WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 11, Issue 2, 788-795. Review Article ISSN 2277– 7105

MODERN TREND IN ANALYTICAL TECHNIQUES: A REVIEW

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Article Received on
06 December 2021,

Revised on 27 Dec. 2021,
Accepted on 16 Jan. 2022

DOI: 10.20959/wjpr20222-22926

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ABSTRACT

The quantitative and qualitative estimation of drugs in analytical chemistry it is very important to identify the best method for method development. This study helps the author to understand the various analytical techniques available for the process of drug development which includes spectroscopy, chromatography, electrochemical techniques, electrophoretic, flow injection analysis, and hyphenated technique. All these methods contain different analytical process with a variety of separate techniques. Also, we discuss about the modern trend which are available, and implacable in all these methods to improve the analytical behavior of these techniques. So, various chemical and instrumental techniques had been evolved to make drugs serve their purpose at normal intervals which are involved inside the estimation of drugs. This review highlights the function of emerging analytical instrumentation and analytical techniques, which includes titrimetric, chromatographic, spectroscopic, electrophoretic, and electrochemical and their corresponding strategies which have been applied inside the analysis of pharmaceuticals for determine the quality of the drugs. The review highlights variety of analytical techniques and their corresponding methods that has been applied in the analysis of pharmaceuticals.

KEYWORDS: Analytical Techniques, Chromatography, Spectroscopy, Titration.

1. INTRODUCTION

Analytical chemistry is play paramount role in the fields of science and medicine and it is linked with the disseverment, identification and quantification of the chemical components. In addition to qualitative analysis is diagnosed by way of colour, odour or melting point, beside Quantitative analysis is achieved by means of quantification of weight or volume.

However, different analytical methods are routinely being utilized for analyzing the drug samples in bulk, pharmaceutical formulation and organic or biological fluids. Analytical techniques may be separated into non instrumental and instrumental. Now, in instrumental methods are constructed for measuring to some physical properties of substance is evaluated its chemical composition through the usage of instrument.

In analytical chemistry the analysis of drugs is useful for the seperation, estimation, quantification of chemical compounds obtained from natural and artificial sources. These compounds are typically constitute upto one or more chemical compounds.[1] The process of analytical chemistry starts with two major categories includes qualitative and quantitative analysis. In qualitative analysis only the obtainable samples are estimated, and in quantitative analysis the total number of elements in a compound should be identified. Nowadays, large number of drugs has been introduced in market, and the demand of drugs is increasing day by day.[2]

From the recent few past years focused on the little molecules which are organic in nature, and also the compounds from natural or synthetic sources. For the analysis of these large or small molecules the various methods are useful for the analytical procedure which includes High Performance Liquid Chromatography (HPLC), High Performance Thin Layer Chromatography (HPTLC), Liquid Chromatography-Mass Spectrometry (LC-MS) etc.[3]

2. ANALYTICAL TECHNIQUES

2.1. Titrimetric techniques

Titrimetric method of analysis is invented by French chemist and physicist Joseph Louis Gay- Lussac in 1835, whichis the volumetric technique which results in the originates the term as titration.[4]

Table 1: various titration techniques.

Acid base Titration	Redox Titration	Precipitaton Titration	Complexometric Titration
Strong acid-strong base	Iodometry or Iodimetry	Mohr method	Back titration
weak acid-strong base	cerimetry	Volhards method	Replacement titration
Strong acid-weak base	permanganometry	Fagans method	Direct titration
Weak acid-weak base	dichrometry	-	Indirect titration

2.2. Chromatographic Techniques

Primarily, chromatography is a separation method that separates mixtures in to individual components by way of the usage of mobile and stationary phase. When the stationary phase is a solid support of adsorptive nature and mobile phase is liquid or gaseous phase it is referred to as adsorption Chromatography.

2.2.1. Thin layer chromatography

In this technique, a solid phase, the adsorbent, is coated onto a solid support as a thin layer usually on a glass, plastic, or aluminium support. First the adsorbent should show extreme selectivity in the direction of the substance being separated in order to the dissimilarities inside the fee of elution be large.[5]

Table 2: Chromatographic adsorbents.[6]

Sr.no.	Most strong adsorbent	Least strong adsorbent
1.	Alumina (Al_2O_3)	Silica gel (SiO_2)
2.	Charcoal (C)	
3.	Florisil (MgO/SiO_2)	

2.2.2. High-performance liquid chromatography (HPLC)

The specificity of the HPLC technique is superior and simultaneously sufficiently precise and accurate. At the time of literature survey, it was realized that HPLC has been the maximum broadly used technique over all of the chromatographic techniques. In liquid chromatography the selection of detection approach is crucial to guarantee that all the components are detected. One of the broadly used detectors in HPLC is UV detector which is able to monitoring several wavelengths concurrently; this is possible because of applying a multiple wavelength scanning program. As in enough quantity, UV detector assures all the UV-absorbing components are detected.

PDA i.e., a photodiode array is a coated array of discrete photodiodes on an integrated circuit (IC) chip for spectroscopy. It is placed at the photograph plane of a spectrometer to permit a range of wavelengths to be sensed concurrently. When a variable wavelength detector (VWD) is used with changing wavelength, a sample must be injected numerous times, to make sure that all of the peaks are detected. In the case of PDA, when it used a wavelength range can be programed and all the compounds that absorb within this range may be recognized in a single analysis. PDA detector also can examine pick purity by matching

spectra inside a peak. PDA detector finds its application in the technique improvement of Iloperidone in pharmaceuticals.[7]

One of the maximum sensitive detectors some of the LC detectors is fluorescence detector. Commonly, the sensitivity of this detector is 10–1000 times higher as compare to the UV detector for active UV absorbing materials used as an advantage that measurement of unique fluorescent species in samples. One of the maximum vital applications of fluorescence is the estimation of pharmaceuticals.[8]

2.2.3 High performance thin layer chromatography (HPTLC)

HPTLC is a rapid separation technique and flexible sufficient to investigate a various range of samples. One of the advantages of this technique is it is simple to handle and requires a short analysis time to analyze the complex mixtures or the crude sample cleanup. Densitometric analysis is also done by HPTLC method for Amlodipine, Hydrochlorothiazide, Lisinopril and Valsartan. HPTLC Fingerprinting for Quality Control of an Herbal Drug - The Case of Angelica gigas Root can be done.[9]

Table 3: Estimation of some category of drugs by using HPTLC technique.[10]

Sr.No	Category of Drug	Drug
1.	Analgesic/Anti-inflamatory	Paracetamol ,Ibuprofen
2.	Cardiovascular agent	Ranolazine,Telmisartan
3.	Antibiotics	Azithromycin
4.	Antiretroviral	Lamivudine
5.	Antipsychotics	Duloxetine,Risperidone

2.2.4. Gas chromatography (GC)

Gas chromatography is an effective separation approach for detection of volatile organic compounds. Currently, assay of drugs carried out with help of gas chromatography such as isotretinion.[11]

2.3. SPECTROSCOPIC TECHNIQUES

2.3.1. Spectrophotometry

Spectroscopy is totally based on the quantitative measurement, properties transmission, and wavelength function. This method has been great advantage to save time, or expenditure of labor. Also, this technique has great precision, and accuracy. In pharmaceutical analysis this method was specially applied to analyze the dosage forms in pharmaceutical industries has been increased regularly.[12]

2.3.2. UV-Visible Spectroscopy

The ultraviolet visible spectroscopy is based in the energy, and radiation or excitation of electrons. In UV-Visible method excitation of electrons is due the energy light, and the region to determine the sample wavelength, and absorbance is in the range of 200 to 800 nm. The absorption were only occurs when the presence of conjugated pielectrons was available.[13]

2.3.3. FTIR Spectroscopy

Infrared spectroscopy based on the principle of molecular vibration of atoms.mainly for detection of functional groups in organic compounds.fourier-transformed infrared spectroscopy is the more accurate and fastest method of IR spectroscopy for getting more resoluted peaks.[14]

2.3.4. Mass Spectroscopy (MS)

Mass spectroscopy the molecule samples were ionized by high energy electrons. The mass of each charge were accurately measured, and examined by the fluctuations of magnetic field, acceleration of electrostatic waves which maintains the precise weight of molecules. It consist of ionization chamber, acceleration, deflection due to electromagnet and finally detection. main Principle based on the detection of mass/charge (m/z) ratio.[14]

2.3.5. Nuclear Magnetic Resonance Spectroscopy (NMR)

NMR is more important than IR spectroscopy to organic chemist. many nuclei may be studied by NMR techniques, but hydrogen and carbon are most commonly available. whereas IR reveals types of functional groups present in molecule, but NMR gives information about number of magnetically distinct atoms in molecule.[14]

2.3.6. Fluorimetry and Phosphorimetry

In fluorimetry technique the highly sensitive system was analyzed by without any loss in precision, and specificity of a method. In the previous studies there is a constant increasing rate in the application numbers was observed in fluorometry or phosphorimetry.[15]

2.4. Electrochemical methods[16]

Electroanalytical methods are a class of techniques in analytical chemistry which study an analyte by measuring the potential (volts) and/or current (amperes) in an electrochemical cell containing the analyte.

Different electrochemical tecgniques are: 1) Potentiometry

2) Coulometry

3) Voltammetry

4) Polarography

5) Amperometry

Table 4: Determination of drug by electrochemical Techniques.[17]

Applicable Technique	Drug determined	Electrode used
Potentiometry	Pentoxifylline N-acetyl-cysteine	Multiwalled carbon nanotube paste electrode Mercury film electrode
Voltammetry	Leucovorin Dopamine	Silver solid amalgam electrode Differential pulse stripping voltammetry
Polarography	Ciclopirox olamine Anti-cancer/vit-k3	Dropping mercury electrode (DME) Polished glassy carbon electrode (GCE)
Amperometry	Verapamil Diclofenac	Dropping mercury electrode Carbon paste electrode

2.5. Hyphenated Techniques[18]

The development of method the seperation technique based on the coupling seperation, and online seperation will acquire to develop a new method for drug analysis which is called as hyphenated techniques. To increase the potential of drug analysis the hyphenated techniques were used.

•Liquid chromatography-Nuclear magnetic resonance (LCNMR)

•Liquid chromatography-Mass spectrometry (LC-MS)

•Liquid chromatography-Infrared spectrometry (LC-IR) • Gas chromatography-Mass spectrometry (GS-MS)

•Capillary electrophoresis-Mass spectrometry (CE-MS) • Liquid chromatography-Photodiode array-Mass spectrometry (LC-PDA-MS)

•Liquid chromatography-Mass spectrometry-Mass spectrometry (LC-MS-MS)

•Liquid chromatography-Nuclear magnetic resonanceMass spectrometry (LC-NMR-MS)

•Liquid chromatography photodiode array-Nuclear magnetic resonance-Mass spectrometry (LCPDA)

3. CONCLUSION

The present study we examine the process of drug development which is based upone the analytical techniques. Nowadays, it is very important to develop a method with minimum errors, and to overcome the faulted errors in analytical chemistry some of latest trends in analytical techniques were available which includes advancement in automated development of HPLC, RP-HPLC, LC-MS etc.

4. ACKNOWLEDGEMENTS

Authors are very much thankful to Asst.Professor Arti jadhav of Dr.Naikwadi College of Pharmacy, sinnar_nashik for their constant help and support.

5. REFERENCES

1. Carr GP, Wahlich JC. A practical approach to method validation in pharmaceutical analysis. Journal of pharmaceutical and biomedical analysis, 1990; 8(8-12): 613-8.
2. M.R. Siddiqui, Z.A. Alothman, N. Rahman, Analytical Techniques in Pharmaceutical analysis: A review, Arabian Journal of Chemistry (2013), doi: http://dx.doi.org/10.1016/j.arabjc.2013.04.016.
3. Ravisankar P, Navya CN, Pravallika D, Sri DN. A review on stepby-step analytical method validation. IOSR J Pharm, 2015; 5(10): 7-19.
4. Pratik R. Zagade, Nikhil N. Kumbhar, Kirti S. Raut and Rutuja U. Thombare, EMERGING INSTRUMENTAL ANALYTICAL TECHNIQUES USED IN PHARMACEUTICAL ANALYSIS: A REVIEW, World Journal of Pharmaceutical Research, 774-795.
5. G.Szepesi, S. Nyiredy. Pharmaceutical and drugs. In J. Sherma, B. Fried (Eds.), Handbook of Thin-Layer Chromatography, 2nd ed., Marcel Dekker, New York, 1996; 208-35.
6. Source:hppp://www.chem.wisc.edu./courses/342/Fall2004/TLC.pdf.
7. A.S. Devi Manjula, T.K. Ravi, Validation of UV Spectrophotometric and HPLC Methods for Quantitative determination of Iloperidone in Pharmaceutical Dosage Form, Int. J. Pharm. Tech. Res, 2012; 4: 576–81.
8. Ulu S.T., Tuncel M. Determination of bupropion using liquid chromatography with fluorescence detection in pharmaceutical preparations, human plasma and human urine. J. Chromatogr. Sci, 2012; 50: 433–39.

9. Frommenwiler, D., Kim, J., Yook, C.-S., Tran, T., Cañigueral, S., & Reich, Comprehensive HPTLC Fingerprinting for Quality Control of an Herbal Drug – The Case of Angelica gigas Root. Planta Medica, 2018; 84(06/07): 465–74.
10. M. Starek, J. Krzek, TLC chromatographic– densitometric assay of ibuprofen and its impurities, J. Chromatogr. Sci, 2010; 48: 825–29.
11. P.C. De Lima Gomes, J.Y. Barletta, C.E. Nazario, A.J. Santos-Neto, M.A. Von Wolff, C.M. Coneglian, G.A. Umbuzeiro, Optimization of in situ derivatization SPME by experimental design for GC-MS multi-residue analysis of pharmaceutical drugs in wastewater, 2011; 34: 436–45.
12. Lacrok PM, Curran NM, Sy WW, Goreck DK, Thibault P, Blay PK. Liquid chromatographic determination of amiodarone hydrochloride and related compounds in raw materials and tablets. Journal of AOAC International, 1994; 77(6): 1447-53.
13. Thyagarajapuram N, Alexander KS. A simplified method for the estimation of amiodarone hydrochloride by reverse- phase high performance liquid chromatography. Journal of liquid chromatography & related technologies, 2003; 26(8): 1315-26.
14. Donald L. Pavia, Gary M. Lampman, George S. kriz, INTRODUCTION TO SPECTROSCOPY_THIRD EDITION, 13-390.
15. Elbarbry FA, Mabrouk MM, El-Dway MA, Determination of the analgesic components of Spasmomigraine tablet by liquid chromatography with ultraviolet detection. J AOAC Int, 2007; 90: 94-101.
16. Wang, Joseph C. (2000). *Analytical electrochemistry*. Chichester: John Wiley & Sons. ISBN 978-0-471-28272-3.
17. Schellens JH, Meerum Terwogt JM, Ten Bokkel Huinink WW, Rosing H, Van Tellingen O, Swart M, Duchin KL, Beijnen JH. Cyclosporin A (CsA) strongly enhances oral bioavailability of paclitaxel (pac) in cancer patients. InProc Am Soc Clin Oncol, 1998; (Vol. 17, p. 186a).