REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1S (2024)
http://www.veterinaria.org
Received: 02/08/2024 Revised:17/08/2024 Accepted: 02/09/2024 Published: 20/09/2024

HPLC METHOD FOR THE SIMULTANEOUS DETERMINATION OF TADALAFIL AND SILDENAFIL IN BULK AND TABLET DOSAGE FORM

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Abstract
The current work aims to establish a validated RP-HPLC method for estimating the combined dosage of sildenafil and tadalafil. Using ZORBAX C18 (250 × 4.6 mm, 5 µm)as a stationary phase and mobile phase, the medicines were separated The mobile phase consisted of acetate buffer pH 3.0 adjusted with acetic acid and methanol (10:90, v/v) at a flow rate of 0.7 mL/min., at 280 mm detection was carried out. Sildenafil's Rt was 4.611 minutes, while Tadalafil's was 3.744 minutes. Tadalafil and sildenafil had respective percentage drug contents of 98.63% when the commercial formulation was examined using the established approach. In the 50–150 PPM range for Tadalafil and 50–150 PPM range for Sildenafil, the approach was determined to be linear.. The results showed that the quantitation limit for sildenafil was 1.65 PPM and the detection limit for tadalafil was 5 PPM. For both medications, the accuracy and precision scores were found to be close to 100% w/w. Additionally, the approach was proven to be specific and robust. Tadalafil and sildenafil in combination dosage form were found to be linear, specific, sensitive, precise, accurate, and robust when analyzed using the proposed RP-HPLC technique.

Keyword: Tadalafil and Sildenafil, HPLC, Validation

Introduction

Tadalafil is a crystalline powder that ranges from white to off white. It is soluable in methanol and just weakly soluble in water. Tadalafil has a molecular weight of 438.4 g/mol and the chemical formula is C22H19N3O4. Tadalafil is quickly absorbed when taken orally. Within 30 to 120 minutes, the plasma concentration reaches its maximum. The cytochrome P450 enzyme system breaks down tadalafil in the liver. 17.5 hours is the elimination half-life. One type of PDE5 inhibitor is tadalafil. One enzyme that degrades cGMP is PDE5. One signaling molecule involved in erectile function is cGMP. Tadalafil helps to raise the amounts of cGMP in the penis, which results in an erection, by preventing the breakdown of cGMP.

Table 1: Drug profile for Tadalafil

Drug Name	**Tadalafil**
Brand Name	Cialis
Class	Phosphodiesterase type 5 (PDE5) inhibitor
Indications	Erectile dysfunction, benign prostatic hyperplasia (BPH)
Dosage	2.5-20 mg orally once daily
Contraindications	Heart disease, liver disease, kidney disease, nitrate Medications
Precautions	Use with caution in people with diabetes, high blood pressure, and bleeding disorders
Overdose	Symptoms may include headache,flusing.and upset stomac.seek inedical attention if you experience any of these symptoms
Storage	Store at room temperature in a dry place

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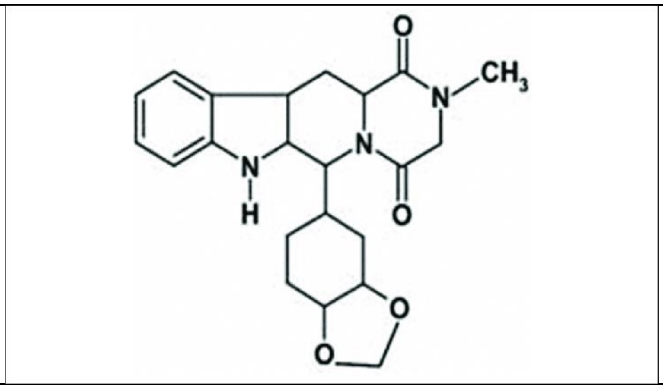
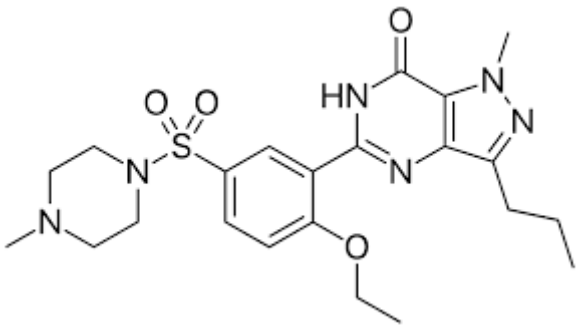
Structure		
IUPAC	(6R,12Ar)-6-(1,3-Benzodioxol-5yl)-2-methy1-2,3,6,7,12a-hexahydropyrazino[1',2':1,6]pyrido[3,4-b]bindole-1,4-dione.	

Sildenafil is a crystalline powder that ranges from White of- white. It is soluable in methanol and just weakly soluable in water. Sildenafil's molecular Wight is 474.6 g/mol and its chemical formula is C22H30N6O4S. When sildenafil is taken orally, it is quickly absorbed. Within 30 to 120 minutes, the plasma concentration reaches its maximum. The cytochrome P450 enzyme system breaks down sildenafil in the liver. Three to five hours is the elimination half-life. One PDE5 inhibitor is sildenafil. One enzyme that degrades cGMP is PDE5. One signaling molecule involved in erectile function is cGMP. Sildenafil helps to raise the amounts of cGMP in the penis, which results in an erection, by preventing the breakdown of cGMP.

Table 2: Drug profile for Sildenafil

Drug Name	**Sildenafil**
Brand Name	Viagra
Class	Phosphodiesterase type 5 (PDE5) inhibitor
Indications	Erectile dysfunction, benign prostatic hyperplasia (BPH)
Dosage	25-100 mg orally 30-60 minutes before sexual activity
Contraindications	Heart disease, liver disease, kidney disease, nitrate Medications
Precautions	Use with caution in people with diabetes, high blood pressure, and bleeding disorders
Overdose	Symptoms may encompass cephalalgia, facial erythema, and gastrointestinal distress; it is imperative to pursue medical evaluation should any of these manifestations occur.
Storage	Store in dry palace at room temperature
Structure	
IUPAC	5-[2-ethoxy-5-(4-methylpiperazin-1-yl)sulfonylphenyl]-1-methyl-3-propyl-6*H*-pyrazolo[4,3-d]pyrimidin-7-one;2-hydroxypropane-1,2,3-tricarboxylic acid

MATERIALS AND METHODS

Chemicals and solvents:

HPLC grade methanol (Lichrosolv**,** Merck Life sciences Pvt. Ltd., Mumbai, India), HPLC water 2487 MPOWER 2. Acetate buffer, composed of sodium acetate, acetic acid, and distilled water, was employed in the investigation. The

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analytical standards for Tadalafil and Sildenafil were graciously provided as a donation from Sigma-Aldrich (USA). The Sildalist tablet, which comprises 100 mg of Sildenafil and 20 mg of Tadalafil was acquired from the local commercial market, produced by Torrent Pharmaceutical Company.

INSTRUMENTATION:

Chromatographic analysis was carried out on a Waters Alliance HPLC system equipped with a 2996 PDA detector and Empower software. Separation was achieved using a ZORBAX C18 column (250 × 4.6 mm, 5 µm) with an isocratic mobile phase The mobile phase consisted of acetate buffer pH 3.0 adjusted with acetic acid and methanol (10:90, v/v) at a flow rate of 0.7 mL/min. Detection was performed at 280 nm, with the column maintained at 37°C and an injection volume of 20 µL.

Table 1: various optimization trials and chromatograms are presented in the following table

Trial No.	Column Specification	Mobile Phase Composition (% v/v)	Observation / Remark
1	ZORBAX C18 (250 × 4.6 mm, 5 µm)	20 mM KH_2PO_4 buffer : Acetonitrile (50:50)	Poor separation between analytes; inadequate resolution
2	ZORBAX C18 (250 × 4.6 mm, 5 µm)	Acetate buffer : Methanol (50:50) pH 3.0 adjusted with acetic acid	Long retention time; peak broadening observed
3	ZORBAX C18 (250 × 4.6 mm, 5 µm)	Acetate buffer : Methanol (70:30) pH 3.0 adjusted with acetic acid	Very long retention time with poor separation
4	ZORBAX C18 (250 × 4.6 mm, 5 µm)	Acetate buffer : Methanol (10:90) pH 3.0 adjusted with acetic acid	Sharp, symmetrical peaks; satisfactory resolution; reduced retention time

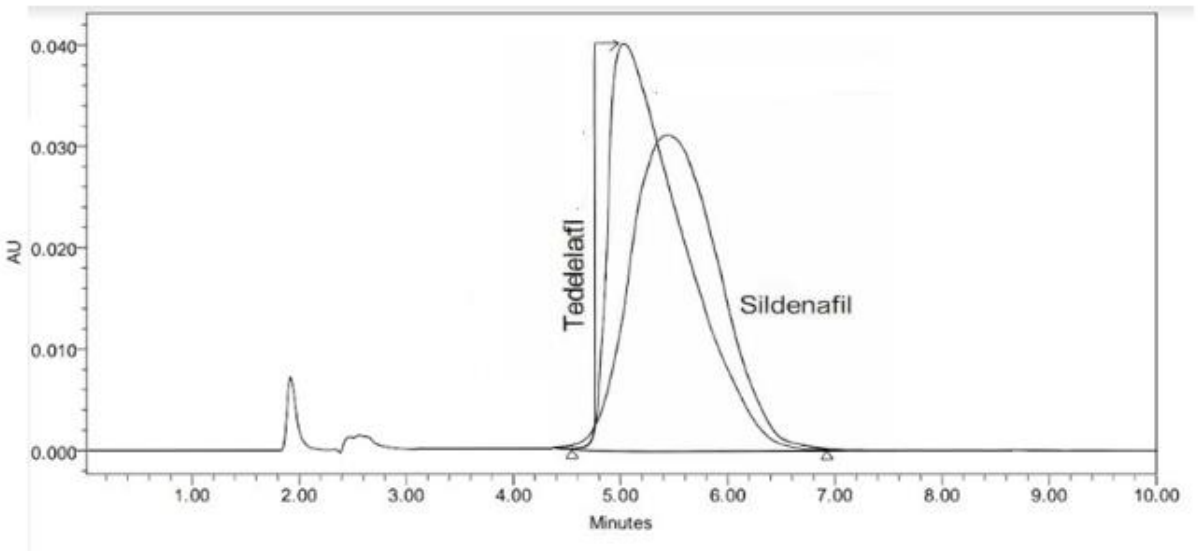

Fig1 – Trial no 1 (20 mM KH_2PO_4 buffer: acetonitrile (50:50, v/v), pH 7.35 (OPA))

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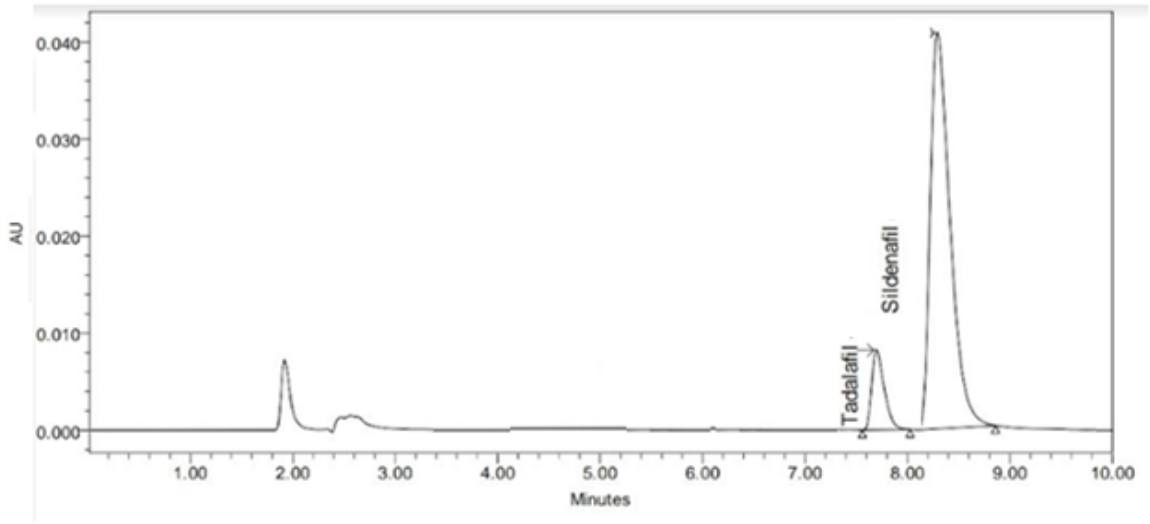

Fig 2 – Trial no 2 (Acetate Buffer: Methanol 70:30)

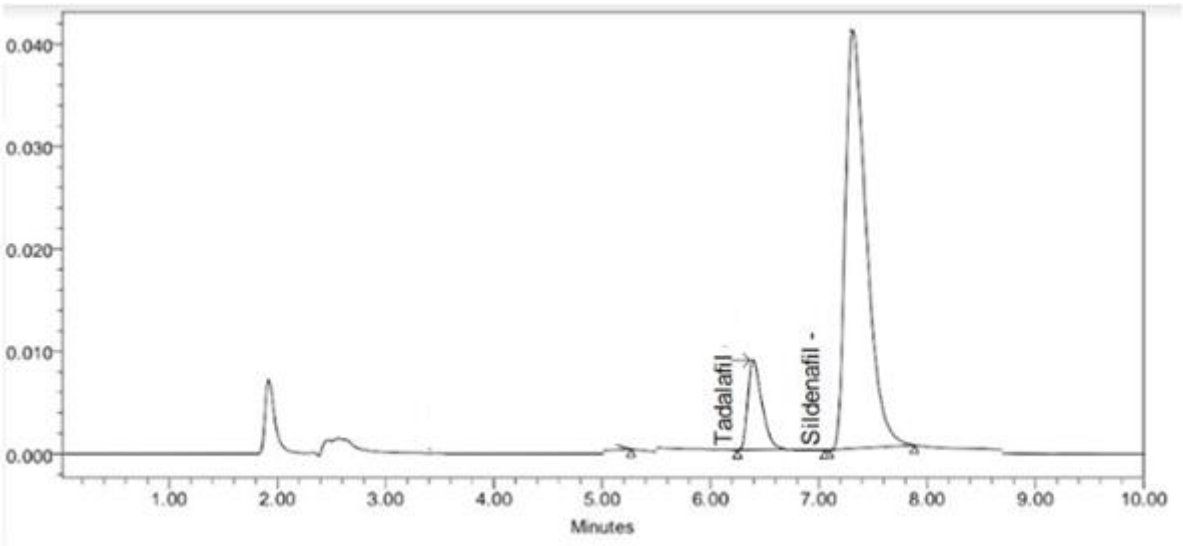

Fig 3 – Trial no 3 (Acetate Buffer: Methanol 20:80)

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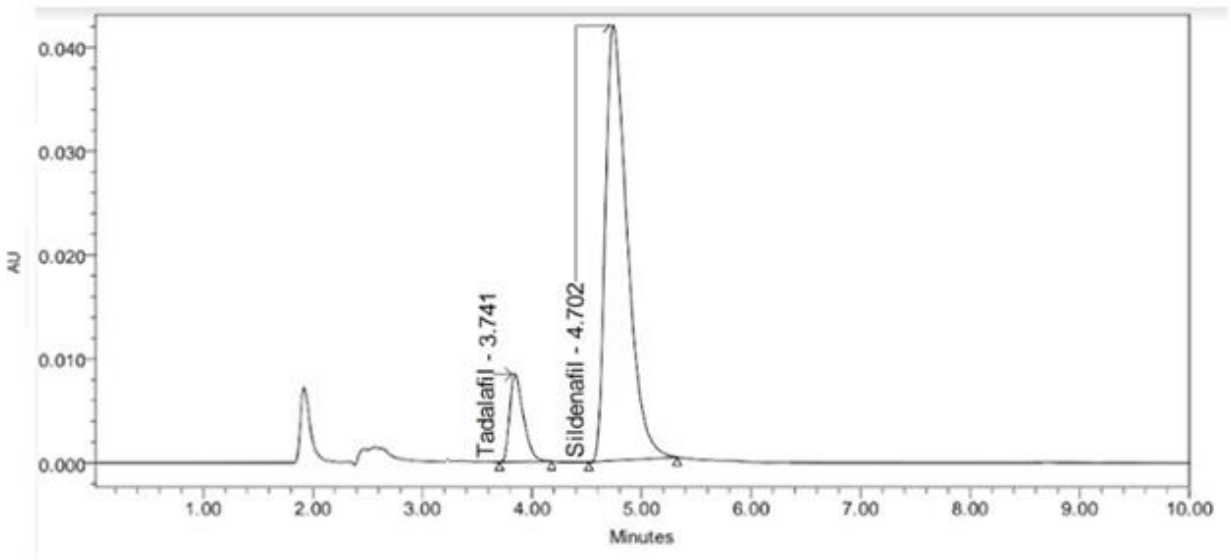

Fig 4– Trial no 4 (Acetate Buffer: Methanol 10:90)

Chromatographic separation was carried out in isocratic mode using a mobile phase consisting of Acetate buffer : Methanol (10:90) pH 3.0 adjusted with acetic acid at a flow rate of 0.7 mL/min. Analysis was performed on a ZORBAX C18 column (250 mm × 4.6 mm, 5 µm) with detection at 280 nm. The column temperature was maintained at 25°C and the total run time was 8 minutes. Data acquisition and processing were conducted using Empower software.

Table 2: Optimized conditions of chromatographic work

Parameter	Optimized Condition
Column (Stationary Phase)	ZORBAX C18 (250 mm × 4.6 mm, 5 µm)
Mobile Phase Composition	Acetate Buffer : Methanol (10:90, v/v)
Flow Rate	0.7 mL/min
Injection Volume	20 µL
Column Temperature	25°C
Detection Wavelength	280 nm
Run Time	8.0 min
Elution Mode	Isocratic

Table 3 System Suitability Table

Parameter	Sildenafil	Tadalafil	Acceptance Criteria
Retention Time (min)	4.71	3.74	—
Resolution (Rs)	—	2.85	≥ 2.0
USP Tailing	1.67	1.32	≤ 2.0
Plate Count (N)	2783	4270	≥ 2000
%RSD (n=6)	0.63	0.24	≤ 2.0

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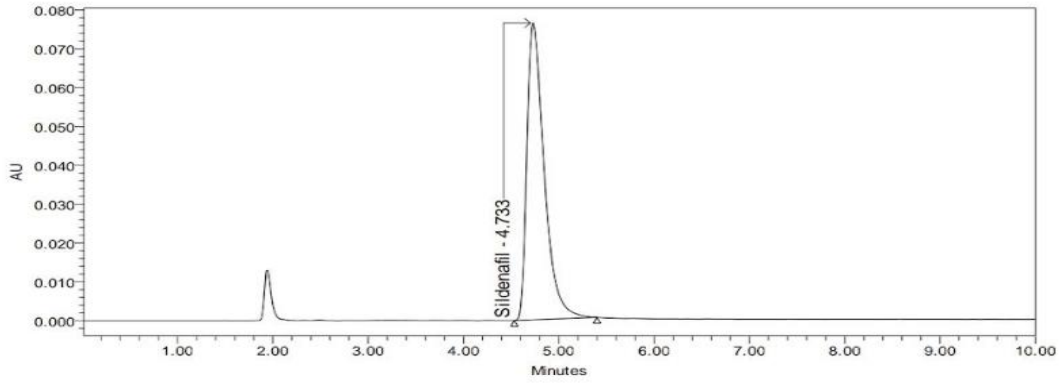
Resolution between Tadalafil and Sildenafil was found to be **2.85**, which is greater than 2.0, confirming adequate chromatographic separation.

Preparation of standard solution

Standard stock solutions were meticulously formulated at a concentration of 200 PPM by individually solubilizing 20 mg of Sildenafil and 20 mg of Tadalafil in mobile phases, specifically a combination of acetate buffer and methanol in a proportion of 10:90, culminating in a total volume of 100 ml to produce a stock solution with an established concentration of 200 PPM. The aforementioned standard stock solution was then appropriately diluted using suitable diluents to achieve various concentrations of Sildenafil and Tadalafil, specifically 50 PPM, 80 PPM, 100 PPM, 120 PPM, and 150 PPM, for the purpose of establishing linearity.

Preparation of Sample Solutions of sildenafil and Tadalafil

Twenty tablets were accurately weighed to determine the average tablet weight and finely powdered. An amount of powder equivalent to 20 mg of Sildenafil and 20 mg of Tadalafil was accurately transferred into a 100 mL volumetric flask. Approximately 70 mL of diluent (acetate buffer:methanol, 10:90 v/v) was added, and the mixture was sonicated for 15 minutes to ensure complete extraction of both drugs. The solution was then cooled to room temperature and diluted to volume with the same diluent to obtain a stock sample solution containing 200 PPM of each drug.The resulting solution was filtered through a 0.45 µm membrane filter. Further appropriate dilutions were prepared from this stock solution using the mobile phase to obtain the required concentration for analysis.



	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count
1	Tadalafil	3.747				
2	Sildenafil	4.733	963929	100.00	1.67	3356.20

Fig 5-Normal chromatogram for Sildenafil

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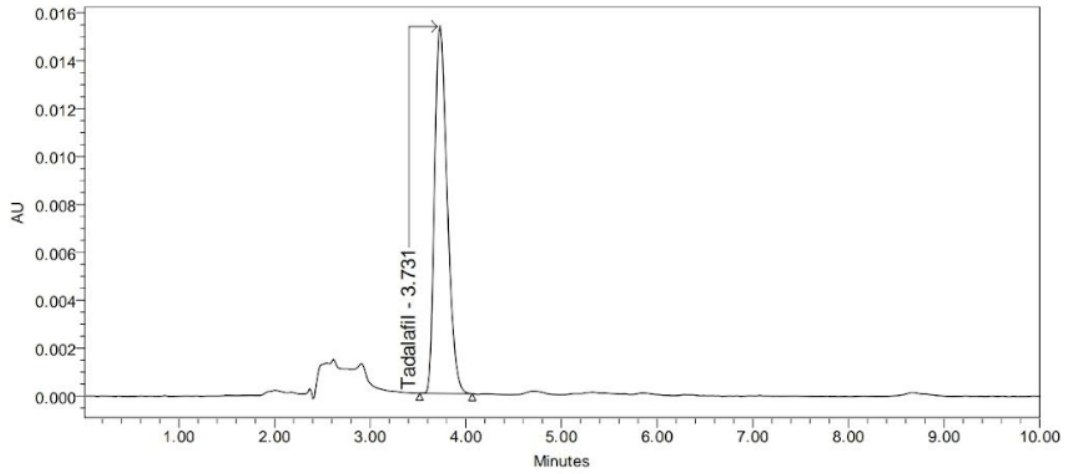
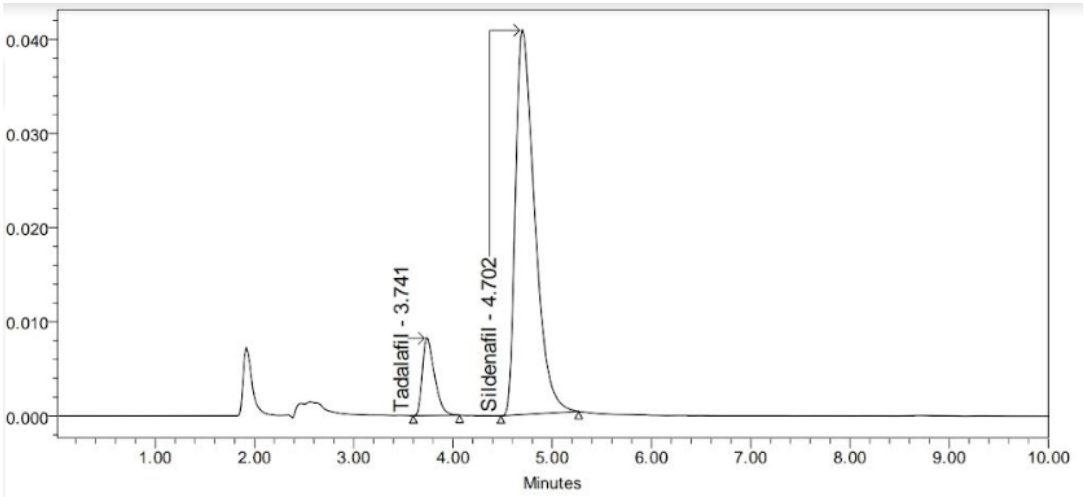


	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count
1	Tadalafil	3.731	140994	100.00	1.32	3746.94

Fig 6-Normal chromatogram for Tadalafil



	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.741	69916	11.30	1.46	4270.63	
2	Sildenafil	4.702	549058	88.70	1.61	2783.07	3.39

Fig7-Normal chromatogram for Tadalafil and Sildenafil STD mixture

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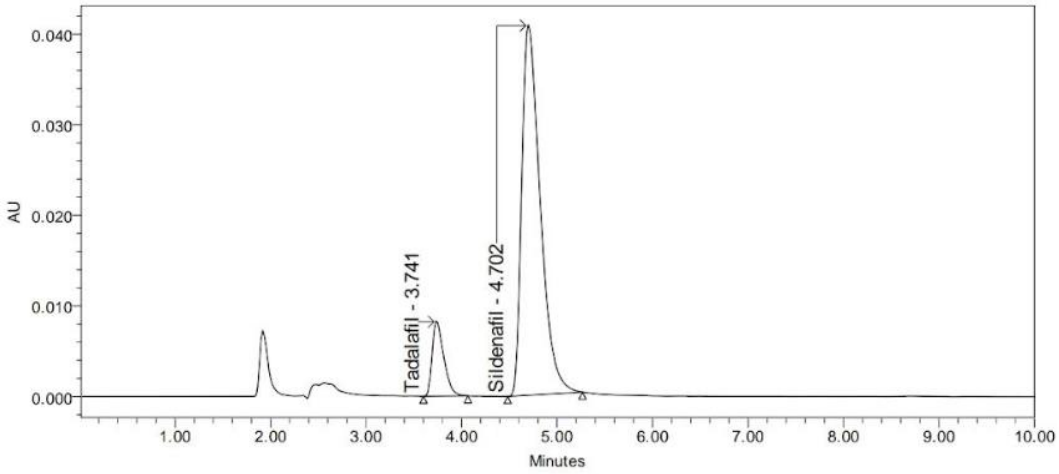

	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.741	69916	11.30	1.46	4270.63	
2	Sildenafil	4.702	549058	88.70	1.61	2783.07	3.39

Fig-8Normal chromatogram for Tadalafil and Sildenafil Sample mixture

METHOD VALIDATION

The methodology that was formulated has been determined to be in compliance with the validation standards established by the ICH and the FDA, with the validation parameters encompassing specificity, linearity, precision, range, accuracy, robustness, sensitivity (Limit of Quantification & Limit of Detection), and the stability of the solution.

Linearity

The linear performance of the proposed RP-HPLC method was investigated within the concentration range of 50–150 ppm for both analytes. A direct and proportional relationship between concentration and chromatographic response was observed throughout the studied range. For Tadalafil, the calibration data generated the regression equation **y = 751.4x − 1921.6** with a determination coefficient (**R^2 = 0.9993**). In the case of Sildenafil, the regression equation was **y = 5280.6x − 9267.2** with an **R^2 value of 0.9996**. The high determination coefficients demonstrate strong linear correlation between analyte concentration and peak area, confirming the suitability of the method for quantitative analysis within the specified range as per regulatory expectations.

Table no 4 Linearity for Tadalafil

S. No.	Concentration (ppm)	Area
1	50	35176
2	80	57932
3	100	74280
4	120	88656
5	150	110049

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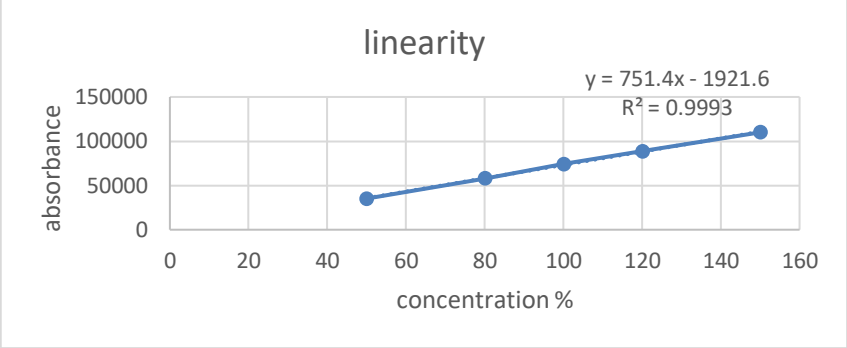

Fig 9-Linearity for Tadalafil

Table5:Linearity for Sildenafil

Sr. No.	Concentration (ppm)	Absorbance (Area)
1	50	258322
2	80	407259
3	100	517853
4	120	627931
5	150	782604

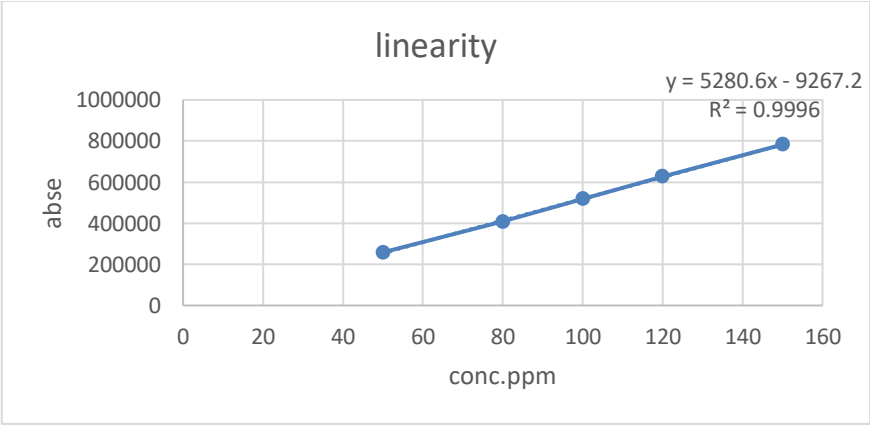

Fig 10 -Linearity for Sildenafil

Accuracy

Accuracy of the method was evaluated by standard addition at 50%, 100%, and 150% of the nominal assay level. The recoveries for Sildenafil and Tadalafil were between 99.65% and 100.45%, with %RSD values below 1.0%. These results demonstrate acceptable trueness and precision, complying with ICH Q2(R2) requirements.

Table 6 Accuracy (Recovery Study) for Tadalafil and Sildenafil

Level	Drug	Mean % Recovery	SD	%RSD
50%	Tadalafil	99.72	0.32	0.32

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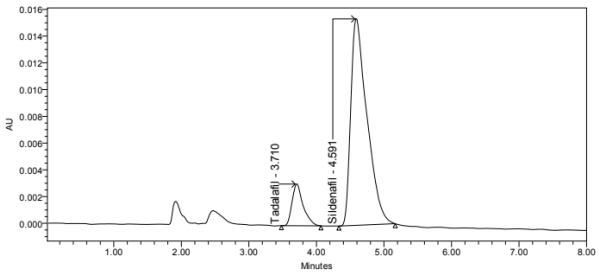
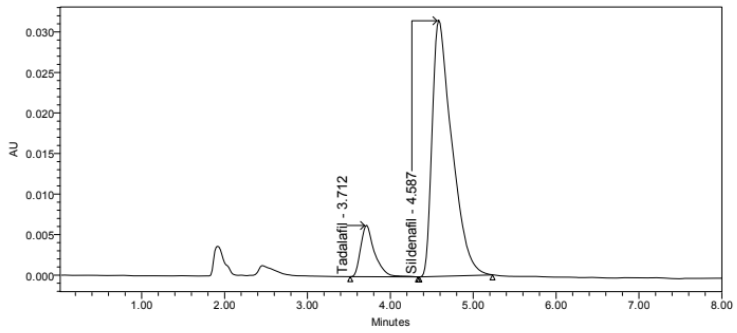
50%	Sildenafil	99.65	0.41	0.41
100%	Tadalafil	100.12	0.28	0.28
100%	Sildenafil	100.08	0.36	0.36
150%	Tadalafil	100.45	0.30	0.30
150%	Sildenafil	99.84	0.38	0.38



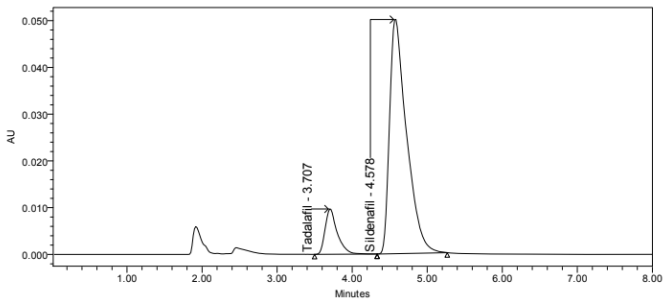
	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.710	35479	12.09	1.39	2517.19	
2	Sildenafil	4.591	257869	87.91	1.72	1456.14	2.45

Fig11 -Chromatogram for Tadalafil and Sildenafil Accuracy 50%



	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.712	73971	12.38	1.45	2439.62	
2	Sildenafil	4.587	523414	87.62	1.74	1530.54	2.45

Fig 12-Chromatogram for Tadalafil and Sildenafil Accuracy 100 %



	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.707	108588	12.09	1.44	2699.59	
2	Sildenafil	4.578	789296	87.91	1.74	1765.45	2.58

Fig 13-Chromatogram for Tadalafil and Sildenafil Accuracy 150%

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High flow variation

Method robustness was assessed by increasing the flow rate from 0.7 to 0.8 mL/min while maintaining other chromatographic conditions constant. A minor reduction in retention time was observed without affecting peak symmetry or efficiency. The %RSD of peak area was below 2% for both analytes, with acceptable tailing factor, plate count (>2000), and resolution (>2.0). These findings confirm that the method is robust against flow rate variation.

Table 7 High Flow Variation Data – Sildenafil (n = 5)

Injection No.	Retention Time (min)	Peak Area	% Area	USP Tailing	USP Plate Count
1	4.266	500539	88.85	1.67	2603.91
2	4.272	501786	88.77	1.70	2589.91
3	4.267	503425	88.79	1.69	2555.72
4	4.271	501535	88.67	1.69	2598.47
5	4.279	501794	88.76	1.71	2480.66

Table 8Statistical Summary

Parameter	Mean	SD	%RSD
Retention Time (min)	4.271	0.005	0.12
Peak Area	501815.8	1036.84	0.21
% Area	88.77	0.07	0.08
USP Tailing	1.69	0.015	0.89
USP Plate Count	2565.73	47.86	1.86

Table9: High flow variation Data for Tadalafil

Injection No.	Retention Time (min)	Peak Area	% Area	USP Tailing	USP Plate Count
1	3.398	62783	11.15	1.51	4371.51
2	3.408	63531	11.24	1.62	4160.89
3	3.405	64091	11.33	1.61	4269.37
4	3.397	63527	11.21	1.58	4199.26
5	3.403	63458	11.23	1.59	4209.03

Table 10Statistical Summary

Parameter	Mean	SD	%RSD
Retention Time (min)	3.402	0.004	0.11
Peak Area	63478.0	465.02	0.73
% Area	11.23	0.07	0.62
USP Tailing	1.58	0.04	2.53
USP Plate Count	4202.01	76.33	1.82

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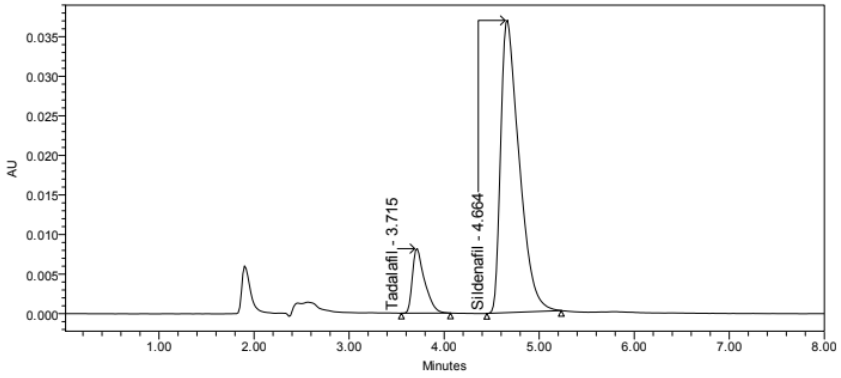

	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.715	72606	12.69	1.60	3807.33	
2	Sildenafil	4.664	499756	87.31	1.68	2517.22	3.30

Fig14-Chromatogram for High flow variation

LOD & LOQ

The sensitivity of the developed RP-HPLC method was established by determining the limits of detection (LOD) and quantification (LOQ) in accordance with ICH Q2(R2) recommendations.The LOD is defined as the minimum concentration of analyte that can be reliably detected under the stated experimental conditions, though not necessarily quantified with acceptable precision. In contrast, the LOQ represents the lowest concentration that can be quantitatively determined with suitable accuracy and precision, ensuring reliable analytical performance at low concentration levels. LOD and LOQ values were calculated using the standard deviation of intercept and slope of the calibration curve in accordance with ICH Q2(R2). Experimental verification confirmed signal-to-noise ratio >3 for LOD and >10 for LOQ.

Table11: LOD and LOQ Results for Sildenafil and Tadalafil

Parameter	Sildenafil	Tadalafil
LOD (ppm)	1.65 ppm	1.65 ppm
LOQ (ppm)	5.0 ppm	5.0 ppm
Retention Time at LOD (min)	4.611	3.744
Retention Time at LOQ (min)	4.614	3.752
S/N Ratio at LOD	>3	>3
S/N Ratio at LOQ	>10	>10
Tailing Factor at LOQ	1.37	1.16
Plate Count at LOQ	3959	4997

The developed RP-HPLC method demonstrated high sensitivity with LOD of 1.65 ppm and LOQ of 5 ppm for both analytes. The %RSD at LOQ level was below 2%, confirming acceptable precision. Therefore, the method is sufficiently sensitive for routine quantitative analysis.

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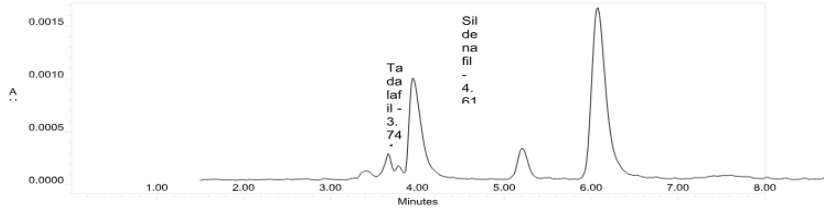
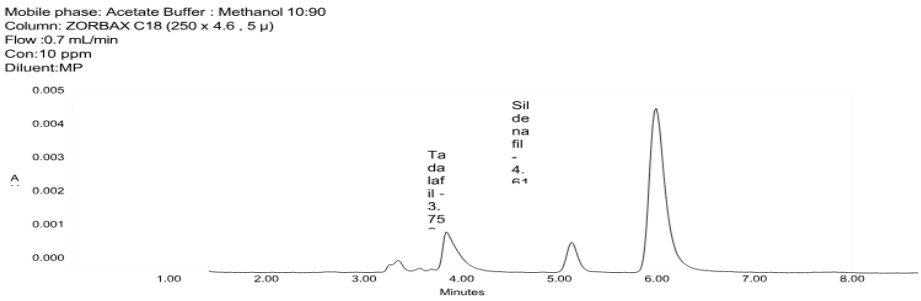


	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	s/n
1	Tadalafil	3.744	2385	12.43	1.24	4872.75	84
2	Sildenafil	4.611	16812	87.57	1.22	4142.76	466

Fig 15: Normal chromatogram LOD & LOQ for std



	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	s/n
1	Tadalafil	3.752	7055	11.51	1.16	4997.10	157
2	Sildenafil	4.614	54257	88.49	1.37	3959.96	854

Fig16: Normal chromatogram LOD & LOQ for sample

Intermediate Precision

Intermediate precision pertains to the performance of the methodology, encompassing both qualitative and quantitative aspects, within a singular laboratory, while also accounting for variations between instruments and across different days, and subsequently computing the percentage relative standard deviation (% RSD) of the assay.Intermediate precision of the developed RP-HPLC method was established by analyzing multiple injections under varied operational conditions, including different days and analytical runs. The variability in peak area response was low, with %RSD values of 1.11% for Sildenafil and 1.58% for Tadalafil, demonstrating satisfactory reproducibility. The fluctuation in retention time remained below 1%, indicating stable chromatographic performance.These findings confirm that the method exhibits adequate consistency and reliability under intermediate precision conditions in accordance with accepted validation criteria.

Table12: Intermediate Precision Results for Sildenafil (n = 12)

Parameter	Mean	Standard Deviation	%RSD
Retention Time (min)	4.636	0.022	0.47
Peak Area	569681.7	6318.3	1.11
% Area	88.78	0.18	0.20

Table13: Intermediate Precision Results for Tadalafil (n = 12)

Parameter	Mean	Standard Deviation	%RSD
Retention Time (min)	3.694	0.016	0.44

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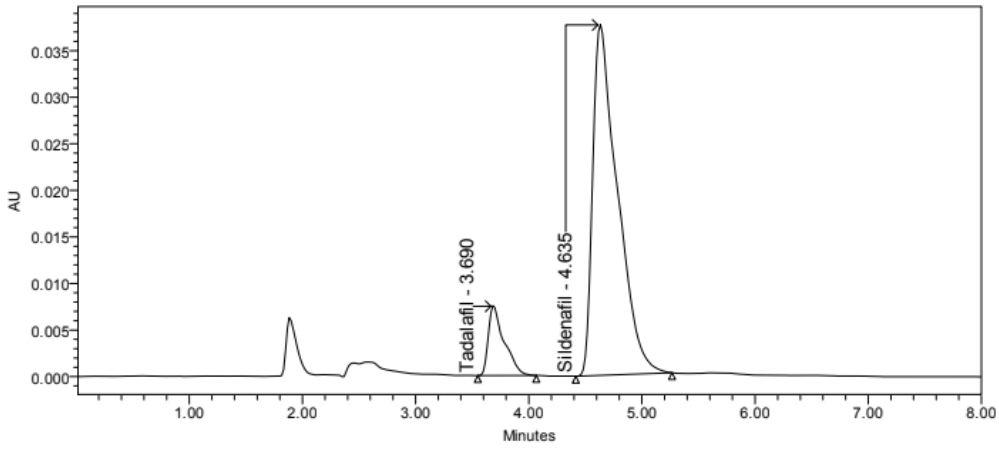
Peak Area	71958.2	1137.8	1.58
% Area	11.23	0.16	1.42



	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.690	72453	11.22	1.79	3550.15	
2	Sildenafil	4.635	573041	88.78	1.91	1550.56	2.99

Fig17-Normal chromatogram Intermediate Precision

Solution stability:

Solution stability was confirmed by repeated analysis of standard and test preparations under identical chromatographic conditions. The %RSD of peak area was 0.77% for Sildenafil and 0.84% for Tadalafil, with retention time variation below 1%, indicating consistent performance. These results demonstrate that both analytes remained stable during the study period and that the method provides reliable quantification.

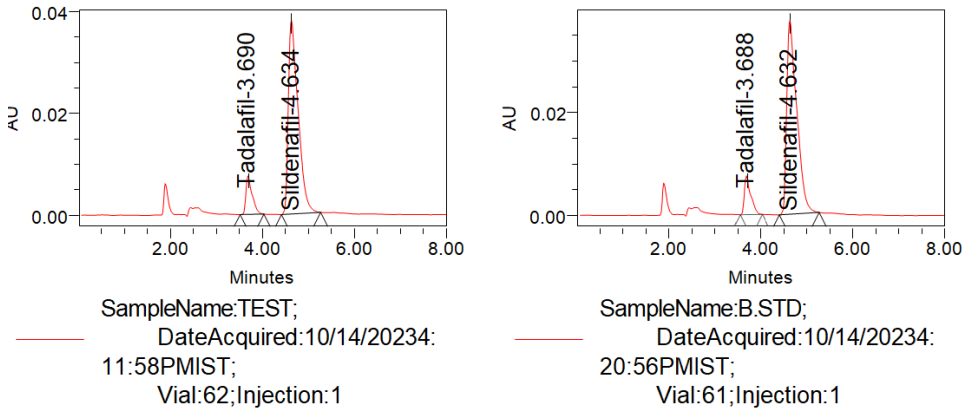


Fig18-Normal chromatogram Solution stability

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
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Table 14: Solution Stability Data Sildenafil

Sr. No.	Sample Name	Vial	Inj.	Analyte	Retention Time (min)	Area	% Area	USP Tailing	USP Plate Count
1	Blank	60	1	Sildenafil	4.707	—	—	—	—
2	B.STD	61	1	Sildenafil	4.632	572142	88.86	1.86	1525.77
3	STD	61	1	Sildenafil	4.632	574563	88.83	1.85	1678.53
4	STD	61	1	Sildenafil	4.626	571258	88.78	1.87	1594.16
5	STD	61	1	Sildenafil	4.630	569867	88.79	1.82	1734.33
6	STD	61	1	Sildenafil	4.627	574885	88.87	1.88	1646.35
7	STD	61	1	Sildenafil	4.627	574106	88.83	1.89	1713.38
8	Test	62	1	Sildenafil	4.634	562212	88.85	1.83	1812.68

Table 15Statistical Summary (Excluding Blank)

Parameter	Mean	Standard Deviation	%RSD
Retention Time (min)	4.639	0.028	0.59
Peak Area	571290.5	4410.9	0.77

Table16: Solution stability Tadalafil

Sr. No.	Sample Name	Vial	Inj.	Analyte	Retention Time (min)	Area	% Area	USP Tailing	USP Plate Count
1	Blank	60	1	Tadalafil	3.747	—	—	—	—
2	B.STD	61	1	Tadalafil	3.688	71761	11.14	1.72	3224.31
3	STD	61	1	Tadalafil	3.687	72227	11.17	1.75	2120.06
4	STD	61	1	Tadalafil	3.686	72020	11.13	1.72	2407.98
5	STD	61	1	Tadalafil	3.688	71939	11.21	1.70	2698.13
6	STD	61	1	Tadalafil	3.686	72174	11.22	1.74	2847.57
7	STD	61	1	Tadalafil	3.689	72246	11.17	1.73	2206.02
8	Test	62	1	Tadalafil	3.690	70529	11.15	1.70	3121.31

Table no 17Statistical Summary (Excluding Blank)

Parameter	Mean	Standard Deviation	%RSD
Retention Time (min)	3.695	0.021	0.57
Peak Area	71842.4	604.7	0.84

Wavelength variation

Robustness with respect to detection wavelength was evaluated by varying the wavelength by ±2 nm from 280 nm. Minimal variation was observed at 278 nm and 282 nm for both Sildenafil and Tadalafil, with %RSD values below 2% and retention time changes under 1%. These results confirm that the method remains stable and reliable despite small wavelength variations.

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Table18: Robustness Study Effect of Wavelength Variation on Tadalafil (n=5)

Wavelength (nm)	Parameter	Mean	Standard Deviation	%RSD
278 nm	Peak Area	72210.6	158.4	0.22
	Retention Time (min)	3.688	0.002	0.05
282 nm	Peak Area	72024.2	175.6	0.24
	Retention Time (min)	3.687	0.001	0.04

Table19: Robustness Study Effect of Wavelength Variation on Sildenafil

Wavelength (nm)	Parameter	Mean	Standard Deviation	%RSD
278 nm	Peak Area	631953	1041.2	0.16
	Retention Time (min)	4.684	0.001	0.03
282 nm	Peak Area	499117	539.2	0.11
	Retention Time (min)	4.668	0.003	0.06

Dissolution study

The developed RP-HPLC method was utilized for the evaluation of dissolution samples of Sildenafil and Tadalafil. Dissolution testing was performed using **USP Apparatus II (paddle method)** with 900 mL of dissolution medium maintained at **37 ± 0.5°C** and a paddle rotation speed of **50 rpm**. Samples were withdrawn at the specified time point and analyzed using the developed RP-HPLC method.

Table 20Dissolution Study Results for Sildenafil (n = 3)

Injection No.	Standard Peak Area	Dissolution Sample Peak Area
1	572142	598734
2	574563	595812
3	571258	597421
Mean	572654	597322
SD	1658.24	1474.63
%RSD	0.29%	0.25%

Table 21Dissolution Study Results for Tadalafil (n = 3)

Injection No.	Standard Peak Area	Dissolution Sample Peak Area
1	71761	74892
2	72227	74436
3	72020	74618
Mean	72003	74649
SD	233.6	229.8
%RSD	0.32%	0.30%

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Table 22Percentage Drug Release:

Parameter	Sildenafil (% Drug Release)	Tadalafil (% Drug Release)
Unit 1	99.12	100.21
Unit 2	98.87	99.76
Unit 3	99.45	100.08
Mean	**99.15**	**100.02**
SD	**0.29**	**0.23**
%RSD	**0.29%**	**0.23%**

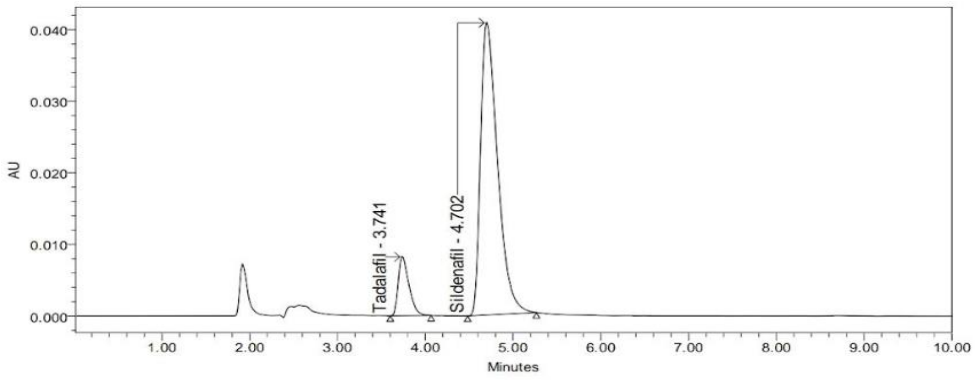
The dissolution study of Sildenafil and Tadalafil showed low variability in peak areas (%RSD < 1%), confirming good system precision.Mean drug release was 99.15% for Sildenafil and 100.02% for Tadalafil, with %RSD below 0.5%, indicating uniform and consistent release.All results meet pharmacopeial limits (NLT 80%), demonstrating that the method is precise and suitable for routine quality control analysis.

Results of assay of marketed formulation

Twenty tablets were individually weighed, and the average tablet weight was calculated. An accurately weighed portion equivalent to one tablet was transferred into a 100 mL volumetric flask. Approximately 50 mL of diluent was added, and the mixture was sonicated for 25 minutes to ensure complete extraction of the drug content. The resulting solution was filtered to remove insoluble excipients.Subsequently, 1 mL of the filtrate was transferred into a 10 mL volumetric flask and diluted to volume with the same diluent to obtain the final analytical solution.

Table 23Table: Assay of marketed formulation

Brand Name	Drug	Label Claim (mg/tablet)	Standard Peak Area	Sample Peak Area	% Assay	%RSD
Sildalist	Sildenafil	100 mg	799456	789296	99.73%	0.91
Sildalist	Tadalafil	20 mg	108690	108588	100.45%	1.21



	Peak Name	RT	Area	% Area	USP Tailing	USP Plate Count	Resolution
1	Tadalafil	3.741	69916	11.30	1.46	4270.63	
2	Sildenafil	4.702	549058	88.70	1.61	2783.07	3.39

Fig19-Normal chromatogram for Tadalafil and Sildenafil Tablet

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Overall Conclusion

A robust, precise, and sensitive RP-HPLC method was successfully developed and validated for the simultaneous estimation of Sildenafil and Tadalafil in bulk drug and tablet dosage form. The method complied with ICH Q2(R2) requirements for specificity, linearity, accuracy, precision, robustness, sensitivity, and solution stability. The assay and dissolution results were within acceptable limits, demonstrating the suitability of the method for routine quality control and pharmaceutical analysis.

Acknwoledgements
The Autor wish to thank Sigma-aldrich (USA) for supplying the samples of tadafil Tadalafil and Sildenafil within the required time so as to enable us to complete this research paper quickly. Also thanks to KPGU Vadodara for provide support and facilities for that work.

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