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Research Article

New Validated UV Spectrophotometric Method for the Quantification of Bisoprolol Fumarate in its Pharmaceutical Dosage Form

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Abstract

The current investigation signifies, a simple, affordable, precise, and accurate UV spectrophotometric method to estimate and validate lumefantrine concentrations in bulk and pharmaceutical formulations. Shimadzu twin beam UV-VIS spectrophotometer operated by UV probe software was used in the study. The resulting absorbance at a maximum wavelength of 268 nm was observed using the solvent 0.1N HCL. Numerous validation metrics, including accuracy, precision, linearity, and optical characteristics, were used to optimise the established method. Within a concentration range of 10-60 µg/mL**,** the regression co-efficient (R^2) value of 0.997 was incorporated to obtain the linearity Graph. Less than 2%, of the results for accuracy and precision studies were executed, which shows increasing accuracy and precision levels. Due to low %RSD values in the recovery exploration, no excipients were included in the formulation of the tablet dosage form. The proposed method's accuracy study was confirmed at (80%, 100%, 120%) three levels, and the outcomes were validated in accordance with ICHQ2R1 guidelines. These findings indicate that the procedure has practical value as a tool for quality control when analysing drugs in their tablet dosage forms in the pharmaceutical industry.

Keywords: Bisoprolol; Validation; Precision; Accuracy; Optical Characteristics

Introduction

Beta blockers, also known as beta blocking medicines, are a type of medication that is used to treat high blood pressure. Beta blockers are medications that prevent the effects of the hormone epinephrine, generally known as adrenaline, from taking effect in the body [1,2]. Beta blockers have this effect because, once taken, they cause the heart to beat more slowly and with less force, which in turn lowers blood pressure. Additionally, beta blockers assist blood arteries relax and dilate, which results in an increase in blood flow [1-3]. Bisoprolol fumarate is a selective beta-1-adrenergic receptor antagonist that has antihypertensive efficacy but no intrinsic sympathomimetic activity. It works by blocking the effects of beta-1 adrenergic receptors. Bisoprolol fumarate inhibits beta-1 adrenergic receptors in the heart by binding to them in a manner that is both selective and competitive. As a result, both cardiac contractility and rate are considerably decreased [2-4]. This results in a decrease in cardiac output as well as a drop-in blood pressure. In addition to this, the hormone renin, which is produced by the kidneys, has its release suppressed by the use of bisoprolol fumarate. When adrenergic neurotransmitters like epinephrine activate 1-receptors, which are largely located in the heart, blood pressure and heart rate rise, which ultimately leads to

an increase in the amount of work that the cardiovascular system does and the amount of oxygen that it requires [4,5]. Studies of the published literature show that only a small number of articles using bisoprolol fumarate in spectroscopy with aqueous solvents have been published up to this point. In light of this, efforts have been made to develop and validate a new analytical approach for the medication bisoprolol fumarate utilizing straightforward solvent systems [5-7], which has the potential to be cost-effective and is easily used for regular analysis. Investigations on the limits of detection and quantification are also carried out, as are the optical characteristics and method validation parameters. These studies ensure that the method in question is both sensitive and linear [4,6,7].

Figure 1: Chemical Structure of Bisoprolol fumarate [2].

Material and Methods

Instrumentation and materials

Shimadzu double beam UV-VIS spectrophotometer controlled by UV probe software with pathlength 1 cm U.V matched quartz cells was used. For all weighing purposes, an electronic balance maker sigma 200/A super was used. GGL Mumbai provided bisoprolol fumarate (standard) as a gift. Bisoprolol fumarate tablet formulation (Bisoheart-2.5, mankind pharma) was purchased locally. All chemicals, solvents, and reagents, such as methanol, HCl, and NaOH, were purchased in analytical grade from Merk Ltd. India.

Method development

The analytical development was ascertained by screening the drug's solubility for finding of a most suitable solvent system used as mobile phase during analysis [3-5].

Solubility study

The solubility of Bisoprolol fumarate in several solvents was tested, and the findings are presented below.

Solvent	Drug Solubility
Distilled water	Readily soluble
0.1N HCl	Soluble
0.1N NaOH	Slightly soluble
Phosphate buffer	Insoluble
Methanol	Readily soluble

Table a: Solubility of Bisoprolol fumarate in different solvent system.

Preparation of stock solution

10 mg of standard drug was dissolved with 1ml of distilled water and then volume was made up to 10ml with 0.1N HCl with constant stirring to get 1000µg/mL solution.

Preparation of working standard solution

From the stock solution 1 mL was taken and diluted with 0.1 N HCl up to 10 ml to get 100 µg/mL solution. From the working standard solution different dilution like 10-60 µg/mL, were prepared.

Scanning and determination of maximum wavelength (ƛmax) using UV spectroscopy

The absorption curve of bisoprolol fumarate showed characteristic absorption maxima at 268 nm in 0.1N HCl. The overlay linearity graph of drug was depicted in figure 2 below.

Figure 2: Linearity overlay Spectrum of Bisoprolol Fumarate.

Preparation of calibration curve

The calibration curve was plotted by taking concentration of drug on X-axis and absorbance on Y-axis. It was shown in figure: the drug has obeyed Beer-Lambert's law in the concentration range of 10-60 µg/ml, it was found to be linear with R^2 0.997. Overlay Spectra of linearity studies in various concentrations are depicted in figure 2. The linearity data are demonstrated in table 1 and the linearity plot are represented in figure 3.

Analytical method validation

Evidence of the procedure's suitability for the intended purpose in terms of quality, reliability, and consistency of results is established by analytical method validation [4,8,9]. Analytical Method Validation has performed as per ICHQ2R1 guidelines. The validation study was carried using various validation parameters like linearity, Accuracy, precision, LOD and LOQ etc. [5,8-10].

Linearity

In order to get perceived levels, a calibration curve was produced by correlating the effect of observed absorbance at 268nm responses to the known concentrations (µg/mL) [10,13-16]. Using the mobile phase (0.1N HCL) the drug concentration from 10to 60 µg/mL, the linearity of the method was tested. Using an MS-Excel 2019 spreadsheet (M/s Microsoft Inc., Washington, USA), correlations were made between concentrations and the obtained absorbance as the responses was done by forcing the line through the origin and values of relevant statistical parameters with Y = 0.003 X + 0.0076, and the regression coefficient (R^2) was also determined as below.

Concentration (µg/mL)	Absorbance at 268 nm
10	0.039
20	0.064
30	0.097
40	0.125
50	0.161
60	0.183

Table 1: Linearity table of Bisoprolol Fumarate in 0.1 N HCl.

Calibration curve interpretation

The standard calibration curve of Bisoprolol fumarate was depicted in figure 3.

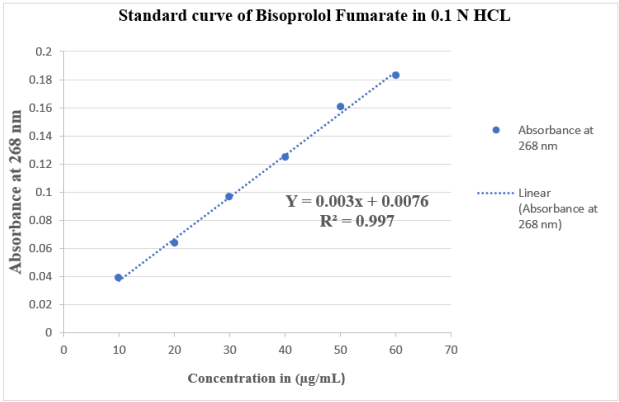

Figure 3: Calibration curve of Bisoprolol fumarate.

The results of Optical characteristics and Validation Parameters are enlisted in table 2.

Optical characteristics and validation parameters

The drug was subjected to various Optical Characteristics and results are outlined below.

Sl. No.	Optical characters	Observed Values
1	Absorbance Maxima	268 nm
2	Beer's Limit	10-60 µg/mL
3	% R.S.D.	1.73
4	Regression Equation(Y*)	0.003x+0.0076
5	Slope (a)	0.003
6	Intercept (b)	0.0076

Table 2: Optical characteristics and Validation Parameters.

Assay of Pharmaceutical Formulations

Assay of marketed formulations are performed for Bisoprolol fumarate and the results are demonstrated in table 3. Absorbance of the respective formulations was estimated and results are found within the acceptance limit.

Sl. No.	Concentration (µg/mL)	Absorbance at 268 nm
1	10	0.032
2	20	0.065

Table 3: Assay of Pharmaceutical Formulations (% Purity).

Precision study

The degree to which a group of measurements obtained from numerous samplings of the same homogenous sample differ from one another is referred to as the degree of scattering. Precision is defined as the intimacy of preparation [10-13]. Precision study was carried out by system, Intraday and interday precision study and the results with statistical analysis are represented in table 4, table 5 and table 6 respectively [14-18].

Sl. No.	Concentration (µg/ml)	Absorbance at 268 nm	Statistical Analysis
1	20	0.054	Mean = 0.0535 S.D = 0.003017 % Relative Standard Deviation = 1.73
2	20	0.049	
3	20	0.054	
4	20	0.057	
5	20	0.056	
6	20	0.051	

Table 4: System Precision (Repeatability).

Intraday and interday precision data of bisoprolol fumarate

The intraday and interday Precision studies are represented below in table 5 and 6 respectively.

Accuracy

The ICH recommendations for the validation of analytical processes [10-12] refer to the correctness or authenticity of the results of an experiment. The accuracy was conducted at three different levels, and the results show that the mean percentage recovery for all levels of data is within the acceptable range (98-102%) [15-18]. The recovery study was performed at three significant levels (i.e. 80%, 100%, and 120%) and the results are demonstrated in table 7. All the statistical parameters are within the limit.

Sl. No.	Concentration (µg/ml)	Absorbance at 268 nm	Statistical Analysis
1	10	0.043	Mean = 0.043 Std. Deviation = 0.001 %R.S.D. = 1.45
2	10	0.042	
3	10	0.044	
4	15	0.058	Mean = 0.05566 Std. Deviation = 0.002517 %R.S.D. = 1.52
5	15	0.056	
6	15	0.053	
7	20	0.071	Mean = 0.073 Std. Deviation = 0.0013 %R.S.D. = 1.78
8	20	0.072	
9	20	0.076	

Table 5: Intraday Precision study of Bisoprolol fumarate.

Sl. No.	Concentration (µg/ml)	Absorbance at 268 nm	Statistical Analysis
1	10	0.041	Mean = 0.043667 Std. deviation = 0.002517 %R.S.D = 1.56
2	10	0.046	
3	10	0.044	
4	15	0.054	Mean = 0.05533 Std. deviation = 0.001528 %R.S. D = 1.76
5	15	0.055	
6	15	0.057	
7	20	0.073	Mean = 0.74 Std. deviation = 0.001 %R.S. D = 1.35
8	20	0.075	
9	20	0.074	

Table 6: Interday Precision study of Bisoprolol fumarate.

Samples	Concentration		Absorbance at 268 nm	Statistical Analysis
	Pure	Formulation		
S1:100%	10	10	0.082	Mean = 0.081 Std. deviation = 0.001 %R.S. D = 1.23
S2:100%	10	10	0.081	
S3:100%	10	10	0.080	
S4:80%	8	10	0.065	Mean = 0.0646 Std. deviation = .000529 %R.S.D = 0.81
S5:80%	8	10	0.0648	
S6:80%	8	10	0.064	
S7:120%	12	10	0.098	Mean = 0.097 Std. deviation = 0.001 %R.S. D = 1.03
S8:120%	12	10	0.097	
S9:120%	12	10	0.096	

Table 7: Accuracy data for Bisoprolol Fumarate.

Limit of detection (LOD) and limit of quantization (LOQ)

The baseline noise was employed to determine LOD and LOQ in accordance with the parameters given by ICHQ2R1 [10]. Various advanced spectroscopic analysis can be performed to find out the detection and quantitation limits of organic compounds as per literature aspects [13-16]. However, the evaluation of these concentration limits was found out, by comparing the estimated signals of samples with known analyte concentrations to those of the blank using S/N ratio of 3:1 for LOD and 10:1 for LOQ [13].

- LOD: The LOD for of Bisoprolol fumarate was found to be 1.3 µg/mL.
- LOQ: The LOQ for of Bisoprolol fumarate was found to be 3.98 µg/mL.

Conclusion

The goal of this study was to design and validate a simple, effective assay method for the quantitative estimation of bisoprolol fumarate. The developed UV-visible Spectroscopic method was found reliable enough to be used for the routine analysis of bisoprolol fumarate. When compared to other reported complex methods of analysis, the current investigation was beneficial in terms of its ease of operation, reliability, sensitivity, cost-effectiveness, accuracy, and precision values and can be implemented for routine analysis in research labs and industries.

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