

Analytical studies on zero order and first order derivative and area under curve UV-spectrophotometric methods for estimation of pimavanserin tartrate in bulk and In-house tablet formulation

Abdul Talib Abdul Wahab¹, Mohammad Mojeeb Gulzar Khan^{2*}, Atul Arun Shirkhedkar³

¹Research Scholar, ²Associate Professor, ³Professor, Dept. of Pharmaceutical Chemistry, ¹⁻³R.C. Patel Institute of Pharmaceutical Education and Research, Shirpur, Dhule, Maharashtra, India

***Corresponding Author: Mohammad Mojeeb Gulzar Khan**

Email: mujeebgulzar@gmail.com

Abstract

The proposed work to establish simple, rapid, sensitive, economical and accurate UV spectrophotometric methods for the quantification of Pimavanserin tartrate in bulk material and *in-house* tablet formulation. This study is designed to validate the developed methods as per ICH guidelines. Pimavanserin tartrate is an atypical anti-psychotic drug also used for the treatment of Parkinson Disease. Four simple UV Spectroscopy methods developed and validated for the estimation of Pimavanserin tartrate, by using double beam spectrophotometer (UV-2450, Shimadzu, Japan). Maximum absorbance (λ_{max}) of pimavanserin tartrate was observed at 226 nm used methanol as a solvent. The calibration curve of concentration range 5-30 $\mu\text{g/ml}$ obeyed Beer Lambert law. The % recovery was found to be in the range of 98-101%. Precision values observed less than 2 in the terms of % RSD that shows precise nature of developed methods. It was concluded that statistical analysis and the result amongst all four methods, AUC method is most simple, specific, accurate and precise. All four methods can be used as routine analysis of Pimavanserin tartrate in bulk and pharmaceutical formulations.

Keywords: Area under curve, Derivative-spectrophotometry, Pimavanserin tartrate, UV Spectroscopy.

Introduction

Pimavanserin tartrate (PMT) is chemically (2*R*, 3*R*) - 2,3 - dihydroxybutanedioic acid; 1-[(4-fluorophenyl) methyl] -1- (1-methylpiperidin-4-yl) -3- [[4-(2-methylpropoxy) phenyl] methyl]urea (Fig. 1). Pimavanserin tartrate (PMT) is one of the atypical anti-psychotic which is also used for the treatment of Parkinson.¹ When it synthesized Pimavanserin has been administered as its tartrate salt.² PMT is not a dopamine receptor antagonist but is having inverse agonist on 5-HT_{2A}³⁻⁷ subtype receptor for the treatment of psychosis in Parkinson's disease (PD) and used in the treatment of schizophrenia. It's also having significant effect on insomnia, it's selective serotonin 5-HT_{2A} receptor inverse agonist, to the slow wave sleep.⁸

Literature survey gives details about analytical methods for determination of PMT. In High Performance Liquid Chromatographic used to Quantification of Pimavanserin in Bulk and Tablet Dosage Form Using A Stability Indicating method,⁹

ultrafast LC for estimation pimavanserin in pharmaceuticals.¹⁰ and UPLC-MS for estimation of Pimavanserin tartrate in rat plasma¹¹ but still no UV spectrophotometry method has been developed for the determination of PMT in bulk and tablet formulation. At the same time, our goal was use to AUC and amplitude technique to established zero order and first order derivative.

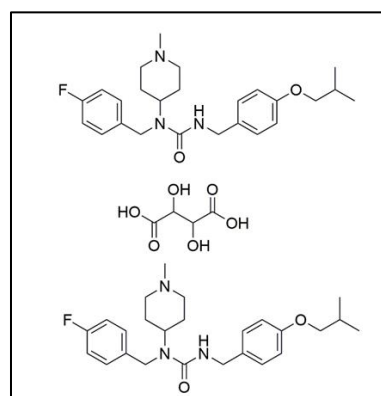


Fig. 1: Chemical structure of pimavanserin tartrate

Materials and Methods

Chemicals

Pure PMT was received from MSN Laboratories PVT. LTD, Hyderabad, India as a gift sample. All chemicals and reagents used were of analytical grade (Rankem India Ltd. Thane, India)

Instrumentation

Use of a double beam UV-VIS spectrophotometer (UV-2450, Shimadzu, Japan), consist of 10 mm quartz cell, connected to a computer loaded with a UV Probe spectra software version 2.21. The instrumental obtained the spectra as follows various procedure of parameters, wavelength range in between 200–400 nm; scanning speed: medium; sampling interval 1.0 nm. All weights were taken on an electronic balance. (Model- AUX 120, Shimadzu, Japan)

Preparation of standard stock solution and selection of determination of lambda (λ_{max}): A stock standard solution was prepared by dissolving 10mg of PMT in a100mL of methanol to get concentration of 100µg/mL. From it, further dilution concentration of 10µg/mL was prepared and scanned in the UV-visible range 400–200nm. Maximum absorbance observed at 226 nm. (Fig. 2)

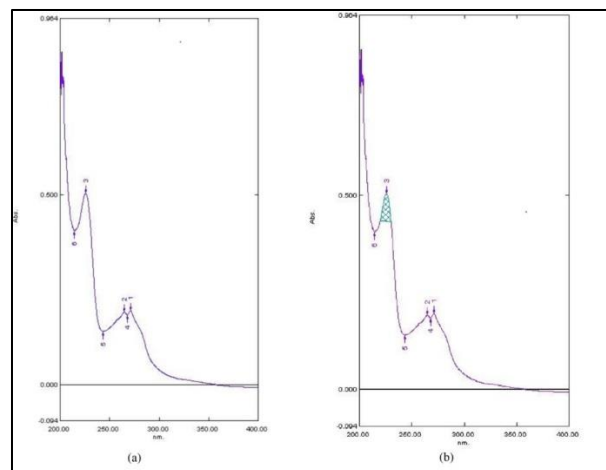


Fig. 2: Zero order spectrum (a) and Area under curve AUC; (b) selected wavelength

Method A (Zero order) and Method B (Zero order AUC): For method A and method B, prepared different standard solutions sets of PMT range from (5-30 µg/mL) from the standard stock solution of PMT (100 µg/mL). For this aliquots of 0.5 – 3.0 mL of standard stock solution are separately pipetted out and transferred to volumetric flask series with capacity up to 10 mL, then volume was made up to the methanol. For method A absorbance was observed at 226 nm shown (Fig. 2(a)). While method B area under curve (AUC) of the zero-order spectrum was recorded between 219.20 and 230.40 nm shown in (Fig. 2(b)). Method A and Method B calibration curves are constructed by plotting zero order spectrum concentration against absorbance and AUC.

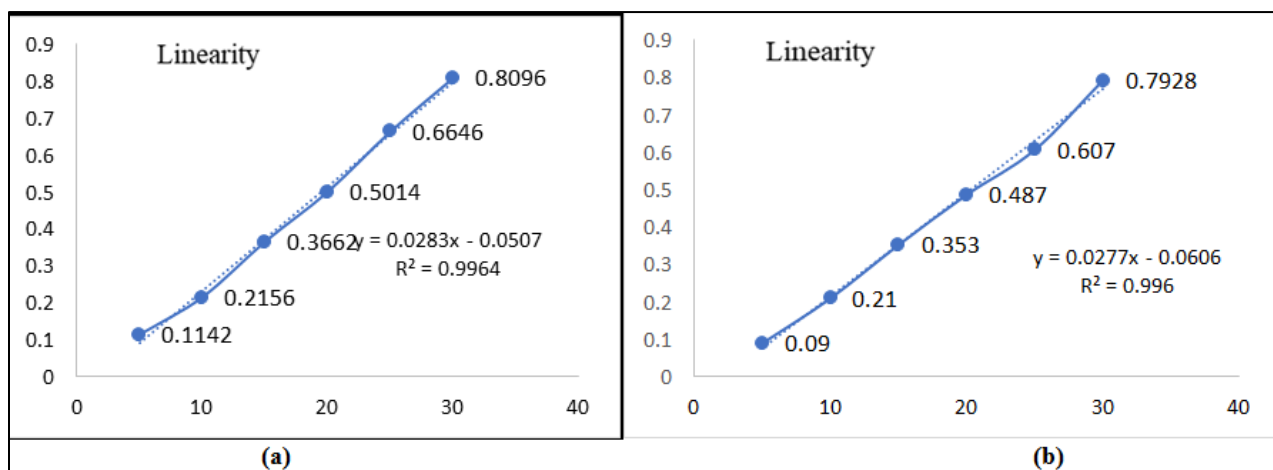


Fig. 3: Calibration Curve of PMT for Method A (a); and Method B (b)

Method C (First order derivative) and Method D (First order derivative AUC): Using UV probe 2.21 version software with delta 4 and scaling factor 10 for method C and method D spectra of previous solution derivatized into first-order spectra. The amplitude of Method C was shown at 232 nm in (Fig. 4(a)). While spectrum selected for method D first order derivative AUC between 228.20 and 238.40 nm shown in (Fig. 4(b)). Method C and D calibration curves are developed by plotting concentration versus amplitude and first-order spectrum AUC respectively, given in (Fig. 5).

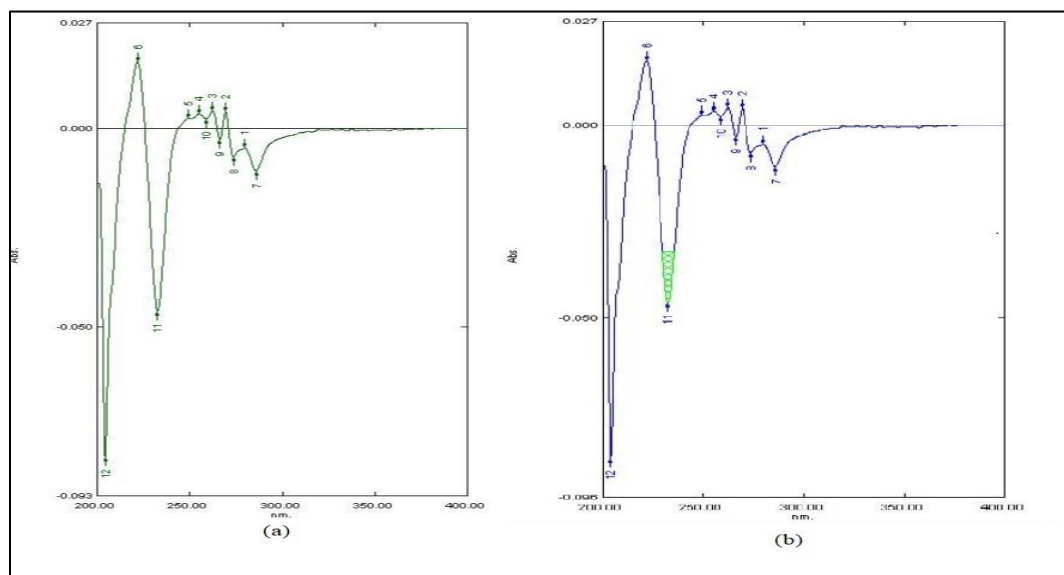


Fig. 4: First order derivative spectrum (a) and area under curve; (b) Between selected wavelengths of pimavanserin Tartrate.

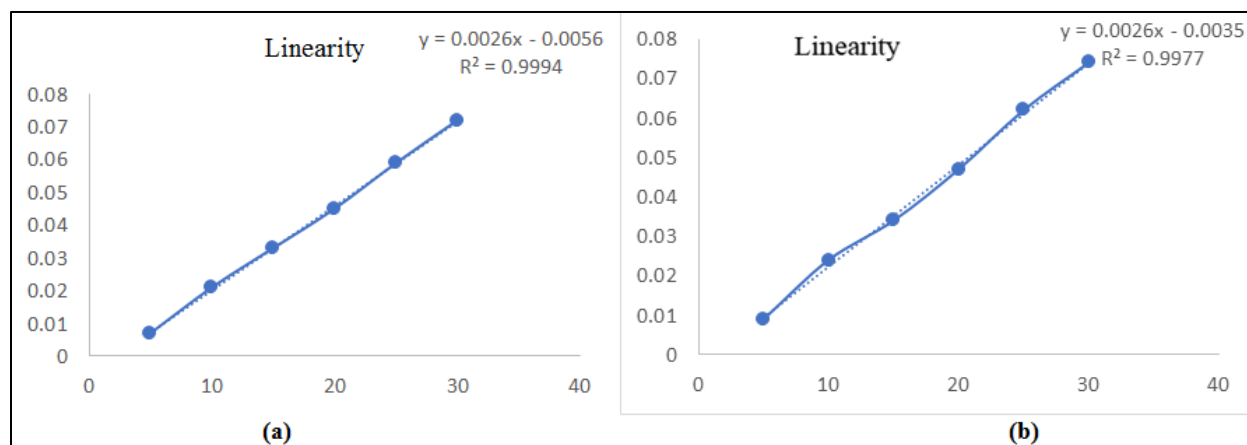


Fig. 5: Calibration Curve of Pimavanserin Tartrate for Method C (a); and Method D (b)

Study of marketed formulation

Formulation of *In-house* tablet preceded taking 10 mg drug with filler or binding agents like Magnesium stearate 8 mg, pregelatinized starch 8mg and micro crystalline cellulose as quantity sufficient for 150 mg. Mixed altogether through mortar and pestle. Repress in the mini tablet compressor and gets 150 mg of tablet

containing about 10 mg of PMT. Formulation of 20 tablet takes place and weigh and average about 149.95 mg, brings a tablets, weigh and triturate to makes fine powders with the mortar and pestle. Quantity of powder equivalents to tablet. Place into 100 volumetric flask, add 50 ml of methanol, sonicated for

15 min and volume adjust to mark. Solvent were filtered through whatman filter paper no.41. 2 ml of filter solution pour in a 10 ml volumetric flask and make up with methanol gets 20 µg/mL of solution. The absorbance measured and the sample concentrations are calculated from the equation of linearity.

Validation of the method

The aim of method was validated with regards to various parameters i.e. linearity, accuracy, precision, repeatability, limit of detection, limit of quantification and ruggedness as per ICH guidelines.¹²

Linearity studies

Analysis of six standard PMT solutions of concentrations 05, 10, 15, 20, 25, and 30 µg / mL evaluated the linearity of the "methods A, B, C, and D". In the concentration range 5-30 µg / mL, the calibration curve was obeyed The Beers and Lambert law and the chart was plotted between concentrations versus absorption, amplitude and AUC.

Accuracy

A defined quantity of stock standard solution has been applied at different levels to the pre-analyzed sample solutions (20 µg/mL) known amounts of solutions were added from standard stock solution at different levels, i.e. 80%, 100%, and 120%. After these formations re-analyzed through the different methods.

Precision

Precision was studied as intraday and interday variations. In this method takes 3 different concentration 15, 20, 25 µg/mL for 3 different times

within a day for intraday precision, while interday precision above same concentration and times, performed in three days for all methods were developed.

Sensitivity

The Sensitivity used for the estimation of limit of detection (LOD) and limit of quantification (LOQ) of PMT. The LOQ and LOD were calculated using equation $LOD=3.3 \times \text{Avg. S.D/S}$ and $LOQ=10 \times \text{Avg. S.D/S}$, where 'Avg. S.D' is the average standard deviation of the absorbance amplitude, and AUC and 'S' is the slope of the corresponding calibration curve.

Repeatability

Repeatability was determined by analyzing 20 µg/mL concentration of pimavanserin tartrate solution for six times for all methods.

Ruggedness

Ruggedness of the proposed methods was determined by analyzing aliquots for 20 µg/mL concentrations of PMT from standard stock solution by two analysts using the same operational and environmental conditions for all methods.

Results and Discussion

System validation

PMT has been tested for linearity, accuracy, precision, sensitivity, LOD, LOQ, repeatability and ruggedness of the following parameters. As per the guidelines, the results were found to be acceptable. The regression analysis data shown in Table 1.

Table 1: Optical characteristics and linearity data of Pimavanserin tartrate

Parameters	Method A	Method B	Method C	Method D
Beer-Lambert's range(µg/mL)	05-30	05-30	05-30	05-30
Lambda Max (nm)	226	219.20-230.40	232	228.20-238.40
Slope	0.0283	0.0277	0.0026	0.0026
Intercept	0.0507	0.0606	0.0056	0.0035
Correlation coefficient	0.9964	0.996	0.9994	0.9977

Linearity: From the linear regression data, the calibration curves shown in (Fig. 3 & 5) linear relationship over the 5-30 µg / mL concentration range for PMT were cleared for "methods A, B, C, and D".

Accuracy: Accuracy determined from the pretested sample solution at three different concentrations i.e. 80%, 100%, 120%. The % Recovery values showed that the accuracy of the methods was found to be satisfactory.

Table 2: Accuracy

Drug	Methods	Initial amount [$\mu\text{g}/\text{mL}$]	Amount added [$\mu\text{g}/\text{mL}$]	Amount recovered [$\mu\text{g}/\text{mL}$, n = 3]	% Recovered	% RSD
Pimavanserin Tartrate	A	20	16	36.10	100.64	0.29
		20	20	40.06	100.30	0.35
		20	24	44.08	100.36	0.21
	B	20	16	35.94	99.63	0.2
		20	20	39.99	99.98	0.18
		20	24	44.00	100.02	0.17
	C	20	16	35.98	99.98	0.32
		20	20	40.03	100.04	0.26
		20	24	44.08	100.09	0.22
	D	20	16	35.99	99.99	0.51
		20	20	40.04	100.40	0.70
		20	24	44.01	100.03	0.42

n- number of determinations Precision

Intra-day: For intraday precision studies three replicates of three different concentration 15, 20, 25 $\mu\text{g}/\text{mL}$ was analyzed at different times in same day. The % RSD and data disclose in (Table 3).

Inter-day: For inter-day precision three replicates of three different concentrations 15, 20, 25 $\mu\text{g}/\text{mL}$ was analyzed in different days subsequently. The % RSD and data disclose in (Table 3).

Table 3: Precision studies

Drug	Methods	Concentration [$\mu\text{g}/\text{mL}$]	Intra-day [n = 3]	% RSD	Inter-day [n = 3]	% RSD
Pimavanserin Tartrate	A	15	14.91	0.57	14.84	0.43
		20	19.95	0.41	19.92	0.59
		25	25.05	0.34	20.03	0.31
	B	15	14.87	0.34	14.93	0.22
		20	19.97	0.42	19.97	0.18
		25	25.11	0.30	25.07	0.28
	C	15	14.98	0.15	14.88	0.13
		20	20.01	0.55	20.01	0.52
		25	25.13	0.19	25.20	0.21
	D	15	15.08	0.19	10.10	0.35
		20	19.88	0.14	20.08	0.12
		25	25.07	0.21	25.13	0.19

n- number of determinations

Sensitivity: The LOD and LOQ for PMT in “method A” were found to be 0.13 μg and 0.39 μg , in “method B” 0.106 μg and 0.321 μg , “method C” 0.143 μg and 0.434 μg , while “method D” 0.147 μg and 0.445 μg .

Repeatability: The results of repeatability in terms of % RSD for “methods A, B, C, and D,” were observed less than 2 that shows precise nature of developed methods. Results are shown in (Table 4).

Table 4: Repeatability studies

Drug	Methods	Amount taken [µg/mL]	Amount found [µg/mL]	% Amount found [n =6]	Mean ± SD	% RSD
Pimavanserin Tartrate	A	20	19.96	99.82	99.82 ± 0.51	0.51
	B	20	20.04	100.21	100.21 ± 0.49	0.49
	C	20	19.88	99.44	99.44± 0.50	0.50
	D	20	19.94	99.32	99.32 ± 1.10	0.74

n- number of determinations

Ruggedness: The results of ruggedness were in acceptable range that is % RSD values less than 2 for all the developed methods as shown in (Table 5). The results proved no statistical differences between different analyst using same operational and environmental condition. That's why it signifies the developed methods are rugged in nature.

Table 5: Ruggedness studies

Drug	Methods	Analyst I		Analyst II	
		% Amount found ± SD [n = 3]	% RSD	% Amount found ± SD [n = 3]	% RSD
Pimavanserin Tartrate	A	100.41 ± 0.52	0.52	100.20 ± 0.36	0.36
	B	100.07 ± 0.58	0.58	100.37 ± 0.57	0.57
	C	99.80 ± 0.76	0.76	99.87 ± 0.78	0.78
	D	99.61 ± 0.79	1.23	99.87 ± 1.12	1.12

n- number of determinations

Analysis of in-house Tablet Formulation: From PMT T *in-house* tablet formulation amount of PMT estimated by using methods A, B, C and D were founded about 100.68%, 100.77%, 100.38%, and 100.44%, respectively. The % amount found from tablet formulation indicates that there was not too much interruption from excipients present *in-house* tablet formulation.

Conclusion

All the methods developed are economical, simple, reliable, accurate and robust and can be used for the analysis of Pimavanserin tartrate. These methods are developed for the quantification of pimavanserin tartrate. It can be also used in routine quality control of the formulations containing pimavanserin tartrate.

Acknowledgments

The authors are thankful to Dr. S. J. Surana Principal R. C. Patel Institute of Pharmaceutical Education and Research, Shirpur, for providing essential laboratory

facilities and grateful MSN Laboratories PVT. LTD., Hyderabad, India for providing Pimavanserin tartrate as a gift sample.

Source of Funding

None.

Conflict of Interest

None.

References

- Hermanowicz S. and Hermanowicz. N. The safety, tolerability and efficacy of pimavanserin tartrate in the treatment of psychosis in Parkinson's disease. *Expert Rev Neurotherapeutics* 2016;16(6):625-33.
- Wu C, Zhou Q, Song D, Li H, Bao C, Liu X et al, (2019). An improved process for the preparation of pimavanserin tartrate. *J Chem Res* 1747519819873643.
- Abbas, A. and Roth, B.L. Pimavanserin tartrate: a 5-HT_{2A} inverse agonist with potential for treating various neuropsychiatric disorders. *Expert opinion on pharmacotherapy*, 2008;9(18):3251-9.

4. Meltzer H.Y, and Roth B.L. Lorcaseerin and pimavanserin: emerging selectivity of serotonin receptor subtype-targeted drugs. *J Clin Invest* 2013;123:4986-91.
5. Rapolu R.K, Raju V.P, Chavali M. and Mulakayala N. A Green and Environmentally Friendly, An Improved Synthesis of Pimavanserin (5-HT_{2A} Receptor). *Asian J Res Chemistr* 2019;12(1):41-5.
6. Peng Y, McCorvy J.D, HPMTsøe K, Lansu K, Yuan S, Popov P et al, (2018) 5-HT_{2C} receptor structures reveal the structural basis of GPCR polypharmacology. *Cell* 2018;172(4):719-30.
7. Roberts C. ACP-103, a 5-HT_{2A} receptor inverse agonist. Current opinion in investigational drugs (London, England: 2000), 2006;7(7):653-60.
8. Ancoli-Israel S, Vanover K.E, Weiner D.M, Davis R.E. and van Kammen, D.P. Pimavanserin tartrate, a 5-HT_{2A} receptor inverse agonist, increases slow wave sleep as measured by polysomnography in healthy adult volunteers. *Sleep medicine*, 2011;12(2):134-41.
9. Koduri G.B, Bollikolla H.B, Dittakavi R. and Navuluri, S. Quantification of Pimavanserin in Bulk and Tablet Dosage Form Using A Stability Indicating High Performance Liquid Chromatographic Method. *Pharmaceutical Sciences*, 2018;24(4):291.
10. Panda S.S, Bera R.K.V.V, Mohanty S, Panigrahi S. and Sahu B, (2019). Analytical procedure development: Concept to application for chemometry based ultrafast LC estimation of pimavanserin in pharmaceuticals. *J Liquid Chromatography Related Technol* 2009;1-13.
11. Wang S, Wang Y, Gao S, Zhang Y, Wang H, Zhao L et al, Development of a UPLC–MS/MS method for determination of pimavanserin tartrate in rat plasma: Application to a pharmacokinetic study. *J Pharm Anal* 2017;7(6):406-10.
12. ICH Harmonized Tripartite Guideline, Q2 (R1): Validation of Analytical Procedures: Text and Methodology, International Conference on Harmonization, Geneva, Switzerland, 2005.

How to cite this article: Wahab ATA, Khan MMG, Shirkhedkar AA. Analytical studies on zero order and first order derivative and area under curve UV-spectrophotometric methods for estimation of pimavanserin tartrate in bulk and In-house tablet formulation. *Int J Pharm Chem Anal* 2019;6(4):120-6.