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METHOD DEVELOPMENT, VALIDATION AND FORCED DEGRADATION STUDIES OF NEW RP-HPLC METHOD FOR SIMULTANEOUS ESTIMATION OF REMOGLIFLOZIN AND TENELIGLIPTIN IN PURE AND TABLET DOSAGE FORM

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Keywords:

Remogliflzin, Teneligliptin, Liquid chromatography, RP-HPLC, Validation

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ABSTRACT: According to ICH guidelines, an easy, cost-effective, accurate, and precise RP-HPLC method for simultaneously determining Remogliflzin and Teneligliptin was developed and validated. The drug's quantity was determined using a photodiode array (PDA) detector. The column was run in isocratic mode with mobile phase acetonitrile and ammonium phosphate buffer at a 40:60 ratio. The flow rate was one milliliter per minute and effluent was measured at 245 nm. The retention times were 2.719 and 7.337 min for Remogliflzin and Teneligliptin respectively. The injection volume was 10µl. as per ICH guidelines the method was validated and the method was found to be linear in the range of 25-150µg/ml for Remogliflzin and 2.5-15µg/m for Teneligliptin. Percentage recovery studies of Remogliflzin and Teneligliptin100.2% and 100%. The LOD & LOQ was found to be 0.3 & 1µg/ml for Remogliflzin and 0.03 & 0.1µg/ml for Teneligliptin. The values of precision and robustness lie within the acceptance limit. Thus, the simultaneous determination of Remogliflzin and Teneligliptin using the suggested method can be successfully employed in routine analysis. Remogliflzin and Teneligliptin were studied for forced degradation in controlled, acidic, basic, peroxide, reduction, UV, thermal and hydrolysis conditions.

INTRODUCTION: Common endocrinological diseases, like Diabetes Mellitus Type 2 (DMT2), are already enormous and growing at alarming percentile throughout the world. As estimated, the number of diabetic patients will increase to more than 500 million by 2030 and above 700 million by 2045 [1, 2]. Diabetes mellitus is a heterogeneous metabolic disorder characterized by altered carbohydrate, protein and lipid metabolism.

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Diabetes and it's abnormalities constitute a major health problem in society [3]. Treatment with a combination of oral hypoglycemic drugs with various mechanisms of action is frequently preferred for improved glycemic control as compared to monotherapy [4, 5].

Remogliflzin etabonate, a newly discovered oral hypoglycemic agent which is insulin-independent [6] chemically designated as (ethyl (2R, 3S, 4S, 5R, 6S)-3, 4, 5 – trihydroxy – 6 -4-(4 isopro-poxybenzyl)-1- isopropyl-5-methyl-1Hpyrazol-3-yl) oxy) tetrahydro - 2H - pyran - 2 - yl) methyl) carbonate **Fig. 1**. The molecular formula of Remogliflzin is $C_{26}H_{38}N_2O_9$ with molecular weight 522.6 g/mol [7]. It is prodrug of Remogliflzin, with benzylpyrazole glucoside based inhibitor of renal

SGLT2 with antihyperglycemic activity [8, 9]. It is also used in the treatment of non-alcoholic steatohepatitis [10]. Genital mycotic infections, urinary tract infections, and dizziness are the common side effects of using Remogliflzin etabonate [11].

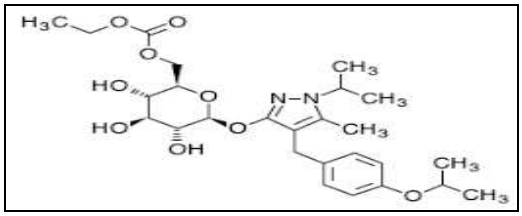


FIG. 1: CHEMICAL STRUCTURE OF HAEMOGLOBIN ETABONATE

Teneligliptin **Fig. 2** is depicted as (3-[(2S, 4S)-4-[4-(3-methyl-1-phenyl-1H- pyrazol-5-yl) piperazin - 1 -yl] pyrrolidin - 2 – yl carbonyl] thiazolidine) is a highly effective, long-lasting and selectively active oral DPP-4 inhibitor [12]. It is highly effective in lowering blood glucose levels. It successfully manages type-2 diabetic mellitus [13]. The chemical formula of Teneligliptin is $C_{22}H_{30}N_6OS$, with a sub-atomic mass of 426.58g/mol [14, 15]. Teneligliptin suppresses postprandial hyperglycemia after meals, allowing it to exert its activity for 24 hours with increased activated glucagon-like peptide 1 (GLP-1) levels [16, 17].

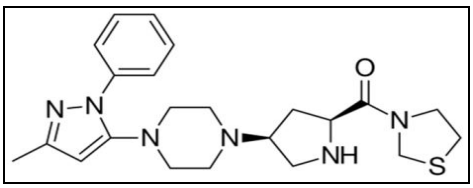


FIG. 2: CHEMICAL STRUCTURE OF TENELIGLIPTIN

The literature survey confirms that few analytical methods are available for the estimation of Remogliflozin alone and in combination with other drugs in API's and formulations using HPLC [18, 19], UV [20], HPTLC [21], UHPLC [22] techniques. Remogliflzin concentration estimation in human plasma has been reported using LC-MS-MS techniques [23]. Using ultraviolet (UV) spectrophotometry [24, 25], HPLC-UV [26], UV-HPTLC [27], HPLC-UPLC [28], high-performance liquid chromatography (HPLC) [29, 30], HILIC [31] and LC-MS/MS [32] analytical techniques are available for the quantification of Teneligliptin either alone or in combination with other drugs. No stability-indicating HPLC technique has yet been published for the simultaneous estimation of Remogliflzin and Teneligliptin. This work aims to develop a simple and accurate HPLC method for simultaneously determining Remogliflzin and Teneligliptin in bulk preparation and pharmaceutical formulation. This method was also validated according to ICH guidelines. Its degradation studies were carried out for Remogliflzin and Teneligliptin under acidic, basic, peroxide, reduction, photo, thermal, and hydrolysis conditions.

MATERIALS AND METHODS:

Instruments and Chemicals: Reverse phase high-performance liquid chromatography method for the simultaneous estimation of Remogliflzin & Teneligliptin. Instruments used - HPLCWaters-2690 Alliance, separation module (isocratic system), column was X Bridge phenyl column (Length 250 mm, diameter 4.6mm, particle size - 5µm), detector used are Waters-996 photodiode array detector, data handling system (Waters empower 2 software). Reagents and chemicals used are acetonitrile (HPLC grade) Standard reagents private limited Hyderabad, water (HPLC grade) Standard reagent private limited Hyderabad, ammonium phosphate buffer analytical range grade.

Drug Sample: Remogliflzin and Teneligliptin raw material and formulation.

Method Development for HPLC: Degassed Methanol and Ammonium Phosphate Buffer in the ratio of 40:60 V/V.

Preparation of Ammonium Phosphate Buffer: Ammonium phosphate weighing 14.9g was added to a beaker with 1000ml of distilled water and thoroughly dissolved. After using formic acid to get the pH to 3.0, a 0.45 membrane filter was used for filtration.

Conditions of Chromatography: Waters X-Bridge Phenyl (250 x 4.6 mm, 5 µm) was used for the HPLC experiments. The elution was conducted with isocratic conditions using acetonitrile: ammonium phosphate (40:60 by volume) at 1.0 ml/min flow rate. The volume of injection was 10 microliter and ten minutes of run time, with the column temperature set to room temperature and at 245nm the absorbance was measured (As highest

absorbance was observed at this wavelength. So, this was selected as the wavelength).

Standard Solution Preparation: Weigh 100mg of Remogliflzin and 10mg of Teneligliptin carefully. These working standards were placed in a 100ml VF, 70ml diluent was added, and the contents were sonicated for 10 minutes to dissolve them contents. Dilute 5 ml of the above solution to 50 milliliter using diluent.

Sample Solution: Using 70 ml diluent, dilute a sample of 180 mg (which is equal to 100 mg Remogliflzin & 10 mg Teneligliptin) in a 100ml volumetric jar. Contents were sonicated for 30 min. Filter the solution with a 0.45 Membrane filter. Using diluent, dilute 5ml of the above solution to 50ml.

System Precision: The system's performance has been validated by assessing device suitability parameters. Limits were found to be met for various parameters, including plate count, tailing, and RSD percentage.

Specificity: The absence of adjuvant interference during applying the planned approach to the study of pharmaceutical formulations demonstrated its selectivity. The method's specificity was assessed in terms of interference caused by the occurrence of any additional placebos. Two dissimilar samples were administered and compared to their placebo counterparts.

Accuracy: Being close to the technique's real meaning defines accuracy. Three concentrations will be used to test the recovery trials. The drug's quantity, percentage of recovery, and standard deviations were calculated after every injection at each level.

Precision: The level of agreement between the various test results determines the analytical methodology's precision. Researchers examined the effects of sampling a similar population more than once. The current process was evaluated regarding its ability to provide repeatable, intraday, and inter-day results. It was examined by sampling the materials on the same day and over different days.

Linearity: Linearity is the feature of the analytical process that allows for a direct proportion of analytical results in response to a certain concentration of the analyte in the Standard. A total of seven series of standard solutions were selected for the assessment of the linearity spectrum. The calibration curve was drawn by comparing regular solution concentration with peak area. The slope, intercept, and coefficient of correlation were calculated by using the least square method.

Forced Degradation: As per ICH guidelines, Q1 (A) R2 stress degradation experiments was performed. The peaks of degradation should be well distanced and at least 1.0 resolution between peaks. For the largest peaks to go over, a separation must occur. A degradation of around 20 percent has been attained via various stress conditions like acid, alkali, peroxide, reduction, thermal, and photo in what is known as a forced degradation experiment.

Robustness: Robustness refers to a procedure's resistance to small process parameter changes and its reliability in normal operation. An organic solution was introduced into the HPLC system for robustness analysis, and the chromatographic settings (such as flow rate and mobile-phase organic content) were modified. The peak asymmetry, separation factor, and retention time were determined by evaluating the impact of altered parameters.

RESULTS AND DISCUSSION: This study aims to establish a single isocratic HPLC method for the simultaneous quantification of Remogliflzin and Teneligliptin in active pharmaceutical ingredients and formulations *i.e.* precise, reliable and cost-effective. According to the UV spectra of these compounds, an appropriate wavelength for the simultaneous estimation of two drugs was chosen.

Optimization of the Method: Using buffers (0.1% Potassium hydrogen phosphate, 0.1% ammonium phosphate, 0.1% formic acid, and water) and acetonitrile as mobile phase, different trials were conducted in isocratic and gradient modes. Various stationary phases, including Intersil ODS and phenyl, were used to test the system. The resolution and retention times were improved by changing the mobile step composition at each trial. In the end, the separation was achieved using a waters X-Bridge phenyl column (250mm x 4.6mm, 5 µm) and a mobile phase of acetonitrile: ammonium

Phosphate (40:60 v/v) with 1.0 ml/min flow rate and detection of UV at a wavelength of 245nm. The entire performance lasted ten minutes. Conditions for optimized chromatography are provided in **Table 1.**

TABLE 1: SUITABILITY CONDITIONS OF OPTIMIZED METHOD

Variables	Appropriate conditions
Column	X Bridge Phenyl (250 x 4.6 mm, 5 µ)
Moving Phase	Acetonitrile: Ammonium phosphate (40:60 v/v)
InjectionVolume	10 micro liter
Rate of stream	1 milliliter /min
ColumnTemperature	Ambient
Wavelength	245nm
Time duration	10 minutes

System Suitability: To attain results, the following device suitability parameters were established after six consecutive injections of normal solution: time, peak area, tailing factor, theoretical plate number, and resolution. The chromatogram in **Fig. 3** was representative of the suitability results detailed in **Table 2.**

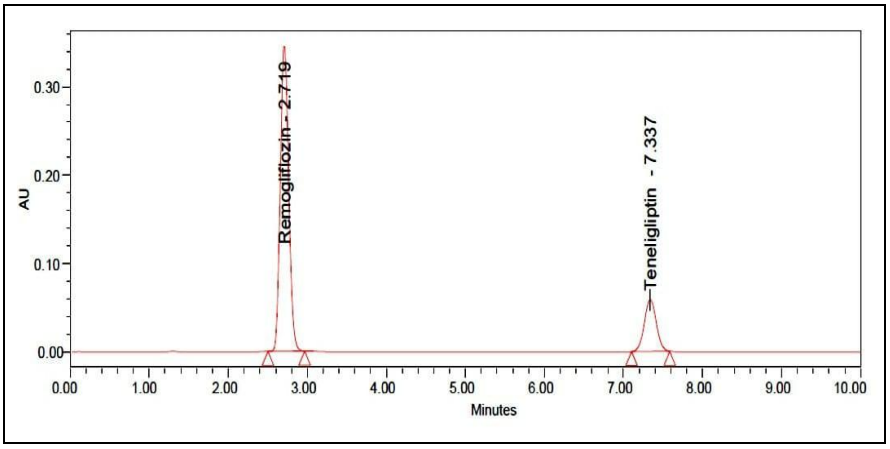
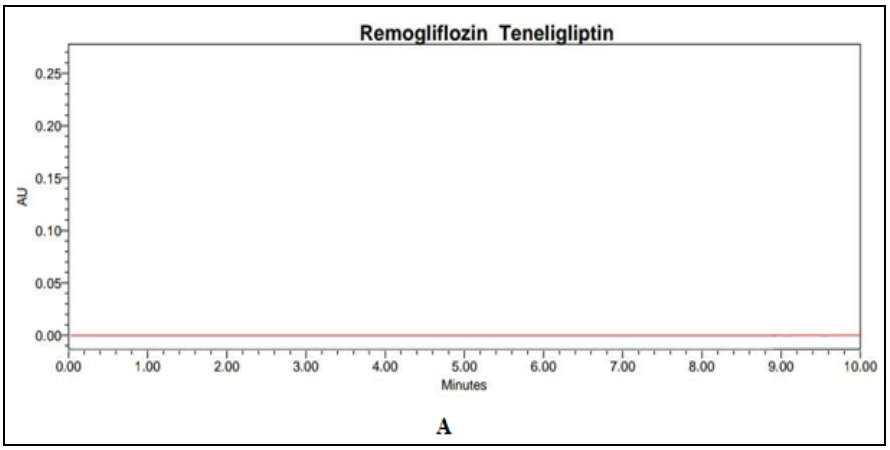


FIG. 3: OPTIMIZED CHROMATOGRAM OF REMOGLIFLOZIN AND TENELIGLIPTIN

TABLE 2: SYSTEM SUITABILITY RESULT

Variables	Remogliflozin	Teneligliptin
Plates number	3069	10986
Tailing	1.15	1.06
Resolution	-	19.14
Elution time of peak	2.719	7.337

Specificity: There was no participation from Remogliflozin and Teneligliptin at the elution time. As seen in **Fig. 4** the blank chromatogram ispresent.



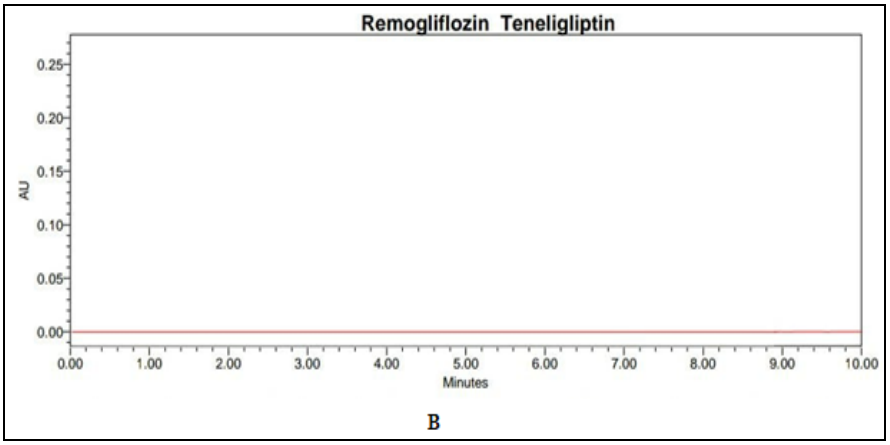


FIG. 4: CHROMATOGRAM OF REMOGLIFLOZIN AND TENELIGLIPTIN (A) BLANK (B) PLACEBO

Linearity: Using a calibration curve to determine the linearity of the peak area, its corresponding concentration was discovered. This graph shows that the range of 25- 150 µg/mL of Remogliflzin and 2.5-15 µg/mL of Teneligliptin had a straight line. For Remogliflzin, the equations of regression were Y = 20111.48x + 42555.07(R^2= 0.9996) and Y = 50153.8x + 2021.07 (R^2 = 0.9998) for Teneligliptine, respectively. Linearity results were demonstrated in **Table 3.**

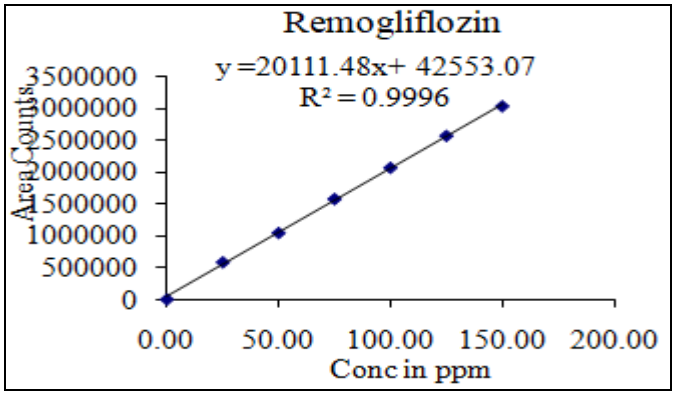


FIG. 5: LINEARITY OF REMOGLIFLOZIN

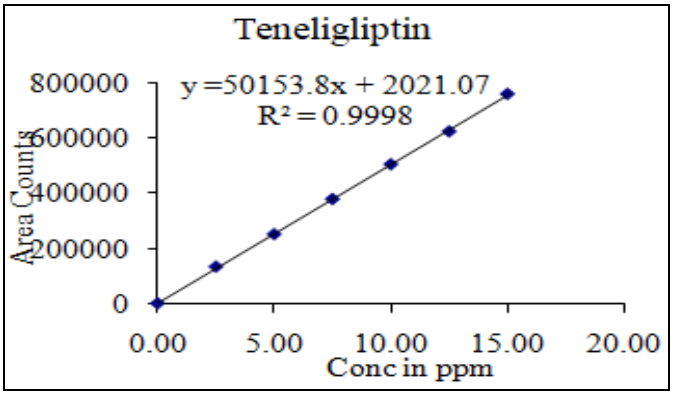


FIG. 6: LINEARITY OF TENELIGLIPTIN

TABLE 3: LINEARITY RESULTS

S. no.	Remogliflozin		Teneligliptin	
	Concentration (µg/mL)	Region	Concentration (µg/ml)	Region
1	25.00	581295	2.50	132642
2	50.00	1042112	5.00	250583
3	75.00	1573748	7.50	378124
4	100.00	2065157	10.00	504016
5	125.00	2564676	12.50	622954
6	150.00	3029409	15.00	758903
Slope	20111.48		50153.80	
Intercept	42553.07		2021.07	
CC	0.99966		0.99989	

Precision: Intraday and intermediate precision variances were assessed about the procedure's accuracy. The samples were examined six times on the same day to obtain intraday results for Remogliflzin and Teneligliptin. The system's intermediate precision was explored by analyzing data in the same laboratory using a variety of examiners and tools. It is very accurate, with an RSD percentage of less than 2%. The precise process yielded the best drug recoveries at each additional concentration. **Table 4** shows the method precision results. Intermediate precision results were shown in **Table 5**.

TABLE 4: RESULTS OF METHOD PRECISION

S. no.	Area count of Remogliflozin	Area count of Teneligliptin
1	2034872	504524
2	2024569	509791
3	2012318	505986
4	2054803	502183
5	2026562	503272
6	2035321	507340
Mean	100.3	100.1
Std.dev	0.706	0.55
%RSD	0.7	0.55

TABLE 5: RESULTS OF INTERMEDIATE PRECISION

S. no.	Remogliflozin	Teneligliptin
1	2037912	506183
2	2018345	507796
3	2053701	513923
4	2047263	509457
5	2014197	503972
6	2025549	501149
Mean	100.4	100.4
Std dev	0.814	0.873
% RSD	0.81	0.87

Accuracy: Three stages of recovery tests were measured the method's precision was reached (50%, 100% and 150%). Active pharmaceutical ingredients were made with strengths of Remogliflzin of 50, 100 and 150 micrograms/mL and Teneligliptin of 5, 10 and 15 micrograms/mL. For each stage of the spike, injected the test solution three times & the test process carried out the assay. In addition to determining the percentage of recovered data, the mean and relative standard deviations have also been found. The strategy was effective because the recovery values fell within the target range. **Table 6 & 7** presents the accuracy results.

TABLE 6: RECOVERY STUDIES OF REMOGLIFLOZIN

Accuracy-Remogliflzin				
Level in %	**Added Amount (mg)**	**Recovered Amount (mg)**	**Recovery %**	**Average % Recovery**
	50	50.52	101.0	100.2
	50	49.52	99.0	
50	50	50.32	100.6	
	100	100.19	100.2	
	100	98.94	98.9	
100	100	101.26	101.3	
	150	149.52	99.7	
	150	152.28	101.5	
150	150	149.47	99.6	

TABLE 7: RECOVERY STUDIES OF TENELIGLIPTIN

Accuracy-Remogliflzin				
Level in %	**Added Amount (mg)**	**Recovered Amount (mg)**	**Recovery %**	**Average % Recovery**
	5	5.01	100.2	100
	5	4.98	99.6	
50	5	5.03	100.6	
	10	10.04	100.4	
	10	10.08	100.8	
100	10	9.96	99.6	
	15	15.02	100.1	
	15	14.88	99.2	
150	15	14.96	99.7	

LOD and LOQ: The concentration level at which the analytes are reliably detected and quantified is the limit of detection and quantification. Remogliflzin and Teneligliptin had a LOD

concentration of 0.3µg/ml, 0.03 µg/ml, and their signal-to-noise values of 3.3. The limit of quantification concentrations of Remogliflzin & Teneligliptin was one microgram per milliliter, 0.1 micrograms per milliliter, and their signal-to-noise values were 10:1.

Robustness: To ensure the robustness of the chromatographic technique, the researchers evaluated the flow rate and the composition of the mobile phase.

Changing the flow rate and mobile phase ratio changes the area of drugs. So, the percentage of relative standard deviation changes. In Table 8 (robustness results), the %RSD values are within the acceptable limit.

TABLE 8: OUTCOMES OF ROBUSTNESS

Degradation	% Deg of Remogliflozin	% Deg of Teneligliptin
Control	0	0
Acid	13.4	13.7
Alkali	14.8	12.9
Peroxide	16	15.3
Thermal	11.7	10.8
Reduction	4.8	3.3
Photo	2.5	4
Hydrolysis	0.9	0.5

Stress Testing: The proposed approach can be used for successful evaluations of release and stability tests, and it can be called a preferable stability technique. Acid, Alkali, peroxide, reduction, photo, and heat degradation are all included in the ICH-required stress testing analysis. The chromatograms show that the selected drugs remained stable under the stress conditions, despite the presence of degraded peaks. Results of forced degradation were given in **Table 9.** Stress testing chromatograms were shown in **Fig. 7, 8 & 9.**

TABLE 9: RESULTS OF FD

Drug Name	Flow Plus (1.1ml/min) %RSD	Flow Minus (0.9ml/min)%RSD	OrganicPlus (50:50) %RSD	Organic Minus (30:70) %RSD
Remogliflozin	0.44	0.8	1.31	0.99
Teneligliptin	0.4	0.32	0.21	0.1

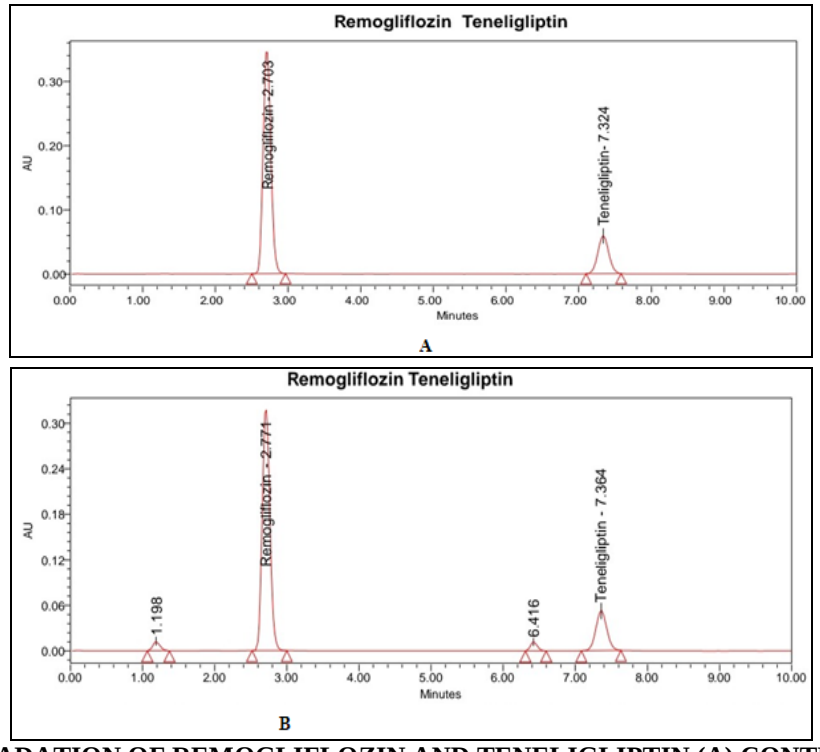


FIG. 7: DEGRADATION OF REMOGLIFLOZIN AND TENELIGLIPTIN (A) CONTROL (B) ACID

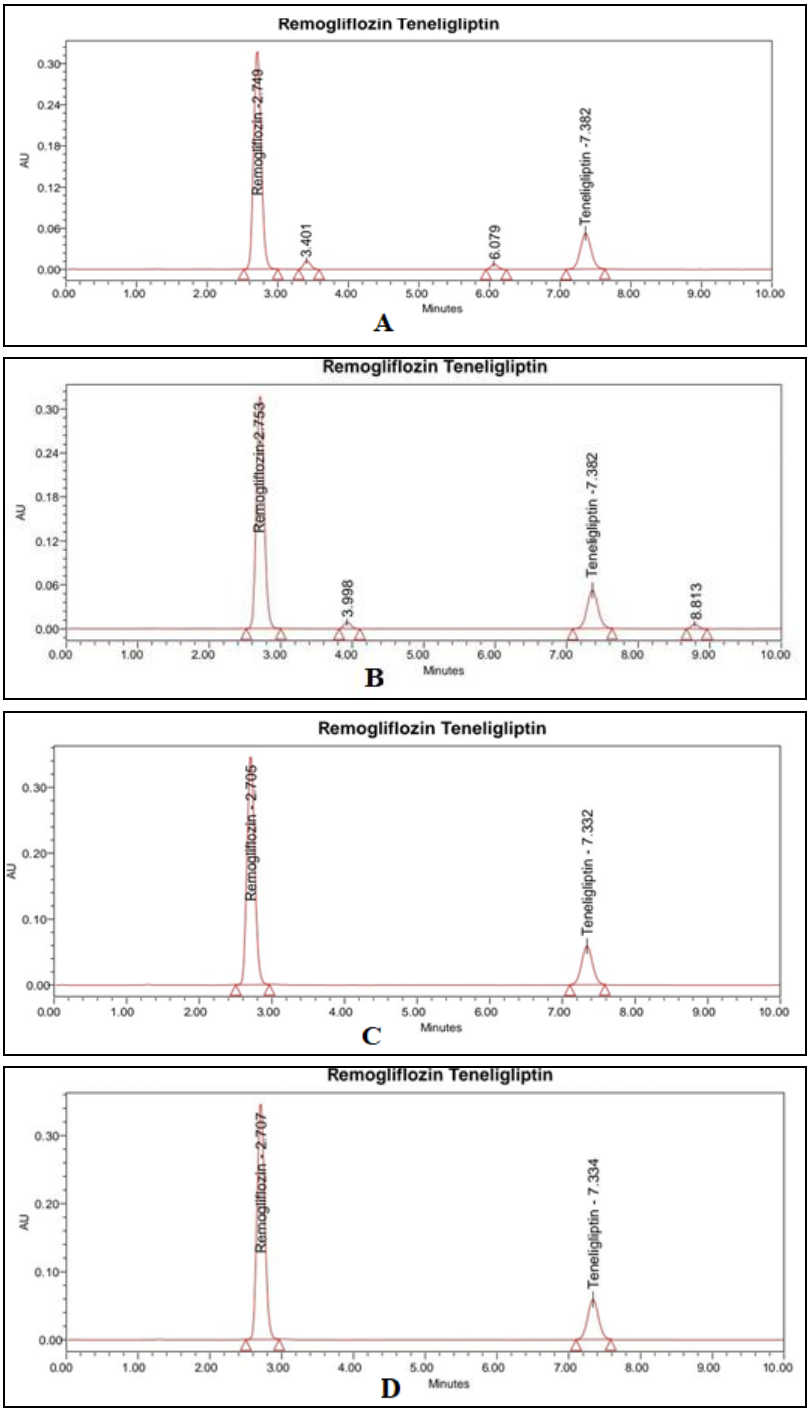


FIG. 8: DEGRADATION OF REMOGLIFLOZIN AND TENELIGLIPTIN (A) ALKALI (B) THERMAL (C) REDUCTION (D) PHOTO

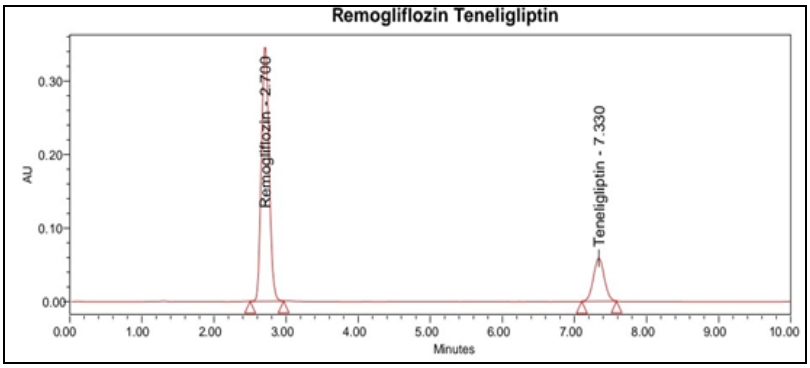


FIG. 9: HYDROLYSIS DEGRADATION OF REMOGLIFLOZIN AND TENELIGLIPTIN

Acid Degradation: Sample stock solution 5 ml was transferred to 50 ml VF, which was then filled with one milliliter of 1N hydrochloric acid and held for fifteen minutes. After fifteen minutes, add one milliliter 1N sodium hydroxide and dilute to the desired strength with solvents. Then it was introduced into HPLC instrument.

Alkali Degradation: Sample stock solution 5 ml was transferred to 50 ml VF, one milliliter of 1N sodium hydroxide was added and held for fifteen minutes. After fifteen minutes, add 1N hydrochloric acid and dilute to the desired strength with diluents. Then it was injected into the HPLC system.

Peroxide Degradation: Transfer 5 ml of sample to a fifty milliliter VF and add one milliliter of thirty percent peroxide solution. After 15 min make up to the mark with diluent. Then it was introduced into HPLC instrument.

Reduction Degradation: Sample stock solution 5 ml was transferred into fifty milliliter VF, add one milliliter of NaHSO4 solution and dilute to the desired strength with solvents. Then it was introduced into the HPLC instrument.

Heat Degradation: The sample stock solution was heated at 105°C for 6 h; the resulting solution was diluted to the desired strength with solvents. Then it was introduced into HPLC instrument.

Photolytic Degradation: The sample solution was exposed to sunlight for 6 h; the resulting solution was diluted to the desired strength with solvents. Then it was introduced into the HPLC instrument.

Hydrolysis Degradation: A sample stock solution of 5 ml was transferred into 50 ml VF, add HPLC water1 ml and dilute to the desired strength with solvents. Then it was introduced into HPLC instrument.

CONCLUSION: For the analysis of Remogliflozin and Teneligliptin in pharmaceutical formulations, the established approach is accurate, precise, and reliable. The uniformity, correctness, reliability, resilience, and forced deterioration of Remogliflozin and Teneligliptin drugs. All the RSDs were less than 2, indicating that the approach is accurate and that the findings obtained by this approach are in good agreement. Moreover, this approach can also be used to improve the pharmaceutical formulation of Remogliflozin and Teneligliptin drugs.

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CONFLICTS OF INTEREST: None

REFERENCES:

1. Zheng Y, Ley SH and Hu FB: Global etiology and epidemiology of type 2 diabetes mellitus and its complications. Nat Rev Endocrinol 2018; 14: 88–98.
2. Saeedi P, Petersohn I, Salpea P and Malanda B: Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045. Results from the International Diabetes Federation Diabetes Atlas. Diabetes Res. Clin. Pract. Nineth Edition 2019; 157: 107843.
3. Bhanu Biswas, Manish Kumar, Jaya Bharathi Sharma, Vipin Saini and Shailendra Bhatt: Method development and validation for estimation of Teneligliptin in tablet dosage form by RP-HPLC. Research J Pharm and Tech 2020; 13(4):
4. Abdul-Ghani MA, Puckett C, Triplitt C, Maggs D, Adams J, Cersosimo EA and DeFronzo R: Initial combination therapy with metformin, pioglitazone and exenatide is more effective than sequential add-on therapy in subjects with new-onset diabetes. Results from the Effificacy and Durability of Initial Combination Therapy for Type 2 Diabetes (EDICT). Diabetes Obes Meta 2015; 17: 268–75.
5. American Diabetes Association. 9. Pharmacologic approaches to glycemic treatment: Standards of medical care in diabetes-2020. Diabetes Care 2020; 43: 98–110.
6. Mohan V, Mithal A, Joshi SR, Aravind SR and Chowdhury S: Drug Design, Development and Therapy 2020; 14: 2487. doi.10.2147/DDDT.S221093
7. Drug profile for remogliflozine. http://pubchem.ncbi.nlm.nih.gov
8. Waller DG, Sampson AP, Renwick AG and Hiller K: Medical pharmacology and therapeutics 4th Edn 457.
9. Tripathi KD: Essential of medical pharmacology; 7th edn; Jaypee brother's medical publisher PVT. LTD. New Delhi, 2013; 258.
10. Elizabeth K Hussey, Anita Kapur, Robin O Connor Semmes, Wenli Tao. Safety, pharmacokinetics and pharmacodynamics of remogliflozin etabonate, a novel SGLT2 inhibitor and metformin when co-administered in subjects with type 2 diabetes mellitus. BMC Pharmacol Toxicol 2013; 1: 625-634.
11. Mikhail Nasser, 2015. Remogliflozin etabonate: a novel SGLT2 inhibitor for treatment of diabetes mellitus. Expert Opin Investig Drugs 24, 1381-7.
12. Yoshida T, Akhashi F, Sakashita H, Kitajima H, Nakamura M, Sonda S, Takeuchi M, Tanaka Y, Ueda N, Sekiguchi S, Ishige T, Shima K, Nabeno M, Abe Y, Anabuki J, Soejima A, Yoshida K, Takashina Y, Ishii S, Kiuchi S, Fukuda S, Tsutsumiuchi R, Kosaka K, Murozono T, Nakamaru Y, Utsumi H, Masutomi N, Kishida H, Miyaguchi I and Hayashi Y: Discovery and

preclinical profile of teneligliptin (3-[(2S,4S)-4-[4-(3-methyl-1-phenyl-1H-pyrazol- 5-yl)piperazin-1-yl]pyrrolidin-2-ylcarbonyl]thiazolidine): a highly potent, selective, long-lasting and orally active dipeptidyl peptidase IV inhibitor for the treatment of type 2 diabetes. Bioorg Med Chem 2012; 20: 5705- 5719.

13. Kishimoto M: Teneligliptin: a DPP-4 inhibitor for the treatment of type 2 diabetes. Diabetes Metab Syndr Obes 2013; 6: 187-195.
14. Manjusha K and Barhate V. Spectrophotometric Determination of an Anti-Diabetic Drug Teneligliptin Bulk and Pharmaceutical Formulations. World Journal of Pharmaceutical Research 2016; 5(5): 1625-1632.
15. Chandana M, Prasad R, Samrajyam B and Naga P: Analytical Method Development and Validation of Teneligliptin In Pharmaceutical Dosage Form By RP-HPLC Method. JHSN 2017; 1(12): 1-12.
16. Goda M and Kadowaki T: Teneligliptin for the treatment of type 2 diabetes. Drug today (Barc) 2013; 49: 615–29.
17. Ideta T, Shirakami Y, Miyazaki T, Kochi T, Sakai H, Moriwaki H and Shimizu M: The dipeptidyl peptidase-4 inhibitor teneligliptin attenuates hepatic lipogenesis *via* AMPK activation in non-alcoholic fatty liver disease model mice. Int J Mol Sci 2015; 16: 29207–18.
18. Bhatkar TV, Badkhal AV and Bhajipale NS: Stability indicating RP-HPLC method development and validation for the estimation of remogliflozin etabonate in bulk and pharmaceutical dosage form. International Journal of Pharmaceutical Research 2020; 12: 160-9.
19. Dimal A. Shah, Ishita I. Gondalia, Vandana B. Patel, Ashok Mahajan and Usmangani K. Chhalotiya: Stability indicating liquid chromatographic method for the estimation of remogliflozin etabonate. J Chem Metrol 2020; 14: 125-32.
20. Vidhi Dave and Patel Paresh: Method development and Validation of UV Spectrophotometric estimation of Remogliflozin Etabonate in bulk and its tablet dosage form. Res J of Pharmacy and Technolo 2021; 14: 2042-4.
21. Dimal AS, Ishita IG, Vandana BP, Ashok M, Usmangani C and Dhruti CN: Stability indicating thin-layer chromatographic method for estimation of antidiabetic drug Remogliflozin etabonate. Future Journal of Pharmaceutical Sciences 2021; 7: 1-12.
22. Patel VA, Pandya CV, Patel ZJ, Patel DR and Pandya AC: Development and validation of novel rp-UHPLC/ DAD methods for simultaneous quantification of Remogliflozin and Metformin in bulk and formulation. Rasaya J Chem 2021; 14(2): 1384-1393.
23. Polli JW, Humphreys JE, Harmon KA, Webster LO, Reese MJ and MacLauchlin CC: Assessment of Remogliflozin etabonate, a sodium dependent glucose co-transporter-2 inhibitor, as a perpetrator of clinical drug interactions: A study on Drug transporters and metabolic enzyme. J Diabetes Metab 2021; 3(5): 1-8.
24. Amit MS, Kiran KD and Varsha AR: A simple UV spectrophotometric method development and validation of teneligliptin in tablet dosage form. Indo Am J Pharm Res 2016; 6: 14-21.
25. Manjusha DK and Barhate VD: Spectrophotometric determination of an anti diabetic drug Teneligliptin bulk and pharmaceutical formulations. W J Pharm Res 2016; 5: 1625-1632.
26. Atul TH, Rathod EA, Gupta KR and Umekar MJ: HPLC and UVspectrophotometric estimation of Teneligliptin from tablet dosage form. J Pharm Biomed Anal 2016; 4: 148-156.
27. Shinde VC, Aher KB, Bhavar GB, Kakad SJ and Chaudhari SR: Development and validation of UV spectrophotometric method and high performance thin layer chromatographic (HPTLC) method for estimation of teneligliptin hydrobromide in pharmaceutical preparation. Der Pharm Lett 2016; 8: 291-301.
28. Ganeshkumar TNV, Vidyadhara S, Niteen AN, Saisilpa Y and Rajyalakshmi M: Method development, validation, and stability studies of teneligliptin by RP-HPLC and identification of degradation products by UPLC tandem mass spectroscopy. J Anal Sci Tech 2016; 7: 18-23.
29. Chandana M, Prasad Rao M, Samrajyam B, Sireesha KSKD and Naga Premi VV: Analytical method development and validation of teneligliptin in pharmaceutical dosage form by RP-HPLC method. J Heal Sci Nur 2016; 1: 1-12.
30. Shailesh VL, Kamna RP, Jani GK and Sachin BN: Simultaneous estimation of teneligliptin hydrobromide hydrate and its degradation product by RPHPLC method. J Pharm Sci Biosci Res 2016; 6: 254-261.
31. Mahesh Attimarad, Venugopal KN and Chohan H Muhammad: An experimental design approach to quantitative expression for quality control of a multicomponent anti diabetic formulation by the HILIC method. Molecules 2022; 27(10): 3135-3152.
32. Chunduri RHB and Dannana G: Development and validation of LC-MS/ MS method for quantification of teneligliptin in human plasma and its application to a pharmacokinetic study. W J Pharm Pharm Sci 2016; 5: 833-850.

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