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**QUANTIFICATION OF TOTAL MECLIZINE HYDROCHLORIDE  
CONTENT IN PHARMACEUTICAL FORMULATION BY UV  
SPECTROPHOTOMETRIC AIDED MULTIVARIATE  
CALIBRATION TECHNIQUE**

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**ABSTRACT**

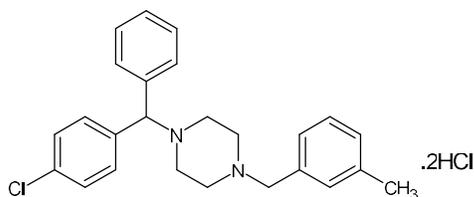
Present abstract employs the use of Multivariate Calibration Technique for the assessment of Meclizine hydrochloride in the marketed pharmaceutical formulation. The multivariate calibration method was developed by utilizing a linear regression equation to analyze the relationship at five distinct concentration levels and recording its absorbance at five different wavelengths close to the drug's maximum absorbance. Over a concentration range of 5–15 g/mL, the technique was shown to be linear with a correlation coefficient value greater than 0.998. Meclizine hydrochloride's  $\lambda_{\text{max}}$  was discovered to be 230 nm. According to ICH protocol Q2 (R1), the created approach was determined to be easy, quick, accurate, and exact. By removing the discrepancies the resulting from instrumental or experimental conditions, this statistical approach produces optimal results.

**Keywords: Meclizine hydrochloride, Antihistamine, Multivariate calibration  
technique, ICH protocol, Validation, UV Spectrophotometry**

**INTRODUCTION**

Meclizine hydrochloride is a piperazine- generation antihistamine [2]. Meclizine  
class Drug [1] that comes under first- hydrochloride is (RS)-1-

[(4chlorobenzhydryl)-4-(3-methylbenzyl) piperazine is shown in **Figure 1**. Due to the unknown safety and effectiveness in children under the age of 12, it should be taken with caution to patients over the age of 65 due to the possibility of confusion and amnesia. Buclizine, cetirizine, cyclizine, and hydroxyzine share characteristics with meclizine in terms of structure and biological action [3]. MCZ is a slow-absorbing hydrophobic drug [4]. Meclizine Hydrochloride has anticholinergic, central nervous system depressive, and local anaesthetic effects. It also works as an antagonist at H1-receptors, decreases labyrinth excitability, and may have an impact on the medullary chemoreceptor trigger zone [5]. Meclizine is official in the Indian Pharmacopeia (IP) [6] and United States Pharmacopeia (USP) [7].



**Figure 1: Chemical structure of Meclizine Hydrochloride**

A review of the literature finds that few analytical methods have been described for the measurement of meclizine hydrochloride in pharmaceutical formulations using UV spectrophotometric techniques.(8) ,high- performance liquid chromatography (HPLC)(9) and liquid

chromatography-tandem mass spectrometry (LC-MS-MS) [10].

The proposed approach gives a higher degree of confidence in findings since it directly assesses MCZ-HCL and has been validated with greater accuracy and precision than the conventional UV-Visible assay. The individual result is simplified and converted into a "m" value as a dependent variable using this multivariate standardization procedure. In this scenario, if an analyte's absorbance (X) i.e. (MCZ-HCL) is scanned at 5 different wavelengths set ( $\lambda = 226, 228, 230, 232$  and  $234\text{nm}$ ), the subsequent formula can be applied for any preferred wavelength.

$$A_{\lambda 226} = a \times C_x + k_1 \text{-----} (1)$$

$$A_{\lambda 228} = b \times C_x + k_2 \text{-----} (2)$$

$$A_{\lambda 230} = c \times C_x + k_3 \text{-----} (3)$$

$$A_{\lambda 232} = d \times C_x + k_4 \text{-----} (4)$$

$$A_{\lambda 234} = e \times C_x + k_5 \text{-----} (5)$$

Where  $A_{\lambda}$  is the absorbance, analyte's a, b, c, d, and e are its linear regression functions' slopes, intercepts are provided as  $k_1, k_2, k_3, k_4,$  and  $k_5$  at the five designated wavelengths, and  $C_x$  is the analyte's concentration. The five equation systems (1-5) stated above can be summarized as follows:

$$A_T = a \times C_x + b \times C_x + c \times C_x + d \times C_x + e \times C_x + K_T \text{-----} (6)$$

The above equation can be further reduced to

$$A_T = C_x (a + b + c + d + e) + K_T \text{-----}$$

---- (7)

Whereas  $K_T$  and  $A_T$  stand for the total intercepts of the regression equations at the selected five wavelengths and the measured absorbance, respectively. The concentration of analyte X may be determined using the formula.

$$C_x = \frac{A_T - K_T}{(a + b + c + d + e)}$$

The primary purpose of this work was to develop a simple, rapid, accurate, precise, and economical UV technique for measuring Meclizine hydrochloride in bulk and marketed formulations using Multivariate Calibration. This technique was developed and validated in accordance with the ICH analytical method validation requirements [11].

## EXPERIMENTAL:

### Chemicals and solvents employed:

- Meclizine hydrochloride
- Meclizine Hydrochloride sample from Ideal Analytical Laboratory; Diligan-25 mg tablet purchased near request
- Methanol – solvent

### Solubility:

- Freely soluble in chloroform, methanol, very slightly soluble in water.

### Instrumentation:

- Ultra Violet-Visible double beam Spectrophotometer (Lab India UV-3092)
- Analytical balance
- Ultra Sonic Bath (ILE, ILTC)

## METHOD DEVELOPMENT:

### Selection of solvent:

Methanol, which was used throughout the analysis as the solvent to solubilize the drug, has been found to be a good solvent for meclizine hydrochloride.

### Preparation of standard stock solution:

Meclizine hydrochloride 25 milligrams was precisely weighed and put to a 10 mL volumetric flask. After adding 5 mL of solvent, the mixture was sonicated for 15 minutes. With the solvent, the final amount was diluted to 10 mL and mixed thoroughly (1 mg/mL). 1 mL of the previous solution was pipetted out and transferred to a 100 mL volumetric flask, wherein the total volume was increased to the desired level with the help of the solvent and completely mixed. The resultant solution was then further diluted with the solvent to produce concentrations ranging from 5 to 15  $\mu\text{g/mL}$ .

### Determination of $\lambda_{\text{max}}$ :

To achieve a concentration of 100  $\mu\text{g/mL}$ , meclizine hydrochloride was diluted with the solvent. This solution was scanned in the 200–400 nm UV region. Figure 2 shows the UV spectra of meclizine hydrochloride.

**Preparation of sample solution:**

The average weight of 15 Meclizine hydrochloride tablets (Diligan tablets, Label claim - 25 mg of (Meclizine hydrochloride)) was calculated. The Tablets were crushed, and the contents were mixed thoroughly. The combined items were weighed to equal 25 mg of Meclizine hydrochloride, which was then dissolved using sonication in 10 mL of solvent for 15 minutes before being filled with the solvent to a volume of 100 mL. The preceding solution has undergone extensive mixing and filtering. For further studies, the filtrate was diluted accordingly.

**METHOD VALIDATION:**

The proposed approach was verified in accordance with the ICH Q2(R1) procedure, which assessed validation criteria such as linearity, sensitivity, precision, and accuracy.

**SYSTEM EVIDENCE:**

The suggested method was evaluated using the ICH Q2(R1) protocol, which evaluated validation standards such as linearity, sensitivity, precision, and accuracy.

**Linearity:**

Meclizine hydrochloride standard stock solution was diluted with the solvent to produce concentrations of 5, 7.5, 10, 12.5, and 15 µg/mL. The absorbance of the prepared concentrations was measured at five different wavelengths chosen around

the drug's maximum (230 nm), namely 226, 228, 230, 232, and 234 nm (**Table 1**), in order to establish linear correlation and eliminate instrumental fluctuations. The overlay UV spectra demonstrating linearity are shown in **Figure 3**. The established linear regression equations for each of the five wavelengths' individual correlation coefficient values were calculated (**Table 2**). The calibration graphs obtained at five different wavelengths are shown in **Figure 3**.

**Limit of Detection (LOD) and Limit of Quantification (LOQ):**

The developed method sensitivity was determined by calculating the limit of detection (LOD) and limit of quantification (LOQ) values using the slope and intercept values of the linear regression line (**Table 2**).

$$\text{LOD} = 3.3 \sigma / S \dots\dots\dots (8)$$

$$\text{LOQ} = 10 \sigma / S \dots\dots\dots (9)$$

**Precision:**

By measuring the absorbance of the linearity solution at 100% concentration (10 µg/mL) at each of the five wavelengths, intraday and interday precision measurements were made. Six times a day (intraday precision) and three distinct days (interday precision) were used to scan the selected concentration. **Figure 4** displays the overlay UV spectra for inter and intraday precision studies where the standard deviation (SD) and percentage

relative standard deviation (% RSD) were computed. **Tables 3-6** provide the absorbance values acquired at the specified wavelengths for intraday and interday precision evaluations.

#### Assay:

The purified sample solution's absorbance was determined at 230 nm. The assay observations are given in **Table 7** along with the amount of drugs present in the formulation.

#### Accuracy (Recovery studies):

Recovery studies using the conventional addition approach were done to check the proposed technique's accuracy at concentrations of 50%, 100%, and 150%.

0.5 mL of the sample solution was pipetted into three distinct 10 mL volumetric flasks from the prepared stock solutions of the standard and sample, and 0.5, 1.0 and 1.5 mL of the standard stock solution were added, respectively, to the volumetric flask above. With distilled water, the final volume was increased up to specification. The recovery percentage numbers were computed. The recovery study findings are given in **Table 8** with its overlay UV spectra shown in **Figure 5**.

#### RESULTS AND DISCUSSION:

The absorption maxima of Meclizine hydrochloride was observed at 230 nm.

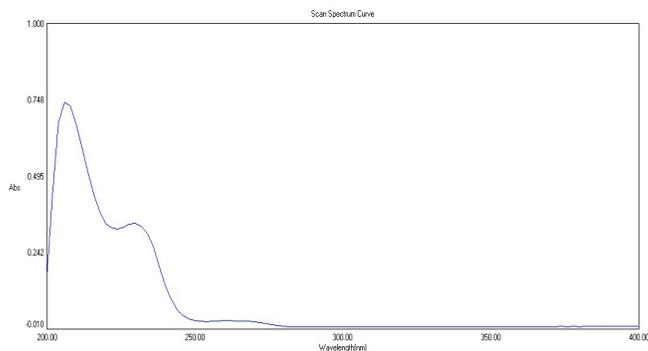


Figure 2: UV Spectra of Meclizine Hydrochloride

#### Linearity:

The developed technique was reported to be linear throughout the stated concentration range of 5- 15 g/ml. A linear regression equation was developed for each of the five wavelengths (226, 228, 230, 232, and 234 nm). The correlation coefficient values obtained were more than 0.998.

#### Limit of Detection (LOD) and Limit of Quantification (LOQ):

The calculated LOD and LOQ values ranged from 0.27 to 0.43  $\mu\text{g/mL}$  and 0.82 to 1.30  $\mu\text{g/mL}$ , respectively.

#### Precision:

Precision investigations were carried out for both intraday and interday. The % RSD values for intraday and interday accuracy

were determined to be in the range of 0.80-1.01 and 0.10-0.75, respectively, which was considered to be significantly below the ICH standards' acceptability criteria of 2%. The developed approach proved reliable as evidenced by the low estimated% RSD value.

#### Assay:

The sample solution's absorbance was determined at 230 nm, and the quantity of meclizine hydrochloride found in the tablet formulation was estimated. The drug achieved a 99.97% w/w assay percentage, and the calculated% RSD was below 2%.

#### Recovery:

The percentage recovery of the drug was calculated and found between 99.00 and 101.52% w/w, which was deemed to be within the ICH protocol limit of 97 to 103% w/w. Hence the method can be reported as accurate.

#### CONCLUSION:

This unique multivariate approach for Meclizine Hydrochloride test is more accurate, exact, repeatable, cost-effective, and sensitive than traditional UV-Visible Spectrophotometry. This multilinear regression analysis has been shown to be beneficial for evaluating the standard medicine and alternative dose forms of Meclizine Hydrochloride. This approach was verified using ICH Quality Guidelines and was confirmed to be within the validation limitations. In comparison to expensive and sophisticated procedures such as HPLC and HPTLC, this is a basic working process that may be employed for regular analysis of Meclizine Hydrochloride in bulk medications and pharmaceuticals.

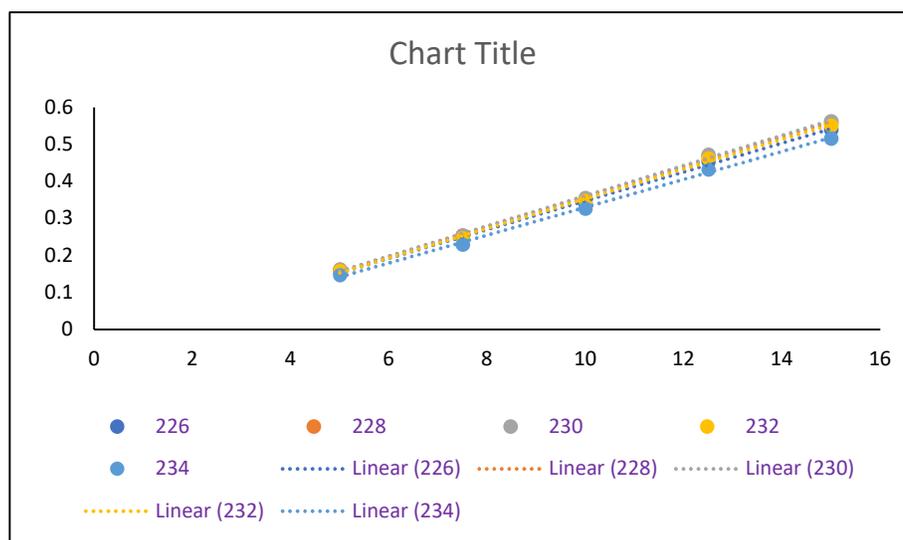


Figure 3: Calibration graph at five selected wavelengths

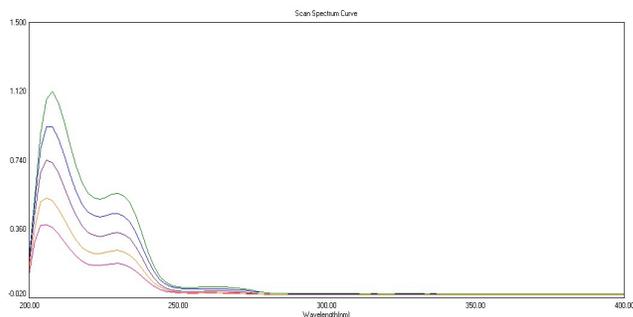


Figure 3: UV Spectrum of Meclizine Hydrochloride showing linearity 230nm

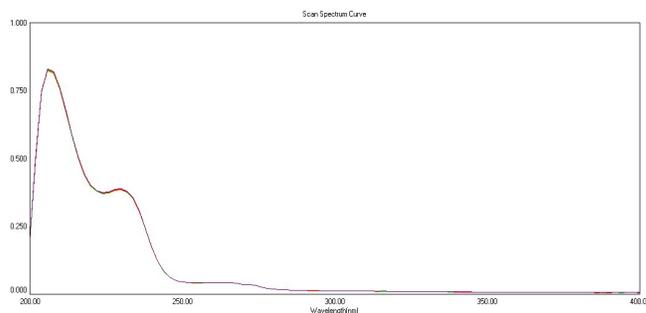


Figure 4: Overlay UV Spectra of MEC HCl showing inter and intraday precision studies.

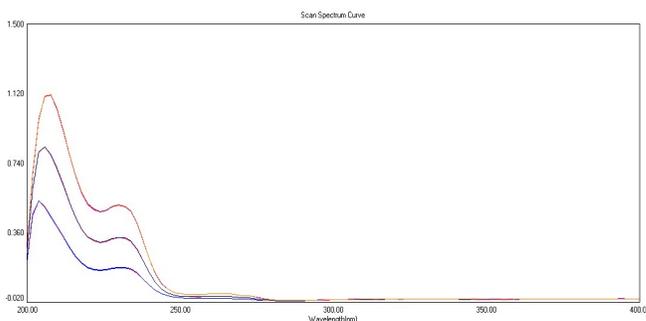


Figure 5: Overlay UV Spectra of Meclizine hydrochloride showing accuracy

Table 1: Multivariate UV calibration at five selected wavelengths

Concentration (µg/mL)	Absorbance (nm)				
	226	228	230	232	234
5	0.157	0.162	0.162	0.158	0.147
7.5	0.247	0.254	0.254	0.246	0.229
10	0.340	0.351	0.355	0.348	0.326
12.5	0.454	0.469	0.472	0.462	0.432
15	0.540	0.559	0.563	0.551	0.516

Table 2: Linearity data showing system suitability parameters at the selected wavelengths

Wavelength (nm)	Regression equation	r <sup>2</sup>	Average of Slope	SD of Intercept	LOD (µg/mL)	LOQ (µg/mL)
226	Y=0.0389x-0.0416	0.998	0.03872	0.003294	0.28	0.85
	Y=0.0389x-0.0442	0.998				
	Y=0.0383x-0.0398	0.998				
	Y=0.0391x-0.0474	0.998				
228	Y=0.0384x-0.0396	0.998	0.03968	0.003604	0.29	0.90
	Y=0.0404x-0.0446	0.998				
	Y=0.0397x-0.0386	0.999				
	Y=0.0394x-0.0368	0.999				

230	Y=0.0395x-0.0362	0.998	0.04066	0.003336	0.27	0.82
	Y=0.0394x-0.0354	0.998				
	Y=0.0408x-0.0468	0.998				
	Y=0.0408x-0.0468	0.998				
	Y=0.041x-0.0482	0.998				
	Y=0.0402x-0.0408	0.998				
232	Y=0.0405x-0.0418	0.998	0.04064	0.005296	0.43	1.30
	Y=0.0401x-0.0478	0.998				
	Y=0.0409x-0.0596	0.998				
	Y=0.0408x-0.0532	0.998				
	Y=0.041x-0.0584	0.998				
234	Y=0.0404x-0.0492	0.998	0.03796	0.004065	0.35	1.07
	Y=0.0376x-0.0464	0.998				
	Y=0.0378x-0.0504	0.998				
	Y=0.0376x-0.048	0.998				
	Y=0.0383x-0.0548	0.998				
	Y=0.0385x-0.0556	0.998				

Table 3: Absorbance values for intraday precision studies

Concentration (µg/mL)	Number of repetitions	Absorbance				
		226 nm	228 nm	230 nm	232 nm	234 nm
10	1	0.366	0.376	0.379	0.370	0.346
	2	0.369	0.378	0.381	0.371	0.348
	3	0.372	0.382	0.383	0.374	0.350
	4	0.373	0.383	0.385	0.375	0.351
	5	0.375	0.384	0.386	0.376	0.352
	6	0.376	0.386	0.387	0.378	0.354

Table 4: Absorbance values for interday precision studies

Concentration (µg/mL)	Number of repetitions	Absorbance				
		226 nm	228 nm	230 nm	232 nm	234 nm
5	1	0.155	0.167	0.161	0.152	0.150
	2	0.157	0.166	0.160	0.154	0.151
	3	0.156	0.167	0.161	0.154	0.152
10	1	0.342	0.353	0.351	0.345	0.328
	2	0.341	0.351	0.350	0.346	0.326
	3	0.343	0.353	0.351	0.345	0.327
15	1	0.544	0.557	0.565	0.553	0.514
	2	0.544	0.556	0.566	0.552	0.513
	3	0.542	0.557	0.567	0.553	0.512

Table 5: Interday precision study

Concentration (µg/mL)	Description	226 nm	228 nm	230 nm	232 nm	234 nm
5	Mean	0.156	0.166	0.160	0.153	0.151
	SD	0.001	0.00057	0.00057	0.0011	0.001
	%RSD	0.64	0.34	0.35	0.75	0.66
10	Mean	0.342	0.352	0.350	0.345	0.327
	SD	0.001	0.0011	0.00057	0.00057	0.001
	%RSD	0.29	0.32	0.16	0.16	0.30
15	Mean	0.543	0.556	0.566	0.552	0.513
	SD	0.0011	0.00057	0.001	0.00057	0.001
	%RSD	0.21	0.10	0.17	0.10	0.19

Table 6: Intraday precision study

Concentration (µg/mL)	Description	226 nm	228 nm	230 nm	232 nm	234 nm
10	Mean	0.371	0.3815	0.383	0.374	0.350
	SD	0.0037	0.0037	0.0030	0.0030	0.0028
	% RSD	1.01	0.99	0.80	0.81	0.81

Table 7: Assay of Meclizine Hydrochloride in marketed pharmaceutical formulation

Label claim (mg)	Amount estimated (mg)	% Assay
25	24.98	99.92
	25.01	100.04
	24.99	99.96
	25.02	100.08
	24.97	99.88
Average		99.976
SD		0.0829
% RSD		0.08

Table 8: Recovery studies

Wavelength (nm)	Conc. levels (%)	Sample Conc. Present (µg/mL)	Standard Conc. (µg/mL)	Final Conc. (µg/mL)	Amount recovered (µg/mL)	% Recovery
226	5	3	2	5	1.98	101.01
	10	3	7	10	7.01	99.85
	15	3	12	15	12.02	99.83
228	5	3	2	5	1.99	100.50
	10	3	7	10	6.98	100.28
	15	3	12	15	11.99	100.08
230	5	3	2	5	2.01	99.50
	10	3	7	10	7.03	99.57
	15	3	12	15	12.01	99.91
232	5	3	2	5	1.97	101.52
	10	3	7	10	6.99	100.14
	15	3	12	15	11.98	100.16
234	5	3	2	5	2.02	99.00
	10	3	7	10	6.97	100.43
	15	3	12	15	11.97	100.25

### ETHICAL STATEMENT

There are no subjects who are humans or any other living creatures used in this study's trials.

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### A DISAGREEMENT OF INTEREST

The authors report no conflicts of interest on the study.

### FINANCIAL SOURCES

No backing has been reported.

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