Development and Validation of UV-Spectroscopic Method for Estimation of Niacin in Bulk and Pharmaceutical Dosage Form

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ABSTRACT

A novel, simple, specific and economic UV Spectrophotometric method has been developed using ethanol as solvent to estimate niacin content in bulk and pharmaceutical dosage formulation. The λmax of niacin was found to be 262 nm. Linearity in the concentration range of 01-19μg/ml was found to be exhibiting good correlation coefficient (R²=0.9991). The developed method was validated statistically to demonstrate linearity, accuracy, precision, LOD and LOQ. The validation parameters were selected as per the ICH [Q2 (R1)] guideline. The results of the study proved the applicability of the present method in routine analysis of niacin in bulk as well as in the formulation.

INTRODUCTION

Niacin, known as Vitamin B3 or nicotinic acid, is chemically pyridine-3-carboxylic acid (Fig. 1) official in IP (Indian Pharmacopoeia, 2007); which is a colorless, water-soluble solid. It has the ability to reduce low density lipoprotein cholesterol (LDL), very low density lipoprotein cholesterol (VLDLC), and triglycerides (TG), and also effectively increase high density lipoprotein cholesterol (HDL) (Villines et al, 2012). Literature survey had revealed various analytical methods (RP-HPLC, HPTLC, UV-Spectroscopy, LC–MS/MS (Vasanthi et al, 2015; Narayankar et al, 2015; Pravish and Padmakar, 2010; Ranganath and Raja, 2014; Bratati et al, 2014; Dewani et al, 2015) for determination of Niacin in pharmaceutical formulations in combination with other drugs. In the present study, efforts were made in developing a simple, specific and economic UV spectrophotometric method using ethanol as solvent to determine Niacin content in bulk and pharmaceutical dosage formulation and validate it as per the ICH guidelines (ICH, 2005).

Fig 1: Chemical Structure of Niacin hydro-2H-pyran-2-yl] ethyl]-3, 7-dimethyl-1, 2, 3, 7, 8-hexahydropyranmethenal-1-yl 2, 2-dimethylbutanoate

MATERIALS AND METHODS

Instruments

UV-Visible double beam spectrophotometer (UV-1800, Shimadzu, Japan) with 1cm matched quartz cells, Micropipette of variable volumes (Microlit, India) and Digital balance (Denver Instrument, Germany) were used.
Materials
Niacin API was procured from B. S. Trading, Howrah, West Bengal, having 99.98% w/w assay value and was therefore used without further purification. Analytical grade Methanol, Potassium dihydrogen phosphate, Hydrochloric acid, Sodium hydroxides were purchased from CDH (P) Ltd. New Delhi. Niacin tablets were purchased from local pharmacy shop of Guwahati, Assam.

Determination of wavelength of maximum absorption (λ_max)
A standard stock solution of Niacin (100 μg/ml) was prepared using ethanol as solvent and 0.2 ml was diluted to 10 ml with the same solvent to obtain 2 μg/ml reference solutions. The reference solution was scanned in the wavelength region of 200-400 nm.

Linearity and range
Nineteen solutions (1-19 μg/ml) of different concentration were prepared from the standard stock solution of Niacin for linearity study. The absorbance of these solutions was observed against ethanol as blank at 262 nm and the obtained data was used for the linearity calibration curve.

LOD and LOQ
Limit of detection (LOD) and Limit of quantitation (LOQ) for the assay was calculated using the following formula:

LOD = 3.3 × (standard deviation of y-intercept of the regression line / slope of the calibration curve)

LOQ = 10 × (standard deviation of y-intercept of the regression line / slope of the calibration curve)

Assay of content of Niacin in tablet dosage form
The newly developed method was applied in order to analyze the Niacin in marketed tablet formulation. Niacin tablet powder equivalent to 100 mg of Niacin was dissolved into 100 ml ethanol by shaking to get the final concentration of 1mg/ml. The solution was then filtered through Whatman filter paper #41. This filtrate was diluted suitably with ethanol to get the solution concentration of 10 μg/ml. The absorbance of this solution was measured and amount of Niacin was calculated from the calibration curve.

Accuracy
Accuracy of the developed method was carried out by performing recovery study using standard addition method, in which standard drug was added at three different concentration (80%, 100% and subsequently by 120%) to the pre-analyzed formulation (10 μg/ml).

Precision
Precision study of the method was performed by intra-day and inter-day variation study. The intraday precision and inter-day precision was ascertained by determining absorbance of 3 replicates of a fixed concentration of the drug (10 μg/ml) at three different time period of the same day and on three different days. The result of the precision studies was expressed in terms of % RSD (percentage of Relative Standard Deviation).

Solution Stability Study
To test the short term stability of Niacin solution, three different concentrations (2, 4 and 6 μg/ml) was prepared and analyzed at 10 hours.

Ruggedness and Robustness
Ruggedness of the method was determined on carrying out the method by two different analysts and Robustness of the method was determined by measuring the absorbance of 10 μg/ml solution of Niacin at 260 nm, 262 nm and 264 nm.

RESULTS AND DISCUSSION
Method Development
The λ_max of Niacin in ethanol was found to be 262 nm. Niacin was found to be linear within the concentration range 01-19 μg/ml and exhibited correlation coefficient of 0.9991 (Fig. 2). The result of regression analysis is given in Table 1.

Table 1: Result of regression analysis of Niacin.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Beer’s Range</th>
<th>Regression Equation</th>
<th>Regression coefficient(R²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niacin</td>
<td>01-19 μg/ml</td>
<td>y=0.0208x-0.016</td>
<td>0.9991</td>
</tr>
</tbody>
</table>

Fig 2: Linearity curve of Niacin at 262 nm.

Validation
LOD and LOQ
The limit of detection (LOD) and limit of quantification (LOQ) were found to be 0.64 μg/ml and 1.94 μg/ml respectively (Table 2) which indicates that the proposed UV method is sensitive.

Table 2: Result of LOD and LOQ.

<table>
<thead>
<tr>
<th>Drug</th>
<th>LOD (μg/ml)</th>
<th>LOQ (μg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niacin</td>
<td>0.64</td>
<td>1.94</td>
</tr>
</tbody>
</table>

Assay of content of niacin in tablet dosage form
The assay results of the commercial formulations are shown in (Table 3). The developed method was in good agreement with the label claim.
Accuracy

Results of recovery study were within the range of 99.15-99.66 % indicating that the developed method is an accurate method for determination of niacin. The results are summarized in Table 4.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Concentration (μg/ml)</th>
<th>% Recovery</th>
<th>Statistical analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure</td>
<td>Formulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 80%</td>
<td>8</td>
<td>10</td>
<td>99.65</td>
</tr>
<tr>
<td>S1 80%</td>
<td>8</td>
<td>10</td>
<td>99.54</td>
</tr>
<tr>
<td>S2 100%</td>
<td>10</td>
<td>10</td>
<td>99.54</td>
</tr>
<tr>
<td>S2 100%</td>
<td>10</td>
<td>10</td>
<td>98.12</td>
</tr>
<tr>
<td>S2 100%</td>
<td>10</td>
<td>10</td>
<td>99.79</td>
</tr>
<tr>
<td>S3 120%</td>
<td>12</td>
<td>10</td>
<td>99.43</td>
</tr>
<tr>
<td>S3 120%</td>
<td>12</td>
<td>10</td>
<td>98.59</td>
</tr>
<tr>
<td>S3 120%</td>
<td>12</td>
<td>10</td>
<td>99.83</td>
</tr>
</tbody>
</table>

Precision

The developed method was found to be precise as the average % RSD values for intraday and inter-day precision study was found to be 0.3677 % and 0.3672 % respectively (Table 5 and Table 6).

Solution Stability Study

Result of short term stability study (Table 7) indicates towards the sample stability in solution for 10 hours which is within the acceptable range.

<table>
<thead>
<tr>
<th>Concentration (μg/ml)</th>
<th>Concentration found (at 10 hours) Mean ± SD, (μg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.973± 0.0068</td>
</tr>
<tr>
<td>4</td>
<td>3.870± 0.0690</td>
</tr>
<tr>
<td>6</td>
<td>5.944± 0.0324</td>
</tr>
</tbody>
</table>

Ruggedness and Robustness

It was observed (Table 8 and Table 9) that there were no significant changes in the results, which demonstrated that the developed method is rugged and robust.

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Concentration (μg/ml)</th>
<th>Absorbance</th>
<th>Statistical Analysis</th>
<th>Concentration (μg/ml)</th>
<th>Absorbance</th>
<th>Statistical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>0.191</td>
<td>Mean : 0.190</td>
<td>10</td>
<td>0.191</td>
<td>Mean : 0.190</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SD : 0.0005</td>
<td></td>
<td></td>
<td>SD : 0.0005</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>0.192</td>
<td>Mean : 0.192</td>
<td>10</td>
<td>0.190</td>
<td>Mean : 0.190</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SD : 0.0005</td>
<td></td>
<td></td>
<td>SD : 0.0005</td>
</tr>
</tbody>
</table>

CONCLUSION

The method proposed in the above study was found to be simple, specific, economic, precise and rapid for the determination of Niacin in bulk as well as in its dosage form. Sample recoveries in all formulations were in good agreement with their respective label claims without interference of excipients and additives. Being economic and precise, the developed method may be preferred as an alternative method for the routine analysis of the Niacin in bulk and pharmaceutical dosage form.

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REFERENCES


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