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Research article ***RP-HPLC***

RP-HPLC method for estimation of abacavir, lamivudineas per ich guidelines

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ABSTRACT

A novel, precise, accurate, rapid and cost effective isocratic reverse phase high performance liquid chromatographic (RP-HPLC) method was developed, optimized and validated for the estimation of Abacavir and Lamivudine in bulk and pharmaceutical dosage forms. The drugs were estimated using Phenomenex Gemini C18 (4.6mm×150mm, 5.0 µm) particle size column. A mobile phase composed of tri ethylamine buffer and methanol in proportion of 32:68 v/v, at a flow rate of 1.0 ml/min was used for the separation. Detection was carried out at 248 nm. The linearity range obtained was 30-70 µg/ml for Darunavir and 10-50 µg/ml for Cobicistat with retention times (Rt) of 3.297 min and 5.405 min for Abacavir and Lamivudine respectively. The correlation coefficient values were found to be 0.999 & 0.999. Precession studies showed % RSD values less than 2 % for both the drugs in all the selected concentrations. The percentage recoveries of Abacavir and Lamivudine were found to be 100.1873% for Darunavir and 100.748% for Cobicistat respectively. The assay results of Abacavir and Lamivudine were found to be 99.82%. The limit of detection (LOD) and limit of quantification (LOQ) were 2.6µg/ml and 7.8µg/ml for Darunavir and 3.4µg/ml 10.2µg/ml for Cobicistat respectively. The proposed method was validated as per the International Conference on Harmonization (ICH) guidelines. The proposed validated method was successfully used for the quantitative analysis of commercially available dosage form.

Keywords: Abacavir and Lamivudine, RP-HPLC, ICH Guidelines, Validation.

INTRODUCTION

Chromatography[2]

The chromatography was discovered by Russian Chemist and botanist *Micheal Tswett* (1872-1919) who first used the term chromatography (colour writing derived from Greek for colour – Chroma , and write – graphein) to describe his work on the separation of coloured plant pigments into bands on a column of chalk and other material such as polysaccharides, sucrose and insulin.

"*Chromatography is a method in which the components of a mixture are separated on an adsorbent column in a flowing system*".

The adsorbent material, or stationary phase, first described by Russian scientist named Tswett in 1906, has taken many forms over the years, including paper, thin layers of solids attached to glass plates, immobilized liquids, gels, and solid particles packed in columns.

"Chromatography is a physical method of separation in which the component to be separated are distributed between two phases of which in stationary while other moves in a definite direction (IUPAC)"

Types of Chromatography

The mobile phase could be either a liquid or a gas, and accordingly we can subdivide chromatography into Liquid Chromatography (LC) or Gas Chromatography (GC). Apart from these methods, there are two other modes that use a liquid mobile phase, but the nature of its transport through the porous stationary phase is in the form of either (a) capillary forces, as in planar chromatography (also called Thin-Layer Chromatography, TLC), or (b) electro osmotic flow, as in the case of Capillary Electro Chromatography (CEC).

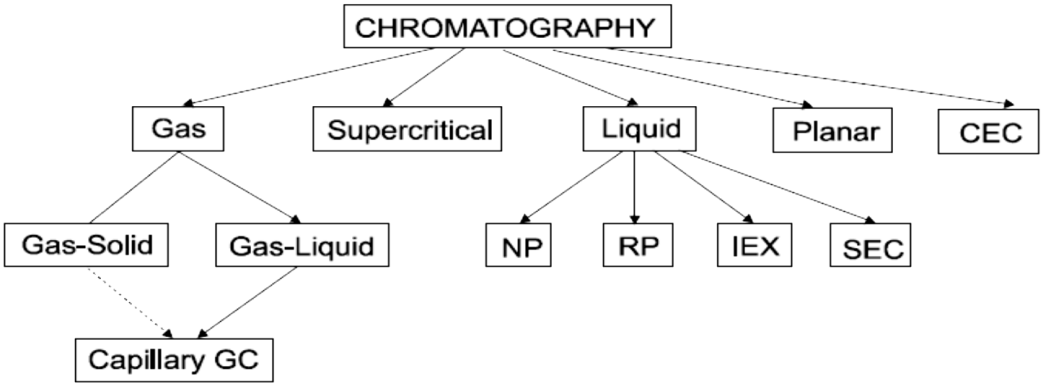

Fig 1: Flow chart for classification of chromatography[4]

METHODS IN CHROMATOGRAPHY[5]

According to nature of stationary and mobile phase

- Solid- Liquid chromatography
- Liquid-Liquid chromatography
- Gas- Solid chromatography
- Gas -Liquid chromatography

According to principle of separation

A. Adsorption chromatography

- Gas Solid chromatography
- Thin layer chromatography
- Column chromatography
- High performance liquid chromatography
- Affinity phase chromatography
- Hydrophobic Interaction chromatography (HIC)

B. Partition chromatography

- Gas liquid chromatography
- Paper partition chromatography
- Column partition chromatography

Based on modes of chromatography

- Normal phase chromatography
- Reversed phase chromatography

Other types of chromatography

- Size exclusion chromatography (SEC)
- Gel permeation chromatography
- Gel chromatography
- Gel Filtration
- Gel permeation chromatography
- Ion exchange chromatography
- Chiral chromatography

Adsorption chromatography

Chromatography in which separation is based mainly on difference between the adsorption affinities of the sample components for the surface of an active solid. The analyte interact with solid stationary surface and are displaced with eluent for active sites on surface.

Partition chromatography

This method results from a thermodynamic distribution of analytes between two liquid phases. On the basis of relative polarities of stationary and mobile phase, partition chromatography can be divided in to normal phase and reverse phase chromatography. In normal phase chromatography, the stationary phase bed is strongly polar in nature (e.g. Silica gel) and the mobile phase is non-polar (such as n-hexane or tetrahydrofuran). Polar sample are thus retained on polar surface of the column packing longer than polar material while in reverse phase chromatography, the stationary bed is non-polar (hydrophobic in nature, while the mobile phase is polar liquid, such as mixture of water and methanol or Acetonitrile. Here the more non polar the material is, the longer it will retain.

Size-exclusion chromatography

This involves a solid stationary phase with controlled pore size. Solids are separated according to molecular size, with the large molecule unable to enter the pores eluted first.

Ion- exchange chromatography

Involves a solid stationary phase with anionic or cationic groups on the surface to separation, HPLC and HPTLC methods have widely been exploited in pharmaceutical analysis because of its simplicity, precision, accuracy and reproducibility of result.

Solid-Phase Extraction [SPE]

A sample preparation technique that uses LC principles to isolate, enriches, and/or purifies analytes from a complex matrix applied to a miniature chromatographic bed. *Offline* SPE is done with larger particles in individual plastic cartridges or in micro-elution plate wells, using low positive pressure or vacuum to assist flow. *Online* SPE is done with smaller particles in miniature HPLC columns using higher pressures and a valve to switch the SPE column online with the primary HPLC column, or offline to waste, as appropriate. SPE methods use step gradients to accomplish bed conditioning, sample loading, washing, and elution steps. The goal is to remove matrix interferences and to isolate the analyte in a solution, and at a concentration, suitable for subsequent analysis.

MATERIALS AND METHOD

Abacavir (Pure)-Sura labs,Lamivudine (Pure)-Sura labs,Water and Methanol for HPLC-LICHROSOLV (MERCK),Acetonitrile for HPLC-Merck.

HPLC METHOD DEVELOPMENT TRAILS

Preparation of standard solution

Accurately weigh and transfer 10 mg of Abacavir and Lamivudine working standard into a 10ml of clean dry volumetric flasks add about 7ml of Methanol and sonicate to dissolve and removal of air completely and make volume up to the mark with the same Methanol.

Further pipette 2.25ml of the above Abacavir and 0.45ml of the Lamivudine stock solutions into a 10ml volumetric flask and dilute up to the mark with Methanol.

Procedure

Inject the samples by changing the chromatographic conditions and record the chromatograms, note the conditions of proper peak elution for performing validation parameters as per ICH guidelines.

Mobile Phase Optimization

Initially the mobile phase tried was Methanol: Water, Acetonitrile: Water with varying proportions. Finally, the mobile phase was optimized to Methanol: TEA buffer pH 4.8 in proportion 32:68 v/v respectively.

Optimization of Column

The method was performed with various columns like C18 column, X- bridge column, Xterra. Phenomenex Gemini C18 (4.6mm×150mm, 5.0 µm) particle size was found to be ideal as it gave good peak shape and resolution at 1ml/min flow.

OPTIMIZED CHROMATOGRAPHIC CONDITIONS

Instrument used : Waters HPLC with auto sampler and PDA Detector 996 model.

Column : Phenomenex Gemini C18 (4.6mm× 150mm, 5.0 µm) particle size

Column temperature : 38˚C

pH : 4.8

Mobile phase : Methanol: TEA buffer pH 4.8 (32:68v/v)

Flow rate : 1ml/min

Wavelength : 248nm

Injection volume : 20µl

Run time : 7 min

METHOD VALIDATION

PREPARATION OF MOBILE PHASE

Preparation of mobile phase

Accurately measured 320ml (32%) of HPLC Methanol and 680ml of TEA buffer (68%) were mixed and degassed in a digital ultra sonicater for 15 minutes and then filtered through 0.45 µ filter under vacuum filtration.

Diluent Preparation

The Mobile phase was used as the diluent.

RESULTS AND DISCUSSION

Optimized Chromatogram (Standard)

Column : Phenomenex Gemini C18 (4.6mm× 150mm, 5.0 µm) particle size

Column temperature : 38˚C

Wavelength : 248nm

Mobile phase ratio : Methanol: TEA buffer pH 4.8 (32:68v/v)

Flow rate : 1ml/min

Injection volume : 20µl

Run time : 7minutes

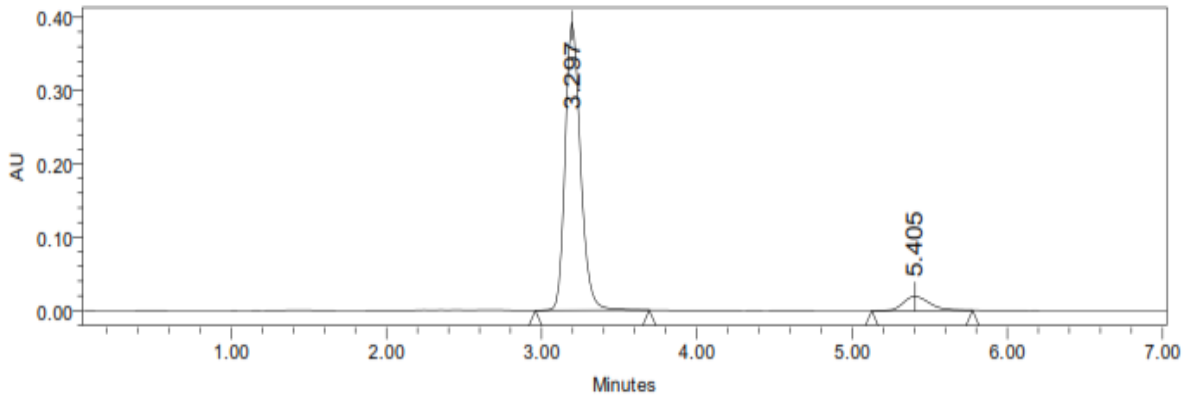

Fig 1: Optimized Chromatogram (Standard)

Table 1: Optimized Chromatogram (Standard)

S.No	Name	RT	Area	Height	USP Tailing	USP Plate Count	USP Resolution
1	Abacavir	3.297	859856	42569	1.24	7896	
2	Lamivudine	5.405	5698	3652	1.36	6582	6.8

From the above chromatogram it was observed that the Abacavir and Lamivudine peaks are well separated and they shows proper retention time, resolution, peak tail and plate count. So it's optimized trial.

Optimized Chromatogram (Sample)

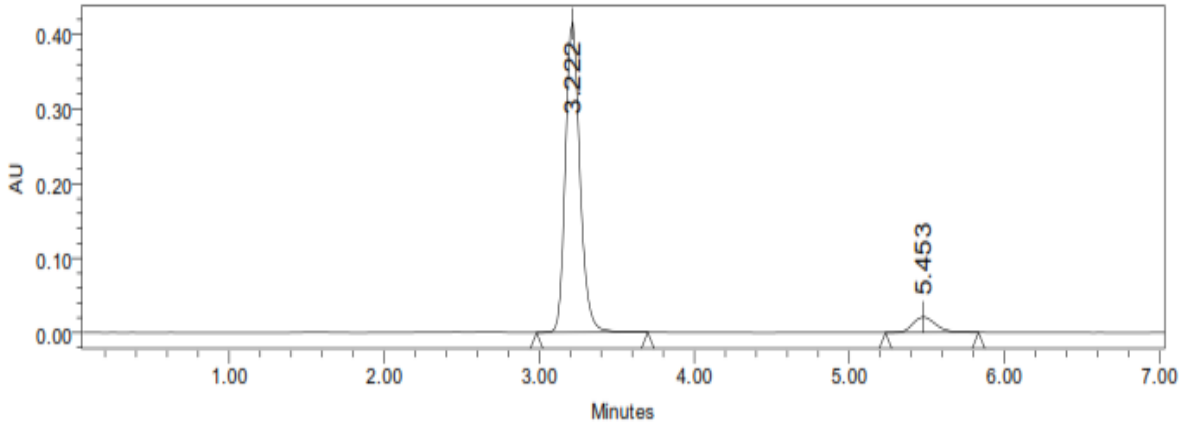

Fig 2: Optimized Chromatogram (Sample)

Table 2: Optimized Chromatogram (Sample)

S.No	Name	RT	Area	Height	USP Tailing	USP Plate Count	USP Resolution
1	Abacavir	3.222	865898	43659	1.26	7985	
2	Lamivudine	5.453	5789	3785	1.38	6659	7.0

- *Resolution between two drugs must be not less than 2.*
- *Theoretical plates must be not less than 2000.*
- *Tailing factor must be not less than 0.9 and not more than 2.*
- *It was found from above data that all the system suitability parameters for developed method were within the limit.*

System Suitability

Table 3: Results of system Suitability for Abacavir

S.No.	Peak Name	RT	Area (µV*sec)	Height (µV)	USP Plate Count	USP Tailing
1	Abacavir	3.200	859865	42568	7895	1.24
2	Abacavir	3.248	859788	42587	7859	1.24
3	Abacavir	3.299	857984	42659	7869	1.24
4	Abacavir	3.297	854879	42875	7849	1.24
5	Abacavir	3.297	857896	42487	7859	1.23
Mean			858082.4			
Std. Dev.			2024.409			
% RSD			0.235922			

- *%RSD of five different sample solutions should not more than 2.*
- *The %RSD obtained is within the limit, hence the method is suitable.*

Table 4: Results of System Suitability for Lamivudine

S.No	Peak Name	RT	Area (µV*sec)	Height (µV)	USP Plate Count	USP Tailing
1	Lamivudine	5.413	5689	3659	6583	1.36
2	Lamivudine	5.484	5687	3648	6592	1.37
3	Lamivudine	5.405	5682	3698	6549	1.37
4	Lamivudine	5.405	5649	3675	6571	1.36
5	Lamivudine	5.409	5674	3649	6529	1.36
Mean			5676.2			
Std. Dev.			16.2696			
% RSD			0.286628			

- *%RSD of five different sample solutions should not more than 2.*
- *The %RSD obtained is within the limit, hence the method is suitable.*

Assay (Standard)
Abacavir

Table 5: Peak Results for Assay Standard

S.No.	Name	RT	Area	Height	USP Tailing	USP Plate Count
1	Abacavir	3.211	859785	42598	1.25	7856
2	Abacavir	3.222	859865	42895	1.24	7859
3	Abacavir	3.254	857849	42578	1.25	7869

Lamivudine

S.No	Name	RT	Area	Height	USP Tailing	USP Plate Count	Resolution
1	Lamivudine	5.414	5699	3685	1.36	6598	6.9
2	Lamivudine	5.453	5687	3659	1.37	6537	6.9
3	Lamivudine	5.424	5689	3649	1.36	6582	7.0

Assay (Sample)
Abacavir

Table 6: Peak Results for Assay sample

S.No	Name	RT	Area	Height	USP Tailing	USP Plate Count
1	Abacavir	3.297	865985	43659	1.26	7985
2	Abacavir	3.294	865798	43875	1.26	7925
3	Abacavir	3.295	865456	43659	1.27	7946

Lamivudine

S.No	Name	RT	Area	Height	USP Tailing	USP Plate Count	Resolution
1	Lamivudine	5.435	5789	3659	1.37	6659	6.9
2	Lamivudine	5.417	5798	3684	1.38	6689	7.0
3	Lamivudine	5.434	5749	3695	1.38	6648	6.9

$$\%ASSAY = \frac{\text{Sample area}}{\text{Standard area}} \times \frac{\text{Weight of standard}}{\text{Dilution of standard}} \times \frac{\text{Dilution of sample}}{\text{Weight of sample}} \times \frac{\text{Purity}}{100} \times \frac{\text{Weight of tablet}}{\text{Label claim}} \times 100$$

The % purity of Abacavir and Lamivudine in pharmaceutical dosage form was found to be 99.82%.

Linearity
Chromatographic data for linearity study: Abacavir

Concentration µg/ml	Average Peak Area
20	164436
30	255571
40	348687
50	439024
60	534830

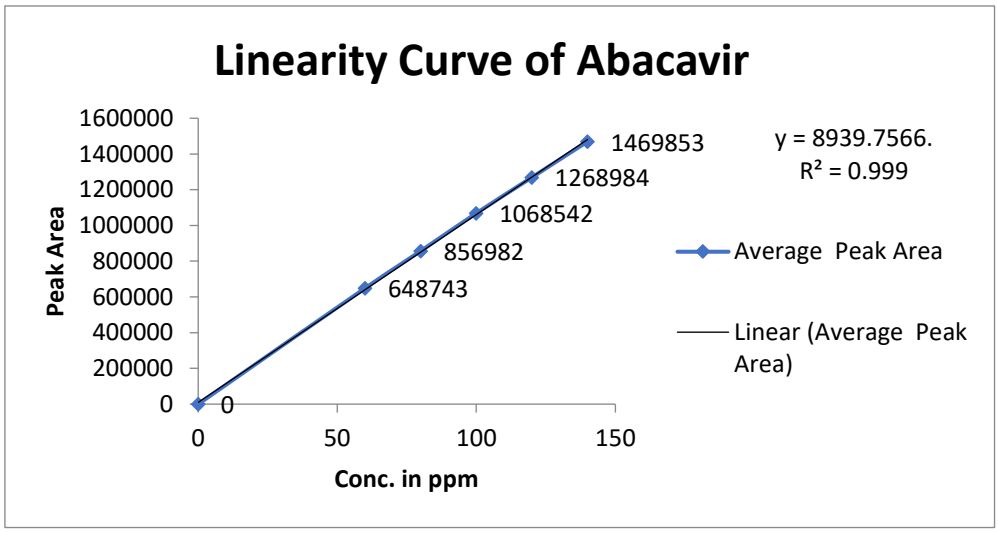

Fig 3: Calibration Curve of Abacavir

Lamivudine

Concentration µg/ml	Average Peak Area
25	1782454
37.5	2728974
50	3688678
62.5	4658022
75	5592695

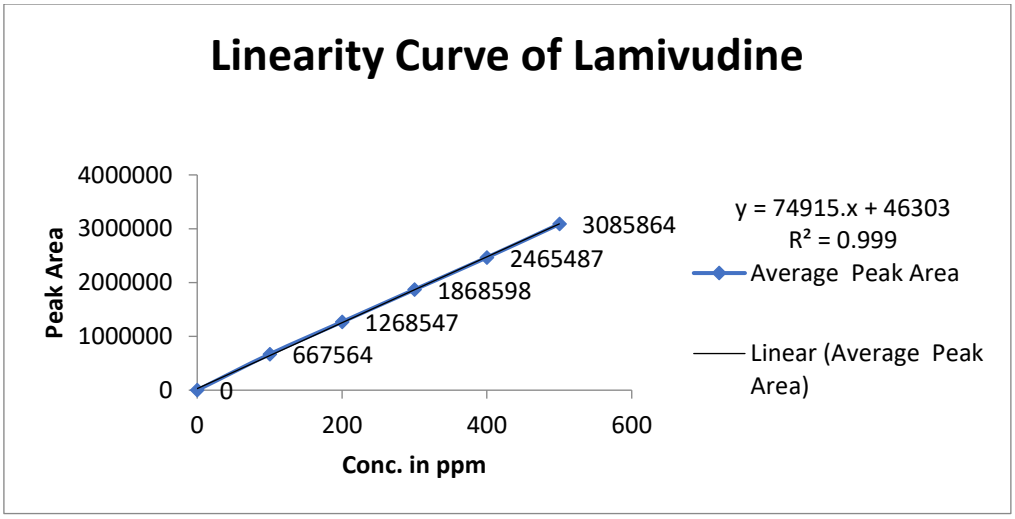

Fig 4: Calibration Curve of Lamivudine

Repeatability

Table 7: Results of Repeatability for Abacavir

S. No.	Peak name	Retention time	Area(µV*sec)	Height (µV)	USP Plate Count	USP Tailing
1	Abacavir	3.213	859856	42659	7859	1.24
2	Abacavir	3.253	857985	42598	7869	1.24
3	Abacavir	3.297	856984	42587	7846	1.25
4	Abacavir	3.215	856987	42569	7819	1.25
5	Abacavir	3.254	859878	42894	7856	1.24
Mean			858338			
Std.dev			1454.222			
%RSD			0.169423			

- *%RSD for sample should be NMT 2*
- *The %RSD for the standard solution is below 1, which is within the limits hence method is precise.*

Table 8: Results of repeatability for Lamivudine

S. No.	Peak Name	Retention time	Area(µV*sec)	Height (µV)	USP Plate Count	USP Tailing
1	Lamivudine	5.441	5697	3659	6592	1.36
2	Lamivudine	5.442	5689	3648	6539	1.36
3	Lamivudine	5.409	5698	3692	6584	1.37
4	Lamivudine	5.520	5639	3648	6579	1.36
5	Lamivudine	5.424	5688	3689	6549	1.36
Mean			5682.2			
Std.dev			24.57031			
%RSD			0.432408			

Intermediate precision

Table 9: Results of Intermediate precision for Abacavir

S.No.	Peak Name	RT	Area (µV*sec)	Height (µV)	USP Plate count	USP Tailing
1	Abacavir	3.211	868956	43659	7985	1.26
2	Abacavir	3.211	869857	43985	7954	1.27
3	Abacavir	3.210	865983	43879	7946	1.26
4	Abacavir	3.212	866587	43865	7963	1.27
5	Abacavir	3.211	864256	43875	7964	1.26
6	Abacavir	3.297	868974	43562	7942	1.26
Mean			867435.5			
Std. Dev.			2167.095			
% RSD			0.249828			

- *%RSD of six different sample solutions should not more than 2.*

Table 10: Results of Intermediate precision for Lamivudine

S.No.	Peak Name	RT	Area (µV*sec)	Height (µV)	USP Plate count	USP Tailing
1	Lamivudine	5.411	5785	3789	6659	1.37
2	Lamivudine	5.410	5798	3758	6625	1.38
3	Lamivudine	5.420	5766	3746	6649	1.38
4	Lamivudine	5.423	5746	3795	6675	1.37
5	Lamivudine	5.419	5782	3761	6653	1.38
6	Lamivudine	5.409	5786	3752	6627	1.37
Mean			5777.167			
Std. Dev.			18.40018			
% RSD			0.318498			

- *%RSD of six different sample solutions should not more than 2.*

Table 11: Results of Intermediate precision Day 2 for Abacavir

S.No.	Peak Name	RT	Area (µV*sec)	Height (µV)	USP Plate Count	USP Tailing
1	Abacavir	3.211	845985	44585	8025	1.27
2	Abacavir	3.233	847895	44895	8069	1.28
3	Abacavir	3.244	848985	44758	8046	1.27
4	Abacavir	3.297	847859	44548	8094	1.28
5	Abacavir	3.297	845984	44865	8042	1.28
6	Abacavir	3.202	847898	44254	8076	1.27

Mean			847434.3			
Std. Dev.			1201.345			
% RSD			0.141763			

- *%RSD of six different sample solutions should not more than 2.*

Table 12: Results of Intermediate precision Day 2 for Lamivudine

S.No.	Peak Name	RT	Area (µV*sec)	Height (µV)	USP Plate Count	USP Tailing
1	Lamivudine	5.411	5898	3986	6852	1.39
2	Lamivudine	5.410	5884	3955	6864	1.39
3	Lamivudine	5.420	5863	3956	6829	1.40
4	Lamivudine	5.405	5845	3945	6874	1.39
5	Lamivudine	5.409	5896	3925	6829	1.39
6	Lamivudine	5.463	5874	3962	6825	1.40
Mean			5876.667			
Std. Dev.			20.39281			
% RSD			0.347013			

- *%RSD of six different sample solutions should not more than 2.*

Accuracy

Table 13: The accuracy results for Abacavir

%Concentration (at specification Level)	Area	Amount Added (ppm)	Amount Found (ppm)	% Recovery	Mean Recovery
50%	451144.3	25	24.998	99.992%	100.1873%
100%	897248.3	50	50.104	100.208%	
150%	1344562	75	75.278	100.362%	

- *The percentage recovery was found to be within the limit (98-102%).*

The results obtained for recovery at 50%, 100%, 150% are within the limits. Hence method is accurate.

Table 14: The accuracy Results for Lamivudine

%Concentration (at specification Level)	Area	Amount Added (ppm)	Amount Found (ppm)	% Recovery	Mean Recovery
50%	2895	15	15.084	100.560%	100.748%
100%	5685.333	30	30.282	100.940%	
150%	8449	45	45.335	100.744%	

- *The percentage recovery was found to be within the limit (98-102%).*

The results obtained for recovery at 50%, 100%, 150% are within the limits. Hence method is accurate.

Abacavir

Table 15: Results for Robustness

Parameter used for sample analysis	Peak Area	Retention Time	Theoretical plates	Tailing factor
Actual Flow rate of 1.0mL/min	859856	3.297	7896	1.24
Less Flow rate of 0.9mL/min	915847	3.639	7251	1.20
More Flow rate of 1.1mL/min	842564	2.859	7415	1.21

Less organic phase (about 5 % decrease in organic phase)	825498	3.460	7365	1.23
More organic phase (about 5 % Increase in organic phase)	814578	3.022	7258	1.22

The tailing factor should be less than 2.0 and the number of theoretical plates (N) should be more than 2000.

Lamivudine

Table 16: Results for Robustness

Parameter used for sample analysis	Peak Area	Retention Time	Theoretical plates	Tailing factor
Actual Flow rate of 1.1mL/min	5698	5.405	6582	1.36
Less Flow rate of 0.9mL/min	6452	6.250	6785	1.32
More Flow rate of 0.8mL/min	5254	4.863	6365	1.34
Less organic phase (about 5 % decrease in organic phase)	5487	6.196	6254	1.38
More organic phase (about 5 % Increase in organic phase)	5369	5.010	6298	1.33

The tailing factor should be less than 2.0 and the number of theoretical plates (N) should be more than 2000.

CONCLUSION

High performance liquid chromatography is at present one of the most sophisticated tool of the analysis. The estimation of Abacavir and Lamivudine was done by RP-HPLC.

The TEA buffer was p^H 4.8 and the mobile phase was optimized with consists of Methanol: TEA buffer mixed in the ratio of 32:68 % v/ v.

A Phenomenex Gemini C18 (4.6mm×150mm, 5.0 µm) particle size or equivalent chemically bonded to porous silica particles was used as stationary phase.

The solutions were chromatographed at a constant flow rate of 1.0 ml/min. The linearity range of Abacavir and Lamivudine were found to be from 30-70µg/ml, 10-50µg/ml respectively. Linear regression coefficient was not more than 0.999, 0.999.

The values of % RSD are less than 2% indicating accuracy and precision of the method. The percentage recovery varies from 98-102% of Abacavir and Lamivudine. LOD and LOQ were found to be within limit.

The results obtained on the validation parameters met ICH and USP requirements. It inferred the method found to be simple, accurate, precise and linear.

The method was found to be having suitable application in routine laboratory analysis with high degree of accuracy and precision.

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