IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ANALYTICAL METHOD DEVELOPMENT AND VALIDATION FOR THE QUANTITATIVE ESTIMATION OF RUCAPARIB IN BULK AND MARKETED PHARMACEUTICAL DOSAGE FORMS

CHENNUPATI V SURESH[1]*, ANEES FATHIMA[2], SANTHOSH ILLENDULA[3], K N VENKATESWARA RAO[4]

1.Professor & Head of Department, Department of Pharmaceutical Analysis, Nalanda College of Pharmacy, Cherlapally (v), Nalgonda (Dt), Telangana (St), India, 508001.

2.Post Graduate Scholar, Department of Pharmaceutical Analysis, Nalanda College of Pharmacy, Cherlapally (v), Nalgonda (Dt), Telangana (St), India, 508001.

3.Associate Professor, Department of Pharmaceutical Analysis, Nalanda College of Pharmacy, Cherlapally (v), Nalgonda (Dt), Telangana (St), India, 508001.

4.Professor & Principal, Nalanda College of Pharmacy, Cherlapally (v), Nalgonda (Dt), Telangana (St), India, 508001.

ABSTRACT

A simple, rapid, specific and accurate reverse phase high performance liquid chromatographic method has been developed for the validated of Rucaparib in bulk as well as in marketed pharmaceutical dosage form. This separation was performed on a Symmetry ODS (C18) RP Column, 250 mm x 4.6 mm, 5µm column with Acetonitrile, Methanol and 0.1% OPA in the ratio of 60:30:10 as mobile phase at a flow rate of 1.0 mL min−1 with UV detection at 235 nm; the constant column temperature was Ambient. The runtime under these chromatographic conditions was less than 6.0 min. The retention time of Rucaparib was found to be 2.570min. The calibration plot was linear over the concentration range of 6–14 µg mL−1 with limits of detection and quantification values of 0.8 and 0.24ng mL−1 respectively. The mean % assay of marketed formulation was found to be 99.79%, and % recovery was observed in the range of 98-102%. Relative standard deviation for the precision study was found <2%.The developed method is simple, precise, specific, accurate and rapid, making it suitable for estimation of Rucaparib in bulk and marketed pharmaceutical dosage form dosage form.

Keywords: Rucaparib, RP-HPLC, Validation, Accuracy, Precision, Robustness, ICH Guidelines.

INTRODUCTION

Rucaparib is a member of the class of azepinoindoles that is 1,3,4,5-tetrahydro-6H-azepino[5,4,3-cd]indol-6-one carrying additional 4-[(methylamino)methyl]phenyl and fluoro substituents at positions 2 and 8 respectively[1]. It is an inhibitor of poly (ADP-ribose) polymerase and is used (as the Camsylate salt) as monotherapy for advanced ovarian cancer and deleterious germline or somatic BRCA mutation. It has a role as an EC 2.4.2.30 (NAD (+) ADP-ribosyltransferase) inhibitor and an anti neoplastic agent. It is an azepinoindole, a member of caprolactams, an organ fluorine compound and a secondary amino compound. It is a conjugate base of a Rucaparib(1+).Rucaparib is an anticancer drug and poly (ADP-ribose) polymerase (PARP) inhibitor. PARP is an enzyme that plays an essential role in DNA repair[2]. Rucaparib is proposed to work in several PARP-dependent and PARP-independent mechanisms of action; however, it causes a unique effect of synthetic lethality. By targeting the genetically-mutated cancer cells that lack a DNA repair mechanism, Rucaparib causes cancer cell death and reduces tumor growth. Rucaparib was granted FDA Breakthrough Therapy designation in April 2015 and accelerated approval in December 2016. The drug was later approved by the European Commission in May 2018. It is currently used to treat recurrent ovarian and prostate cancer in adults. Rucaparib is a Poly(ADP-Ribose) Polymerase Inhibitor[3]. The mechanism of action of Rucaparib is as a Poly(ADP-Ribose) Polymerase Inhibitor. The IUPAC name of Rucaparibis 6-fluoro-2-[4-(methylaminomethyl)phenyl]-3,10-diazatricyclo[6.4.1.04,13]trideca-1,4,6,8(13)-tetraen-9-one. The Chemical Structure of Rucaparib is shown in following Fig-1.

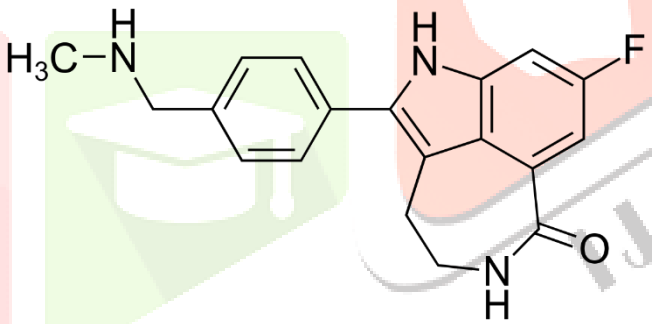

Fig-1: Chemical Structure of Rucaparib

Literature survey revealed that very few analytical methods have been reported for the estimation of Rucaparib in pure drug and pharmaceutical dosage forms using liquid chromatography. The aim of the present work is to develop a validated simple, precise and accurate RP-HPLC method with UV detection for the determination of Rucaparib in bulk and pharmaceutical dosage form.

EXPERIMENTAL

Table-1:List of Instrument used

S. No.	Instruments/Equipments/Apparatus
1.	**HPLC** with Empower2 Software with Isocratic with UV-Visible Detector (Waters).(23)
2.	**T60-LAB INDIA** UV – Vis spectrophotometer
3.	Electronic Balance **(SHIMADZU ATY224)**
4.	Ultra Sonicator **(Wensar wuc-2L)**
5.	Thermal Oven
6.	Symmetry ODS RP C_{18},5µm, 15mm x 4.6mm i.d.
7.	P^H Analyzer **(ELICO)**
8.	Vacuum filtration kit **(BOROSIL)**

Table-2:List of Chemicals used

S.No.	Name	Specifications		Manufacturer/Supplier
		Purity	Grade	
1.	Doubled distilled water	99.9%	HPLC	Sd fine-Chem ltd; Mumbai
2.	Methanol	99.9%	HPLC	Loba Chem; Mumbai.
3.	Di potassium hydrogen orthophosphate	96%	A.R.	Sd fine-Chem ltd; Mumbai
4.	Acetonitrile	99.9%	HPLC	Loba Chem; Mumbai.
5.	Potassium di hydrogen orthophosphate	99.9%	A.R.	Sd fine-Chem ltd; Mumbai
6.	Sodium hydroxide	99.9%	A.R.	Sd fine-Chem ltd; Mumbai
7.	Hydrochloric acid	99.9%	A.R.	Loba Chem; Mumbai.
8.	Hydrogen Peroxide	99.9%	A.R.	Loba Chem; Mumbai.

METHOD DEVELOPMENT

Selection of Wavelength

The standard & sample stock solutions were prepared separately by dissolving standard & sample in a solvent in mobile phase diluting with the same solvent.(After optimization of all conditions) for UV analysis. It scanned in the UV spectrum[4] in the range of 200 to 400nm. This has been performed to know the maxima of Rucaparib, so that the same wave number can be utilized in HPLC UV detector for estimating the Rucaparib. The scanned UV spectrum is attached in the following page,

Sample & Standard Preparation for the UV-Spectrophotometer Analysis

25 mg of Rucaparib standard was transferred into 25 ml volumetric flask, dissolved & make up to volume with mobile phase. Further dilution was done by transferring 0.5 ml of the above solution into a 10ml volumetric flask and make up to volume with mobile phase.

Optimization of Chromatographic Conditions: The chromatographic conditions were optimized by different means. (Using different column, different mobile phase, different flow rate, different detection wavelength & different diluents for sample preparation etc.

Table-3: Summary of Process Optimization

Column Used	Mobile Phase	Flow Rate	Wave length	Observation	Result
Symmetry $C_{18,}$ ODS, Reverse Phase, 250 mm x 4.6 mm, 5µm, Column.	Methanol : Acetonitrile = 40 : 60	1.0ml/min	235nm	Very Low response	Method rejected
Symmetry $C_{18,}$ ODS, Reverse Phase, 250 mm x 4.6 mm, 5µm, Column.	Methanol : Acetonitrile = 55 : 45	1.0ml/min	235nm	Low response	Method rejected
Symmetry $C_{18,}$ ODS, Reverse Phase, 250 mm x 4.6 mm, 5µm, Column.	Acetonitrile : Water = 50:50	1.0ml/min	235nm	Tailing peaks	Method rejected
Symmetry $C_{18,}$ ODS, Reverse Phase, 250 mm x 4.6 mm, 5µm, Column.	Methanol : Water = 70:30	1.0ml/min	235nm	Resolution was not good	Method rejected
Symmetry $C_{18,}$ ODS, Reverse Phase, 250 mm x 4.6 mm,	ACN : Methanol: 0.1% OPA = 70:25:5	1.0ml/min	235nm	Tailing peak	Method rejected

5µm, Column.					
Symmetry $C_{18,}$ ODS, Reverse Phase, 250 mm x 4.6 mm, 5µm, Column.	ACN : Methanol: 0.1% OPA = 60:30:10	1.0ml/min	235nm	Nice peak	Method accepted

Preparation of Mobile Phase:

600ml of HPLC Grade Acetonitrile, 300ml of HPLC Grade Methanol and 100ml 0.1% OPA were mixed well and degassed in ultrasonic water bath for 15 minutes. The solution was filtered through 0.45 µm filter under vacuum filtration[7].

Validation of Analytical Method

The developed method was further validated as per ICH guidelines for accuracy, Precision, LOD, LOQ, specificity, sensitivity, and robustness.

RESULTS AND DISCUSSION

Optimization of Analytical Method

Selection of Wavelength:

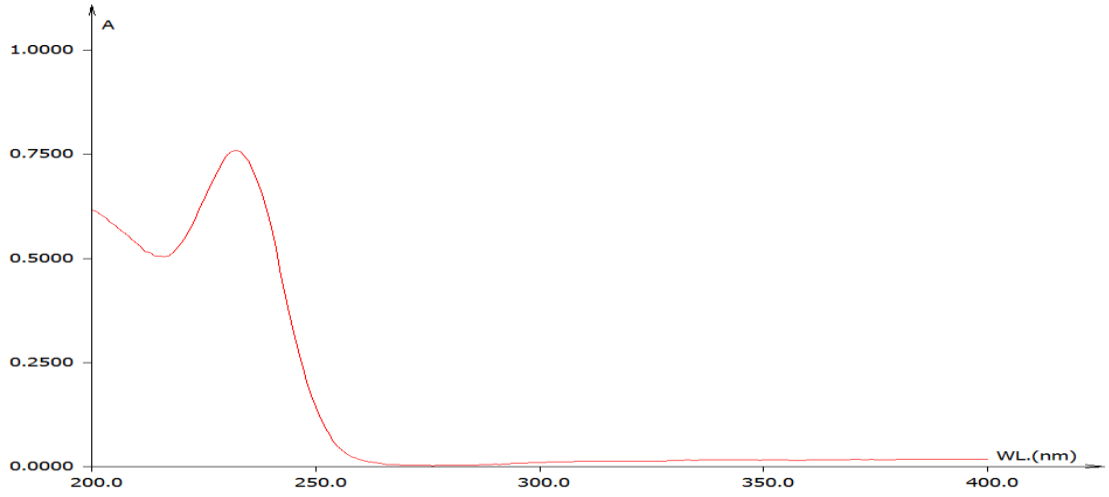

Fig-2: UV Spectrum for Rucaparib

Observation: While scanning the Rucaparib solution we observed the maxima at 235nm. The UV spectrum has been recorded on T60-LAB INDIA make UV – Vis spectrophotometer model UV-2450.

Summary of Optimized Chromatographic Conditions

The Optimum Chromatographic conditions obtained from experiments can be summarized as below:

Table-4:Summary of Optimised Chromatographic Conditions

Mobile phase	ACN : Methanol: 0.1% OPA = 60:30:10
Column	Symmetry ODS (C_{18}) RP Column, 250 mm x 4.6 mm, 5µm
Column Temperature	Ambient
Detection Wavelength	235 nm
Flow rate	1.0 ml/ min.
Run time	06 min.
Temperature of Auto sampler	Ambient
Diluent	Mobile Phase
Injection Volume	10µl
Type of Elution	Isocratic
Retention time	2.570 minutes

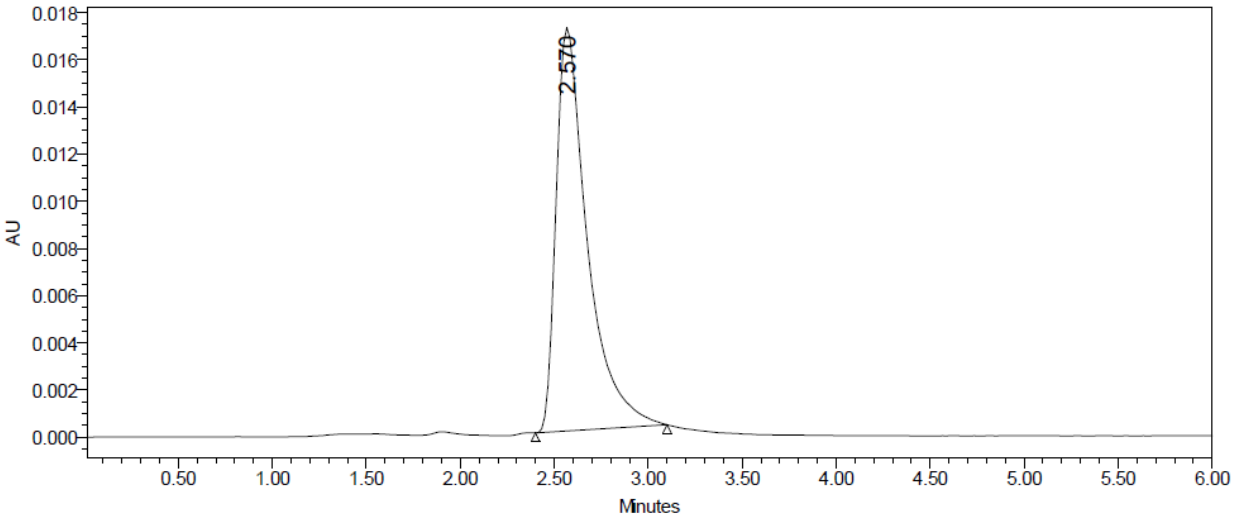

Fig-3: Chromatogram of Rucaparib in Optimized Condition

Observation: The selected and optimized mobile phase was ACN: Methanol: 0.1% OPA = 60:30:10 and conditions optimized were flow rate (1.0 ml/minute), wavelength (235nm), Run time was 06 mins. Here the peaks were separated and showed better resolution, theoretical plate count and symmetry. The proposed chromatographic conditions were found appropriate for the quantitative determination of the drug.

Method Validation

1. Accuracy:

Recovery Study:

To determine the accuracy of the proposed method, recovery studies were carried out by adding different amounts (80%, 100%, and 120%) of pure drug of Rucaparib were taken and 3 replications of each has been injected to HPLC system. From that percentage recovery values were calculated from the linearity equation y = 19423x + 5444.4. The results were shown in table-5.

Table-5: Readings of Accuracy

Conc. In ppm	**Conc. Found**	**Peak Area**		**% Recovery**
8	8.035	161523		100.437
8	8.153	163815		101.912
8	8.061	162023		100.762
			Avg.	101.037
			S.D	0.775
			%RSD	0.767046
Conc. In ppm	**Conc. Found**	**Peak Area**		% Recovery
10	9.930	198315		99.30
10	10.033	200320		100.33
10	10.044	200540		100.44
			Avg.	100.0233
			S.D	0.628835
			%RSD	0.628688
Conc. In ppm	**Conc. Found**	**Peak Area**		% Recovery
12	11.981	238151		99.841
12	12.066	239819		100.55
12	12.215	242712		101.791
			Avg.	100.7273
			S.D	0.987021
			%RSD	0.979894

2.Precision:

2.1. Repeatability

The precision of each method was ascertained separately from the peak areas & retention times obtained by actual determination of six replicates of a fixed amount of drug. Rucaparib (API). The percent relative standard deviation was calculated for Rucaparib are presented in the table-6.

Table-6: Readings of Repeatability

HPLC Injection Replicates of Rucaparib	Retention Time (Minutes)	Peak Area (AUC)
Replicate – 1	2.572	197236
Replicate – 2	2.570	197762
Replicate – 3	2.573	195969
Replicate – 4	2.570	194724
Replicate – 5	2.574	198327
Replicate – 6	2.573	198711
Average		**197121.5**
Standard Deviation		**1515.213**
% RSD		**0.768667**

Observation: The repeatability study which was conducted on the solution having the concentration of about 10µg/ml for Rucaparib (n =6) showed a RSD of 0.768667% for Rucaparib. It was concluded that the analytical technique showed good repeatability.

2.2. Intermediate Precision/Ruggedness:

2.2.1. Intra-Day & Inter-Day:

The intra & inter day variation of the method was carried out & the high values of mean assay & low values of standard deviation & % RSD (% RSD < 2%) within a day & day to day variations for Rucaparib revealed that the proposed method is precise.

Intra Day/Day-1/Analyst-1:

Table-7: Results of Intermediate Precision Analyst 1 for Rucaparib

S.No.	Peak Name	RT	Area (µV*sec)	USP Plate count	USP Tailing
1	Rucaparib	2.580	206587	3102	1.16
2	Rucaparib	2.597	206859	2986	1.18
3	Rucaparib	2.581	207854	3054	1.13
4	Rucaparib	2.573	208965	3154	1.14
5	Rucaparib	2.590	206547	3157	1.12
6	Rucaparib	2.572	209865	3268	1.18
Mean			**207779.5**		
Std.Dev.			**1381.9336**		
%RSD			**0.665**		

Inter Day/Day-2/Analyst-2:

Table-8: Results of Intermediate Precision Analyst 2 for Rucaparib

S.No.	Peak Name	RT	Area (µV*sec)	USP Plate count	USP Tailing
1	Rucaparib	2.580	215263	3215	1.17
2	Rucaparib	2.597	214235	3652	1.19
3	Rucaparib	2.581	213254	3496	1.15
4	Rucaparib	2.573	212367	3258	1.16
5	Rucaparib	2.590	213698	3365	1.17
6	Rucaparib	2.572	217456	3524	1.14
Mean			**214378.8**		
Std.Dev.			**1791.516**		
%RSD			**0.835678**		

Observation: Intraday and interday studies show that the mean RSD (%) was found to be within acceptance limit (≤2%), so it was concluded that there was no significant difference for the assay, which was tested within day and between days. Hence, method at selected wavelength was found to be precise.

3. Linearity & Range:

The calibration curve showed good linearity in the range of 6 – 14 µg/ml, for Rucaparib (API) with correlation coefficient (r^2) of 0.999 (Fig-4). A typical calibration curve[18]has the regression equation of y = 19423x + 5444.4 for Rucaparib.

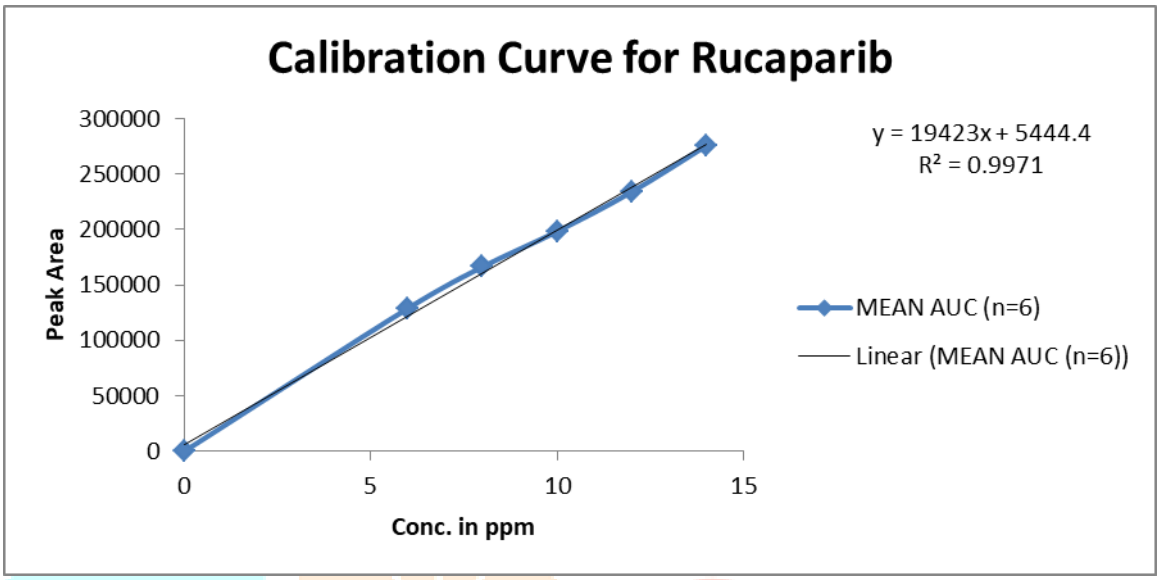

Fig-4:Calibration Curve of Rucaparib (API).

Table-9: Linearity Results

CONC.(µg/ml)	MEAN AUC (n=6)
0ppm	0
6ppm	129013
8ppm	166523
10ppm	198315
12ppm	234151
14ppm	275819

Linearity Plot:

The plot of Concentration (x) versus the Average Peak Area (y) data of Rucaparib is a straight line.

Y = mx + c

Slope (m) = 19423

Intercept (c) = 5444.4

Correlation Coefficient (r) = 0.99

Validation Criteria: The response linearity is verified if the Correlation Coefficient is 0.99 or greater.

Conclusion: Correlation Coefficient (r) is 0.99, and the intercept is 5444.4. These values meet the validation criteria.

4. Specificity:

The system suitability for specificity was carried out to determine whether there was any interference of any impurities in the retention time of the analytical peak.

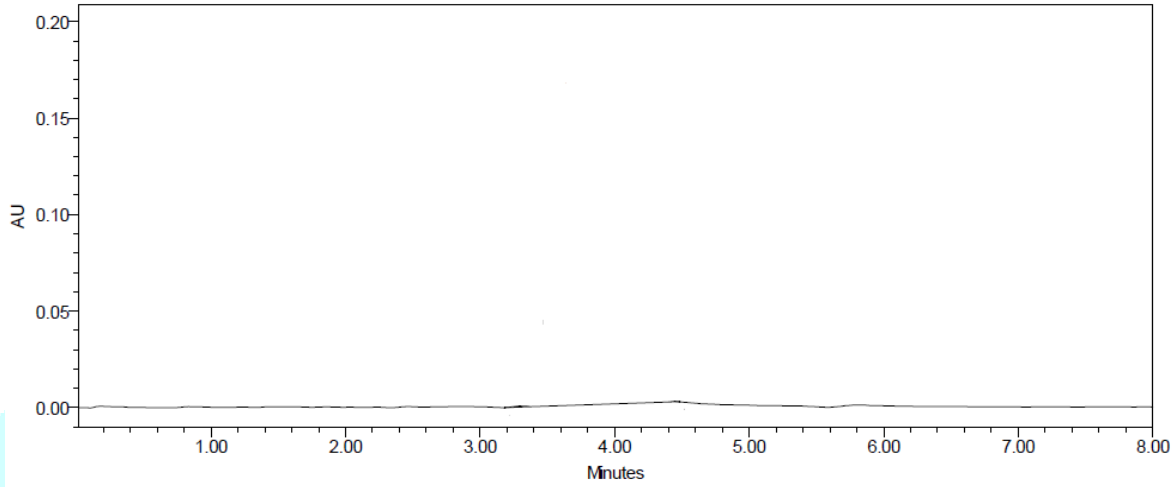

Fig-5: Chromatogram for Blank Solution

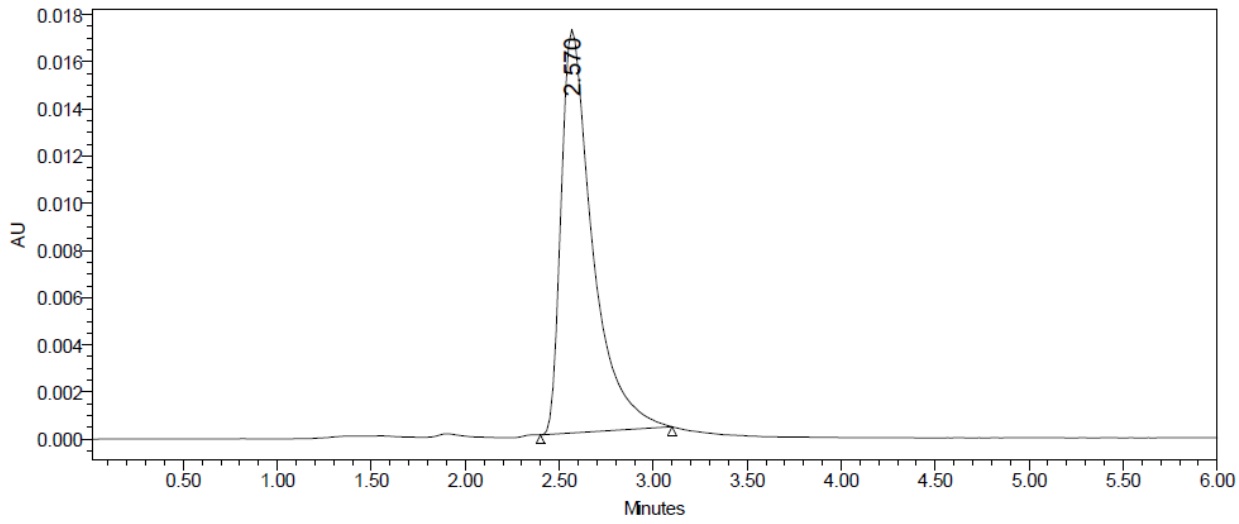

Fig-6: Chromatogram of Rucaparib Standard Solution

Observation: The study was performed by injecting blank and standard into the system. There was no interference of any peak in the blank with the retention time of the analytical peaks.

5. Method Robustness: Influence of small changes in chromatographic conditions such as change in flow rate (± 0.1ml/min), Wavelength of detection (±2nm) &organic phase in mobile phase (±5%) studied to determine the robustness of the method are also in favour of (Table-10, % RSD < 2%) the developed RP-HPLC method for the analysis of Rucaparib (API).

Table-10: Results for Robustness for Rucaparib

Parameter Used for Sample Analysis	Peak Area	Retention Time	Theoretical Plates	Tailing Factor
Actual Flow rate of 1.0 mL/min	203654	2.570	2915	1.16
Less Flow rate of 0.9 mL/min	265876	2.573	3652	1.19
More Flow rate of 1.1 mL/min	298653	2.631	3854	1.20
Less Organic Phase	315874	2.590	3945	1.17
More Organic Phase	326985	2.602	3487	1.19

6. LOD & LOQ:

LOD: The detection limit of an individual analytical procedure is the lowest amount of analyte in a samplewhich can be detected but not necessarily quantitated as an exact value[24].

$$\mathbf{LOD = 3.3 \times \sigma / s}$$

Where

σ = Standard deviation of the response

S = Slope of the calibration curve

LOQ: The quantitation limit of an individual analytical procedure is the lowest amount of analyte in a sample which can be quantitatively determined.

$$\mathbf{LOQ = 10 \times \sigma / S}$$

Where

σ = Standard deviation of the response

S = Slope of the calibration curve

Observation: The Minimum concentration level at which the analyte can be reliable detected (LOD) & quantified (LOQ) were found to be 0.08 & 0.24µg/ml respectively.

7. System Suitability Parameter: System suitability was carried out with six injections of a solution of 100% concentration having 10µg/ml of Avapritinib into the chromatographic system. Several theoretical plates (N) were obtained and the calculated tailing factor (T) was reported in table-11.

Table-11:Dataof System Suitability Parameter

S.No.	Parameter	Limit	Result
1	Asymmetry	T ≤ 2	Rucaparib=0.23
2	Theoretical plate	N > 2000	Rucaparib=2987
3	Tailing Factor	T<2	Rucaparib=1.17

8. Estimation of Rucaparib in Pharmaceutical Dosage Form

Twenty pharmaceutical dosage forms were taken and the I.P. strategy was taken after to decide the normal weight. Above measured tablets were at last powdered and triturated well. An amount of powder proportionate to 25 mg of medications were exchanged to 25 ml volumetric flagon, make and arrangement was sonicated for 15 minutes, there after volume was made up to 25 ml with same dissolvable. At that point 10 ml of the above arrangement was weakened to 100 ml with versatile stage. The arrangement was separated through a layer channel (0.45 □m) and sonicated to degas. The arrangement arranged was infused in five reproduces into the HPLC framework and the perceptions were recorded.

A copy infusion of the standard arrangement was additionally infused into the HPLC framework and the peak regions were recorded. The information is appeared in Table-12.

Assay % =

$$\frac{AT}{AS} \times \frac{WS}{DS} \times \frac{DT}{WT} \times \frac{P}{100} \times \text{Avg. Wt} = \text{mg/tab}$$

Where:

AT = Peak Area of medication acquired with test arrangement

AS = Peak Area of medication acquired with standard arrangement

WS = Weight of working standard taken in mg

WT = Weight of test taken in mg

DS = Dilution of Standard arrangement

DT = Dilution of test arrangement

P = Percentage virtue of working standard

Table-12: Recovery Data for estimation of Rucaparib in Nuparp 200 Tablet

Brand Name of Rucaparib	Labelled amount of Drug (mg)	Mean (± SD) amount (mg) found by the proposed method (n=6)	Assay % (± SD)
Nuparp 200 Tablet (Catalent CTS, Inc.)	200mg	199.563 (± 0.458)	99.63 (±0.368)

Result & Discussion: The amount of drug in Nuparp 200 Tablet was found to be 1.99.563 (± 0.458) mg/tab for Rucaparib & % assay was 99.63 %.

Stability Studies

Results of Stability Studies: The results of the stress studies indicated the **specificity** of the method that has been developed. Rucaparib was stable in thermal and photolytic stress conditions. The result of forced degradation studies are given in the following table-13.

Table-13:Results of forced degradation studies of Rucaparib API.

Stress condition	Time	Assay of active substance	Assay of degraded products	Mass Balance (%)
Acid Hydrolysis (0.1 M HCl)	24Hrs.	81.36	18.64	100.0
Basic Hydrolysis (0.I M NaOH)	24Hrs.	83.37	16.63	100.0
Thermal Degradation (50 ^{0}C)	24Hrs.	98.92	1.08	100.0
UV (254nm)	24Hrs.	96.33	3.67	100.0
3 % Hydrogen peroxide	24Hrs.	89.41	10.59	100.0

SUMMARY AND CONCLUSION

To develop a precise, linear, specific & suitable stability indicating RP-HPLC method for analysis of Rucaparib, different chromatographic conditions were applied & the results observed are presented in previous chapters.Isocratic elution is simple, requires only one pump & flat baseline separation for easy and reproducible results. So, it was preferred for the current study over gradient elution. In case of RP-HPLC various columns are available, but here Symmetry ODS (C_{18}) RP Column, 250 mm x 4.6 mm, 5µm Column was preferred because using this column peak shape, resolution and absorbance were good. Mobile phase & diluent for preparation of various samples were finalized after studying the solubility of API in different solvents of our disposal (methanol, Acetonitrile, dichloromethane, water, 0.1N NaOH, 0.1NHCl). Discovery wavelength was chosen in the wake of examining the standard arrangement of medication more than 200 to 400nm. From the U.V range of Rucaparib it is apparent that a large portion of the HPLC works can be proficient in the wavelength scope of 210-300 nm helpfully. Further, a stream rate of 1.0 ml/min and an infusion volume of 10µl were observed to be the best investigation. The outcome demonstrates the created technique is amazingly, one more reasonable strategy for measure and dependability related debasement examines which can help in the investigation of Rucaparib in various details.

BIBLIOGRAPHY

1. https://go.drugbank.com/drugs/DB12332
2. https://pubchem.ncbi.nlm.nih.gov/compound/Rucaparib
3. https://en.wikipedia.org/wiki/Rucaparib
4. Morgan, David J., "Fraction collector (post on Flickr)". *Flickr*. Retrieved, 28 October 2015.
5. Karger, Barry L. "HPLC: Early and Recent Perspectives". Journal of Chemical Education. 74: 45. Bibcode:1997JChEd.74...45K, *1997*.
6. Henry, Richard A., "The Early Days of HPLC at Dupont". Chromatography Online. Avanstar Communications Inc, 1 February 2009.
7. Quality Assurance, worth the effort, Inforum, volume 7;number.4, October 2003.
8. P.D. Sethi, Quantitative Analysis of drugs in Pharmaceutical formulation, IIIrd Ed., pp.1-21, 51-56.
9. Text on Validation of Analytical Procedures, ICH Harmonized Tripartite Guidelines, 1994.
10. Validation of Analytical Procedures: Methodology. ICH-Guidelines Q2B, Geneva. 1996, 11. (CPMP/ICH/281/95).
11. CH.V.Suresh, S. Greeshma, Santhosh Illendula ; A new analytical Method development and validation of estimation of avapritinib by RP-HPLC , International Journal of Multidisciplinary Research and Growth Evaluation, 2023; 04(01) : 175-182
12. Santhosh Illendula, Naveen Kumar Singhal ; A Review: Novel analytical method development & validation for the determination of selected anti cancer & anti viral drugs, World Journal of Pharmacy & Pharmaceutical Sciences 2022; 11(07): 533-566

13. CH. V. Suresh, M. Sri Raaga, Santhosh Illendula ;Development of stability indicating RP-HPLC method and validation for the estimation of cabotegravir and Rilpivirine in pure form and marketed pharmaceutical dosage form , YMER, 2023; 22(02) : 703-725.
14. Santhosh Illendula, M. Sanjana & Rajeswar Dutt ; A validated stability indicating RP_HPLC method development for the estimation of pomalidomide in bulk & pharmaceutical dosage form , International Journal of Pharmacy and Biological sciences, 2019: 09(01): 63-72
15. Development and validation of HPLC method - A Review, Vibha Gupta et al, International Research Journal of Pharmaceutical and Applied Sciences, 2012; 2(4):17-25.
16. A Review: HPLC Method Development and Validation, Santosh Kumar Bhardwaj *et al. International Journal of Analytical and Bio analytical Chemistry, accepted 20 November 2015.
17. Method Development: A Guide to Basics Quantitative & Qualitative HPLC, LC, GC chromacademy.
18. Lalit V Sonawane*, Bio analytical Method Validation and Its Pharmaceutical Application- A Review Pharmaceutica Analytical Acta 2014, 5:3Center for Drug Evaluation and Research (CDER) Reviewer Guidance.
19. ICH Topic Q 2 (R1) Validation of Analytical Procedures: Text and Methodology.
20. D. Suchitra[1], Satyanarayana Battu[2]*, A Stability Indicating Reverse Phase-HPLC Method Development and Validation for the Estimation of Rucaparib in Bulk and Pharmaceutical Dosage Form, American Journal of Analytical Chemistry, 12, 96-107. Doi: 10.4236/ajac.2021.124008.
21. Saiempu Ravi Kishore and SK. Abdul Rahman, Estimation of Rucaparib in Biological Matrices by LC-ESI-MS/MS, International Journal of Pharmacy and Biological Sciences-IJPBSTM, (2019), 9 (1): 1274-1281.
22. Vamsee krishna Gorijavolu[1], Ajay Kumar Gupta[1] and Y. A. Chowdary[2], a Sensitive Bio Analytical Method Development and Validation of Rucaparib in Human Plasma by LC-ESI-MS/MS.
23. Bolleddu R, Venkatesh S, Bhongiri B, Varanasi S. Establishment of Quality Parameters for Flowers of Karanja [Pongamia pinnata (L.) Pierre] through Powder Microscopy and Phytochemical Studies. J Drug Res Ayurvedic Sci 2018; 3 (4):228-233.