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Eco-conscious UPLC Analysis for the Quantification of Adagrasib in Bulk and Tablets

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ABSTRACT

Ultra Performance Liquid Chromatography (UPLC) is a new and simple method for figuring out how much Adagrasib is present in a pharmaceutical dose form. This approach is sensitive, quick, accurate, and repeatable. A Waters Alliance e2695 system (150×4.6 mm, 3.5 µm) with a Waters XBridge C18 column and a mobile phase of acetonitrile and formic acid (0.1%) in a 70:30 v/v ratio was used to separate adagrasib. Detection was performed using a photodiode array detector at room temperature, with a flow rate (1.0 mL.min^{-1}), and absorption measured at 269 nm. A Purity Flag of "No" in the Empower software, indicating that the purity angle is less than the purity threshold, confirmed that the Adagrasib peak is homogeneous. The method yielded a theoretical plate count greater than 2000 and a tailing factor not exceeding 1.0. The %RSD for peak area measurements was less than 1.0%. The process was verified in using ICH guidelines. Overall, the quantitative analysis of Adagrasib was carried out using a simple, cost-effective, suitable, accurate, precise, and reliable method.

Key words: Adagrasib, XBridge C18 column UPLC, %RSD, & ICH guidelines

INTRODUCTION

Adagrasib is marketed as an anticancer drug under the trade name Krazati, Adagrasib is used as a treatment for non-small cell lung cancer.[1-2] From one to two Adagrasib is a RAS GTPASE inhibitor.[1] A verbal component is present. Mirati Therapeutics is the company that developed it.[1-3] The most frequent side effects are fatigue, musculoskeletal pain, nausea, vomiting, diarrhea, edema, hepatotoxicity, renal impairment, cough, pneumonia, disorientation, constipation, stomach discomfort, and an extended QTC interval.[2] The most common abnormalities in laboratory tests include decreased the following hemoglobin, sodium, lymphocytes, albumin, potassium, dmagnesium and

platelets and increased aspartate aminotransferase, creatinine, alanine aminotransferase, and lipase. When combined with cetuximab in 2024, it was authorized by the FDA in December 2022 for use in the action of lungs and colorectal cancer in the (US) United States.[1-6]

Adagrasib may be recommended for patients with locally advanced or metastatic non-small cell lung cancer who have had at least one previous systemic treatment and who have a KRAS G12C mutation as identified by an FDA-approved test.[1-2,7] In June 2024, the US FDA expedited the approval of adagrasib+cetuximab for patients with KRAS G12C-mutated locally highly developed or metastatic colorectal cancer, as well as those who had previously received chemotherapy based on fluoropyrimidine, oxaliplatin, and irinotecan, based on an FDA-approved test Figure 1.[8]

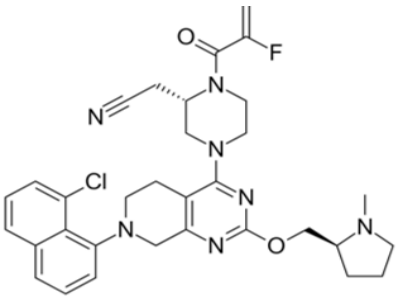

Fig. 1. Structure of Adagrasib

Adagrasib can be quantified using the developed UPLC technique, which is not only precise and efficient but also environmentally friendly. This eco-conscious approach is justified by the use of smaller sample and reagent volumes, faster analysis times, greener solvents (acetonitrile and 0.1% formic acid), efficient instrumentation (UPLC), and a reduction in overall solvent consumption.

For consistent medication quality, safety, and efficacy in accordance with regulatory requirements, the quantification of Adagrasib in both bulk and tablet dosage forms is essential. The proposed UPLC technique is justified for this purpose due to its high sensitivity and precision, specificity, compliance with ICH guidelines, eco-conscious approach, application versatility, robustness, and cost-effectiveness.

Earlier chromatographic techniques used either costly LC-MS/MS9, UPLC-MS/MS UPLC10, bioanalytical techniques were published after a review of the HPLC-MS/MS[11-12] literature. The current study's objective is to establish a novel, straightforward, isocratic RP-UPLC technique for estimating Adagrasib in formulations and bulk.

A recently developed new analytical method utilizing UPLC was utilized to validate Adagrasib in both pharmaceutical dosage forms and bulk forms. The findings of the provided method indicate that Adagrasib in bulk and pharmaceutical formulation may be determined using the developed technology. It is suitable to utilize this industry standard approach in quality control evaluations.

MATERIALS AND METHODS

Instrumentation

An Agilent 1290 Infinity II LC system (Pump: Quaternary; Software: Empower 2.0) equipped with a PDA detector was used. A Rheodyne manual sample injector, fitted via a 77251 switching valve, was integrated into the chromatographic system. The sample was injected into a 20 µL loop using the Rheodyne injector. For the optimized analysis conditions, sample weighing was performed using a DENVER SI234 model electronic balance. The λmax value was determined using a UV-2301 model spectrophotometer. Analytical-grade chemicals and HPLC-grade solvents were employed throughout the analysis.

Preparation of Solutions (stock, working standard and sample solutions)

To prepare a concentration (1000 µg/mL), 10 mg of the pure drug was precisely dissolved in acetonitrile and the volume was increased to 10 mL in a volumetric flask to create a stock solution of Adagrasib. Then, to make a working standard solution with a final concentration of 100 µg/mL, 1 mL of the stock solution was diluted with 10 mL of the same solvent.The experiment was conducted using Krazati, a commercial version of Adagrasib that has 200 mg per tablet. After precisely weighing an amount of the finely powdered tablet equal to 10 mg of Adagrasib, it was put to a volumetric flask (10 mL). The volume was adjusted once the powder was dissolved in the mobile phase. To reach a final concentration of 1000 µg/mL, the resultant solution was diluted with the mobile phase and filtered using nylon membrane filter paper.

Stress Study

Studies on FD (forced degradation) were conducted to assess Adagrasib's stability under

several stressors. Degradation was assessed by comparing chromatograms of treated samples with those of the untreated standard solution. The following conditions were applied: Photolytic degradation: Samples were exposed to ambient laboratory light and UV light for 24 hours. Thermal degradation: For up to 24 h, samples were heated to 80°C in a hot air oven. Acid and base hydrolysis:100 mg of Adagrasib was hydrolyzed in 20 mL of decinormal HCl or NaOH solution for 24 and 48 hours. Oxidative degradation: 100 mg of Adagrasib was treated with 20 mL of 3% H_2O_2 (hydrogen peroxide) and kept at room temperature for 24 hours.

RESULTS AND DISCUSSION

Method Development

The wavelength of the detector was set at 269 nm in order to quantify the Adagrasib while accounting for the observed absorption maxima Figure 2.

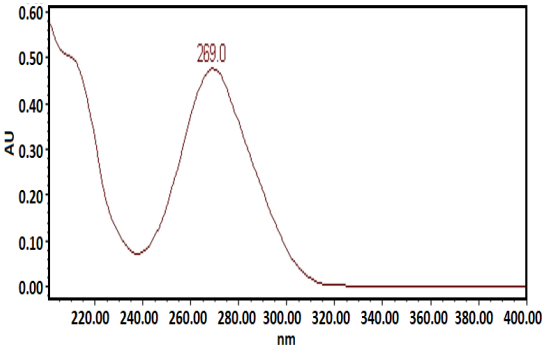

Fig. 2. PDA -Spectrum of Adagrasib

Until the Adagrasib peak was separate and the system suitability requirements were satisfied, isocratic elution with several mobile phase compositions was carried out in addition to adjusting parameters including the column, mobile phase composition, pH buffers, wavelength, and flow rate. Two experimental trials were carried out using organic solvents and a (150 mm × 4.6 mm, 3.5 µm) Luna Phenyl-Hexyl column, as shown in Table 1. Acetonitrile (ACN) with 0.1% orthophosphoric acid (OPA) was used as the mobile phase composition in each trial, with flow rates (1.0 mL/minute). Operating in isocratic mode with MP (mobile phase) ratios of 70:30 and 60:40, respectively. The temperature of the column was kept at 25°C for durations ranging from six to ten minutes. A sample was injected (10 µL) into the UPLC system. The system suitability criteria were not met, as indicated in Fig. 3, and baseline instability was observed during these trials.

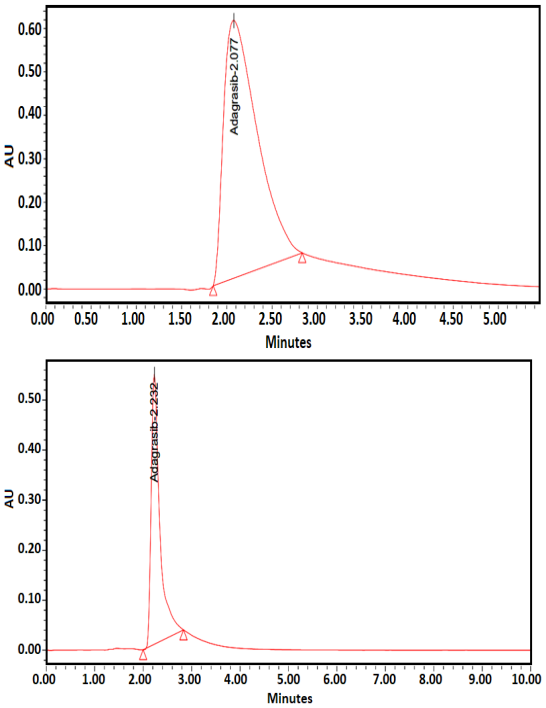

Fig. 3. Chromatograms obtained from Luna Phenyl Hexyl (150mmx4.6, 3.5µm)

The second phase trials (Table 1) utilized running at a 1.0 mL/min flow rate of in an isocratic mode by a 50:50 mobile phase ratio of ACN (acetonitrile) and 0.1% orthophosphoric acid (OPA). For nine minutes, The temperature of the column was kept at 25°C for durations ranging from six to ten minutes. A sample was injected (10 µL) into the UPLC system. The prominent peak observed in these trials is shown in Figure 4.

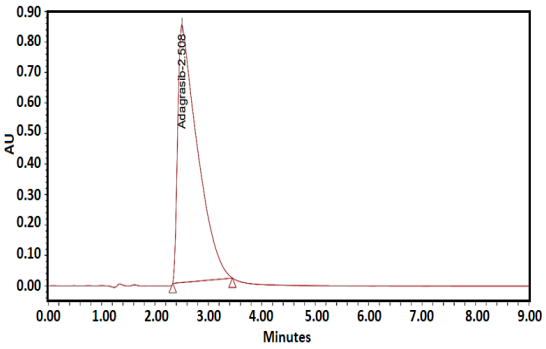

Fig. 4. Chromatogram obtained from Luna Phenyl Hexyl (150mmx4.6, 3.5*µ*m) column

The third phase experiments (Table 1) employed a Acetonitrile (ACN) and 0.1% formic acid in 90:10 and 80:20 ratios make up the mobile phases of the (150 mm×4.6 mm, 3.5 µm) Waters XBridge C18 column. A 1.0 mL/min flow rate was used for isocratic separation. For 10 minutes, The temperature of the

column was kept at 25°C for durations ranging from six to ten minutes. A sample was injected (10 µL) into the UPLC system. The broad peak observed in these trials is shown in Figure 5.

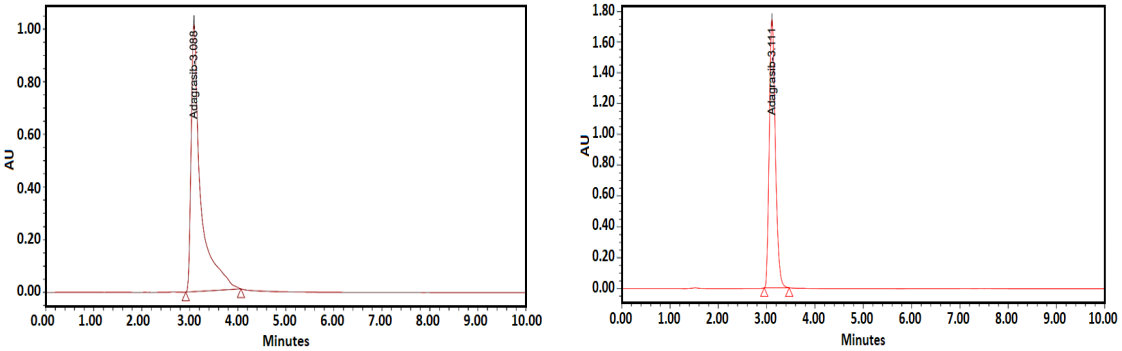

Fig. 5. Chromatograms obtained from Waters X-bridge C18 (150x4.6nm,3.5µm) column

In conclusion, the third phase trial (Table 1) employed the same column and organic solvents as previous phases but utilized a 70:30 mobile phase ratio. A reversed-phase (RP) column resembling the Waters (150 mm×4.6 mm, 3.5 µm) XBridge C18 was connected to a PDA detector in order to sustain a steady flow rate of 1.0 mL/minute. Operated in isocratic elution mode, the mobile phase was composed of 1% formic acid and acetonitrile at a 70:30 ratio. Consequently, the final phase trial conditions are optimized (Table 2; Fig. 6), demonstrating well-resolved separation peaks, a stable baseline, and high plate counts.

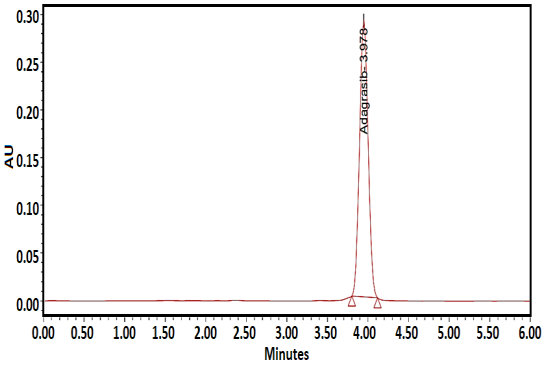

Fig. 6. Optimized Chromatogram

Table 1: Conducted Trials by Various Conditions

Trial No	Mobile Phase/Wave length	Column	Flow Rate	Run Time	Remarks
1	ACN+0.1% OPA (70:30) 200-400nm	Luna Phenyl Hexyl (150mmx4.6, 3.5µm)	1mL/min	6 min	System suitability conditions are not within the limit
2	ACN+0.1% OPA (60:40), 269nm	Luna Phenyl Hexyl (150mmx4.6, 3.5µm)	1mL/min	10 min	Base line is not sufficient
3	ACN+0.1% OPA (50:50), 269nm	Waters X-bridge C18 (150x4.6nm,3.5µm)	1mL/min	9 min	Broad peak is observed
4	Acetonitrile + 0.1% Formic acid (90:10) 269nm	Waters X-bridge C18 (150x4.6nm,3.5µm)	1mL/min	10 min	Tailing is not within the limit
5	Acetonitril, 0.1% Formic acid (80:20), 269nm	Waters X-bridge C18 (150x4.6nm,3.5µm)	1mL/min	10 min	Response of the peak is very high
6	Acetonitrile + 0.1% Formic acid (70:30), 269nm	Waters X-bridge C18 (150x4.6nm,3.5µm)	1mL/min	6 min	This method is suitable for validation

Table 2: Chromatography Conditions of the Method

Parameters	Observation
Instrument used	Waters Alliance e-2695HPLC
Injection volume	10µL
Mobile Phase	ACN and formic acid (0.1%) (70:30)
Column	Waters C18 X-bridge (150mmX4.6, 3.5µm)
Wave Length	269 nm
Flow Rate	1 mL/min
Runtime	6min
Mode of separation	Isocratic
Diluents	Mobile phase

System Suitability and Specificity

To ensure the adequacy of the existing method for its intended purpose, a system suitability test (SST) was performed. Under optimal conditions, the system suitability parameters summarized in Table 3 were within the acceptable limits, confirming the system's performance. Specificity was assessed by evaluating potential interferences from degradation products, blanks, and placebos. During Adagrasib's retention time, neither the diluent nor placebo showed any interference Fig. 7. The Adagrasib peak exhibited a tailing factor of less than 2 and more than 2000 theoretical plates, further validating the system's suitability

A specificity study was conducted during Adagrasib's retention time to confirm the absence of interference from degradation products or other contaminants. The method demonstrated specificity, as no peaks were observed at Adagrasib's retention time of 3.978 minutes in the blank chromatogram Figure 8.

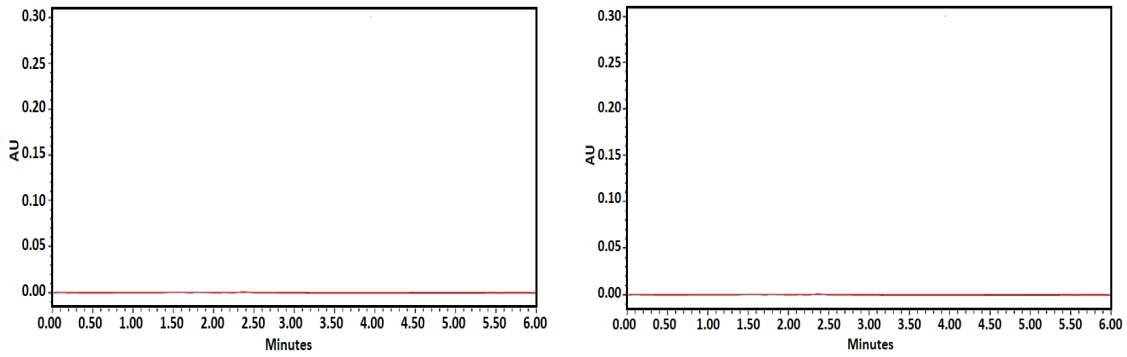

Fig. 7. Blank and Placebo Chromatograms

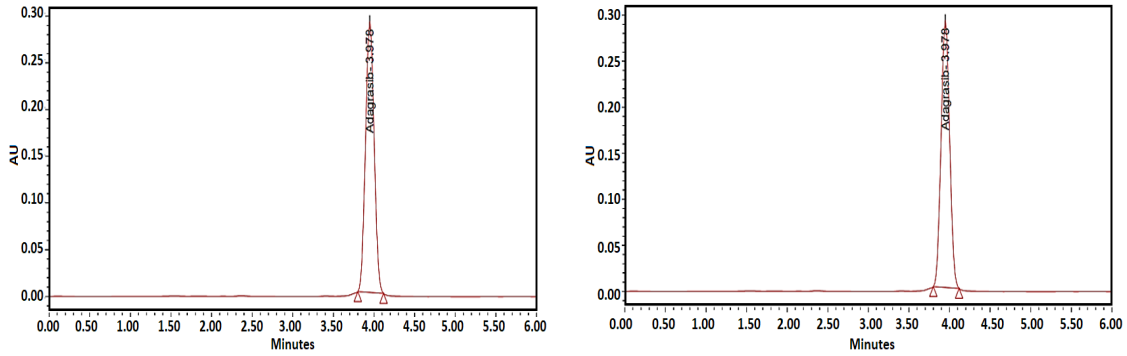

Fig. 8. Standard and optimized chromatograms

Table 3: System suitability parameters at optimized conditions

Sr. No	Parameter	Adagrasib
1	Retention time (RT)	3.978
2	USP Plate count	19238
3	USP Tailing factor	1.05
4	Percent RSD	0.19
5	Purity angle (PA)	5.024
6	Purity threshold (TH)	21.343
7	Purity plag	No

Stress Study/Stability Indicating Studies

The stress research was carried out to evaluate the suggested method's specificity and stability-indicating qualities. Chromatograms obtained under various stress conditions (Fig. 5) demonstrated clear separation between Adagrasib and its degradation products. This separation indicates that the method is free from interference by degradation products. The outcomes validate the suggested approach's accuracy and stability-indicating capabilities.Table 2 presents the outcomes of the stress-induced degradation of Adagrasib. Adagrasib exhibits greater susceptibility to oxidation and alkali-induced degradation compared to heat and hydrolysis conditions, as evidenced by the higher degradation levels observed (Table 4). These findings confirm the method's selectivity, making it appropriate for regular analysis of quality control. The Empower software analysis indicates that the purity angle (PA) is less than the purity threshold (TH) across all chromatograms (Fig. 9a–h), confirming the homogeneity of the Adagrasib peak.

Table 4: Results of stress study data of Adagrasib

	%Assay of degraded sample (A1)	%Degradation w.r.t. control sample (B1*)	PA	TH
Control	100	0	5.024	21.343
Acid	88.0	12.0	5.056	21.375
Alkali	86.4	13.6	5.077	21.366
Peroxide	84.3	15.7	5.012	21.306
Reduction	97.9	2.1	5.081	21.353
Thermal	98.7	1.3	5.019	21.357
Photolytic	89.9	10.1	5.058	21.361
Hydrolysis	99.0	1.0	5.043	21.339
B1*= (100– A1) /100*100				

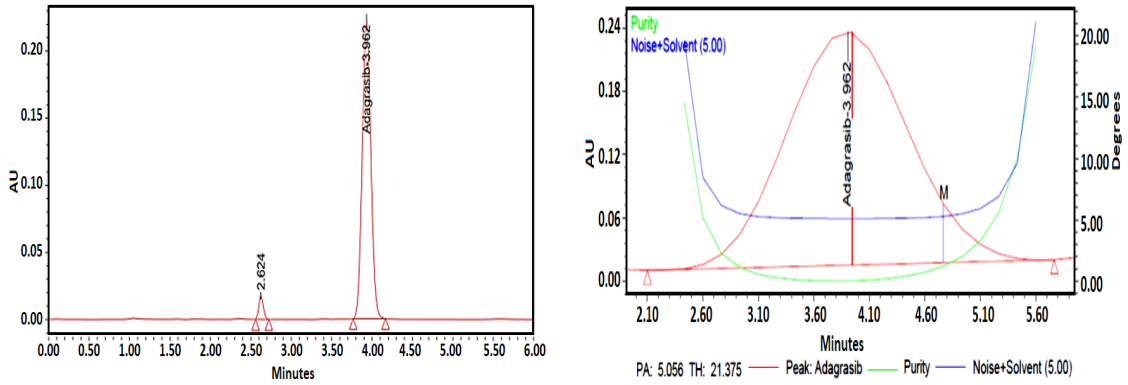

Fig. 9(a). Chromatogram of Acid degradation and Purity Plot

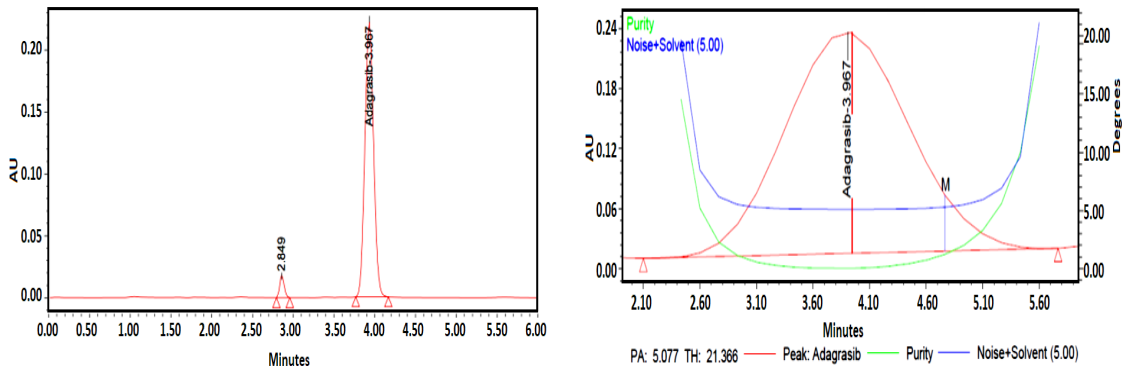

Fig. 9(b). Chromatogram of Alkali degradation and Purity Plot

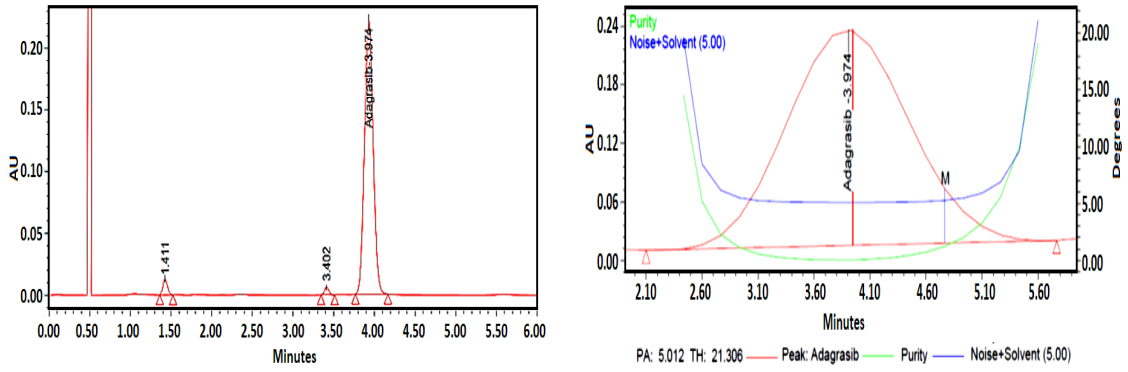

Fig. 9(c). Chromatogram of Peroxide degradation and Purity Plot

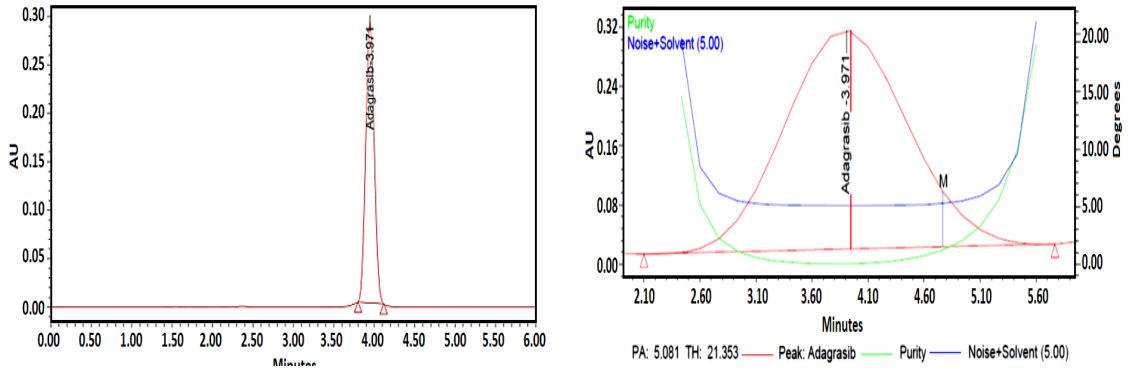

Fig. 9(d). Chromatogram of Reduction degradation and Purity Plot

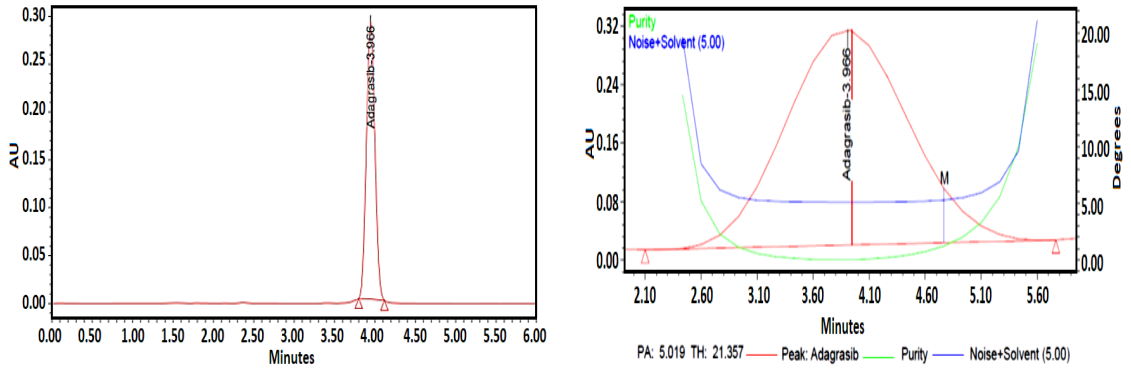

Fig. 9(e). Chromatogram of Thermal degradation and Purity Plot

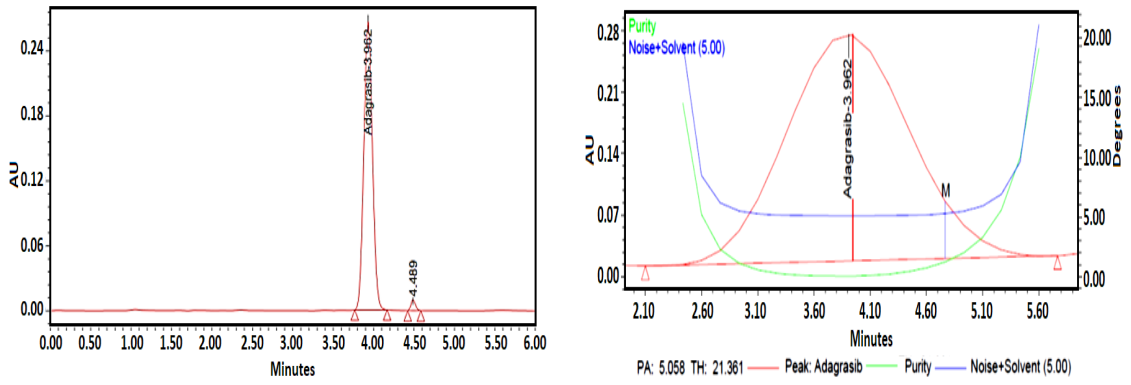

Fig. 9(f). Chromatogram of Photo degradation and Purity Plot

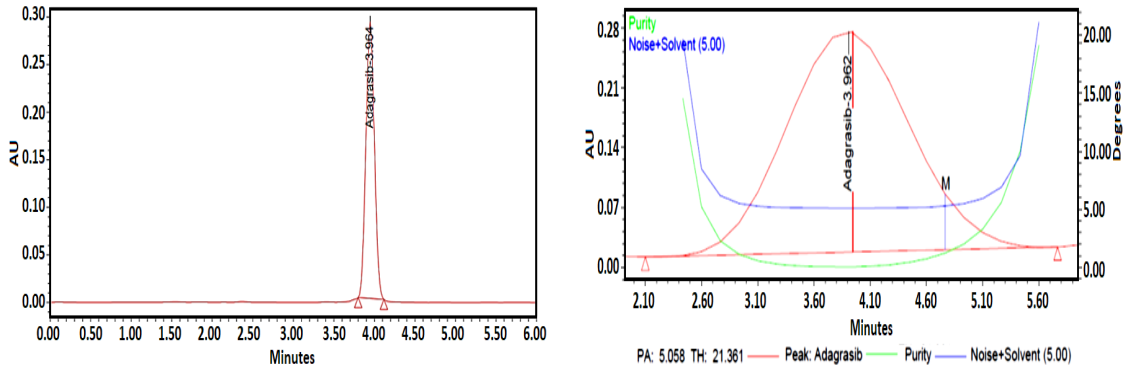

Fig. 9(g). Chromatogram of Hydrolysis degradation and Purity Plot

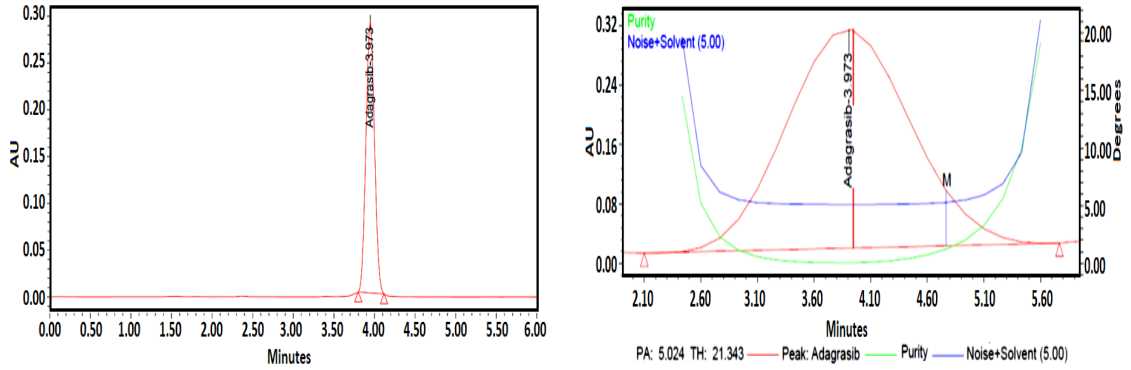

Fig. 9(h).Chromatogram of Control degradation and Purity Plot

Method validation

The present guidelines[13] were followed to validate the above proposed optimized method for determination of Adagrasib.

Linearity

A strong linear correlation was observed between the average response of three replicate measurements (Table 5) and Adagrasib concentrations ranging from 50 to 300 µg/mL, as depicted in Fig. 10. The calibration curve yielded the regression equation: y = 15013.72x + 16922.29, with a correlation coefficient (r^2) of 0.99969. Representative chromatograms illustrating the linearity at concentrations of 25%, 50%, 75%, 100%, 125%, and 150% of the target concentration are shown in Figure 11.

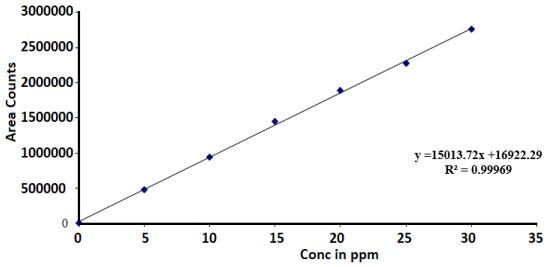

Fig. 10. Calibration Curve for Adagrasib at 269nm

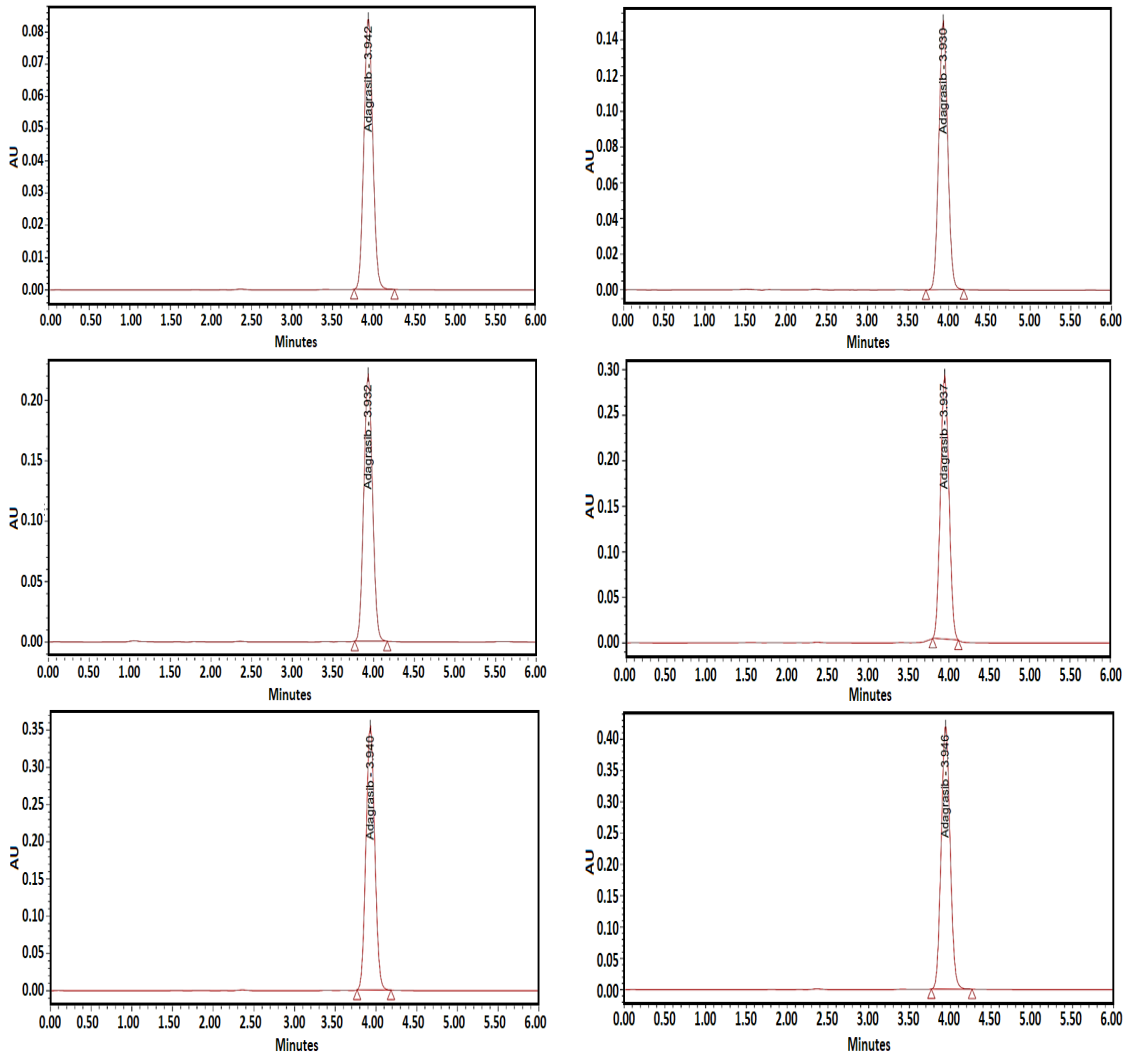

Fig. 11. Chromatogram of Linearity-25%, 50%, 75%, 100%, 125% &150%

Table 5: Results of linearity for Adagrasib

Sr. No	Adagrasib Conc. µg.mL^{-1}	Response
1	50	727388
2	100	1531368
3	150	2344478
4	200	3041402
5	250	3750723
6	300	4487500
Regression equation	y = 15013.72x + 16922.29	
Slope	15013.72	
Intercept	16922.29	
R^2	0.99969	

Accuracy

The percentage recovery is used to evaluate the accuracy of an analytical procedure, which reflects how closely the measured value agrees with the true value. In this study, recovery experiments were conducted by spiking the sample with known quantities of Adagrasib at 50%, 100%, and 150% of the target concentration. Six replicate preparations were analyzed for each level. The chromatographic data, including the estimated percent recovery from the peak areas at each spiking level, are presented in Table 6 and Fig. 12. The percent recovery of Adagrasib ranged from 99.70% to 100.20%, indicating that the method's accuracy falls within the acceptable range. These results verify that the suggested analytical approach for determining adagrasib is accurate.

Table 6: Accuracy Results of Adagrasib

%Concentration	Average Area	Average add Amount (mg)	Amount Response(mg)	% Recovery	Average %Recovery
50%	1519657	10	10.01	100.1	100.1
	1527840	10	10.06	100.6	
	1513462	10	9.97	99.7	
100%	3035487	20	20.0	100.0	100.0
	3026114	20	19.93	99.7	
	3042689	20	20.04	100.2	
150%	4559758	30	30.04	100.1	100.0
	4555677	30	30.01	100.0	
	4542103	30	29.92	99.7	

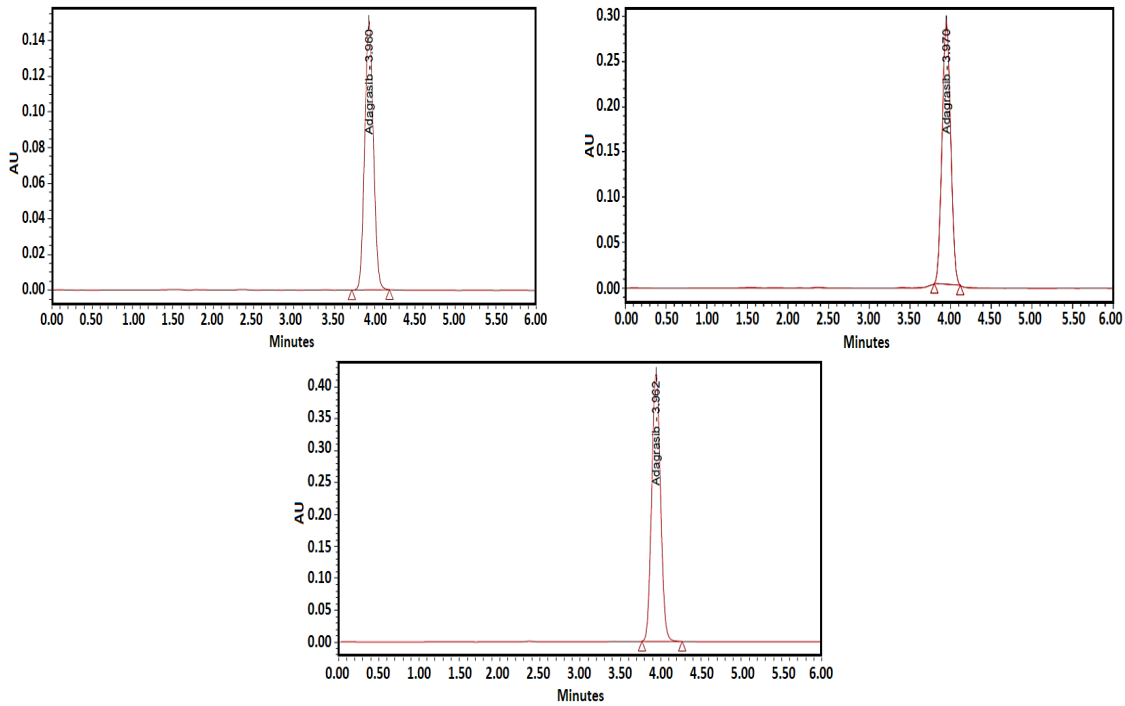

Fig. 12. Chromatogram of Accuracy 50% and 100% and 150%

Precisions (Method and Intermediate)

After two different testing settings, the precision quantifies the difference in the Adagrasib sample's results. Six replicates were employed to

perform the investigations for both method and intermediate precisions (MP and IP) in order to validate the existing approach (Fig. 13). Variations in the instrument, column, and analyst parameters were employed to achieve the intermediate precision. The computed percentage RSD values for MP and IP were 0.19 and 0.47, respectively, and both fall within the ICH-mandated acceptable limits (Table 7). It has a strong technique and a high level of accuracy. The percentage RSD values for the intermediate and method precisions are 0.47 and 0.19, respectively.

Table 7: Results of Precision (Method and Intermediate) Study

Sr. No	Responce of Adagrasib (m.p.)	Responce of Adagrasib (IP)
1	3037402	3039871
2	3044073	3016498
3	3032956	3046161
4	3029647	3050735
5	3031617	3029774
6	3041456	3054628
Mean	3036192	3039611
S.D	5753.665	14305.252
%RSD	0.19	0.47
Concentration of Adagrasib-200 µg./mL0^{-1}		

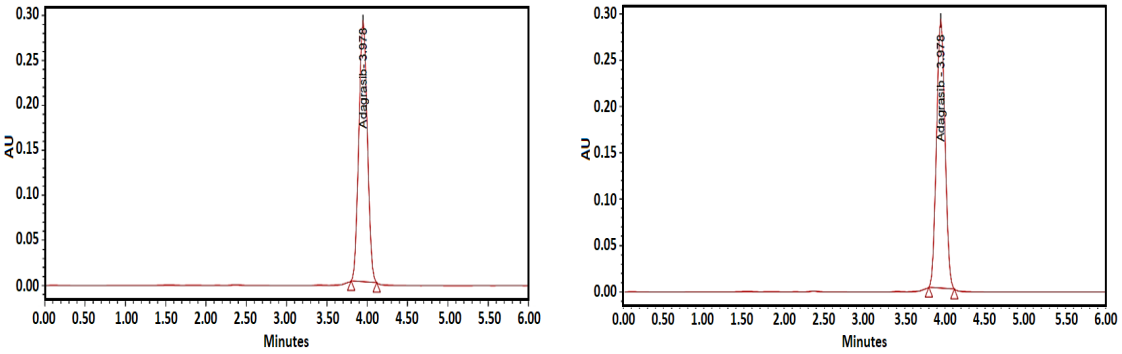

Fig. 13. Method Precision and Intermediate Precision chromatograms

Robustness

To assess the robustness of the analytical method, deliberate variations were introduced to critical parameters, including the flow rate and organic phase composition (Fig. 14 and 15). A reference solution of 20.0 µg/mL Adagrasib was analyzed under these modified conditions. Important chromatographic parameters, include retention time, peak area, tailing factor, and theoretical plates, remained consistent despite a ±5% variation in the organic solvent concentration (Table 8). The observed changes in peak area were minimal, within a 2.0% range, suggesting that, under the investigated method, the approach is dependable and robust.

Table 8: Results of robustness/ruggedness experiment of Adagrasib

Changed Parameters	Changed Condition	RT(min)	Response	USP ailing Factor	USP Plate count
Flow rate (mL.min^{-1})	Low flow (0.9 mL)	4.135	2836425	1.07	19357
	Actual (1 mL)	3.978	3037402	1.05	19238
	High flow (1.1 mL)	3.056	3114556	1.02	19170
Organic Phase Change	Low Org (63:37)	4.367	2738487	1.13	19386
	Actual (70:30)	3.983	3044073	1.09	19232
	High Org (77:23)	3.150	3335602	1.04	19141

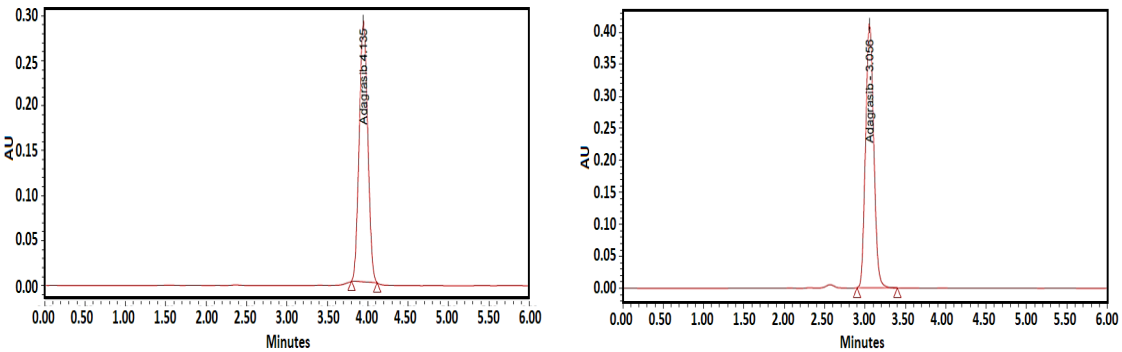

Fig. 14. Less and more flow rate Chromatograms

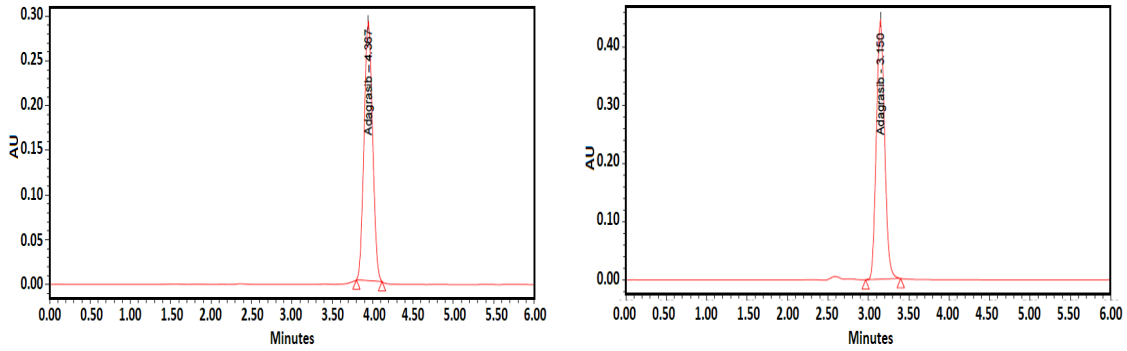

Fig. 15. Less and more Organic Phase Chromatograms

LOD and LOQ

The (LOQ; 0.6 µg/mL) limits of quantitation and (LOD; 2.0 µg/mL) detection for Adagrasib are respectively (Fig. 16). These values are well below the established thresholds, demonstrating the high sensitivity of the analytical method.[14-26]

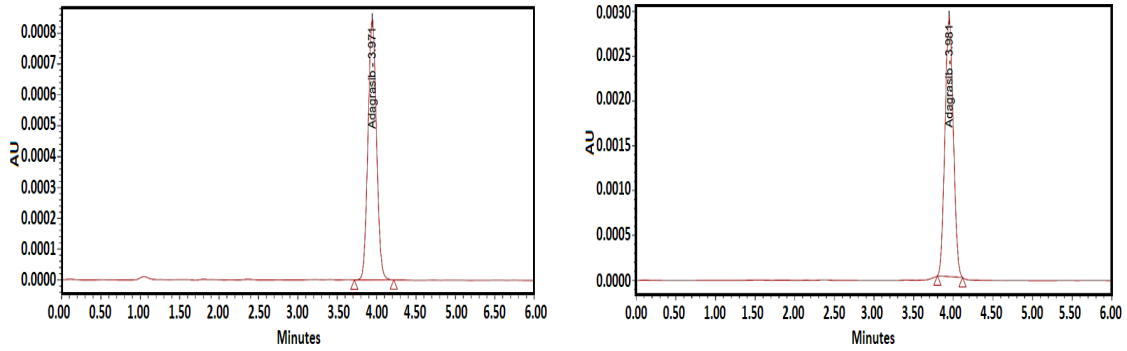

Fig. 16. Chromatograms for LOD and LOQ

Pharmaceutical formulation analysis

As the recovery values of Adagrasib were found to be satisfactory (Table 9).

The created method was applied to determine the dosage of Adagrasib in tablet formulations (Fig. 17). In addition to spectrophotometers,[17,21] HPLC instruments are now available at relatively affordable prices for laboratories in developing countries. Consequently, UPLC methods are increasingly being adopted in quality control laboratories in these regions. Consequently, in compliance with current ICH criteria, the current approach was effectively employed for the estimation of Adagrasib in tablet formulations.

Table 9: Pharmaceutical Formulation Assay

Sr. No	Brand Name	Form	Dosage	Amount Prepared	Amount Found	%Assay
1	Adagrasib	Tablet	200 mg	20 µg/mL	20.0 µg/mL	100.0

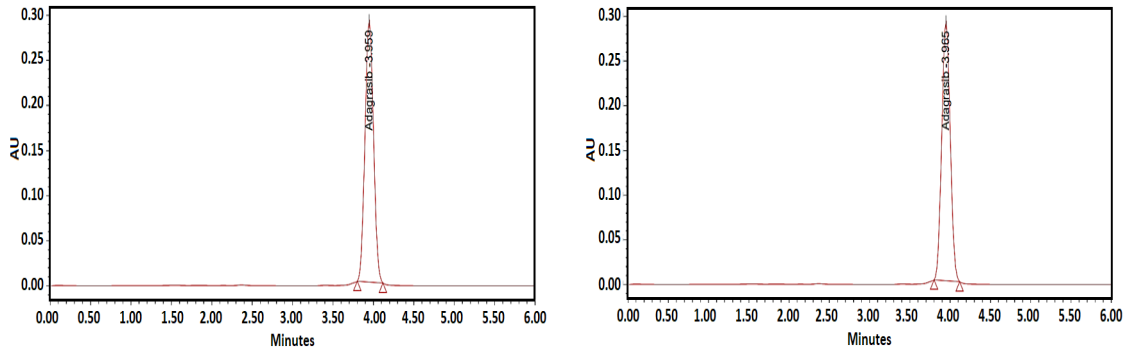

Fig. 17. Pharmaceutical Formulation Assay Chromatograms

CONCLUSION

The UPLC method developed and validated in this study is straightforward, with a short run time, making it suitable for routine quality control applications. Its efficacy in quantifying Adagrasib and assessing its stability under various conditions underscores its potential for analyzing active pharmaceutical ingredients (APIs) and tablet formulations in quality control laboratories.

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Conflict of interest

NIL

REFERENCES

1. Krazati-adagrasib tablet, coated. Daily Med. U.S. National Library of Medicine., **2021**.
2. FDA grants accelerated approval to adagrasib for KRAS G12C-mutated NSCLC. U.S. Food and Drug Administration (FDA)., **2022**.
3. Mirati Therapeutics Announces U.S., Mirati Therapeutics Inc., **2022**.
4. Drug Approval Package: Krazati. U.S. Food and Drug Administration (FDA)., **2023**.
5. Research, C.F. FDA grants accelerated approval to adagrasib with cetuximab for KRAS G12C-mutated colorectal cancer" FDA., **2024**.
6. Grisham, J. FDA Approves First Colorectal Cancer Treatment that Targets KRAS Gene Memorial Sloan Kettering Cancer Center. www.mskcc.org., **2024**.
7. Accelerated Approval: Krazati (adagrasib) oral tablets (PDF). U.S. Food and Drug Administration., **2022**.
8. FDA grants accelerated approval to adagrasib with cetuximab for KRAS G12C-mutated colorectal cancer". U.S. Food and Drug Administration (FDA)., **2024**.
9. Kruithof P.D., de Beer Y.M., Gulikers J.L., Stolk L.M., Hendriks L.E., Croes S., van Geel R.M., *J Chromat* B., **2023**, 1231-123918.https://doi.org/10.1016/j.jchromb.2023.123918.
10. Lei, P.; Shen, W.; Tang, H.; You, L.; Chen, G.; Tang, Y.; Lu, W.; Drug. Design. Development and Therapy., **2024**, 31:1-2.
11. Retmana, I.A., Loos, N.H.; Schinkel, A.H.; Beijnen, J.H.; Sparidans, R.W.; Biomed, *Chromatg.*, **2023**, *37*(11):e5720. DOI: 10.1002/bmc.5720.
12. Du, P.; Xuan, L.; An, Z.; Zhang, Y., *Analyst.*, **2022**, *147*(6), 1175-80.DOI:10.1039/d1an01928g
13. International conferences of harmonization Validation of analytical procedures test and methodology. Q2(R1)., **2005**, Available from:http://www.ich.org.
14. Kishore,V.N.; Ramana, G.V.; Nadh, R.V.; Prasad. G., *Rasay J Chem.*, **2021**, *14*(4), 2236-2245. DOI: org/10.31788/RJC.2021.1446412.
15. Gorumutchu, G.P.; Ratnakaram, V.N., *Int J Appl Pharm.*, **2019**, *11*(1), 168-173.DOI: 10.22159/ijap.2019v11i1.30125).
16. Giri Prasad G., Venkata Nadh R., Kishore V.N.V., *Int J Res Pharm Sci.,* **2019**, *10*(4), 3369–75. DOI: https://doi.org/10.26452/ijrps.v10i4.1646.
17. Gorumutchu, G.P.; Ratnakaram, V.N. *Res J Pharm Tech.*, **2019**, *12*(1), 209-212. DOI: 10.5958/0974-360X.2019.00038.6.
18. Prasad, G.G.; Nadh, R.V.; Kiran, K.K., *Int J Res Pharm Sci.*, **2019**, *10*(1), 117-124.DOI: 10.26452/ijrps.v10i1.1787.
19. Giri Prasad, G.; Venkata Nadh, R.; Sireesha, M., *Asian J Pharma.*, **2018**, *12*(4): Suppl S822-S828,DOI: org/10.22377/ijgp.v12i04.2261.
20. Gorumutchu, G.P.; Ratnakaram, V.N., *Int J Green Pharm.*, **2018**, *12*(4), 822-828.DOI: org/10.22377/ijgp.v12i04.2261.
21. Gorumutchu, G.P.; Ratnakaram, V.N., *Rese J Pharma Techn.*, **2019**, *12*(3), 1347-52.DOI: 10.5958/0974-360X.2019.00226.9.
22. Giri Prasad, G.; Venkata Nadh, R., Sireesha M., *Orient J Chem.*, **2019**, *35*(1), 363-369, DOI: org/10.13005/ojc/350145.
23. Giri Prasad G., Venkata Nadh R., Sireesha M., *Orient J Chem.*, **2019**, *35*(Special Issue-1), 48-53, DOI:org/10.13005/ojc/35Specialissue107.
24. Giri Prasad, G.; Venkata Nadh, R.; Kishore, V.N.V., *Orient J Chem.*, **2019**., *35*(Special Issue), 694-699, DOI: 10.13005/ojc/350226.
25. Giri Prasad, G.; Venkata Nadh, R., *Orient J Chem.* ddddd., **2018**, *34*(6), 3112- 3117.DOI: 10.13005/ojc/340656.
26. Giri Prasad G.; Venkata Nadh., and Sireesha. M., *Asian J Pharm.*, **2018**, *12*(4) (Suppl), S1390-S1396, DOI:10.22377/ajp.v12i04.2940.