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Original Research Article

Development of UV-Visible spectrophotometric method for the estimation of vildagliptin in different medium

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ABSTRACT

Aim: A simple, accurate, precise, cost effective, rapid and sensitive UV/visible spectrophotometric method was developed for the determination of Vildagliptin in active pharmaceutical dosage form. The developed method was validated as per ICH guidelines.
Materials and Methods: The purity of Vildagliptin was characterized by melting point, Fourier Transform Infra-Red and DSC. The drug was analyzed using UV/visible spectrophotometric method was validated in terms of linearity and range. The solvents used was water, 0.1 N HCl and phosphate buffer pH 7.4 and the wavelength corresponding to maximum absorbance of the drug were found at 210 nm.
Result: Melting point of drug was found 151.67°C nearly corresponds to its actual melting range. The linear response for concentration range of 2-12 μg/ml of vildagliptin for water, 0.1 N HCl and phosphate buffer pH 7.4 was recorded each with regression coefficient R^2 = 0.9998, 0.9994 and 0.9991 respectively.
Conclusion: The drug was confirmed by interpretation of UV spectra. Hence, proposed method stands out validated and shows a linear relationship and thus may be used for routine analysis of Vildagliptin in pharmaceutical dosage forms.

1. Introduction

Diabetes represents a spectrum of metabolic disorders, which has become a major health challenge worldwide.[1] The unprecedented economic development and rapid urbanization in Asian countries, particularly in India has led to a shift in health problems from communicable to non-communicable diseases.[2,3]

Vildagliptin, an antihyperglycemic drug, is having high water solubility and shorter elimination half-life.[4] It is sold under the brand name Galvus, is an oral anti-hyperglycemic agent of the dipeptidyl peptidase-4 (DPP-4) inhibitor class of drugs. Vildagliptin inhibits the inactivation of GLP-1 and GIP by DPP-4, allowing GLP-1 and GIP to potentiate the secretion of insulin in the beta cells and suppress glucagon release by the alpha cells of the islets of Langerhans in the pancreas.[5]

The aim of the present work was to develop a simple, sensitive, precise and accurate UV/Visible spectrophotometric method for the determination of Vildagliptin in its pure form and pharmaceutical formulations further, to validate the developed method.

2. Materials and Methods

2.1. Materials

All the chemicals used were of analytical grade. All the solutions were freshly prepared. Vildagliptin was obtained from Macleods Pharmaceuticals Ltd, Baddi, India as gift sample.

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2.2. Methods

Vildagliptin was estimated using UV-Visible spectrophotometer (Shimadzu model 1800 double beam) at the wavelength of maximum absorption (210 nm) in different medium. The drug was characterized by melting point, Fourier Transform Infra-Red (FTIR) techniques and Differential Scanning Calorimetry (DSC). The analysis of the drug was carried out by UV-Visible method which was validated on analytical parameters like linearity and range as per guidelines laid down by International Conference on Harmonization (ICH).[6,7]

2.3. Physical characterization of vildagliptin

The physical characterization of procured drug sample of vildagliptin was determined on the basis of following parameters.

2.4. Organoleptic properties

The organoleptic properties have been determined for nature, colour, taste and odour of the pure sample of vildagliptin.[8]

2.5. Melting point

The melting point of vildagliptin was determined using capillary melting point method. Small quantity of drug was filled in a thin walled capillary tube, sealed from one end. This capillary was then put in the melting point apparatus. The temperature at which the drug started melting and temperature at which it completely melts was recorded.

2.6. Fourier transform infrared spectroscopy (FTIR)

FTIR spectrum was used as an analytical technique for identification of pure drug sample. The spectra for the sample were recorded using a Bruker Vertex 70 FTIR spectrophotometer by KBr pellet method. The samples were analysed by mixing with potassium bromide (1:10) individually and pressed to form a thin pellet by applying pressure using KBr press. The formed pellets were placed within the sample holder. Spectral scanning was taken in the wavelength region between 4000-400 cm^{-1}. FTIR scans of Vildagliptin were recorded.[9,10]

2.7. Differential scanning calorimetry (DSC)

Differential scanning calorimetery (DSC) of pure Vildagliptin was done using Mettler Toledo differential scanning calorimeter and the thermogram was recorded.[11]

2.8. Determination of λmax by UV spectroscopy

For determining λmax of Vildagliptin, 100 mg of drug was dissolved in methanol and diluted to 100 ml to form strength of 1000 μg/ml with the same solvent then; 1ml of this solution was diluted to 10 ml with methanol to give strength of 100 μg/ml. It was then scanned in the range of 400 to 200 nm using methanol as a blank using UV-Visible spectrophotometer (UV-VIS 1800, Shimadzu Corporation), and the maximum wavelength will be determined.[12]

2.9. Calibration curves in different solvents

Calibration curve of Vildagliptin was prepared with the help of UV spectroscopy. Calibration curve of Vildagliptin was prepared in water, phosphate buffer 7.4 and 0.1 N HCl.

2.10. Calibration curve of vildagliptin in water as solvent

2.10.1. Preparation of stock solution

Accurately weighed 100 mg of vildagliptin was transferred in 100 ml volumetric flask. The drug was dissolved and diluted upto the mark with water to give a solution with concentration of 1000 μg/ml. An aliquot of 10 ml from the above solution was withdrawn and diluted upto 100 ml with water to obtain a stock solution having concentration of 100μg/ml.

2.10.2. Preparation of solutions to obtain calibration curve

Appropriate aliquots from stock solution of vildagliptin (0.2, 0.4, 0.6, 0.8, 1 and 1.2 ml) were accurately withdrawn in 10 ml volumetric flask and diluted upto the mark with water to obtain the final concentration of solution in range of 2-12 μg/ml and scanned at λmax. Absorbance of these solutions of vildagliptin were recorded at their λmax using water as blank.

2.11. Calibration curve of vildagliptin in phosphate buffer 7.4 as solvent

2.11.1. Preparation of stock solution

Accurately weighed 100 mg of vildagliptin was transferred in 100 ml volumetric flask. The drug was dissolved and diluted upto the mark with phosphate buffer 7.4 to give a solution with concentration of 1000 μg/ml. An aliquot of 10 ml from the above solution was withdrawn and diluted upto 100 ml with phosphate buffer 7.4 to obtain a stock solution having concentration of 100μg/ml.

2.11.2. Preparation of solutions to obtain calibration curve:

Appropriate aliquots from stock solution of vildagliptin (0.2, 0.4, 0.6, 0.8, 1 and 1.2 ml) were accurately withdrawn in 10 ml volumetric flask and diluted upto the mark with phosphate buffer 7.4 to obtain the final concentration of solution in range of 2-12 μg/ml and scanned at λmax. Absorbance of these solutions of vildagliptin were recorded at their λmax using phosphate buffer 7.4 as blank.

2.12. Calibration curve of vildagliptin in 0.1 N HCL as solvent

2.12.1. Preparation of stock solution

Accurately weighed 100 mg of vildagliptin was transferred in 100 ml volumetric flask. The drug was dissolved and diluted upto the mark with 0.1 N HCl to give a solution with concentration of 1000 μg/ml. An aliquot of 10 ml from the above solution was withdrawn and diluted upto 100 ml with 0.1 N HCl to obtain a stock solution having concentration of 100μg/ml.

2.12.2. Preparation of solutions to obtain calibration curve

Appropriate aliquots from stock solution of vildagliptin (0.2, 0.4, 0.6, 0.8, 1 and 1.2 ml) were accurately withdrawn in 10 ml volumetric flask and diluted upto the mark with 0.1 N HCl to obtain the final concentration of solution in range of 2-12 μg/ml and scanned at λmax. Absorbance of these solutions of vildagliptin were recorded at their λmax using 0.1 N HCl as blank.

2.13. UV method validation

The ultraviolet spectrophotometric method was validated for different parameters like linearity and range.

2.14. Linearity

The linearity was evaluated by analysing the different concentration of standard solution of vildagliptin. Calibration curves were constructed by plotting a graph by taking concentration (μg/ml) on X-axis and absorbance on Y-axis. This plot gives a straight line and the linearity can be determined using y = mx + C formula regression equation was calculated.

Table 1: Calibration curve data for Vildagliptin in different medium

S. No.	Concentration (μg/ml)	Absorbance (nm)		
		Water	0.1 N HCl	Phosphate buffer pH 7.4
1	2	0.055	0.029	0.027
2	4	0.071	0.046	0.048
3	6	0.083	0.064	0.069
4	8	0.095	0.082	0.091
5	10	0.108	0.101	0.116
6	12	0.121	0.119	0.138

2.15. Range

The Range of the analytical method was decided from the interval between the upper and lower level of the calibration curve by plotting curve.

3. Results & Discussion

3.1. Organoleptic properties

The organoleptic properties of vildagliptin (Table) are matching with those reported in the standard literature thus supporting its identity.

Table 2: Organoleptic properties

Sr. no.	Organoleptic properties	Reported	Experimental
1	Colour	White	White
2	Odour	Odourless	Odourless
3	Taste	Tatseless	Tasteless
4	Appearance	Crystalline powder	Crystalline powder

3.2. Melting point

Table 3: Melting point of vildagliptin

S.No.	Melting point (°C)	Average
1.	151	
2.	151	151.67 °C
3.	153	

The melting point of Vildagliptin was found to be in the range of 151.67°C which meets as per specification.

3.3. Fourier transform infrared spectroscopy (FTIR)

In the FTIR spectra of vildagliptin, the principal peaks were found at 3,293, cm^{-1} attributed to N–H stretching vibrations. The peak obtained at 2842 cm^{-1} is allocated to alkane C-H stretching. The prominent peak at 2,236 cm^{-1} was attributed to nitrile stretching vibrations. The peaks at 1,710, 1449, and 1,250 cm^{-1} were assigned to amide C=O, N=O and C–N stretching which corresponds to the literature peaks confirming the purity of drug sample.

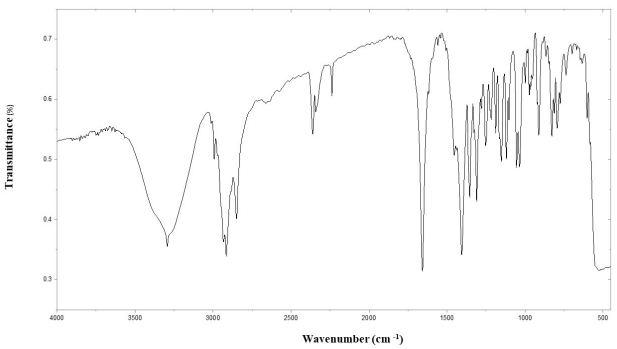

Fig. 1: FTIR spectra of vildagliptin

Table 4: Prominent FTIR peaks of Vildagliptin

S. No.	Groups	Observed peaks(cm^{-1})	Standard range(cm^{-1})
1.	C-N (amine) stretching	1250	1250-1000
2.	N=O (Nitro) stretch	1449	1550-1350
3.	C=O stretching	1710	1725-1705
4.	C≡N (Nitrile) stretching	2236	2260-2220
5.	Alkane C-H stretching	2842	3000-2840
6.	N-H stretch	3293	3500-3060

4. Differential Scanning Calorimetry (DSC)

According to the differential scanning calorimetry thermogram (Fig 7.1.8 (a)) Vildagliptin exhibited a sharp endothermic peak at 152.57°C corresponding to its melting point.

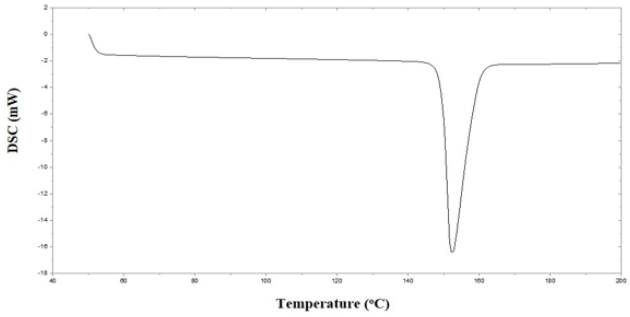

Fig. 2: DSC spectra of vildagliptin

4.1. Determination of λ max by UV spectroscopy

The λ max of Vildagliptin was found to be 210 nm as can be seen from the scan (Figure 7.1.3)

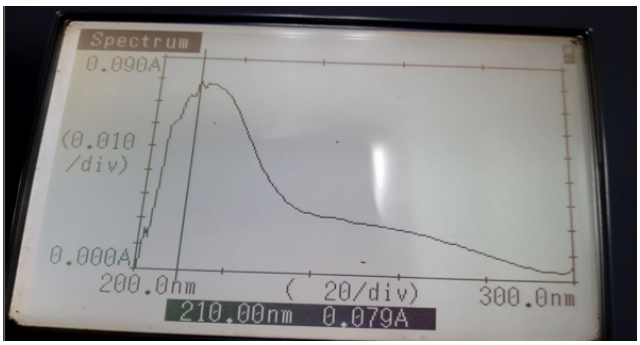

Fig. 3: λ max of Vildagliptin

Calibration of Vildagliptin was prepared in water by making suitable dilutions and was found to be linear, thus it follows Lambert Beers law and the R^2value was found to be 0.9998.

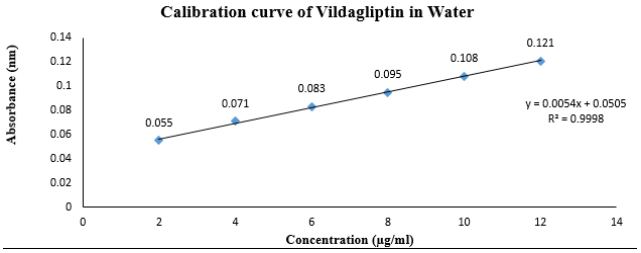

Fig. 4: Calibration curve of vildagliptin in water at its λmax

Calibration of Vildagliptin was prepared in 0.1 N HCl by making suitable dilutions and was found to be linear, thus it follows Lambert Beers law and the R^2value was found to be 0.9994.

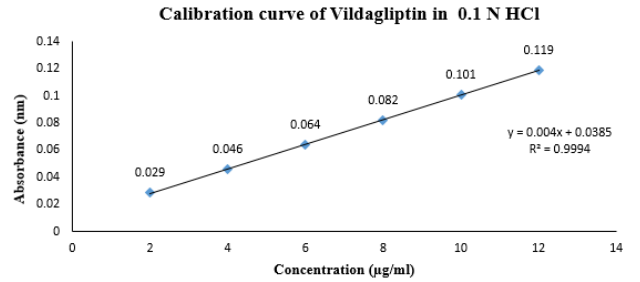

Fig. 5: Calibration curve of vildagliptin in 0.1 N HCl at its λmax

Calibration of Vildagliptin was prepared in phosphate buffer pH 7.4 by making suitable dilutions and was found to be linear, thus it follows Lambert Beers law and the R^2value was found to be 0.9991.

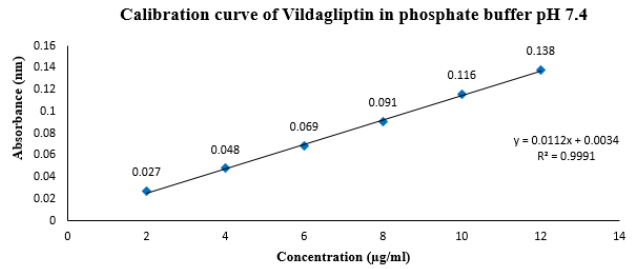

Fig. 6: Calibration curve of vildagliptin in PB 7.4 at its λmax

4.2. Method validation

The developed method was validated as per ICH guidelines for the following parameters:

4.3. Linearity

The linearity for Vildagliptin was determined by taking the concentration from 2-12 μg/ml for each solvent. The regression equation for water as solvent was found to be y = 0.0054x + 0.0505, R^2 = 0.9998, for 0.1 N HCl as solvent was found to be y = 0.004x + 0.0385, R^2 = 0.9994 and for phosphate buffer pH 7.4 as solvent the regression equation is y = 0.0112x + 0.0034, R^2 = 0.9991.

4.4. Range

The observed range of vildagliptin in test solution was observed from 0.055nm to 0.121 nm for water as solvent, 0.029 nm to 0.119 nm for 0.1 N HCl as solvent and 0.027 to 0.138 nm for phosphate buffer pH 7.4 as solvent.

5. Conclusions

The method was validated and found to be simple, sensitive, and precise as per ICH guidelines. Hence, proposed method may be used for routine analysis of these drugs in pharmaceutical dosage forms. An excellent linear relationship was observed in the concentration ranges. It shows a linear relationship between absorbance and concentration. The correlation coefficient are within the limit. Results were well within acceptance criteria that indicate excellent scope of the method for the determination of vildagliptin in pharmaceutical dosage forms and bulk.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Punthakee Z, Goldenberg R, Katz P. Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome. Can. *J Diabetes*. 2018;42(1):10–5.
2. Ahrén B. Vildagliptin: an inhibitor of dipeptidyl peptidase-4 with antidiabetic properties. *Drug Eval*. 2006;15(4):431–42.
3. Stein SA, Lamos EM, Davis SN. A Review of the Efficacy and Safety of Oral Antidiabetic Drugs. *Expert Opin Drug Saf*. 2013;12(2):153–75.
4. Lauster CD, Mckaveney TP, Muench SV. Vildagliptin: A Novel Oral Therapy for Type 2 Diabetes Mellitus. *Am J Health Syst Pharm*. 2007;64(12):1265–73.
5. Omar B, Ahrén B. Pleiotropic Mechanisms for the Glucose-Lowering Action of DPP-4 Inhibitors. *Diabetes*. 2014;63(7):2196–202.
6. Guideline IHT. Text On Validation of Analytical Procedures; 1994. p. 1–5.
7. (R1) IQ. Validation of Analytical Procedures: Text and Methodology; 2014. Available from: https://somatek.com/wp-content/uploads/2014/06/sk140605h.pdf.
8. Chaudhari PM, Paithankar AV. Formulation optimization and evaluation of transdermal patch of vildagliptin for treatment of diabetes mellitus. *Int J Creative Res Thoughts*. 2020;8(3):1713–22.
9. Waghulde M, Naik J. Comparative study of encapsulated vildagliptin microparticles produced by spray drying and solvent evaporation technique. *Dry Technol*. 2017;35(13):1644–54.
10. Naik JB, Waghulde MR. Development of Vildagliptin Loaded Eudragit® Microspheres by Screening Design: In Vitro Evaluation. *J Pharm Investig*. 2018;48(6):627–37.
11. Baig M, Khan S, Naeem MA, Khan GJ, Ansari MT. Vildagliptin loaded triangular DNA nanospheres coated with eudragit for oral delivery and better glycemic control in type 2 diabetes mellitus. *Biomed Pharmacother*. 2018;97:1250–8. doi:10.1016/j.biopha.2017.11.059.
12. Beckett AH, Stenlake JB. Pharmaceutical Chemistry. vol. 2. and others, editor. CBS Publisher and Distributor; 2004. p. 284–6.

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