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Optimization and Validation Methods for Assay of Acyclovir Cream Determination by High Performance Liquid Chromatography

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Abstract. The aim this study is to obtain an effective and efficient of method for assay of acyclovir cream determination. Chromatography separation on a reverse phase a YMC - Triart C₁₈ column (4.6 x 150 mm, 5 µm), the mobile phase consisted of water and acetonitrile (95: 5 v/v) at a flow rate 1.2 mL/min with UV-Vis detection at 252 nm, volume injected was 20 µL, with UV detection at 252.0 nm. The retention time of acyclovir was ± 3.5 min. Validation studies were achieved by using the limit of detection (LOD), limit of quantification (LOQ), precision, accuracy, selectivity parameter. The LOD and LOQ values were 0.27 µg/mL and 0.83 µg/mL. The average standard deviation (RSD) value of precision is 0.35% and accuracy is 0.34%. Robustness shows that the method is resistant to variation in the mobile phase, the Acyclovir cream analysis method meets the ICH 1994 requirements, so it can be applied to the assay of Acyclovir determination in Cream dosage forms.

1. Introduction

Acyclovir is an synthetic analogue of guanine used in the treatment and prevention of infectious diseases caused by the *Herpes simplex* virus or *Varicella zoster*. According to WHO (World Health Organization) data, acyclovir is included in the list of essential drugs needed in basic health system. Acyclovir is an antiviral drug that was discovered in 1977 [1]. Acyclovir works specifically against the herpes virus by interfering with the viral DNA polymerase mechanism. Acyclovir is available in Tablet, intravenous injection, ointment and cream dosage forms. Acyclovir cream or ointment has specific properties without disturbing the physiology of normal cells. The side effects of Acyclovir cream to genital lesions can cause irritation or a burning feeling [2].

According to the Indonesian law No. 36 year 2009 article 105 paragraph 1 about health that drugs and medicinal ingredients must complete pharmacopoeia standards and other standard books[3]. One of the parameters of the drug complied with the standards if the assay substances contained therein complied the requirements of the Indonesian Pharmacopoeia. Requirements for assay of acyclovir cream according to the Indonesian Pharmacopoeia V edition 2014, which contains acyclovir (C₈H₁₁N₅O₃), not less than 95.0% and not more than 105.0% of the amount stated on the label [4].The determination of acyclovir cream levels has been carried out in several previous studies using spectrophotometry, FTIR (fourier transforms infrared). The published assays of Acyclovir cream will



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carry out optimization and complete validation of these modifications. The modification of the method carried out was optimization and validation of the determination of Acyclovir cream levels using the method of determining the levels of Acyclovir Tablets found in Indonesian Pharmacopoeia V edition 2014.

This study aims to obtain an effective and efficient method and validate the method obtained in determining the levels of acyclovir cream.

2. Experimental

Instrumentation

Chromatographic separation was performed on a UFLC (Ultra Fast Liquid Chromatography) system equipped with an LC-20AL¹⁵ Shimadzu, Japan), UV-VIS Detector SPDA-20A (Shimadzu, Japan). Column YMC - Triart C18 (4.6 x 150 mm, 5 µm), LC solution was applied for data collecting and processing. UV-VIS spectrophotometer, analytical scale (Mettler Toledo), nylon membrane filters (Whatman), oven (Memmert Universal Oven UN110), hot plate (Wisestir MSH-300), micropipette (Micropipette Eppendorf Research Plus), ultrasonic (Ney[®] Ultrasonic 14H), and glassware.

Materials

Standardized Acyclovir raw material was obtained from Hubei Yitai - China, Acyclovir raw material was obtained from Hubei Yitai - China, placebo of acyclovir cream, a generic product of acyclovir cream was obtained from PT Kimia Farma, Tbk., sodium hydroxide pellets (analytical grade) was obtained from Emsure[®], acetonitril (gradient grade) was obtained from Merck, aqua bidest was obtained from WIDA WITM Unicap.

3. Methods

1. Determination of the maximum wavelength of acyclovir

A Acyclovir solution of concentration 0.1 mg/mL was prepared by 200.0 mg of the acyclovir cream dissolving the appropriate amount in 0.1 N NaOH solution, diluted (serial dilution of 0.1 mL to concentration 0.01 µg/mL), and Measure the absorption at a maximum absorption wavelength of approximately 255 nm.

2. Preparation of working conditions

a. Preparation of 0.1 N NaOH solution

A 0.1 N NaOH solution was prepared by dissolving 4.0 grams of sodium hydroxide pellets for analysis in 1000 mL of aquabidest.

b. Making placebo of acyclovir cream

Table 1. Composition a placebo of acyclovir cream

Composition per 100 mg of placebo cream:	
Propylene glycol	40.0%
Sodium Lauryl Sulfate	0.8%
Paraffin soft white	12.5%
Liquid paraffin	5.0%
Cetostearyl alcohol	6.8%
Poloxamer 407	1.0%
Aqua Purificata	ad 100%

Placebo of Acyclovir cream is made by melting the oil phase (cetosteryl alcohol, soft white paraffin, liquid paraffin and poloxamer 407) and the water phase (propylene glycol, sodium lauryl

sulfate and aqua purificata) into an oven at 70 °C for 15 min. Then the oil phase and the water phase are mixed in hot conditions until it form into a creamy mass [5].

c. Standard solutions and samples preparation

A stock solution or sample of acyclovir was prepared by dissolving the appropriate amount in 0.1 N NaOH solution in order to obtain a final concentration of 0.01 mg/mL solution of acyclovir. Working standards were freshly prepared, diluted (serial dilution of 0,1 mL to concentration 0,01 µg/mL), and used for the analysis.

d. Chromatographic Technique

All chromatographic experiments were using YMC - Triart C18 (4.6 x 150 mm 5 µm) column. The mobile phase consisted of a mixture of water and acetonitrile (95:5% v/v). The flow rate was 1.2 mL/min and the volume injected was 20 µL. The analytes was detected using UV detection at 252.0 nm.

3. Optimization of chromatographic conditions (mobile phase, solvent and flow rate)

At this stage an experiment was carried out by injecting a standard solution and a 20 µL of acyclovir sample at a concentration of 0.01 mg/mL into the HPLC system with a mobile phase of water and acetonitrile v/v and the optimal ratio was sought.

4. Validation

a. System Suitability

The standard solution was injected with 20 µL 6 replicates and the response was observed. RSD area (%) of each active substance was calculated. The chromatogram results were calculated the tailing factor, column capacity factor (K prime), the theoretical plate number (Theoretical Plate) and the resolution of each active substance.

b. Selectivity

The selectivity of the method was evaluated by comparing the chromatograms obtained from the samples containing acyclovir standard with those obtained from blank sample.

c. Linearity and range

The linearity different concentrations of standard solution were prepared to contain 8, 9, 10, 11, 12 µg/mL of acyclovir. These solutions were analysed and calculated. The calibration curves was plotted using peak area versus standard solution concentration.

d. Limit of Detection and Limit of Quantification

A curve is made between the concentration of each active substance and the area from the linearity test data. Then determine the regression equation, slope and intercept. Determined the limit of detection and limit of quantification using the formula:

$$LOD = \frac{3,3 \sigma}{S} \quad 1)$$

$$LOQ = \frac{10 \sigma}{S} \quad 2)$$

Where σ is the standard deviation respond an S is the slope of the regression equation.

e. Accuracy

As much 20 µL sample solutions at 3 concentrations of 8, 10 and 12 µg/mL, were injected respectively into the HPLC instrument in the selected mobile phase and flow rate, repeated 3 replicates for each concentration. Then the accuracy (% RSD) is calculated with a value of not more than 2%.

f. Precision

1) Ripitability (Repetition)

A 100% standard solution and 100% test solution were prepared and each solution was injected 6 replicates in succession. System suitability test: RSD (%) of 6 replicates the standard solution injection of $\leq 2.0\%$.

g. Strength (Robustness)

Performed like a precision test, but made changes in the organic composition of the mobile phase ($\pm 2\%$) were measured compared to normal conditions, and carried out on the stability of the solution for 5 hours. Calculate the level and area RSD (%) of each active substance. Then compare the resulting variations.

5. Data analysis

The area of each Acyclovir chromatogram generated from the HPLC software is entered into the formula so that the percentage of acyclovir levels will be obtained. The percentage results are then processed using simple statistical methods.

4. Results and Discussion

The first step of experiments were conducted to establish the optimum experimental conditions the acyclovir cream. That is determination of the composition of the mobile phase [21] flow rate with to do optimization using [22] LC Shimadzu LC-20AD UFLC, column YMC - Triart C18 (4.6 x 150 mm 5 μm), wavelength 252 nm, injection volume 20 μL using the mobile phase water and acetonitrile with various variation [12] concentration and flow rate 1,2mL/min. The analysis results selected from the optimization are the mobile phase composition of water and acetonitrile (95:5 v/v), resulting in an area 3540782, the theoretical plate number of 23375.726, a tailing factor of 1.396, with a retention time of 3.590. [13]

[11] Next selection of the flow rate of the mobile phase with a variation of the flow rate of 0.8, 1.0 and 1.2 mL/min. The flow rate obtained was 1.2 mL/min, with a concentration of 0.01 mg/mL resulting in an area 3509013, the theoretical plate number of 24070.203, a tailing factor of 1.428, with a retention time of 3.563. This [10] shows good results and meets the required requirements, then composition mobile phase water and acetonitrile (95:5 v/v) and a flow rate of 1.2 mL/min were selected for the assay analysis of acyclovir in the cream preparation.

The validation of method for assay of acyclovir cream aims to ensure the accuracy of the method. System suitability test was performed daily before running analysis to check detector response to the analyte.

The Selectivity, no compounds responded at the same time as the retention time of acyclovir or no interference around the test area (Table 2).

Table 2. Selectivity

No.	Sample Name	Retention Time (min.)	Compound	Area	Resolution	Effectiveness
1	Mobile Phase	-	-	-	-	-
2	Solvent	-	-	-	-	-
3	Placebo	-	-	-	-	-
4	Raw Material	3.475	Acyclovir	3592417	-	-
5	Sample	3.481	Acyclovir	3568188	-	-
<i>Requirements</i>		No compounds responded at the same time as the retention time of acyclovir or no interference around the test area.			Resolution $n \geq 2.0$	-

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Linearity and range. Linearity is a method for obtaining test results that are directly proportional to the concentration of the analyte in a given range. From the experiment with 5 series of sample concentrations ranging from 8-12 $\mu\text{g/mL}$, a calibration curve was obtained with the line equation $Y = 348690.2 + 348690.2 C$ ($\mu\text{g/mL}$) with a correlation value (r) of 0.9990. the results are shown in Table 3, while a linearity curve in Figure 1.

Table 3. Data of Linearity Sample Solution

No.	Target conc. (%)	Sampel weight (mg)	C theoretical ($\mu\text{g/mL}$)	Area	Sample Rate (%)	Recovery (%)
1	80	8,01	8	2860743	79.99	99.99
2	90	9.01	9	3167489	88.58	98.42
3	100	10.00	10	3514179	98.38	98.38
4	110	11.01	11	3918551	109.60	99.64
5	120	12.01	12	4228663	118.29	98.57
Average Recovery						99.00
Standard Deviation						0.76
% RSD						0.76
R						0.9990
Requirements: $r \geq 0.99$; Recovery 98 - 102%						

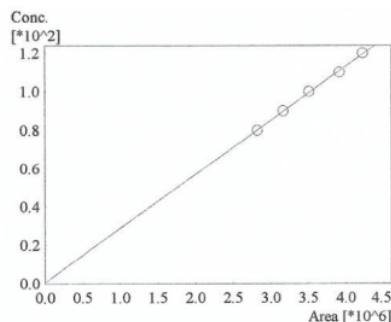


Figure 1. Linearity Curve of Assignment of Acyclovir Cream

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The limits of detection (LOD) and quantification (LOQ) are calculated based on the deviation of the response and the slope of the linear regression curve. The linear regression curve is obtained from the linearity test. The result of the limit of detection is 0.27 $\mu\text{g/mL}$ and the limit of quantification is 0.89 $\mu\text{g/mL}$.

Precision and accuracy results are show in Table 4 and 5. The precision test is carried out by injecting a 100% concentration solution 6 replicates. From the results of the implementation of precision validation, it is obtai 20 that the results meet the requirements with RSD 0.35%. For determination of accuracy, were injected in triplicate into the HPLC system (concentrations 8, 10 and 12 $\mu\text{g/mL}$) and compared to standard acyclovir solutions. The accuracy criterion is highly dependent on the concentration of the analyte in the sample matrix and on the method's accuracy (RSD). (Hamita H., 2004). The results of the accuracy test obtained that % recovery was in the range 99.56 - 100.61% with an average % recovery of 100.05% and a relative standard deviation of 0.34% (Table 5). The recovery value meets the requirements where a good range must be in the range of 98.0–102.0% with a relative standard deviation of $\leq 2.0\%$.

Table 4. Data of Precision Sample Solution

No.	Target Conc. (%)	Sample Weight (mg)	Area	Content (%)	Recovery (%)
1	100	200.15	3559096	99.61	99.61
2	100	200.17	3576320	100.09	100.09
3	100	200.10	3579626	100.21	100.21
4	100	200.11	3586198	100.39	100.39
5	100	200.15	3595223	100.63	100.63
6	100	200.12	3571680	99.98	99.98
Average Recovery					100.15
Standard Deviation					0.35
% RSD					0.35
Requirements: % RSD \leq 2.0%					

Table 5. Data of Accuracy Sample Solution

No.	Target Conc. (%)	Sample Weight (mg)	Area	Content (%)	Recovery (%)
1	80	160.12	2855400	79.92	99.90
2	80	160.10	2847201	79.70	99.62
3	80	160.14	2846127	79.65	99.56
4	100	200.12	3572427	100.00	100.00
5	100	200.15	3594637	100.61	100.61
6	100	200.10	3586114	100.40	100.40
7	120	240.18	4284882	119.93	99.94
8	120	240.20	4287559	120.26	100.21
9	120	240.15	4296036	120.26	100.21
Average Recovery					100.05
Standard Deviation					0.34
% RSD					0.34
Requirements: % RSD \leq 2.0%; Recovery 98 - 102%					

Robustness is the durability of the analysis method is the measurement capacity of the analytical method which is not affected by small changes, but deliberately given variations in its parameters and gives an indication that the method is good as long as it is used in normal conditions. It is necessary to vary the critical parameters in testing to measure how robust the method is. Identify at least 3 analysis factors that could affect the results if they were replaced or changed [6]. In this study, a number of parameters were varied, including: variations in the mobile phase, and the stability of the sample solution was also tested for storage time of 5 hours.

The results of testing the variations in the mobile phase (Table 6) and the stability of the solution (Table 7) show good results, because the deviation results obtained meet the requirements of \leq 2.0 %.

Table 6. Robustness Data of Mobile Phase Variation

No.	Ratio Water: Acn	Area		Content (%)		Savings of food (%)	
		Std	Smpl	Std	Smpl	Std	Smpl
1	Normal (95:5)	3586371	3571224	100.40	99.97	-	-
2	(A) 93:7	3558351	3555486	99.62	99.53	0.78	0.44
3	(B) 97:3	3537425	3580021	99.03	100.21	1.36	0.25
Requirements: Deviation \leq 2.0%							

Table 7. Robustness Data of Solution Stability

No.	Time of Storage	Area		Content (%)		Savings of food (%)	
		Std	Smpl	Std	Smpl	Std	Smpl
1	0 hours	3540353	3522123	99.11	98.58	-	-
2	1 hours	3533124	3523856	98.91	98.63	0.20	0.05
3	2 hours	3535472	3535698	98.98	98.98	0.14	0.41
4	3 hours	3536807	3525859	99.02	98.71	0.10	0.13
5	4 hours	3557102	3523154	99.58	98.63	0.47	0.05
6	5 hours	3529303	3542100	98.81	99.16	0.31	0.59

Requirements: Deviation $\leq 2.0\%$

5. Conclusions

Based on the research results, it was found that the chromatographic conditions acceptable, it can be concluded that the analysis of all the optimization and validation methods for assay of Acyclovir Cream determination complied all the parameters of the validation test of the analysis method and or complied the ICH 1994 requirements, so that it can be used for the determination of Acyclovir levels in the cream preparation.

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