WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.453
Volume 14, Issue 23, 772-789. Research Article ISSN 2277–7105

ANALYTICAL METHOD DEVELOPMENT AND VALIDATION FOR THE SIMULTANEOUS DETERMINATION OF METFORMIN HYDROCHLORIDE AND DAPAGLIFLOZIN BENZOATE BY RP-HPLC METHOD IN TABLET DOSAGE FORM

Vijayamirtharaj Ramaswamy*, Harsha Vardhinee Kandasamy, Kalai Selvi Ponnusamy, Chithra Manickam, Senthil Kumar Natesan

Department of Pharmaceutical Analysis, JKKMRF-Annai J.K.K Sampoorani Ammal College of Pharmacy, Komarapalayam, Namakkal, Tamil Nadu, India. (Affliated to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India).

Article Received on 27 Oct. 2025,
Article Revised on 17 Nov. 2025,
Article Published on 01 Dec. 2025,

https://doi.org/10.5281/zenodo.17746094

***Corresponding Author**

Vijayamirtharaj Ramaswamy

Department of Pharmaceutical Analysis, JKKMRF-Annai J.K.K Sampoorani Ammal College of Pharmacy, Komarapalayam, Namakkal, Tamil Nadu, India. (Affliated to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India).

How to cite this Article: Vijayamirtharaj Ramaswamy*, Harsha Vardhinee Kandasamy, Kalai Selvi Ponnusamy, Chithra Manickam, Senthil Kumar Natesan. (2025). Analytical Method Development And Validation For The Simultaneous Determination of Metformin Hydrochloride And Dapagliflozin Benzoate By Rp-Hplc Method In Tablet Dosage Form. World Journal of Pharmaceutical Research, 14(23), 772–789.

ABSTRACT

The objective of this study was to develop a new simple, rapid, sensitive, and validated reversed phase-high performance liquid chromatography (RP-HPLC) method for the simultaneous estimation of Metformin Hydrochloride and Dapagliflozin Benzoate in tablet dosage form. By utilizing RP-HPLC, this method fills a gap in the existing literature. Optimizing various parameters of the chromatographic process was key to developing an effective method for separating and detecting drugs. International guidelines and regulatory requirements were followed for the validation of the method, including specificity, linearity, accuracy, Precision, robustness, and suitability for the system. For analysis of mixed solutions containing Metformin Hydrochloride and Dapagliflozin benzoate, a Chromatographic separation was achieved on a Phenomenex C 18 column (150x4.6mm), 5µm, a mobile phase ratio consisting of Buffer: ACN: Methanol (30:5:65) at flow rate 1.2 ml/min, and total run time 8 min, The injection volume 20µl. The detection wavelength is 249nm. Approximately 2000 plates were found, indicating a successful chromatographic

separation. With a tailing factor of less than 2 and a well-resolved peak, the peaks appear symmetrical and well-resolved. In order to ensure there were no interfering peaks, retention times for Metformin Hydrochloride and Dapagliflozin benzoate were found to be 2.078 and 3.238 min. As for Metformin Hydrochloride, the correlation coefficient (R^2) is 0.9993 and Dapagliflozin benzoate is 0.9996. This indicates a good linear relationship between drug concentrations and peak areas based on the high correlation coefficients. For Metformin Hydrochloride and Dapagliflozin benzoate, the %RSD values were 0.09% and 1.42%, respectively, below the acceptable limit of 2%. As a result, the method is accurate and repeatable. In the study of Metformin Hydrochloride, the mean percent recovery was 100.09%, while in the study of Dapagliflozin benzoate, the mean percent recovery 100.34%. Under varied conditions, both Metformin Hydrochloride and Dapagliflozin benzoate showed %RSD values within the Acceptable range of 2%, demonstrating the robustness and reliability of the method. This Study concluded that valuable insight is provided into the use of validated RP-HPLC methods in this study, which contributes significantly to the evolution of pharmaceutical analytical techniques.

KEYWORDS: Metformin Hydrochloride and Dapagliflozin benzoate, RP-HPLC, Method development, Method validation.

INTRODUCTION

Metformin **(Figure 1)** (also referred to as Glucophage) is a biguanide-class oral anti-diabetic. It is the first-line medicine for the treatment of type 2 diabetes, particularly for overweight and obese individuals. There is also emerging evidence for its usefulness in gestational diabetes, while safety issues still prevent widespread usage in this situation. It turns on the AMP-activated protein kinase (AMPK). It is used to treat polycystic ovarian syndrome and has been studied for other disorders where insulin resistance is a contributing factor.[1]

Dapagliflozin **(Figure 2)** is given as a crystalline solid. Dapagliflozin decreases renal glucose reabsorption through the solid-glucose cotranspoter (SGLT) and provides an insulin-free option for regulating blood glucose levels in type 2 diabetic patients. Dapagliflozin is a first-generation SGLT inhibitor that selectively targets SGLT2 over SGLT1. Dapagliflozin is a first-generation SGLT inhibitor that selectively targets SGLT2 over SGLT1.[2]

Metformin HCL and Dapagliflozin are used to treat type 2 diabetes. The combined mode of action of Metformin HCL and dapagliflozin, as well as their outstanding efficacy and safety

profiles, support the utilization of this fixed-dose combination as a therapeutic option for T2DM patients.

The literature review reveals that several methods have been reported for estimating Metformin HCl and Dapagliflozin benzoate alone or in combination with other drugs in their pharmaceutical dosage forms, but none of these methods are available for estimating these drugs in the selected pharmaceutical dosage form. In the investigation of formulations containing two or more pharmaceuticals, one drug may interfere with the estimation of another. To avoid this, component combinations frequently separate by extraction, which makes the process timeconsuming, difficult, and often inaccurate. As a result, it was considered worthwhile to create an analysis approach capable of estimating both medications in combination without the need for separation. As a result of the literature review, it was believed to design a precise, accurate, easy, and reliable method for estimating medication in tablets utilizing the following technology of RP HPLC method for Metformin HCl and Dapagliflozin benzoate. The technique was confirmed, and recovery tests were undertaken using ICH criteria and many statistical metrics.[3]

MATERIALS AND METHODS

Chemicals and Reagents

Acetonitrile, Di – Sodium Hydrogen ortho Phosphate (AR Grade), Ortho phosphoric acid (AR Grade), Water and Methanol of HPLC grade were obtained from S.D. Fine Chemicals Pvt. Ltd., India, Sigma - Aldrich Chemicals Pvt. Ltd. Pharmaceutical grade Metformin HCL + Dapagliflozin benzoate Zydus Medica Healthcare Pvt. Ltd (Dapaglyn M– MET PLUS 10mg/ 500mg), Zydus MEDICA Pvt. Ltd., Gujarat, India respectively.

Instruments

The analysis was performed by using the Shimadzu digital electronics balance, pH meter - Elico Pvt. Limited, India, Jasco V-600 UV/ Vis- spectrophotometer, Shimadzu HPLC Prominence *i* LC – 2030 liquid chromatograph system with UV – VISIBLE detector and auto sampler injector. Chromatograms were recorded and integrated on PC installed with Lab solutions chromatographic software. Shimadzu liquid chromatograph equipped with LC – 10 AT VP pump, SPDM10A VP diode array detector and rheodyne 7725 *i* injected with a 20 µl loop. Chromatograms were recorded and integrated on PC installed with LC solutions chromatographic software.

Chromatographic Conditions

Waters Corporation (Milli – Q -Water) was used for method development, forced degradation and method validation. This system is comprised of a ternary gradient pump and auto sampler (2487 Separation module), column oven and a photo diode array detector. Inspire (4.6 x 150mm, 5µm) column was used. The instrumental settings were a flow rate of 1 mL/min, a column temperature at 40°C and a detector wavelength of 260 nm. The injection volume was 10 µL. Data acquisition was made with the software PC 1000 (Thermo Separations Products, Riviera Beach, FL).

REAGENTS AND SOLUTIONS

Preparation of Mobile Phase

a. Selection of mobile phase

Solvent type, solvent strength, strength of buffer and optimum pH were optimised to get the chromatographic conditions that gave best separation.

The mobile phase was made up of buffer and acetonitrile in a 30:70 ratio (v/v). The pH of the mobile phase was adjusted to 3.0 using sodium hydroxide. The buffer employed in the mobile phase consisted of 0.1% of orthophosphoric acid in double-distilled water. The mobile phase was premixed, filtered using a 0.45-µm filter, and degassed.

b. Preparation of stock solution

500mg of Metformin HCL and 10 mg of Dapagliflozin benzoate were accurately weighedand transferred in to a separate 50 ml volumetric flask and sufficient mobile phase was added to dissolve the drug. The final volume was made up to 50 ml with mobile phase (primary stock solution). Pipette out 2ml from the above stock solution into a 50mlvolumetric flask and the final volume was made up to the mark with the mobile phase.

Preparation of Sample solution

20 tablets were weighed and powdered, tablets powder equivalent to 500mg of Metformin HCL and 10 mg of Dapagliflozin benzoate was transferred in to a 50 ml volumetric flask, sufficient amount of mobile phase was added and dissolved by 20 minutes ultrasonication. Then made the volume up to the mark with the mobile phase and filtered with 0.45 µ filter paper. Pipette out 2 ml from the above solution and diluted to 50ml withthe mobile phase.

Recording the chromatogram

A steady baseline was recorded with the fixed chromatographic conditions and 20 µg of standard drug solutions and sample solutions were injected and chromatograms were recorded. Calibration curve was plotted using the standard drug peak area versus concentration of standard solutions.

METHODS DEVELOPMENT[4-21]

The developed method was fully validated for the parameters as per ICH guidelines.

System suitability

A standard solution was prepared by using Metformin HCl and Dapagliflozin benzoate working standards as per test method. The working standard solution was injected 5 times into the HPLC; chromatograms were recorded and measured the responses for the major peaks. System suitability parameters such as retention time, theoretical plates and asymmetric factor.

Linearity

Linearity is achieved through a series of standards. Appropriate volume from the stock solution was diluted to get the final concentration of 200, 300, 400, 500, 600 µg/mL for Metformin HCl and 5, 7.5, 10, 12.5, 15 µg/mL for Dapagliflozin benzoate. Then the chromatogram was recorded for each concentration, plot the graph concentration versus area.

Accuracy

This study was performed using a minimum of 3 concentration levels, each intriplicate determinations 75, 100 and 125% from the label claim of metformin HCl and Dapagliflozin was taken in to a 50 ml volumetric flask and sufficient mobile phase was added, sonicated 20 min for dissolving the drugs, final volume was adjusted up to the mark with the mobile phase. Pipette out 2 ml from the above solution into a 100 ml volumetric flask and final volume was adjusted up to the mark with the mobile phase. Calculate the individual recovery and mean recovery values.

Precision

To determine the precision, Repeatability, Intermediate precision and Reproducibility analysis was performed. The standard solution was injected for five times and measured the area for all five injections in HPLC. The %RSD for the area of five replicate injections was

found to be within the specified limits. Precision study was carried out by injecting a sample solution in to HPLC without changing the assay procedure and the results are shown the % RSD is less than 2 % for Metformin HCl and Dapagliflozin benzoate. The low RSD value indicated that the method was precise.

Limit of detection and Limit of quantification

The LOD and LOQ of the developed method were determined by analyzing progressively low concentration of the standard solution using the developed methods. The LOD is the concentration of the analyte that gives a measurable response (signal to noise ratio 3.3). The LOQ is the lowest concentration of the analyte, which gives a response that can be accurately quantified (signal to noise ratio of 10). The determination of the limit of quantification is carried by minimum concentration at which the analyte can reliably be quantified is established.

Stability

The standard drug solutions were subjected to stability studies under room temperature. it was determined by keeping the drug solution for 3 days at room temperature. The chromatogram was recorded by injecting the sample solution at once per day and calculated the amount of drug present. Stability of solutions were analysed by looking for any changes in retention time, resolution, peak shape etc.

Robustness

The concept of robustness of an analytical procedure has been defined by the ICH as a measure of its capacity. Robustness of the method were determined by changing the method parameters (wavelength ± 1nm from 1nm, Flow rate ± 0.1, pH ± 0.05 and the mobile phase ratio ± 2 %).

Specificity (forced degradation studies)

Sample degradation is also a technique for assessing specificity by deliberately degrading the sample and to look for the appearance of other peaks in the chromatogram. Here, the drugs were subjected to acid degradation (0.5 N HCl), base degradation (0.5 N NaOH), oxidative degradation (3% H2O2) and neutral conditions to achieve 10 to 20% degradation from the initial material.

RESULT AND DISCUSSION

The present study aimed to create a new RP-HPLC method for separating and quantifying Metformin HCl and Dapagliflozin benzoate in bulk and pharmaceutical dosage forms. A wavelength of 249 nm was selected for the study. It was found that a system comprising of Buffer: ACN: Methanol in the ratio of 30:5:65 which gave good resolution and peak characteristics. The column used was Phenomenex C 18 column (150x4.6mm,) particle size 5µm with flow rate of 1.2 ml/min with pH adjusted to 3.5 using UV detection at 249 nm.Various mobile phase compositions were tested. However, Trail 6 was Metformin HCl and Dapagliflozin benzoate are eluted at 2.078 and 3.238 respectively, efficiency parameters are indicate the good separation, asymmetric. So this method was selected for further analysis. In RP-HPLC method, optimizations of different chromatographic parameters like selection of chromatographic method, detection wavelength, selection of mobile phase, mobile phase ratio, etc., were done.

1. System suitability

System suitability tests were carried out on a freshly prepared standard solution of the MET and DAP to scrutinize the various optimized parameters. System suitability parameters like plate number (N), tailing factor (Tf), capacity factor (k`), resolution (Rs) and relative standard deviation of peak area for repetitive injections were studied and it was found that the values were within the limits. Results are shown in (Table no. 1)

2. Linearity

From the linearity studies, specified concentration levels were determined. Metformin hydrochloride was found to be linear in the concentration range of 200 to 600 µg/ml. Dapagliflozin benzoate was found to be linear in the concentration range of 5 to15 µg/ml. Each set was analyzed to plot a calibration curve. Standard deviation (SD), slope, intercept and coefficient of determination (r 2) of the calibration curves were calculated to ascertain linearity of the method. Results are shown in (Fig. 3- 4)

3. Accuracy or Recovery

Accuracy is represented and determined by recovery experiments. Recovery studies were carried out at 75%, 100% and 125% levels. Good recovery values show that the method is free from interferences. Accuracy was evaluated by determining the analyte in solution sprepared according to the standard addition method and expressed in terms of percentage

recoveries of MET and DAP from the real samples. Results are shown in (Table no. 2 & Fig. 5- 7).

4. Precision

The precision evaluated at the repeatability of the method was studied by calculating the relative standard deviation (RSD). All precision results were summarized in (Table 3)

a). Repeatability: This study was performed with a minimum of three replicate measurements of sample solution at 0 hrs, 8 hrs and 16 hrs in a same day.

b). Intermediate precision: Intermediate precision was performed by injecting the sample solution in to HPLC at three different days, different analysts and in different instruments.

c). Reproducibility: Reproducibility studies were done in two laboratories and the results were compared.

5. Determination of the Limits of Detection and Quantitation:

The LOD and LOQ of the developed method were determined by analyzing progressively low concentration of the standard solution using the developed methods. The LOD is the concentration of the analyte that gives a measurable response (signal to noise ratio 3.3). The LOQ is the lowest concentration of the analyte, which gives a response that can be accurately quantified (signal to noise ratio of 10). LOD and LOQ of Metformin HCl and Dapagliflozin benzoate were found to be 359.561 ng/mL, 84.037 ng/mL and 108.958 ng/ml, 254.658 ng/m (Table 5).

6. System Suitability Study

Stability of drug solution was determined by keeping the drug solution for 3 days at room temperature. The chromatogram was recorded by injecting the sample solution at once per day and calculated the amount of drug present. There is no significant degradation was observed. The stability test results (Table 6) are indicating the drug solutions are stable up to 3 days at room temperature.

7. Robustness

Robustness of the method were determined by changing the method parameters (wavelength ± 1nm from 1nm, Flow rate ± 0.1 (Chromatogram no. 33-36), pH ± 0.05 andthe mobile phase ratio ± 2 %), the results were presented in Table 4. Based on the results of these studies show, the small changes made to the method procedure, but it willnot affect the method results so this method is robust. the results are present in the (Table – 7& Fig. 8- 11).

8. Assay

Sample solution was prepared according to the above described procedure. Then the solution was injected in to the HPLC and calculated the amount of Metformin HCl, Dapagliflozin benzoate present in the each tablet by using the above mentioned formula, results are present in the (Table – 8,9 & Fig. 12- 17)

Tablet no. 1: System suitability parameters.

S. No	MET Area	DAPA Area	MET Theoretical plates	DAPA Theoretical plates	MET Tailing factor	DAPA Tailing factor
1	4208745	400587	3568.305	4836.127	1.276	1.105
2	4208746	396574	3586.231	4836.241	1.285	1.118
3	4198754	398567	3528.97	4863.727	1.256	1.126
4	4184764	397854	3594.212	4758.963	1.274	1.113
5	4207841	399852	3567.422	4698.521	1.293	1.133
AVG	4201770	398686.8	3569.028	4798.716	1.2768	1.119
SD	10397.99	1592.19	25.1889	68.2888	0.01388	0.0109
% RSD	0.247467	0.3993	0.7057	1.4230	1.0872	0.9769

Tablet no. 2: Accuracy (Recovery studies for MET & DAPA).

Concentration (%)	Added AMT amount (mg)		Amt recovered (mg)		Amt recovered (%)	
MET/DAPA	MET	DAPA	MET	DAPA	MET	DAPA
75	375	9.375	374.65	9.394	99.90	100.20
100	500	12.5	495.17	12.649	99.03	101.19
125	625	15.625	621.83	15.487	99.49	99.11

The percentage recoveries of the three concentrations (75 %, 100% and 125%) were found to be close to 100%, indicative of high accuracy of this method.

Table no. 3: Precision results for MET and DAPA.

Parameters	Sampling time	MET			DAPA		
		Amount present (mg)	Amount present (%)	RSD (%)	Amount present (mg)	Amount present (%)	RSD %
Repeatability	0 hrs	495.11	99.02	0.0920	12.62	100.97	1.4542
	8^{th}hrs	499.69	99.93	0.9449	12.37	100.62	0.5498
	16^{th}hrs	503.98	100.79	0.3633	12.60	100.83	0.7566
Intermediate precision	1^{st}Day	504.63	100.92	0.4993	12.55	100.42	0.7712
	2^{nd}day	503.59	100.71	0.3197	12.63	101.06	0.6141
	3^{rd}day	497.53	99.50	0.1257	12.70	101.64	0.1250
	Analyst-1	502.26	100.45	0.1907	12.63	101.07	0.8081
	Analyst-2	504.35	100.87	0.1197	12.61	100.94	0.6498
	Instrument	501.00	100.20	0.7276	12.66	101.30	0.1559

	-1						
	Instrument -2	504.86	100.97	0.1219	12.61	100.94	0.4287

Table no. 4: LOD and LOQ results for MET and DAPA.

S.No	MET	DAPA
1	2056745	188634
2	2057246	187858
3	2058874	187658
SD	1113.106	515.5502
Slope	10215.91	20244.82
LOD(µg/mL)	0.359561	0.084037
LOQ (µg/mL)	0.108958	0.254658

Table no. 5: LOD and LOQ results for MET and DAPA.

S.No	MET	DAPA
1	2056745	188634
2	2057246	187858
3	2058874	187658
SD	1113.106	515.5502
Slope	10215.91	20244.82
LOD(µg/mL)	0.359561	0.084037
LOQ (µg/mL)	0.108958	0.254658

Table no. 6: System Suitability.

Parameters	MET		DAPA	
	Amount present (mg)	Amount present (%)	Amount Present (mg)	Amount Present (%)
Day1	504	98.60	12.65	101.25
Day2	504.38	100.87	12.64	101.17
Day3	503.88	100.77	12.64	101.16

Table no. 7: Robustness.

Parameters		MET			DAPA		
		Amount present (mg)	Amount present (%)	RSD %	Amount present (mg)	Amount Present (%)	RSD %
Wavelength (nm)	248	493.04	98.60	0.1139	12.64	101.16	0.0549
	250	505.57	101.11	0.1237	12.63	101.11	0.0504
FlowRate (mL/min)	1.3	502.87	100.57	0.3725	12.61	100.94	0.4278
	1.1	502.90	100.58	0.7906	12.65	101.23	0.0153
Mobile phase(%of (Methanol)	67	502.99	100.59	0.3907	12.65	101.27	0.1750
	63	504.86	100.97	0.09942	12.58	100.66	0.3853
pH	3.55	498.76	99.75	1.1828	12.64	101.18	0.0634
	3.45	500.30	100.06	1.3808	12.63	101.08	0.0801

Table no. 8: Assay results for MET.

SAM Area	STD Area	Amt present	%Amt present
4257964	4201770	501.7721	100.3544
4287561	4201770	505.2599	101.0517
4287956	4201770	505.3064	101.0612
4281863	4201770	504.5884	100.9176
4178293	4201770	492.3834	98.4766
4187956	4201770	493.5221	98.7044
	AVG	500.4721	100.0944108
	SD	5.977577	1.195515343
	%RSD	1.194388	1.194387712

Table no. 9: Assay results for DABA.

SAM Area	STD Area	Amt present	%Amt present
403156	398687	12.54026	100.3220
406321	398687	12.63871	101.1096
403652	398687	12.55569	100.4454
406328	398687	12.63893	101.1114
401357	398687	12.4843	99.8744
398741	398687	12.40293	99.2234
	AVG	12.54347	100.3477463
	SD	0.091207	0.729659142
	% RSD	0.727131	0.727130573

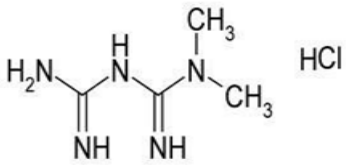

Fig. 1: Metformin Hcl.

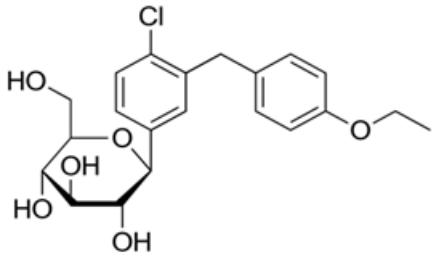

Fig. 2: Dapagliflozin Benzoate.

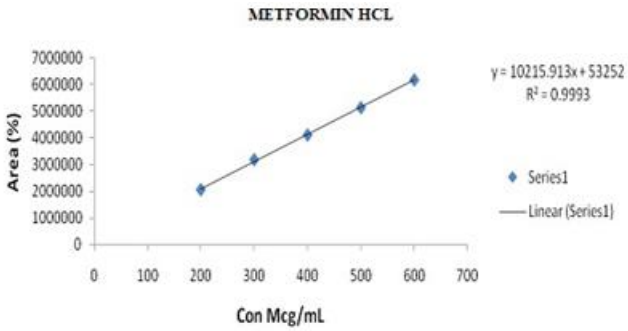

Fig. 3: Linearity of Met and Dapa.

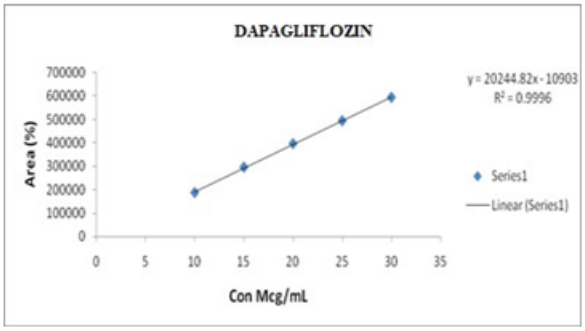

Fig. 4: Linearity of DAPA.

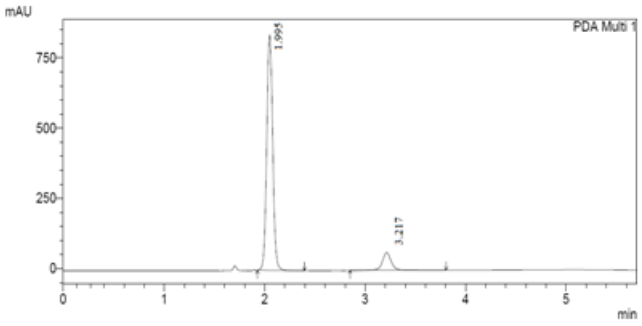

Fig. 5: Accuracy 75%.

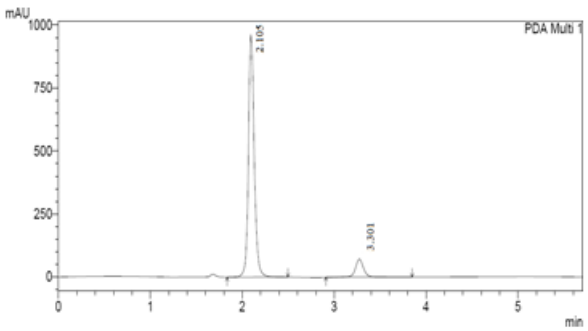

Fig. 6: Accuracy 100%.

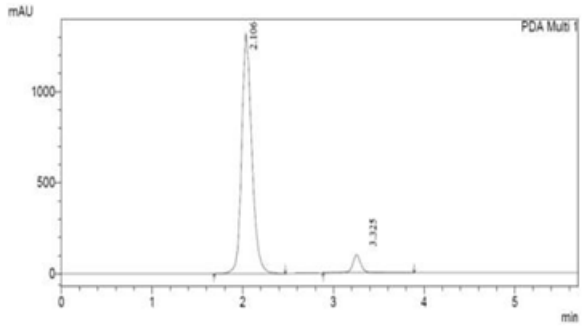

Fig. 7: Accuracy 125%.

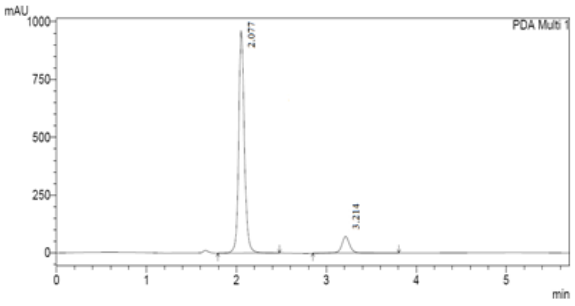

Fig. 8: Robustness–Flowrare–0.1mL/min.

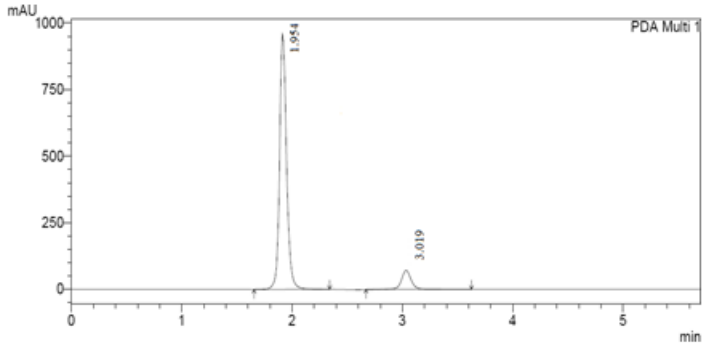

Fig. 9: Robustness–Flowrare+0.1mL/min.

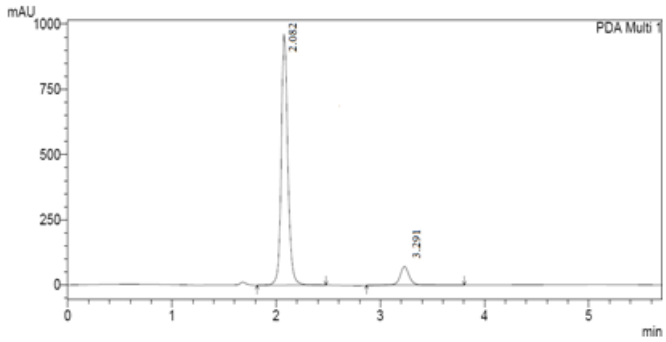

Fig. 10: Robustness–Mobile Phase – 2%.

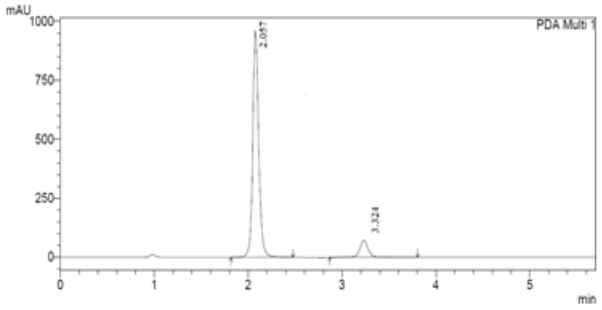

Fig. 11: Robustness–Mobile Phase + 2 %.

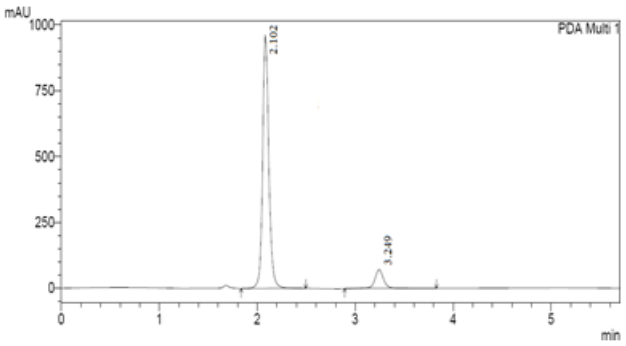

Fig. 12: Assay (Chromatogram of standard 1).

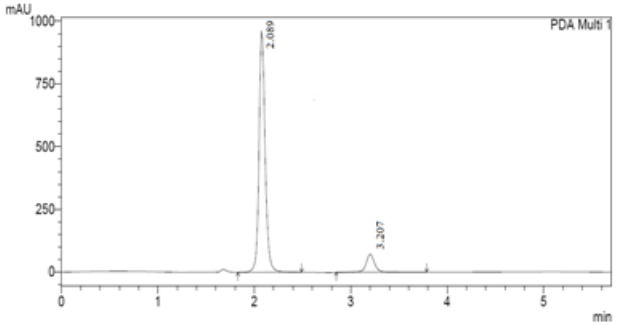

Fig. 13: Assay (Chromatogram of standard 2).

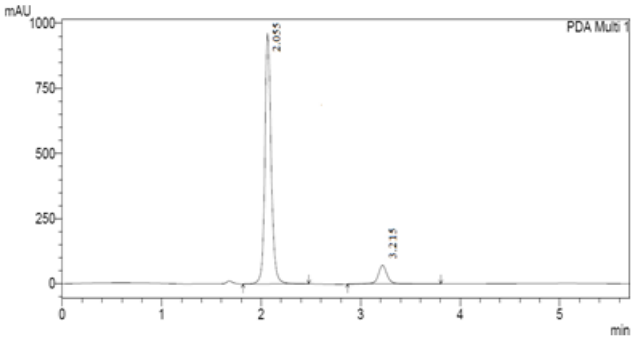

Fig. 14: Assay (Chromatogram of standard 3).

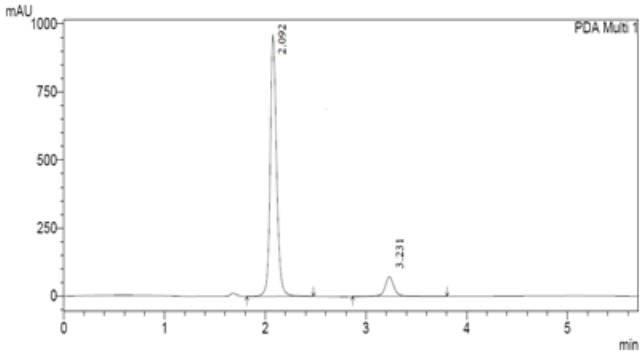

Fig. 15: Assay (Chromatogram of standard 4).

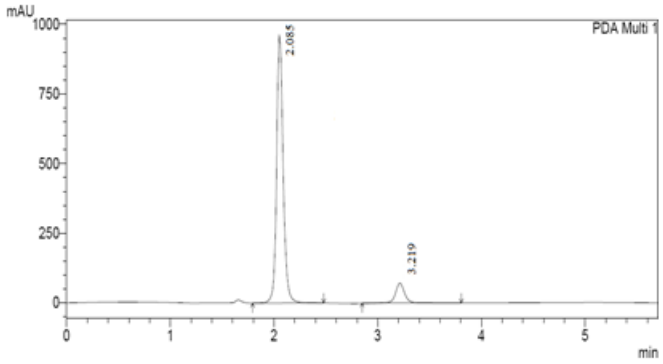

Fig. 16: Assay (Chromatogram of standard 5).

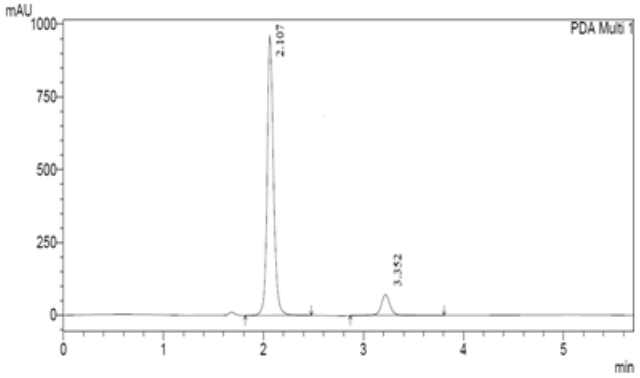

Fig. 17: Assay (Chromatogram of standard 6).

CONCLUSIONS

The technique described above may be applied to the simultaneous measurement of Metformin and Dapagliflozin Benzoate in pharmaceutical dose form. The procedure is validated and demonstrated to be accurate and precise. The validation studies demonstrated that the stability-indicating RP-HPLC technique is simple, mass compatible, accurate, robust, and specific, with no interference from excipients or degradation products. The proposed

approach was successfully used to conduct quantitative analyses of MET and DAPA in tablets. The approach may thus be applied to regular analysis, quality control, and stability investigations of pharmaceutical tablets containing these medicines.

REFERENCE

1. https://go.drugbank.com/drugs/DB00331
2. https://go.drugbank.com/drugs/DB06292
3. ICH: Text and Methodology International Conference on Harmonization. Geneva, Switzerland: International Federation of Pharmaceutical Manufacturers Associations, 2005; Q2(R1). Validation of Analytical Procedures.
4. International Conference on Harmonization (ICH) guideline. Validation of analytical procedures: text and methodology. International Conference on Harmonization, Geneva, Switzerland, 2007; Q2(R1): 1-13.
5. Jitendra Debata, Sundeep Kumar, Sajal Kumar Jha, et al., A New RP-HPLC method Development and Validation of Dapagliflozin in bulk and tablet dosage form. International Journal of Drug Development and Research, Jun. 26, 2017; 9(2): 48-51.
6. Khagga Bhaggasri, Samreen Begum, Thaneru Sureka, et al., RP-HPLC Method for Dapagliflozin and Metformin HCL in Bulk and Combined Formulation. Archives Of Pharmacy Practice, 2021; 12(4): 106-110.
7. Kumara Swamy G, Shruthi S, Rajkumar M, et al., A New stability indicating RP-HPLC method for simultaneous determination of saxagliptin and dapagliflozin in bulk and combined tablet dosage forms. Asian Journal of Pharmaceutical Analysis and Medicinal Chemistry, 2017; 5(3): 113–121.
8. Manoharan G, Ismaiel A M, Ahmed Z M. Stability-indicating RP-HPLC method development for Simultaneous Determination and Estimation of Dapagliflozin in raw and tablet formulation. Chemistry Research Journal, 2018; 3(2): 159-64.
9. Mante G. V, Hemke A. T, Umekar M. J. RP-HPLC Method for Estimation of Dapagliflozin from its Tablet. International Journal of ChemTech Research, 2018; 11(1): 242-248.
10. Meera Devi M, Ankit R. Patel. A Review on Analytical Methods for Estimation of Dapagliflozin and Vilagliptin in Tablet Dosage Form. International Journal of Pharmacy and Pharmaceutical Research, Jan. 2023; 26(2): 334-343.
11. Nikam N, Maru A, Jadhav A, Malpure P. Analytical Method Development and validation of metformin hydrochloride by using RP-HPLC with ICH guidelines. International

Journal of Trend in Scientific Research and Development, 2019; 3(8): 415-419.

12. Pintu Prajapati, Bageshree Rana, et al., Simultaneous Chromatographic Estimation of Vildagliptin and Dapagliflozin Using Hybrid Principles of White Analytical Chemistry and Analytical Quality by Design. Journal of AOAC International, Jan. 4, 2023; 107(1): 212-222.
13. Pontarolo R, Caroline P.U, et al., HPLC-MS/MS Method for the Simultaneous Determination of Vildagliptin, Metformin, and Metformin related compounds in tablets. International Journal of Pharmacy and Pharmaceutical Sciences, 2014; 6(11): 203-207.
14. Priya P, Janki P, Bhumi P, Ankita, et al., Stability Indicating RP-HPLC Method Development and Validation for Simultaneous Estimation Of Dapagliflozin Propanediol Monohydrate and Vildagliptin in Tablet Dosage Form. International Journal Of Creative Research Thoughts, Mar. 3, 2023; 11(3): 696-706.
15. Sadhana B T, Mohite S K, Snehal M, et al., Development and validation of UV Spectrophotometric Methods for Simultaneous Estimation of Voglibose and Dapagliflozin Hydrochloride in bulk and tablet dosage form. Indo American Journal of Pharmaceutical Research, 2023; 13(4): 7018-7024.
16. Sally Nasser, Ismail Salama, Samia M Mostafa, et al., Comparative HPLC and HPTLC study for the Simultaneous Determination of Dapagliflozin and Metformin HCL in Bulk and Pharmaceutical Formulation. Journal of Planar Chromatography - Modern TLC., Dec. 1, 2018; 31(6): 469-476.
17. Sharmila Donepudi, Suneetha Achanta. Simultaneous Estimation of Saxagliptin and Dapagliflozin in Human Plasma by Validated High Performance Liquid Chromatography - Ultraviolet Method. Turkish Journal Of Pharmaceutical Science, Jun. 2019; 16(2): 227.
18. Shveta H. Parmar, Sachin B. Narkhede, et al., Development and Validation of UV-Spectroscopic First Derivative and HPTLC Analytical Methods for Simultaneous Estimation of Dapagliflozin Propanediol Monohydrate and Saxagliptin HCL in synthetic mixture. European Journal of Biomedical and Pharmaceutical Sciences, 2018; 5(5): 668-681.
19. Thiyagaranjan D, Magharla D.D. Stability Indicating HPLC Method for the Simultaneous Determination of Dapagliflozin and Saxagliptin in bulk a tablet dosage form. Current Issues in Pharmacy and Medical Sciences, 2018; 31(1): 39-43.
20. Ujwal Chaudhari, Jagdish K Sahu, Payal R Dande. Analytical Method Development, Validation and Forced Degradation Study of Dapagliflozin by RP-HPLC. Drug Metabolism and Bioanalysis Letters, 2023; 16(2): 140-152.

21. Vishva S. Patel, Pankaj Kapupara, Jitendra O. Bhangale. Stability Indicating RP-HPLC Method For Simultaneous Estimation Of Dapagliflozin and Vildagliptin in Pharmaceutical Dosage Form. European Chemical Bulletin, 2023; 12(9): 1918-1930.