;2:101–121.
6. https://pubchem.ncbi.nlm.nih.gov/compound/Teneligliptin
7. Patil M, Jani HD, Khoja SS, Pirani NA, Khoja S, "A Review on chemistry and pharmacological activity of Metformin hydrochloride and Teneligliptin hydrobromide hydrate in combined dosage form" *PharmaTutor*; 2017; 5(3); 24-30.
8. Vidhi S.Dave,Dr. Paresh U.Patel, "Development and Validation of UV Spectroscopic method for Dapagliflozin in its API and tablet formulation." *AEGAEUM Journal*,2020,Vol 8,Issue 5,840-846.
9. Anokhi Patel, Preeti Jadeja, Dr. Rajashree Mashru, "Analytical method development and validation for simultaneous estimation of Dapagliflozin and Teneligliptin hydrobromide hydrate from synthetic mixer by three different UV spectrophotometric methods." *World J. Pharm. Res.*,2022,Vol 11, Issue 7,770-783.
10. Dr. K. Bhavyasri, T.Surekha, "Bioanalytical method development and validation of Dapagliflozin and

Metformin hydrochloride in combined dosage form using UV spectroscopy"*gedrag & organisatie review*,2020,vol.33, Issue 02,272-283.
11. Arulselvan Murugesan, Mukthinuthalapati Mathrusri Annapurna, "Simple quantified and validated stability indicating stress degradation studies of oral antibiotic agent Dapagliflozin by RP-HPLC method."*Int.J.Pharm*,2022,Vol14,Issue 1,231-237.
12. G.V.Mante,A.T.Hemke and M.J.Umekar, "RP-HPLC method for estimation of Dapagliflozin from its tablet."*Int. J. Chemtech Research*, 2018,242-248.
13. Gunasekar Manoharan, Ahmed M. Ismaiel, Mohammed Ahmed, "Stability indicating RP-HPLC method development for simultaneous determination and estimation of Dapagliflozin in raw and tablet formulation."*chem. Research J.*, 2018,3(2);159-164.
14. Mitali V. Verma,Chirag J.Patel,M.M.Patel, "Development and Stability indicating HPLC method for Dapagliflozin in API and Pharmaceutical dosage form."*Int. J. App Pharm*,2017 Vol 9,Issue 5,33-41.
15. Bhavyasri K, Surekha T, Begum S, Sumakanth M. "RP-HPLC method for Dapagliflozin and Metformin HCL in bulk and combined formulation ."*Arch pharm pract*. 2022; 12(4): 106-110.
16. Nandre, D.S..A. Ahmed, and K.GJ, "Stability indicating HPLC method development and validation for simultaneous estimation of Dapagliflozin and Metformin tablet dosage form," *AJPCR*,2022,Vol. 15,109-114.
17. Padmaja, B. R.,B. Sivagami, R.Chandrasekar and M.N. babu. "A highly validated RP-HPLC method development for the simultaneous estimation of Dapagliflozin and Saxagliptin in tablet dosage forms." *Int. J.Pharma. Sci.* and drug Research,2018, Vol.10,372-378.
18. Afshan U. Rooj,P.Shyam Sundar, R. Vasanthi, M. Alagar Raja, K. Rajeshwar Dutt, K.N.V.Rao, and H. Ramana, "Development and validation of RP-HPLC method for simultaneous estimation of Dapagliflozin Metformin in bulk and in synthetic mixture." *World J. Pharm. pharm. Sci.*,2017,Vol.6,Issue 7,2139-2150.
19. B. V. Suma, Deveswaran R., Premnath Shenoy, "A new high-performance thin layer chromatographic method development and validation of Dapagliflozin in bulk and tablet dosage form"*Int J Pharm Pharm Sci*,2019, Vol. 11, Issue 8, 58-63.
20. Y. Surendranath Reddy,D. Gowri Sankar, "New stability indicating UPLC method for simultaneous determination of Dapagliflozin and Saxagliptin"*IJPSR*, 2019,Vol. 10(7): 3311-3317.
21. Maruthi R,Chandan R.S,Barath M,G Naveen Datta, Merryl D'Shilva,Kajal Kumari M,Farhan Ahmad,Geetha R, "Analytical method development and validation of teneligliptin by UV spectroscopy." *RJPT*,2021,14(1), 75-78.
22. Vashi Dhara, Gamit Dharmistha, "Development and validation of uv- spectroscopic method for simultaneous estimation of Remogliflozin Etabonate and Teneligliptin in bulk and pharmaceutical dosage form by simultaneous equation method." *wjpps*, 2022,Vol. 8, Issue 8, 149-153.
23. Parul Bisht,Archana Gahtori, "Development and validation of UV visible spectrophotometric method for simultaneous determination of Teneligliptin hydrobromide and Metformin hydrochloride in its bulk and dosage form" *JETIR*,2020, Vol. 7, Issue 6,998-995.
24. Girish D. Dahikar, Gayatri Bobade, "Development and validation of stability indicating RP-HPLC method for Teneligliptin hydrobromide hydrate."*Am.J.PharmTech Res.* 2021,11(1), 1-12.
25. Bhoomi D. Patel, Nidhi J. Dharsandiya,Ankit Chaudhary, "Development and validation of RP-HPLC method for estimation of Teneligliptin and its impurity in tablet" *Int. J. Pharm. Sci. Rev. Res*.,2021,69(2),127-133.
26. Bhanu Biswas, Manish Kumar, Jai Bharti Sharma, Vipin Saini, Mullana, Ambala, "Method development and validation for estimation of Teneligliptin in tablet dosage form by RP-HPLC." *RJPT*, 2020; 13(4),1774-1778.
27. Dr. Pradnya Lokhande, "Analytical method development and validation of Teneligliptin by using RP-HPLC with ICH guidelines"*Int. J. trend Res*.,2019, Vol 3,Issue-3,259-263.
28. Vashi Dhara,Gamit Dharmistha, "Development and validation of RP-HPLC method for simultaneous estimation of Remogliflozin Etabonate and Teneligliptin in pharmaceutical dosage form."*wjpps*,2022,Vol 11, Issue 8,1504-1516.
29. Rajani Vetapalem, Rajendra Prasad Yejella, Lakshmana Rao Atmakuri, "Development and validation of a stability indicating RP-HPLC method for simultaneous estimation of Teneligliptin and Metformin." *Turk. J.Pharm*.Sci, 2018,17(2),141-147.

30. Swetha A, Ramyakuber B., "A novel stability-indicating reverse phase liquid chromatographic method for the simultaneous estimation of Metformin and Teneligliptin in pure and pharmaceutical formulations." *Int. J.App.Pharm*.,2018, Vol 10, Issue 5,274-280.
31. Gopal S. I.,Nitin S.B.,Lokesh R.G.,"RP-HPLC Method development and validation of Teneligliptin and Metformin in pharmaceutical dosage forms" *Int.Res.J.Pharm*., 2017,8 (8),52-55.
32. Mehul Patel, Divya Patel, Umang Shah,Heta Kachhiya, "Simultaneous quantification of Teneligliptin hydrobromide and Metformin hydrochloride: an improved HPTLC method with implementation of Plackett-Burman design" *J. Chem. Metrol*.,2021,15:1, 65-75.
33. Viral Patel, Chintan Pandya, Zalak Patel, Dharmesh Patel, "Isocratic RP-UHPLC method development and validation of stability-indicating for simultaneous determination of teneligliptin and metformin in fixed-dose combination." *Current Chemistry Letters*, 2021, 10(4), 503-516.

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