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Development and validation of RP-HPLC method for quantitative analysis of Modafinil in pure and pharmaceutical formulations

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ABSTRACT

The present work aim to develop a simple, accurate and sensitive RP-HPLC method and validated for the estimation of Modafinil in pure drug and it's tablet dosage form.A reverse phase high performance liquid chromatographic method was performed by using Agilent,XDBC$_{18}$ column (100 mmX 4.6 mmX5µ paricle size) with UV detection at 225 nm. An isocratic mobile phase consisting of Potassium dihydrogen Phosphate Acetonitrile:50:50 (v/v) at a flow rate of 1ml/min. The retention time for Modafinil was 4.32 min. The method was linear in the concentration range of 12.5-75 µg/ml of Modafinil with the correlation coefficient of 0.999. The method was validated for linearity,accuracy,precision,limit of detection,limit of quantification,robustness and ruggedness.Recovey of Modafinil was found to be 99% to 101%.The developed reverse phase high performance liquid chromatographic method was simple, sensitive, precise and accurate and the method was found suitable for estimating in tablet dosage form.

Keywords: Modafinil, C$_{18}$ column, Reverse phase, Validation

1. INTRODUCTION

Modafinil is chemically 2-[(Diphenyl methyl)-sulfinyl] acetamide. It is a1-adrenergic agonist and is used for clinical evaluation in hypersomnia and narcolepsy. It is not official in any of the pharmacopoeia but is listed in the Merck Index[1] and Martindal[2] . Literature survey revealed the estimation of Modafinil by several techniques such as simultaneous estimation by HPLC[3] determination of Modafinil in human plasma by solid-phase[4] and liquid-liquid extraction by HPLC [5-6],by RP-HPLC techniques [7-8].Determination of related substance in Modafinil and determination of Modafinil by a chiral chromatography[9], LC-MS[10],Electro spray MS[11]and GC-MS[12] .The focus of present study was to develop and validate a rapid, stable and economic RP-HPLC method for the estimation of Modafinil in bulk and its formulation.In the present study, a new RP-HPLC method was developed which shown high reproducibility and sensitivity. The developed method was validated as per ICH guidelines.

.2. MATERIALS AND METHODS

2.1. Standards and chemicals used

Modafinil was provided by Ranbaxy laboratories,Guargon.All the chemicals Acetonitrile, water were HPLC grade, Merck Specialties Private Limited, Mumbai, India. Commercial tablets of Modafinil were purchased from local market .

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2.2. Preparation of the mobile phase

Into a 1000ml cleaned volumetric flask, acetonitrile 500ml and Potassium dihyogen phosphate 500ml (which are filtered through 0.25mm membrane filters by vacuum filtration) were slowly added , mixed well and sonicated upto 20min. Cool the above solution and pH was adjusted to 3.5 with ortho phosphoric acid.This solution is again sonicated to 10min. Cool the solution to room temperature and use for chromatography method.

2.3. Preparation of Standard drug solutions

100mg of Modafinil was accurately weighed and is dissolved in few ml of the mobile phase and sonicated for few min to dissolve the drug completely. Then it is filtered through 0.2µ pore filter paper and the volume is made up to 100ml with mobile phase to get a concentration of 1mg/ml stock solution. This solution is further diluted with same solvent to obtain required working standard concentrations.

2.4. Preparation of Sample Preparation

20 commercial tablets of Modafinil (Provake-100mg)were finely powdered and the powder equivalent to 10mg of Modafinil accurately weighed to 50ml volumetric flask and dissolved in few ml of mobile phase. The above solution was subjected to sonication for 15min. After getting clear solution it is filtered through 0.25µ membrane filter and the solution is made up to 50ml with mobile phase resulting in preparation of 10 mg/ml solution. This is further diluted so as to obtain required concentration of Modafinil pharmaceutical dosage form.

2.5. RP-HPLC Method development

Based on nature and solubility characteristics of Modafinil, reverse phase mode of HPLC was selected for chromatography. Among different RP-HPLC stationary phases tried, C_{18} column was found to be optimum.In order to get sharp peak with base line separation from interfering peaks carried out a number of experiments by varying the composition of solvents and mobile phase flow rate. To have an ideal separation of the drug under isocratic conditions, mixtures of solvents like methanol, water and acetonitrile with or without different buffers in different combinations were tested as mobile phase. A mixture of Aceto nitile : Potassium dihydrogen phosphate (50:50) (v/v) was proved to be the most suitable of all the combinations, since the chromatographic peak obtained was better defined and resolved and almost free from tailing.The chromatographic conditions for the estimation of Modafinil was discussed in table 1.

Table 1. Optimized chromatographic conditions for estimation of Modafinil

Parameter	Condition
Mobile phase	Potassium di hydrogenphosphate buffer:Acetonitrile: (50:50) (v/v)
Pump mode	Isocratic
pH	3.5
Diluents	Mobile phase
Column	Agilent,XDBC18 column (100mm X 4.6 mm, 5µ)
Column Temp	Ambient
Wavelength	225nm
Injection Volume	10 µl
Flow rate	1.0ml/min
Run time	8minutes

3.0 RESULTS AND DISCUSSION

3.1 Analysis of formulation

The sample solution was injected and a chromatogram was recorded. The injections were repeated six times and the peak areas were recorded. The amount of drug present in the pharmaceutical formulation was calculated using standard calibration curve (concentration in µg/ml was taken on X –axis and average peak area on Y –axis). A representative chromatogram has been given in Fig. 1.

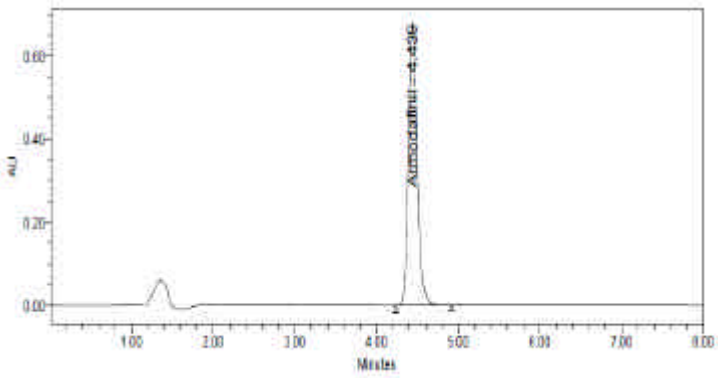

Fig. 1 chromatogram of Modafinil

3.2 VALIDATION OF THE PROPOSED METHOD

As an integral part of analytical method development is validation. The proposed method was validated as per ICH guidelines.

3.2.1. Linearity

It is the ability of the method to elicit test results directly proportional to analyte concentration with in a given range. Linearity was performed by preparing standard solutions of Modafinil at different concentration levels, ten micro liters of each concentration was injected in into the HPLC system. The peak responses were read at 225nm and the corresponding chromatograms were recorded. Linearity plots of concentration over peak areas was constructed. Linearity results were obtained in the concentration range of 12.5-75µg/ml .The results were presented in Table 2.

Table 2. Linearity results of Modafinil

Concentration of Modafinil in ppm	Peak area
12.5	1257515
25	2525285
37.5	3733544
50	5095601
62.5	6312222
75	7581496

3.2.2. Precision

Precision is the degree of repeatability of an analytical method under normal operational conditions. Precision of the method was performed as intraday precision, Inter day precision.

Intraday precision

To study the intraday precision, six replicate standard solutions (50µg/ml) of Modafinil were injected. The percent relative standard deviation (% RSD) was calculated and it was found to be 0.86 which are well with in the acceptable criteria of not more than 2.0.

Interday precision

To study the interday precision, six replicate standard solutions (50ppm) of Modafinil were injected on three consecutive days .The percent relative standard deviation (% RSD) was calculated and it was found to be 0.50 which are well with in the acceptable criteria of not more than 2.0.

32.3. Ruggedness

The ruggedness of the method was determined by carrying out the experiment on different instruments like Shimadzu HPLC(LC2010 A HT),By different operators using different columns of similar type like Hypersil C_{18} Hichron C_{18} . It was observed that there were no marked changes in the chromatograms, which demon started that the RP-HPLC method developed,is ruggedness.

3.2.4. Limit of Detection and Limit of Quantification

A Calibration curve was prepared using concentrations in the range of 40-100 µg/ml (expected detection limit range). The standard devia-

tion of Y-intercepts of regression line was determined and kept in following equation for the determination of Detection limit and Quantitation limit.The results were reported in table-3.

$$\text{Limit of detection} = \frac{\sigma \times 3.3}{S}$$

$$\text{Limit of quantification} = \frac{\sigma \times 10}{S}$$

Where,
σ = the standard deviation of the response.
S = the slope of the calibration curve

Table 3. Limit of Detection and Limit of Quantification for Modafinil

Parameter	Values
Limit of Quantification	3.00µg/ml
Limit of Detection	1.0µg/ml

3.2.5. Accuracy

The accuracy of the method was determined by standard addition method. A known amount of standard drug was added to the fixed amount of pre-analyzed sample solution. The standard addition method was performed at 50%, 100% and 150% level of 50ppm. The solutions were analyzed in triplicate at each level as per the proposed method. The percent recovery was calculated and results are presented in Table 4. Satisfactory recoveries ranging from 99% to 101% were obtained by the proposed method. This indicates that the proposed method was accurate, there is no interference of additives.

Table 4 . Accuracy Recovery Results

Level	Target In µg/ml	Amount of Modafinil spiked (µg/ml)	Total in µg/ml	Amount of Modafinil recovered (µg/ml)	% Recovery
	50	25	75	75.3	100.4
50%	50	25	75	75.2	100.2
	50	25	75	75.1	100.1
	50	50	100	100.2	100.2
100%	50	50	100	100.1	100.1
	50	50	100	100.3	100.3
	50	75	125	125.4	100.3
150%	50	75	125	125.3	100.2
	50	75	125	125.2	100.16

3.2.6. Robustness

The robustness study was performed by slight modification in flow rate of the mobile phase, pH of the buffer and composition of the mobile phase. . It was observed that there were no marked changes in chromatograms, which demonstrated that the developed method was robust in nature.The robustneess results were mentioned in table 5. 1,5.2 and 5.3

Table 5. Robustness results

Table 5.1-Data of effect of variation in flow rate

S.No	Flow Rate (ml/min)	System Suitability results USP Plate Count	USP Tailing
1	0.8(less)	8627	1.19
2	1.0(Actual)	8898	1.22
3	1.2(more)	8048	1.22

Table 5.2 Data of effect of variation in Mobile phase

S.No	Mobile phase Ratio	System Suitability results USP Plate Count	USP Tailing
1	48:52 (less Organic phase)	8614	1.19
2	50:50(Actual)	8860	1.13
3	52:48(more organic phase)	8701	1.28

Table 5.3 Data of effect of variation in wavelength

S.No	Wavelength	System Suitability results USP Plate Count	USP Tailing
1	220 (less)	8582	1.18
2	225(Actual)	8860	1.13
3	230(more)	8458	1.18

3.2.7. System suitability parameters:

The system suitability parameters like Tailing factor ,Theoretical plates are discussed in the table 6

Table 6. System suitability parameters

Retension time	AREA	USP plate count	USP tailing
4.329	5008442	9068	1.22

4. CONCLUSION

A convenient, rapid, accurate, precise RP-HPLC method has been developed for estimation of Modafinil.The proposed method followed the ICH guidelines.The proposed method can be used for the routine analysis of Modafinil in bulk preparations of the drug and in pharmaceutical dosage forms without interference of excipients.

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