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Original Article

Development and Validation of a Rapid and Sensitive RP-UPLC Method For Quantitative Determination of Glipizide in Pharmaceutical Dosage Forms

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ABSTRACT

Background: A rapid, reliable, efficient, and accurate RP-UPLC method was developed and validated for quantifying Glipizide in commercial samples and tablets. **Materials and Methods:** Separation was achieved using a BEH C18 column (100 × 2.1mm, 1.8µm) with a mobile phase of 50:50 v/v 0.01 N potassium dihydrogen phosphate buffer and acetonitrile, flowing at 1.0 mL/min. Detection occurred at 234 nm. **Results:** Glipizide showed a retention time of approximately 1.25 min with symmetrical peak shapes. The R-squared value (0.999) indicated that this RP-UPLC method is linear throughout the tested concentration range (2.5 - 15 µg/mL). The percent recovery (%) of Glipizide was 99.99%, indicating that the assay was highly accurate. **Conclusion:** Precision investigations also revealed percent RSD values lower than 1%. The LOD and LOQ are 0.05 µg/mL and 0.14 µg/mL. The validated RP-UPLC technique will be used to conduct routine Quality Control analyses of Glipizide tablets in accordance with ICH criteria.

Keywords: Accuracy, Detection, Glipizide, ICH guidelines, Method validation, Separation.

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INTRODUCTION

UPLC is a form of chromatography that offers improved chromatographic performance relative to traditional HPLC in terms of resolution, sensitivity and analysis time.[1,2] The key factors contributing to this improvement include the ability to utilize small particle sized stationary phases (sub-2 µm) and increased pressure limits to enable faster elution and separation of compounds. This makes UPLC a viable analytical option for Pharmaceutical Quality Control, where timely and accurate quantitation of drug substance is required. Due to its high throughput capabilities and lower solvent consumption, UPLC is widely preferred for routine Quality Control, Impurity Profiling, Stability Indicating Studies, Dissolution Testing, and Bio-analytical Studies.[3,4] Glipizide, a second-generation Sulphonylurea Oral Hypoglycaemic Agent, is commonly used to treat Type 2 Diabetes Mellitus. It promotes insulin release from pancreatic beta cells and improves peripheral glucose consumption, which aids in glycemic management. The accurate and precise measurement of Glipizide in pharmaceutical dosage forms is critical to ensuring its quality, safety, and therapeutic efficacy. Although various analytical methods like UV Spectrophotometry and conventional HPLC have been used for Glipizide estimation, they often suffer from long run times, low sensitivity, and high solvent consumption.[5,6]

The development of a quick, sensitive, and dependable reversed-phase ultra-performance liquid chromatography technology is critical for accurately quantifying Glipizide in bulk medication and pharmaceutical dosage forms. The current work aimed to develop and validate a simple, efficient, and reproducible RP-UPLC method for determining Glipizide in compliance with ICH validation requirements. The proposed method provides a cost-effective and high-throughput analytical approach with suitable precision, accuracy, and sensitivity, making it appropriate for routine quality control analysis in pharmaceutical laboratories.[7,8]

METHODOLOGY

Instrumentation

Optimized Chromatographic Conditions

An improved reversed-phase UPLC was used to achieve a satisfactory peak symmetry, resolution and sensitivity in a reasonably short analysis time for the chromatographic separation

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of a Glipizide.[9] A BEH C18 analytical column (100 mm × 2.1 mm, 1.8 µm) at 30°C was used for chromatographic analysis. The mobile phase used was 0.01 N potassium dihydrogen phosphate buffer and acetonitrile (50:50 v/v) at flow rate of 1.0 mL/min. The analyte was monitored at 234 nm with an Acquity TUV detector and the injection volume was 0.30 µL. The optimized method provided efficient separation of Glipizide, producing a distinct and well-defined chromatographic peak with satisfactory system suitability results and reduced retention time. Therefore, the proposed chromatographic conditions support rapid, reliable, and routine estimation of Glipizide in pharmaceutical analysis.[10,11]

Chemicals and Reagents

Acetonitrile which is an analytical-grade product and buffer solution that has been received from HPLC-grade suppliers were both used as solvents for the dissolution of glipizide into a mixture of 50% (v/v) acetonitrile and 50% (v/v) buffer solution.[12,13] Both above-mentioned components were also used as diluents to prepare both standard and sample solutions.

Preparation of Buffer Solution

To make 0.1% orthophosphoric acid buffer, 1 mL of orthophosphoric acid was diluted in 1000 mL of HPLC-grade water.[14] Potassium dihydrogen orthophosphate buffer was made by dissolving 1.36 g potassium dihydrogen orthophosphate in approximately 900 mL of Milli-Q water. Subsequently, 1 mL of triethylamine was added, and the pH was adjusted to 3.0 with dilute orthophosphoric acid. The solution was eventually produced up to 1000 mL with Milli-Q water and mixed uniformly before use.

Standard Stock Solution preparation

Glipizide standard stock solution was made by dissolving 5 mg of correctly weighed Glipizide in diluent in a 50 mL volumetric flask.[15] The solution was sonicated for 10 min to achieve complete dissolution, followed by dilution up to the mark with the same diluent to obtain a final concentration of 100 µg/mL. Working standard solutions were created by serially diluting the stock solution with diluent to yield concentrations ranging from 2.5 to 15 µg/mL.

Preparation of Sample Solution

Five Glipizide tablets were inserted in a volumetric flask containing 50 mL of solvent (diluent). Five Glipizide tablets were precisely metered.[16,17] The Glipizide tablets were dissolved in 50 mL of diluent. The solution was sonicated to remove all of the Glipizide from the pills. The solution was filtered, yielding a sample stock concentration of 100 µg/mL. To make a working sample solution, place one mL of sample stock solution in a 10 mL volumetric flask and dilute to volume with diluent. A final concentration of 10 µg/mL was achieved.

Evaluating System Performance (System Suitability)

Five replicate injections of the working standard solution into the UPLC system were used to assess system suitability.[18] To confirm the effectiveness, accuracy, and performance of the chromatographic system, parameters like retention time, theoretical plates, tailing factor, and percentage RSD of peak area were calculated.

Method Precision

Repeatability

Six duplicate sample solutions were injected at a concentration of 10 µg/mL in order to assess method precision. To evaluate the repeatability of the devised analytical approach, the percentage RSD of the relevant peak regions was computed.

Intermediate Precision

To determine intermediate precision, the same 5 independent samples (at 10 µg/mL), that were analyzed on a separate day were used to calculate % assay and % R.S.D. values.

Linearity

Linearity was evaluated utilizing six Glipizide standard solutions within the concentration range of 2.5-15 µg/mL. The produced solutions were injected into the UPLC system, and calibration plots were created by graphing peak area vs the corresponding drug concentration.[21]

Accuracy

Accuracy was assessed by performing recovery studies at three concentration levels: 50%, 100%, and 150% of the target Glipizide concentration. The spiked sample solutions were analyzed in triplicate, and the percentage recovery was calculated to evaluate method accuracy.[22]

The percentage recovery was calculated and acceptance criteria were set between 98% and 102%.

Limit of Detection (LOD)

A LOD solution was made by diluting 2.5 mL of stock solution to 10 mL with diluent, then from that solution 0.1 mL was diluted again to 10 mL with diluent for analysis.[23]

Limit of Quantification (LOQ)

To prepare the LOQ solution, 0.25 mL of the standard stock solution was precisely placed into a 10 mL volumetric flask and diluted to the mark using diluent.[24]

Robustness

Robustness was assessed by intentionally altering chromatographic parameters, including flow rate, mobile phase composition, and column temperature. The resultant system suitability parameters

adhered to acceptable ranges, demonstrating that the suggested approach was robust according to ICH requirements.[25]

RESULTS AND DISCUSSION

System Suitability

The refined RP-UPLC technique for Glipizide (GZE) quantification shown effective chromatographic separation utilizing a BEH C18 column, with a mobile phase consisting of 0.01 N potassium dihydrogen phosphate buffer at pH 4.8 and acetonitrile in a 50:50 (v/v) ratio, at a flow rate of 1.0 mL/min. Under these conditions, Glipizide was eluted at around 1.254 min, so validating the expedited nature of the established analytical technique. The acquired chromatographic peak was crisp, symmetrical, and exhibited minimal tailing, indicating high column efficiency and satisfactory peak performance. The complete isolation of Glipizide from other sample components further validated the method's selectivity. The decreased retention period shortened the overall run time and improved sample throughput, rendering the approach very appropriate for routine pharmaceutical quality control applications.

System suitability was assessed through six replicate injections of the standard solution under optimized chromatographic conditions. The retention time of Glipizide was consistent, ranging from 1.248 to 1.254 min, indicating stable chromatographic performance. The peak areas showed good reproducibility, with a mean value of 471,924, standard deviation of 2,766.5, and % RSD of 0.6%, which complied with the accepted criterion of less than 2%. Theoretical plate counts ranged from 3,297 to 3,532, confirming adequate column efficiency, while tailing factors between 1.72 and 1.87 indicated acceptable peak symmetry. These results demonstrate that the system was suitable for the routine quantitative analysis of Glipizide.

The system suitability study demonstrated that the developed RP-UPLC method provides reliable and reproducible chromatographic performance for Glipizide analysis. The retention time, theoretical plate number, tailing factor, and % RSD values complied with the prescribed acceptance criteria, confirming adequate system precision, column efficiency, and peak symmetry. These findings support the suitability of the optimized method for rapid and routine quality control evaluation of Glipizide pharmaceutical formulations.

The chromatographic system demonstrated excellent separation efficiency with theoretical plate counts exceeding 3000 and acceptable peak symmetry. The resolution factor greater than 2 confirmed adequate separation of Glipizide from adjacent chromatographic components and excipients.

Statistical Parameters

Parameter	Value
Mean Peak Area	471924
Standard Deviation	2766.5
%RSD	0.6

Statistical Parameters

Parameter	Value
Average Peak Area	473966
Standard Deviation	2417.4
%RSD	0.5

Observation

Intermediate precision was assessed to establish the reproducibility of the developed RP-UPLC method under day-to-day analytical conditions. Six independently prepared Glipizide sample solutions were analyzed on a different day using the same chromatographic parameters. The peak area responses ranged from 457,486 to 460,736, with a mean value of 458,899 and a standard deviation of 1,448.5. The % RSD was found to be 0.3%, which is markedly lower than the acceptance criterion of ≤2.0%. This low variability confirms the precision, reliability, and robustness of the method during routine laboratory analysis, supporting its applicability for the quantitative estimation of Glipizide in pharmaceutical dosage forms.

Statistical Parameters

Parameter	Value
Average Peak Area	458899
Standard Deviation	1448.5
%RSD	0.3

Observation

%RSD was found to be 0.3

Linearity

The RP-UPLC method for determining Glipizide was found to be linear across values ranging from 2.5-15 µg/mL, or 25-150% of the working concentration. Calibration curves were created by graphing concentration against peak area. Peak area values grew proportionately as concentrations increased, implying a proportional or linear connection between concentration and detector response. Peak area values varied from 115226 to 703198 for concentrations between 2.5 µg/mL and 15 µg/mL, which indicates that the method has good analytical sensitivity in the range of interest. A high value of the correlation coefficient (R^2 = 0.999), also confirms the high degree of linearity of this method. These findings indicate that the RP-UPLC method described

Table 1: Standard stock solution preparation for linearity level.

Linearity Level (%)	Volume Taken (mL)	Diluted to (mL)	Concentration (µg/mL)
25	0.25	10	2.5
50	0.50	10	5
75	0.75	10	7.5
100	1.00	10	10
125	1.25	10	12.5
150	1.50	10	15

Table 2: Accuracy.

Level	Sample Stock (mL)	Standard Added (mL)	Diluted to (mL)
50%	0.5	1.0	10
100%	1.0	1.0	10
150%	1.5	1.0	10

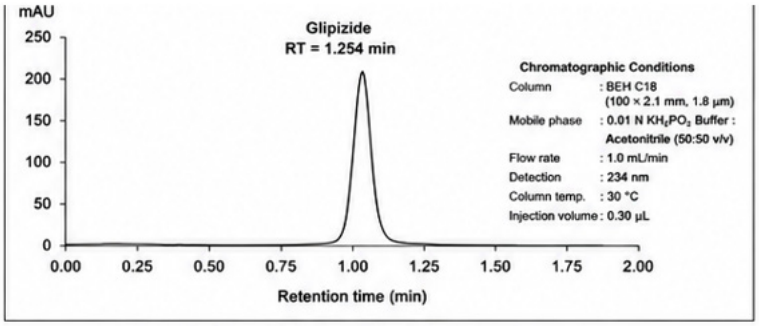

Figure 1: Optimized chromatogram for GZE.

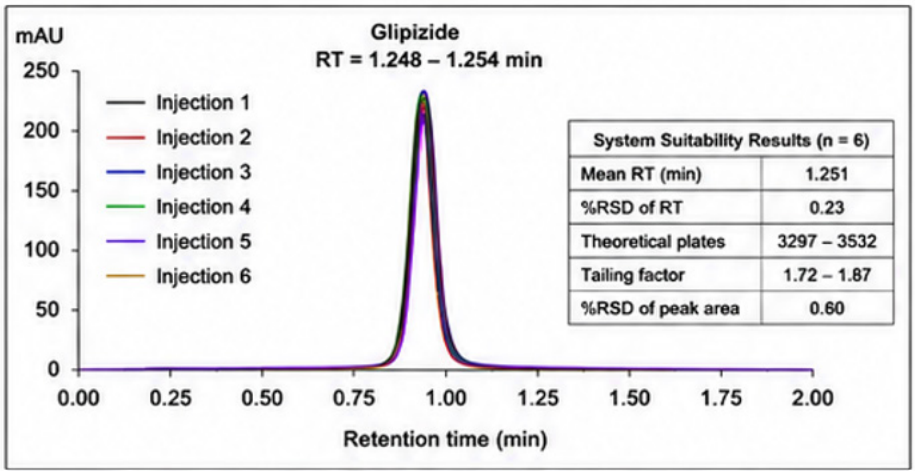

Figure 2: System suitability chromatogram for GZE (Six replicate injections, 10 µg/mL).

herein provides an accurate and reliable measure of Glipizide in the specified concentration ranges and is applicable to routine pharmaceutical analysis.

Observation

The correlation coefficient was calculated to be 0.999, showing excellent linearity.

Accuracy

The accuracy of the RP-UPLC method was evaluated through recovery studies by spiking Glipizide into samples at 50%, 100%, and 150% levels. Concentrations were measured in triplicate. Percentage recoveries ranged from 99.02% to 101.16%, with an average recovery of 99.99%. These results, within the 98-102% range, indicate no interference from excipients and confirm the

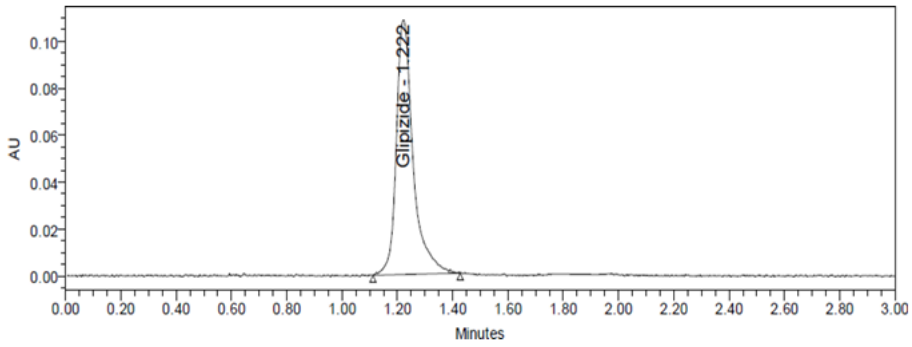

Figure 3: Intermediate precision CGM for GZE.

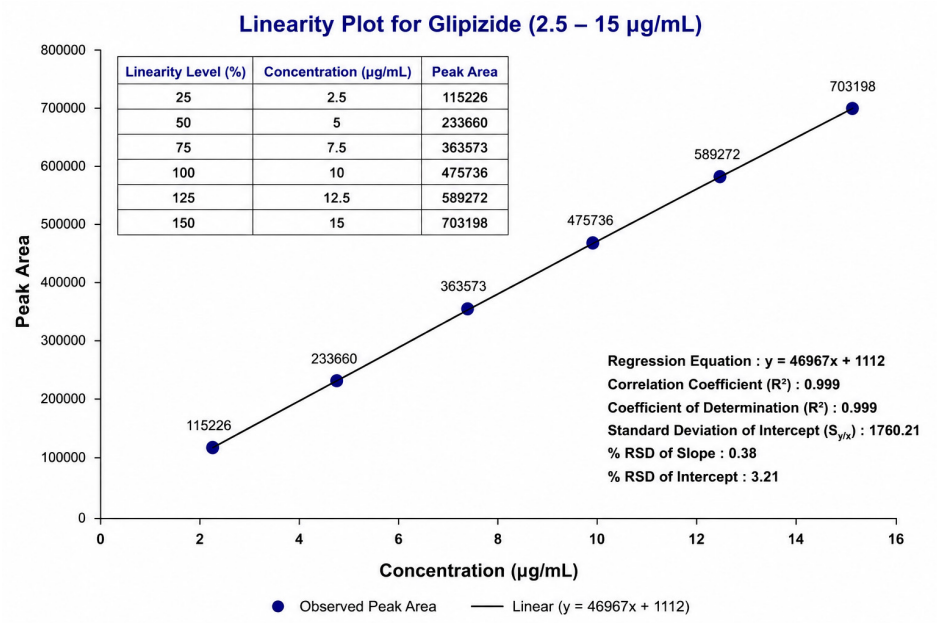

Figure 4: Linearity plot for Glipizide.

method's accuracy for quantitative estimation of Glipizide in pharmaceutical formulations.

Residual Analysis

Residual analysis was performed to evaluate the goodness-of-fit of the calibration model. The residual values were randomly distributed around the zero baseline without any systematic trend, confirming homoscedasticity and absence of proportional bias in detector response. The low residual values indicate excellent predictability of the regression model throughout the analytical range.

Specificity and Selectivity

Specificity of the developed RP-UPLC method was evaluated by injecting blank, placebo, standard, and sample solutions individually under optimized conditions. No interfering peaks appeared at Glipizide's retention time (~1.254 min), demonstrating excellent specificity. Peak purity analysis confirmed that the Glipizide peak was spectrally homogeneous and free from co-eluting excipient interference, proving the method's selectivity for accurate quantification of Glipizide in pharmaceutical dosage forms.

LOD

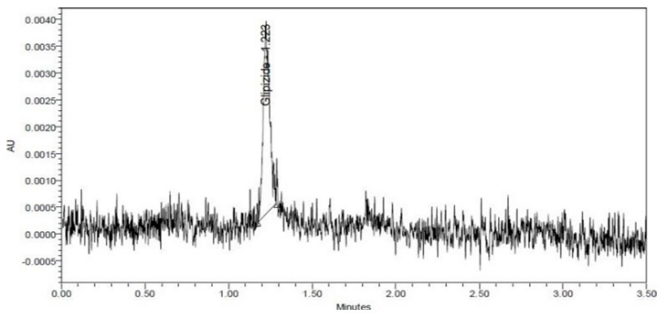

Figure 5 (a):

LOD for CCGM of GZE.

Observation

The GZE in this method was found to be 0.05µg/mL.

LOQ

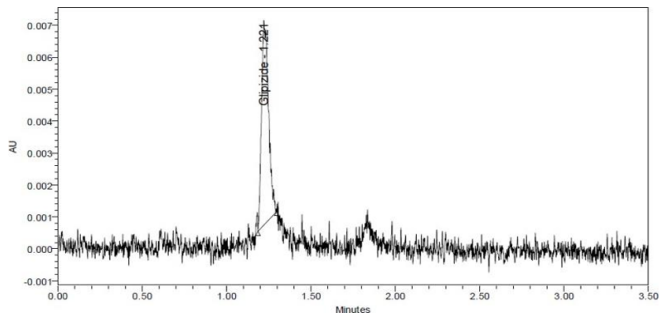

Figure 5 (b):

LOQ for CGM of GZE.

Observation

The GZE in this method was found to be 0.14µg/mL.

Robustness

Robustness studies were conducted to assess the resilience of the new RP-UPLC technique against slight intentional alterations in chromatographic parameters. The impact of flow rate variations, mobile phase composition, and column temperature on chromatographic responsiveness and precision was assessed. The % RSD values of peak area under these modified conditions varied from 0.7% to 1.6%, according to the ICH Q2(R^1) acceptance threshold of a maximum of 2.0%. The minimal variability noted throughout the examined conditions suggests that the method upholds stable analytical performance despite minor procedural variations. Therefore, the established approach is deemed robust and appropriate for routine quality control analysis of Glipizide in both raw materials and final pharmaceutical products.

Observation

The RSD values were all within the predicted range, confirming the robustness of this RP-UPLC technique.

The new RP-UPLC approach exhibited enhanced analytical performance in terms of speed, sensitivity, and operational efficiency compared to previously published methods for Glipizide estimation. The approach demonstrated a retention period of roughly 1.25 min and a total chromatographic run time of 3 min, facilitating expedited sample analysis while reducing solvent consumption. The low Limits of Detection (LOD) and Quantification (LOQ) values of 0.05 µg/mL and 0.14 µg/mL, respectively, demonstrate the method's great sensitivity. The approach exhibited linearity within the concentration range of 2.5-15 µg/mL, with a correlation coefficient of 0.999, so affirming the reliability of the detector response and its appropriateness for quantitative analysis. The results confirm the suggested RP-UPLC method as a unique, sensitive, and high-throughput analytical technique for the routine quality monitoring of Glipizide pharmaceutical products.

Table 2: Chromatographic Resolution Parameters.

Parameter	Acceptance Criteria	Observed Value
Retention time	Consistent	1.254 min
Tailing factor	< 2	1.72-1.87
Theoretical plates	> 2000	3297-3532
Resolution factor (Rs)	> 2	2.8
%RSD of peak area	< 2%	0.6%

Assay of Formulation

The validated RP-UPLC method was effectively utilized to quantify Glipizide content in commercial tablet formulations. The percentage assay readings varied from 99.24% to 100.60%, yielding a mean drug content of 100.03%. The low relative standard deviation of 0.50% indicates exceptional repeatability and validates the dependability of the analytical method. The assay findings fell within the approved specification range of 98-102%, indicating that the suggested approach is accurate, precise, and appropriate for routine quality control testing of Glipizide pharmaceutical dosage forms.

Statistical Parameters

Parameter	Standard	Sample	% Assay
Average	471924	473966	100.03
Standard Deviation	2766.5	2417.4	0.51
%RSD	0.6	0.5	0.5

DISCUSSION ON CHROMATOGRAPHIC BEHAVIOUR AND OPTIMIZATION

The chromatographic behaviour of Glipizide under the optimized RP-UPLC conditions demonstrated excellent separation efficiency, peak symmetry, and analytical sensitivity. The utilization of a BEH C18 column (100 × 2.1 mm, 1.8 µm) significantly contributed to improved chromatographic resolution and reduced analysis time due to the high surface area and reduced particle size of the stationary phase. Sub-2 µm particle technology enhances mass transfer kinetics and minimizes band broadening, thereby producing sharper chromatographic peaks and superior separation efficiency compared to conventional HPLC columns.

The optimized mobile phase, composed of 0.01 N potassium dihydrogen phosphate buffer and acetonitrile (50:50 v/v), provided an ideal polarity balance and controlled ionization of Glipizide

Table 3: Peak Data of Glipizide (GZE).

Sl. No.	Peak Label	RT (min)	Peak Area	Theoretical Plates (USP)	Tailing Factor (USP)
1.	GZE	1.248	467517	3308	1.83
2.	GZE	1.248	472303	3316	1.87
3.	GZE	1.250	475521	3297	1.78
4.	GZE	1.251	472259	3532	1.80
5.	GZE	1.252	473651	3424	1.81
6.	GZE	1.254	470290	3397	1.72

Table 4: Repeatability (Precision) Data for Glipizide (GZE).

Sl. No.	Peak Area
1.	470229
2.	472163
3.	476639
4.	474619
5.	474079
6.	476068

Table 5: Intermediate Precision Data for Glipizide (GZE).

Sl. No.	Peak Area
1.	457723
2.	459238
3.	457486
4.	460434
5.	460736
6.	457774

molecules, enhancing retention behavior and peak symmetry. The acidic buffer stabilized the analyte and reduced secondary interactions with residual silanol groups, minimizing peak tailing. The observed tailing factor range of 1.72-1.87 confirms acceptable chromatographic symmetry suitable for quantitative analysis. A retention time of approximately 1.254 min reflects rapid analyte elution without compromising performance, attributed to the optimized organic phase composition and the high efficiency of the UPLC stationary phase. This substantially decreases total run time and solvent consumption, making the method highly advantageous for high-throughput pharmaceutical quality control environments. Compared with conventional HPLC methods reporting retention times between 4.5-5.8 min, the proposed RP-UPLC method demonstrates significantly improved analytical speed and operational efficiency.

Scientific Interpretation of Validation Results

The approach displayed exceptional linearity throughout the 2.5-15 µg/mL range, with a correlation coefficient of 0.999, indicating robust proportionality between Glipizide concentration and detector response. Minimal residual variability and uniform peak

Table 6: Linearity Concentration and Responses of Glipizide (GZE).

Linearity Level (%)	Concentration (ppm)	Peak Area
25	2.5	115226
50	5	233660
75	7.5	363573
100	10	475736
125	12.5	589272
150	15	703198

area enhancements validate detector dependability throughout the analytical spectrum, affirming its appropriateness for routine quantitative analysis in pharmaceutical quality control. Studies on repeatability (% RSD 0.5%) and intermediate precision (% RSD 0.3%) demonstrated exceptional reproducibility, suggesting that tiny operational variances, analyst discrepancies, and daily fluctuations do not substantially impact performance. The resilience and precision are essential for industrial batch release testing and stability research.

The method's low LOD (0.05 µg/mL) and LOQ (0.14 µg/mL) reflect superior sensitivity, attributed to efficient chromatographic separation, narrow peak widths, and enhanced detector response under optimized UPLC conditions. This sensitivity benefits trace-level quantification and low-dose pharmaceutical formulations.

Industrial Applicability of the Developed RP-UPLC Method

The developed RP-UPLC method possesses substantial industrial applicability due to its rapid analysis time, excellent precision, low solvent utilization, and compliance with ICH Q2(R^1) validation requirements. The method can be effectively employed in:

- Routine quality control testing.
- Assay determination.
- Dissolution profiling.
- Stability studies.
- Process validation.

Table 7: Accuracy Data for Glipizide (GZE).

% Level	Amount Spiked (µg/mL)	Amount Recovered (µg/mL)	% Recovery
50%	5	5.06	101.16
50%	5	5.03	100.57
50%	5	5.00	100.07
100%	10	9.99	99.90
100%	10	9.97	99.72
100%	10	9.94	99.44
150%	15	15.09	100.58
150%	15	14.85	99.02
150%	15	14.92	99.48

Mean % Recovery = 99.99%.

Table 8: Results for Residual analysis of the calibration model.

Concentration (µg/mL)	Experimental Peak Area	Predicted Peak Area	Residual
2.5	115226	118529	-3303
5	233660	235947	-2287
7.5	363573	353364	10209
10	475736	470782	4954
12.5	589272	588199	1073
15	703198	705617	-2419

Table 9: Robustness Data of Glipizide (GZE).

Parameter	%RSD
Flow rate (-) 0.27 mL/min	0.7
Flow rate (+) 0.33 mL/min	1.3
Mobile phase (-) 55:45	1.4
Mobile phase (+) 45:55	1.4
Temperature (-) 25°C	1.5
Temperature (+) 35°C	1.6

- And batch release analysis of glipizide pharmaceutical formulations.

The reduced solvent consumption additionally supports environmentally sustainable analytical practices and lowers operational expenditure in pharmaceutical manufacturing laboratories. The short chromatographic cycle time enhances sample throughput, which is highly beneficial in large-scale industrial analytical settings where rapid release testing is critical.

CONCLUSION

A quick and accurate RP-UPLC method was established and validated for the quantification of Glipizide in bulk medication and pharmaceutical formulations. Separation was accomplished on a BEH C_{18} column with a 0.01 N potassium dihydrogen phosphate buffer at pH 4.8 and acetonitrile in a 50:50 (v/v) ratio as the mobile phase. The approach yielded a distinct and symmetrical Glipizide peak with a retention duration of approximately 1.254 min. The system appropriateness characteristics, such as % RSD, tailing factor, and theoretical plate count, conformed to acceptable standards. The approach demonstrated exceptional precision, exhibiting % RSD values of 0.5% for repeatability and 0.3% for intermediate precision. Linearity was established within the range of 2.5-15 µg/mL, exhibiting a correlation coefficient of 0.999. Accuracy was evidenced by recovery values between 99.02% and 101.16%, yielding a mean recovery of 99.99%. The low Limits of Detection (LOD) and Quantification (LOQ) values of 0.05 µg/mL and 0.14 µg/mL validated the method's sensitivity. The findings suggest that the established RP-UPLC approach is appropriate for regular quality control assessment of Glipizide. Robustness experiments indicate that the method's performance was not significantly affected by minor alterations in chromatographic settings, and the relative standard deviation (R.S.D. %) remained within acceptable limits. The drug concentration in the tablet formulation assay varies from 99.24% to 100.60%, with a mean assay value of 100.03%. These data indicate that the methodology is appropriate for pharmaceutical analysis. Consequently, the technique is applicable for routine quality control analysis of Glipizide in pharmaceutical formulations. The brief analytical duration and minimal solvent usage enhance cost-effectiveness and offer advantages for high-throughput pharmaceutical laboratories, hence endorsing the application of this technology.

Table 10: Comparative Evaluation of Reported Analytical Methods for Glipizide and the Proposed RP-UPLC Method.

Method	Mobile phase composition	RT (min)	Linearity range (µg/mL)	LOD (µg/mL)	LOQ (µg/mL)	Total analysis time	Remarks
Reported RP-HPLC Method	Methanol:Water (70:30 v/v)	5.8	5-50	0.25	0.75	10 min	Longer run time and higher solvent consumption
Conventional HPLC Method	Acetonitrile:Buffer (60:40 v/v)	4.5	10-60	0.18	0.55	8 min	Moderate sensitivity
UV Spectrophotometric Method	Methanol solvent system	-	2-20	0.50	1.50	-	Lower specificity and sensitivity
Previously Reported UPLC Method	Phosphate buffer:Acetonitrile (55:45 v/v)	2.8	5-25	0.10	0.30	5 min	Improved speed compared with HPLC
Proposed RP-UPLC Method	0.01 N KH_2PO_4 Buffer:Acetonitrile (50:50 v/v)	1.25	2.5-15	0.05	0.14	3 min	Rapid, highly sensitive, economical, and suitable for routine QC analysis

Table 11: Assay of Formulation for Glipizide (GZE).

Sample No.	Standard Area	Sample Area	% Assay
1	467517	470229	99.24
2	472303	472163	99.65
3	475521	476639	100.60
4	472259	474619	100.17
5	473651	474079	100.05
6	470290	476068	100.47

Table 12: Summary of Validation Parameters as per ICH Q2(R^1).

Validation Parameter	Result	Acceptance Criteria	Compliance
Specificity	No interference observed	No interfering peaks	Complies
Linearity range	2.5-15 µg/mL	Suitable analytical range	Complies
Regression coefficient (R^2)	0.999	≥ 0.999	Complies
Regression equation	y = 46967x + 1112	—	—
Repeatability (%RSD)	0.5%	< 2%	Complies
Intermediate precision (%RSD)	0.3%	< 2%	Complies
Accuracy (% recovery)	99.02-101.16%	98-102%	Complies
LOD	0.05 µg/mL	Low detection limit	Complies
LOQ	0.14 µg/mL	Low quantification limit	Complies
Tailing factor	1.72-1.87	< 2	Complies
Theoretical plates	3297-3532	> 2000	Complies
Resolution	2.8	> 2	Complies
Robustness (%RSD)	0.7-1.6%	< 2%	Complies

ABBREVIATIONS

BEH: Bridged Ethyl Hybrid; **CCGM:** Calibration Curve Chromatogram; **CGM:** Chromatogram; **GZE:** Glipizide; **HPLC:** High-Performance Liquid Chromatography; **ICH:** International Council for Harmonisation; **LOD:** Limit of Detection; **LOQ:** Limit of Quantification; **ppm:** Parts Per Million; **QC:** Quality Control; **RP-UPLC:** Reversed-Phase Ultra-Performance Liquid Chromatography; **RSD:** Relative Standard Deviation; **RT:** Retention Time; **USP:** United States Pharmacopeia; **v/v:** Volume by Volume.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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