International Journal of
Analytical, Pharmaceutical and Biomedical Sciences

Research Article

Volume: 1: Issue-2: April-June -2012 *Copyrights@2012* *ISSN: 2278-0246*
Received: 08th May-2012 *Revised: 13th May-2012* *Accepted: 16th May-2012*
Coden : IJAPBS *www.ijapbs.com*

A VALIDATED STABILITY-INDICATING HPLC ASSAY METHOD FOR ACYCLOVIR IN BULK DRUG

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ABSTRACT: An isocratic reversed phase stability-indicating high-performance liquid chromatographic (HPLC) assay method was developed and validated for quantitative determination of Acyclovir in bulk drugs. An isocratic, reversed phase HPLC method was developed to separate the drug from the degradation products, using an Water Nova Pack C18 (250 x 4.6) mm, 5µ column and the mobile phase containing 1.0gm Sodium dihydrogen phosphate and 1.0 gm 1-octaneSulfonic acid salt in 1000ml water filter and mixed. Prepare a homogenous mixture of buffer, methanol and acetonitrile (50:20:30,v/v/v). The detection was carried out at wavelength 264 nm. The developed method was validated with respect to linearity, accuracy (recovery), precision, system suitability, selectivity, robustness prove the stability indicating ability of the method.
Key Words: HPLC, Acyclovir, Degradation, Chromatographic Column.

INTRODUCTION

Acyclovir is used orally for the treatment and prophylaxis of initials and recurrent episodes of genital and labial herpes and for the acute treatment of herpes zoster for the treatment varicella (chickenpox) in immunocompetent individuals [1-3]. The chemical name for acyclovir is 2-amino-1,9-dihydro-9- [(2-hydroxyethoxy) methyl]-6H-purine-6-one, or 9- [(2-hydroxyethoxy) methyl]- guanine. Its molecular formula is $C_8H_{11}N_5O_3$, and molecular weight 225.21 g/mol [4].

Acyclovir (Fig-1) is commonly used as the free acid form in solid oral dosage forms, whereas the sodium salt is used in parenteral dosage forms. [5,6]. Acyclovir is normally present in a hydrated form consisting of three acyclovir molecules to two molecules of water, [7] corresponding to a theoretical water content of about 5%, but dose and solubility are normally expressed in units of anhydrous acyclovir [8] Acyclovir is described as “slightly soluble in water” in different Pharmacopoeias. The solubility of acyclovir in most of the literature are range from 1.2 to 1.6 mg/mL at room temperature (22 to 250C). [9-13]. Acyclovir is an ampholyte with both weak acid and basic groups and pKa values are 2.27 and 9.25 at 37^0C [14], and the partition coefficient (log P) in n-octanol is - 1.57 at 22^0C [15].

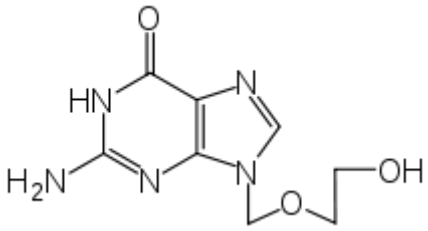

Fig-1: Chemical Structure of Acyclovir

Literature survey

Literature survey revealed that numerous HPLC methods have been reported for estimation of acyclovir in pharmaceutical formulations has been reported [16-24]. Present study involves development of RP-HPLC method using simple mobile phase which was sensitive and rapid for quantification of acyclovir in tablet samples as well as subsequent validation of developed method according to ICH guide lines. [25].

EXPERIMENTAL

Material and reagents

Acyclovir bulk drug was made available from Lupin Ltd. India (purity 99.8). Sodium dihydrogen phosphate, 1-octaneSulfonic acid was obtained from Qualigens fine chemicals, India Limited. Acetonitrile and methanol were obtained from Rankem laboratories, India. All chemicals and reagent were used as HPLC grades, Milli-Q-Water was used throughout the experiment.

Chromatographic Conditions

A chromatographic system (Systronic) consisting of quaternary solvent delivery pump, a degasser, an auto- injector, column oven and UV detector**.** The chromatographic column of 250 mm length and internal diameter of 4.6 mm filled with Octadecyl silane Water Nova Pack C18 (250 x 4.6) mm, 5µ stationary phase with particle size 5 micron and pore size 100A was used. The instrumental settings were a flow of 1 ml/min, the injection volume was 20 µl. and wavelength 264 nm.

Mobile Phase

The mobile phase containing 1.0gm Sodium dihydrogen phosphate and 1.0 gm 1-octane Sulfonic acid salt in 1000ml water filter and mixed. Prepare a homogenous mixture of buffer, methanol and acetonitrile (50:20:30, v/v/v).

Preparation of Standard stock solutions

Standard stock solutions of 500 ppm of Acyclovir in acetonitrile and water (25:75) were prepared in volumetric flasks.

Sample solution

500 ppm of Acyclovir in 100ml calibrated flask containing acetonitrile and water mixture (25:75.The desired concentration for the drug was obtained by accurate dilution and the analysis was followed up as in the general analytical procedure [26,27].

Selectivity

Selectivity is the ability of the method to assess unequivocally the analyte in the presence of components, which may be expected to be present. Typically, these might include degradants, matrix etc. The selectivity of the developed LC method for Acyclovir was carried out in the presence of its degradation products. Stress studies were performed for Acyclovir bulk drug to provide an indication of the stability indicating property and selectivity of the proposed method. Intentional degradation was attempted to stress condition exposing it with acid (0.25 N Hydrochloric acid), alkali (0.25N NaOH) hydrogen peroxide (10%) heat (60 ^{o}C) to evaluate the ability of the proposed method to separate Acyclovir from its degraded products. For heat study, study period was 3 days where as for acid, oxidation 48 hr and for base 2 hour. Assay studies were carried out for stress samples against Acyclovir reference standard and the mass balance (% assay + % sum of all impurities + % sum of all degraded products) was calculated.

RESULTS AND DISCUSSION

Optimization of chromatographic conditions

The main target for the development of chromatographic method was to get the reliable method for the quantification of Acyclovir from bulk drug and which will be also applicable for the degradable products. Initially, we took the effort for the development of HPLC method quantification of standard Acyclovir from bulk. For this purpose, we have used Water nova pack C18(150X4.6)mm,5µ, Kromasil C18(150X4.6)mm,5µ, Inertsil ODS 3V C18(250X4.6)mm,5µ and Kromasil C18(250X4.6)mm,5µ,Star ODS-II C18 (250X4.6)mm,5µ and Grace Alpha C18 (250mm x 4.6)mm,5u Out of these used HPLC column, Water Nova Pack C18 (250mm x 4.6)mm,5u found to comparatively better and gave the graph with better gaussian shape at retention time 9.38 min. To improve the shape and width of the graph, for the above columns different solvents and buffer taken for trials such as 0.1M KH_2PO_4 and Acetonitrile (60:40,v/v) in these trials peak shape is not good, another trials 0.01M Ammonium acetate P^H-5.9 and acetonitrile(20:80,v/v) peak shape not found well, trials Acetonitrile and water (80:20, v/v) column temperature 35 ^oC peak shape not found good, trials K_2HPO_4,Methanol and water (10:70:20,v/v/v)column temperature 35 ^oC, trials 1.0gm KH_2PO_4 and 0.45gm 1-Hexa sulphonic acid sodium salt make pH-3.5 Ortho phosphoric acid and methanol(25:75, v/v) peak shape obtained but retention is not good, finally try for 2.0gm Sodium dihydrogen phosphate and 1.0 gm 1-octaneSulfonic acid salt in 1000ml water filter and mixed. Prepare a homogenous mixture of buffer, methanol and acetonitrile (50:20:30, v/v/v).

Result of forced degradation experiments

Considerable degradation was not observed in Acyclovir bulk samples, under stress conditions such acid, thermal stress .Considerable degradation of Acyclovir was observed under stress condition such as base, and oxidative hydrolysis leads to the formation of some unknown degradation peaks. The mass balance of Acyclovir in stress samples was close to 100% and moreover, the unaffected assay of Acyclovir in the Tablets confirms the stability indicating power of the method. The summary of forced degradation studies is given in Table 1.

Table 1: Summary of Forced degradation results

Stress condition	Time	Assay of active Substance %	Remarks
Acid Hydrolysis (0.5 N HCl)	48 Hrs	80.45	Degradation
Base Hydrolysis (0.25 N NaOH)	2 Hrs	78.56	Degradation
Oxidation (10% H_2O_2)	48 Hrs	86.45	Degradation
Thermal (80°C)	3days	98.47	negligible
Photolytic degradation	1.2Lux million Hrs	98.21	negligible degradation

Method Validation

System suitability

For system suitability studies, five replicate injections of acid, base and oxidative degraded solutions were used and the RSD of peak area ratio, resolutions, tailing factor and number of theoretical plates of the peak were calculated. The system suitability results are shown in Table 2.

Table 2: System suitability reports

Compound (n=3)	Retention Time	% RSD	USP tailing	Theoretical plates
Acyclovir	9.38	0.44	0.89	9120

Precision

The precision of the method was studied by determining the concentrations of the drug Acyclovir in the tablet for six times[28]. The results of the precision study (Table 3) indicate the reliability of the method (RSD %< 2).

Table 3. Results of the Linearity study and Precision

Ingredient	Precision (% RSD)	Linearity (µg/ml)	Slopes* (n= 3)	Coefficients of correlations
Acyclovir	0.77	80-120	2578	0.99971

*Standard deviation shown in parentheses

Accuracy (Recovery test)

The accuracy of an analytical procedure expresses the closeness of agreement between the value, which is accepted either as a conventional true value or an accepted reference value and the value found. Accuracy of the method was studied by recovery experiments.

The recovery experiments were performed by adding known amounts of the drugs in the placebo. The recovery was performed at three levels, 80%, 100% and 120%. The recovery samples were prepared as aforementioned procedure. The solutions were then analyzed, and the percentage recoveries were calculated from the calibration curve. The recovery values for Acyclovir ranged from 98.22% to 99.66% (Table 4). The average recoveries of three levels nine determinations for Acyclovir were 98.33- 99.70%.

Table 4: Results of the Recovery Tests for the Acyclovir

Level of Addition (%)	Amount added (n = 3) (ppm)	% Recovery*	% Average recovery^
80	50	98.11	98.14
100	100	99.22	99.44
120	150	99.70	99.65

* RSD shown in parenthesis.

^ Average recovery = the average of three levels, nine determinations

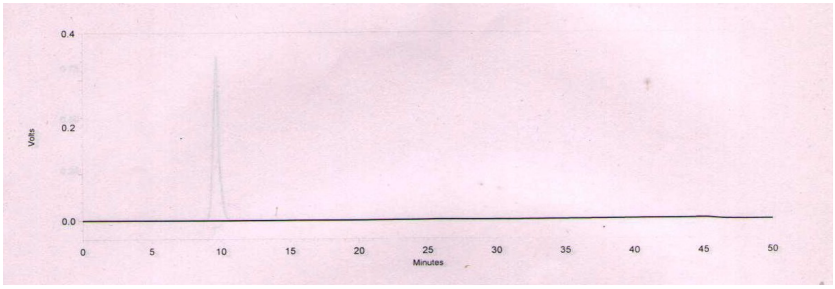

Figure- 1. A Typical Chromatogram of Acyclovir Blank.

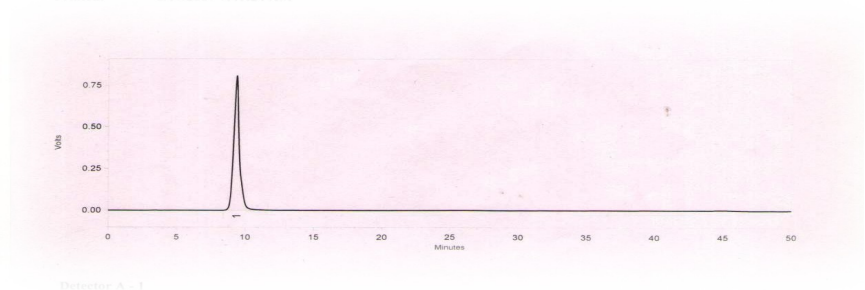

Figure-2. A Typical Chromatogram of Acyclovir Sample Preparation.

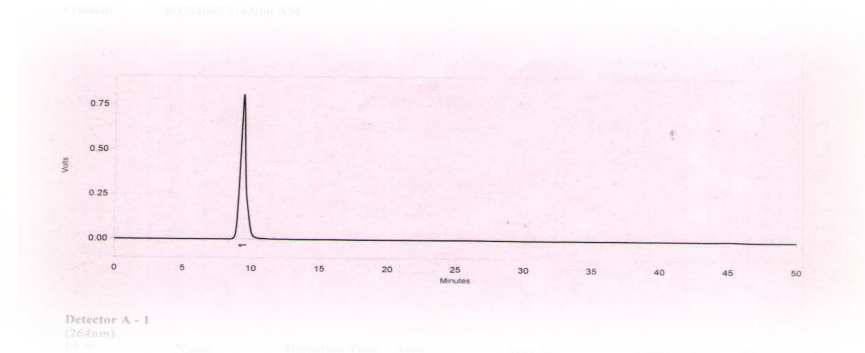

Figure- 3.A Typical Chromatogram of Acyclovir Standard Preparation

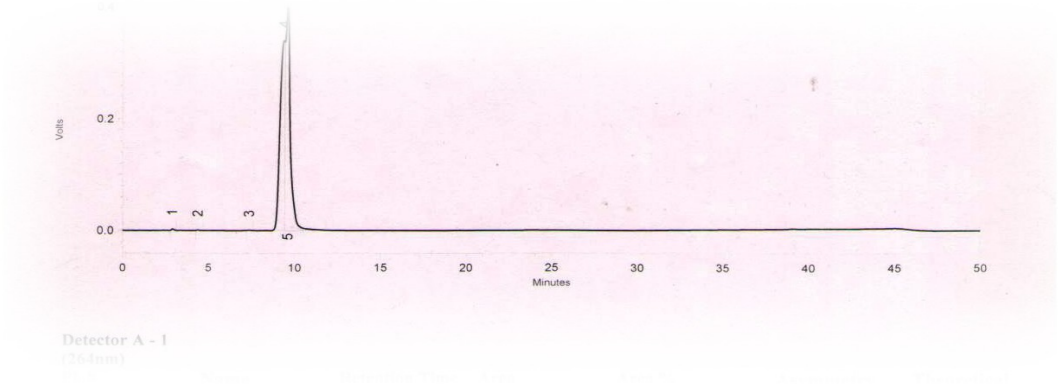

Figure-4. A Typical Chromatogram of Acyclovir Acid Degradation.

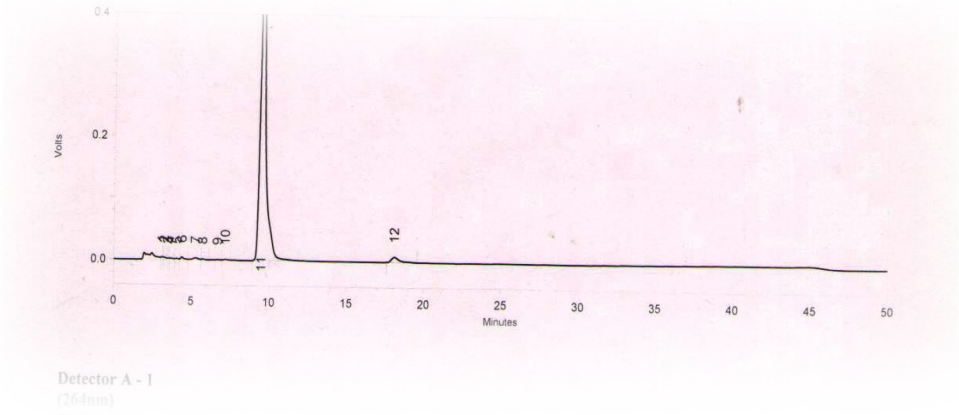

Figure-5. A Typical Chromatogram of Acyclovir Alkali Degradation.

Calibration and linearity

Linearity test solutions for the method were prepared from Acyclovir stock solutions at six concentrations levels from tested from 80% to 120% of the targeted level of the assay concentration Acyclovir. Standard solutions containing 80-120 µg/ml of Acyclovir in each linearity level were prepared. Linearity solutions were injected in triplicate. The calibration graphs were obtained by plotting peak area verses the concentration data was treated by least-squares linear regression analysis, the calibration graphs were found to be linear in the mentioned concentrations the slopes and correlation coefficients are shown in Table–5.

Table 5. Results of the LOD and LOQ

Name	%LOD	%LOQ
Acyclovir	0.11	0.43

Robustness

To determine the robustness of the developed method experimental condition were purposely altered and the resolution between Acyclovir and acid degraded product were evaluated. The flow rate of the mobile phase was 1.0 ml/min. To study the effect of flow rate on the resolution, it was changed by 0.2 units from 0.8 to 1.2ml/min while the other mobile phase component was held as stated in chromatographic conditions. The effect of percent organic strength on resolution was studied by varying acetonitrile from –10 to +10 % while other mobile phase components were held constant as stated in chromatographic condition. The effect of column temperature on resolution was studied at 25 and 35ºC instead of 30ºC while the other mobile phase components were held constant stated in chromatographic condition. The results are shown in Table-6

Table 6: Results of robustness study

Sr. No.	Parameters	Variations	Resolutions between Acyclovir and base degraded product
1	Temperature	25 ºC 35 ºC	8.21 7.68
2	Flow rate	0.8 ml/min 1.2 ml/min	8.02 8.94
3	Mobile phase	40.5 ml 49.5 ml	3.7 3.3

LOD and LOQ (Sensitivity)

A series of solutions in the range 0.2–1.1% of the assay concentration (40 µg mL−1) were prepared by dilution of the standard solutions. Each solution (20 µL) were injected five times, the areas were measured for the drug peak, and the standard deviation for the five injections was calculated for each concentration. On the basis of data obtained, the standard deviation at concentration 0 was calculated and this value was used for calculation of the LOD and LOQ. The results are shown in Table-5

Stability of analytical solution

The stability of the standard solutions and the sample solutions was tested at intervals of 24, 48 and 72 h. The stability of solutions was determined by comparing results of the assay of the freshly prepared standard solutions. The RSD for the assay results determined up to 72 h for Acyclovir was 0.35 %. The assay values were within ± 2 % after 72 h. The results indicate that the solutions were stable for 72 h at ambient temperature.

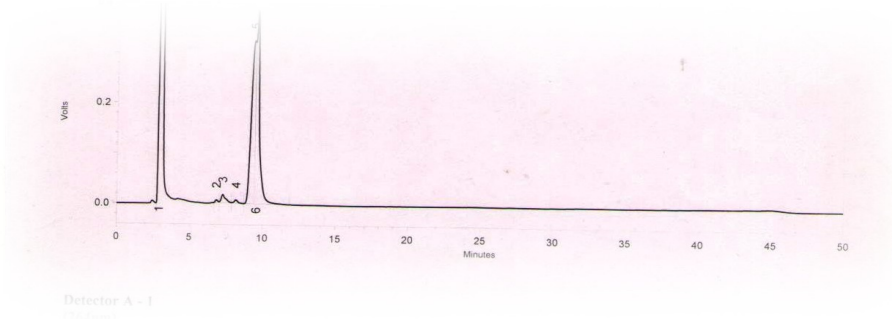

Figure- 6.A Typical Chromatogram of Acyclovir Peroxide Degradation.

CONCLUSION

The method developed for quantitative determination of Acyclovir is rapid, precise, accurate and selective. The method was completely validated showing satisfactory data for all method-validated parameters tested. The developed method is stability indicating and can be used for assessing the stability of Acyclovir as bulk drugs. The developed method can be conveniently used for the assay determination of Acyclovir in bulk drugs and pharmaceutical dosage form.

ACKNOWLEGDEMENT

The authors are grateful to University Grant Commission (UGC) New Delhi for financial support and thankful to Lupin Ltd. India for gift samples of Acyclovir

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