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ANALYTICAL STUDIES AND ITS IMPORTANCE IN AYURVEDIC PHARMACEUTICALS

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ABSTRACT

Pharmacological industry is the heart of the Healthcare and plays a major role of delivering the effective and safer medicines without any toxicities. Like the food we consume that make us healthy and prevent the disorders without any impurities, the same way, medicines we consume should provide us with good health and arrest the possible complications by treating the disorder effectively. For this, pharmaceutical branch of the modern science has conducted numerus techniques to make the drugs or the medicines effective and free from toxicities. It includes various analytical techniques that are conducted either singly or in combination to make the drug more effective, standardized and safe. Due to the resurgence of the use of Ayurvedic medicines, regulatory bodies demand the rigorous pharmaceutical research of the medicinal plants. Application of these modern analytical techniques in Ayurvedic pharmaceuticals and pharmacology will help the Ayurvedic scholars to gain in depth knowledge of the medicinal plants thereby making novel techniques in drug research towards the innovation of drug standardization.

KEYWORDS: *Ayurveda, Analytical studies, Pharmaceuticals, Pharmacology, Dravyaguna.*

INTRODUCTION

Ayurveda is one of the oldest and the traditional Indian medicinal system with the history of 5000yrs. Till date, it remains the most ancient and a living tradition with authentic,

philosophical and experimental genealogy. It is defined as a science of life according to Ayurveda Acharyas that aims at holistic well-being of the individual with both health and the perspective of personalized medicine. As it incorporates the physical, psychological, philosophical, ethical, and spiritual health aspects of the individual, it is also known to be a complete medical science.[1] World Health Organization states that nearly about 70–80% of the world population rely on herbal sources such as nonconventional medicines for their health issues.[2]

Globalization of Ayurvedic science as a healthcare demand scientific evidence for its wider acceptance and application. Current evidence-based medicine inquire has been a requisite for safety and efficacy of the herbal medicines. This needs a complete understanding of the Medicinal plants that are described in detail in the science and the application of current pharmaceutical standards to upgrade the excellence and the quality of the medicinal formulations of Ayurveda. In addition to the methodized knowledge and pharmacopoeia of Ayurveda, many natural products or herbs are available and are used in local and global health traditions. Establishing the evidence base for these well practiced remedies requires a novel amalgamation path of drug development.[3]

The genesis and development of the Modern pharmaceuticals has brought a revolution in human health by generating new drugs and treatments thereby creating wonders in the healthcare system. Pharmaceuticals play a vital role in delivering the safe and the quality drugs to the society for the betterment of their health. These pharmaceuticals would serve their purpose only if they are administered in the proper dose and the amount and are free from impurities. This pharmaceutical industry includes many techniques and methods for making the drugs or the medicinal plants safer and devoid of the impurities. It encompasses various chemical and instrumental methods that were developed at regular intervals at the estimation of drugs.[4]

Pharmaceuticals is not new for Ayurveda; it is being practiced under the branch called Dravyaguna and Bhaisajya Kalpana since centuries. This begins with the identification of the medicinal plants till the complete formulation of the medicines with numerous methods such as Ritu (Seasons), Kala (Time of collection), Samrakshana (Storage and Preservation), Shodhana (Purification), Bhavana (Trichuration) etc with different modes of drug consumption such as Swarasa (Juice), Kalka (Paste), Kashaya (Decoction), Vati and Gutikas (Tablets) etc. Present study makes an attempt to evaluate the role of modern pharmaceuticals

that include the analytical techniques in the course of drug development and the application of these techniques in Ayurvedic science which would help a researcher to understand the need of these techniques for the upgradation of the Ayurvedic pharmaceuticals.

METHODS

Pharmaceuticals

Research in the past has played a crucial role in the progress and development of pharmaceuticals with the blend of chemistry and the clinical research. The contribution of microbiology, biochemistry, chemistry and pharmacology has set a standard in the drug discovery where new drugs are generated with the exchange of ideas between biologists and chemists and not just by the imagination of chemists. In the field of pharmaceutical research, the analytical investigation of drug materials, formulations and elimination of impurities is very important. Pharmaceutical analysis includes the analytical assay methods with the aim of providing the quality to bulk drug materials by their active ingredient. These assay methods in the monographs include titrimetric methods, spectrometry, chromatography, capillary electrophoresis and the electro analytical methods.[4]

Analytical techniques play a major role from the stages of drug development to marketing and post marketing which includes physical and chemical stability of the drug, selection, design and dosage form, assessment of stability of the drug molecules, identification and quantification of the impurities that are essential to evaluate the toxicity profiles of the impurities to distinguish from that of the API. Pharmacokinetic studies include the analysis of drug and its metabolite with either quantitative or qualitative methods.[5]

Analytical Techniques

This encompasses titrimetric methods, chromatographic techniques like thin layer chromatography, high performance thin layer chromatography, high performance liquid chromatography, gas chromatography and spectroscopic techniques like etc.

Titrimetric techniques

Origin of this method of analysis dates back to the middle of the 18th century. Gay–Lussac invented the volumetric method which gradually became titration in 1835. Titrimetric methods have been shown to be advantageous in kinetic measurements to establish the reaction rates. In addition to this time and labour are also saved with high precision and less requirement of the reference standards.[6,7]

Chromatographic techniques

It includes thin layer chromatography, high performance thin layer chromatography, high performance liquid chromatography and gas chromatography.

Thin layer chromatography

This is the most popular technique conducted for the analysis of a wide variety of organic and inorganic materials. Its distinctive features such as minimal sample clean-up, flexibility in sample distinction, wide choice of mobile phases, low cost and high sample loading capacity has made it a powerful tool for screening the bulk drugs and unknown materials.[8] This technique provides a high degree of postulation regarding the components of the drug and their separation. It also helps in identification and determination of various impurities of pharmaceuticals.[9, 10]

High performance thin layer chromatography (HPTLC)

This technique has emerged as an important instrument in drug analysis. HPTLC is considered as a fast separation technique and has ability of analysing a wide variety of samples. It is easy to handle and takes short time to analyse the complex or the crude sample cleanup. The entire chromatogram is evaluated with a variety of parameters without time limits in this technique and also provides reliable results with simultaneous and independent development of multiple samples and standards on each plate.[11]

High-performance liquid chromatography (HPLC)

This technique is more advanced and used in separation of the complex mixture of molecules encountered in biological and chemical systems to identify the better role of individual molecules. Precision and accuracy of HPLC are attainable with wide-ranging system suitability tests that are carried out before the HPLC analysis. High specificity, precision and accuracy is also high in this technique.[12]

Gas chromatography

Gas chromatography is a powerful separation technique used for the detection of volatile organic compounds. This provides accurate quantitative determination of complex mixtures and traces of compounds down to parts per trillion with the combining separation and on-line detection. Gas liquid chromatography has a substantial role in the analysis of pharmaceutical product.[13] It also plays the role of an important tool for analysis of impurities of pharmaceuticals. Currently gas chromatography is being applied in estimation of impurities

of the pharmaceuticals and residual solvents which is listed as impurity by the International Conference of Harmonization.[14]

Spectroscopic techniques

Spectrophotometry

Spectrophotometry is defined as the quantitative measurement of the reflection or properties as a function of wavelength. These methods take less time and labour consumption. The precision of these methods is also excellent. The usage of spectrophotometry has increased rapidly and is applied in the analysis of pharmaceutical dosage form.[15,16]

Near infrared spectroscopy (NIRS)

It is a procedure that is rapid and non-destructive that provides multi component analysis of almost any matrix. In recent years, due to its raw material testing, product quality control and process monitoring, has procured a wide commendation within the pharmaceutical industry NIR spectroscopy has major advantages over the other analytical techniques as it can provide easy sample and preparation without any pretreatments, expectation of chemical and physical sample parameters from one single spectrum and the probability of separating the sample measurement position by use of fibre optic probes. The major pharmacopoeias highly recommend and has adopted NIR techniques where, the European Pharmacopoeia in chapter 2.2.40 (The European Pharmacopoeia and Council of Europe, 2002) and United States pharmacopoeias (chapter 1119 United States Pharmacopoeia USP 26 NF 21, 2003) mentions about the suitability of NIR instrumentation for application in pharmaceutical testing. This spectroscopy opens many qualitative and quantitative interesting perceptions in pharmaceutical analysis with multivariate data analysis.[17]

Nuclear magnetic resonance spectroscopy (NMR)

Since the first report appeared in 1996 describing the use of NMR spectroscopy to screen for the drug molecules, the field of NMR based screening has proceeded promptly. Over the last few years, a variety of state-of-the-art approaches have been presented and found a widespread application in both pharmaceutical and academic research. Recently NMR finds its application in quantitative analysis in order to determine the impurity of the drug, characterization of the composition of the drug products and in quantitation of drugs in pharmaceutical formulations and biological fluids.[18,19]

Fluorimetry and Phosphorimetry

This kind of spectrometry is one of the techniques without the loss of specificity and serves the purpose of high sensitivity. In the recent years, a gradual increase in the number of articles have been observed on the application of fluorimetry and phosphorimetry in quantitative analysis of various drugs and biological fluids.[20]

Electrochemical methods

Currently, the application of electrochemical techniques in the analysis of drugs and pharmaceuticals has undergone a rapid expansion and this can be attributed to the sophisticated instrumentation and the understanding of the techniques. Varieties of electroanalytical methods are available for quantification of pharmaceuticals.[4]

Kinetic method of analysis

Though this technique was developed in 1950s, presently it is taking a major resurgence in activity. These automatic techniques are based on open systems that include the flow system and the continuous addition of reagent (CAR) technique.[4]

Electrophoretic methods

Capillary electrophoresis (CE) method is an instrument essential for the analysis of pharmaceuticals. It is based on the separation of charged analytes under the impact of an electric field through a small capillary. It is vastly applicable in the analysis of inorganic ions and the biopolymer analysis. Advantages include quicker time scale, small amount, nano litre injection volumes and takes place under aqueous conditions.[21]

Flow injection and sequential injection analysis

This technique is the automation of a chemical procedure It was introduced to transform the concept of automation in chemical analysis with the permission of instrumental measurement and in the absence of physical and chemical equilibriums. In this procedure, liquid sample is injected into a moving, non-segmented uninterrupted carrier stream of a suitable liquid and thereby it has led to significant contribution in the pharmaceutical analysis of automation and specialized monograph its advantages are well documented. Introduction of SIA technique has created an interest in the scientific community to conduct more researches in automation of the pharmaceutical area.[22]

Hyphenated techniques

These are considered as the current standard analytical techniques or the procedures in pharmaceuticals. It includes the combination of analytical techniques such as the coupling of a separation technique and on-line separation technique et. Last two decades has seen a remarkable contribution and advancement in the application of these hyphenated techniques in pharmaceutical analysis. A variety of hyphenated techniques such as LC-MS, GC-MS, LC-NMR, CE-ICP-MS and CE-MS are some of the techniques that are applied in the analysis of pharmaceuticals.[23,24]

Pharmaceuticals in Ayurveda

Ayurvedic classics consider 'drug' as one among the four important components of the *Chikitsa (Treatment)* and a tool for the physician in successful treatment. *Aushadha dravyas (Drugs)* occupies the prime position in treatment and known to possess both effective and destructive properties and therefore need to be used carefully. Acharya Charaka opines that every single substance in the universe is loaded up with therapeutic potential provided it is used judiciously with appropriate indications. These substances are derived from the sources such as plants, animals or minerals. As the plants, animal or mineral products are not suitable to be used in whichever form they are, they need to undergo different methods of processing to make it palatable. The branch that deals with such processing methods which makes a material into an effective drug is known as Pharmaceutics. In Ayurveda this is termed as 'Bhaisajya Kalpanaa' which is followed since 5000yrs. The term Bhaisajya Kalpanaa is derived from the word 'Bhaisajya' means a drug and Kalpana means the methods of processing. According to Ayurvedic science, 'Drug' and its importance is embedded in the properties and the activities of the substance or the ingredients present in it and its effects on the human body. Efficacy, safety, stability and palatability are the four major and basic requirements of a good drug or the medicine.[25]

Dravyaguna and the Bhaisajya kalpana branch of Ayurvedic science has vastly described in detail starting from the identification and collection of authentic raw material, application of standardized processing techniques, and production of quality drug to packaging and storage of the drug based on the rutus, kala and Ayurvedic principles. As described above, though every substance in the universe possesses therapeutic potential to become a drug. With an exception, all the parts of the substance are not always therapeutically useful and therefore it needs to undergo various processing methods and only the therapeutically useful part which

is termed as ‘Saara Bhaaga’ is considered for the administration. Many a times, substances may consist of more than one constituent that are therapeutically effective and requires different procedures to separate out such useful constituent. This includes the methods where, the components soluble in water are extracted in water whereas solvents like fat, oil or alcohol are required to extract ingredients soluble in those solvents. Sometimes application of combined solvent system is also needed.[25]

Depending on the requirement, different procedures are adopted to extract the therapeutically useful ingredients. Water and alcohol are being the major solvents used for majority of the extractions. Based on the availability and requirement, both the fresh as well as dried plant material is used for processing which encompasses different methods adopted to prepare a drug that is effective, safe with stability for a longer period. As per Ayurvedic science, pharmaceutical processing depends on factors such as nature of the raw material, concentration of the dosage form, solubility of therapeutically useful component of the plant, heat stability, route of administration and shelf life.[25]

Application of Analytical techniques in Ayurveda

Ayurvedic treatment is considered as holistic and customized based on the Prakriti with the objective of prevention rather than just cure. It includes both single and the polyherbal formulations with respect to its pharmaceuticals. Standardizing a medicine or drug to ensure the quality and efficacy of the preparation in terms of raw materials and manufacturing practices is predominant. Biopotency of the drugs are assessed by the composition of active principles and their individual concentration. Ayurvedic medicine is also called as traditional medicine and also herbal medicine and its healing process are mainly based on plant-based preparations. The classics emphasize the importance of herbal medicines by highlighting the point that even poisons can have medicinal value when used appropriately and the medicines can be toxic if used inappropriately. The Ayurvedic preparations are able to reverse the pathophysiological processes of the diseases and thereby harmonizing the bodily functions. Most of the Ayurvedic classical preparations are polyherbal and poly-herbomineral formulations and the constituents or the active ingredients present in them can have different actions on proper and ideal combination and also the therapeutics actions can be enhanced. On the contrary, improper combination of the drugs can lead to severe toxic effects and complications.[26] Combination of phytochemical constituents are necessary for the therapeutic benefits of a formulation. But at the same time interaction and connection

between the constituents can cause chemical incompatibility. Hence it is very important to study the phytoconstituents that can work synergistically to bring desired therapeutic effects. In addition, determination of bioactive compounds and its safety evaluation are obligatory for the proper mechanism of action of medicinal herbs.

In the Modern pharmaceuticals, analytical chemistry is a branch of knowledge that is growing in a rapid manner that provides information on the component identification, segregation and measurement thus helping in determining the bioavailability of drugs and specific drug metabolic pathways.[27] Though there are various analytical techniques in pharmaceutical industry, the current emergence of hyphenated techniques that includes numerous analytical techniques and serve as the standard procedure helps in the assessment of the quality of a preparation starting from raw materials till the end product. These techniques are proving beneficial by its rapid, selective and accurate synthesis of information regarding a particular formulation or drug. Metabolomic profiling, fingerprinting and spectroscopic technique processing strategies make them more accurate.[28]

Application of these analytical techniques including the hyphenated techniques to Ayurvedic pharmacology helps in standardization of the herbal preparations and further re-validate and re-authenticate the Ayurvedic formulations and preparations. Single herb consists of multiple components and in case of a polyherbal preparation, there is a complexity of constituents. Though the traditional approach of standardization of Ayurvedic drugs is effective in the management of disorders, application of analytical techniques helps in the documentation of scientific evidence with increased efficacy and quality of the formulations. This authorizes the initiation and the innovation of the drug development and growth thereby enriching Ayurvedic pharmaceuticals and its concept followed since ages.[29]

DISCUSSION

The presence of possible toxicities in the medicinal drugs has led to the vigorous pharmaceutical researches and constant upgradation and innovation in the pharmaceutical industries. Herbal medicines or Ayurvedic medicines are no exception to this. Due to the accelerated growth in the use of Ayurvedic medicines worldwide in the past few decades, pharmaceutical regulatory bodies are demanding a safe and quality drug or the formulation with stability and the longer shelf life.

Analysis is an important step in every product, but in case of drugs it is more important as it involves life. In comparison to general consumer products, in drugs there can only be quality to manufacture the standard product and no other products. This quality of the product comes from series of tests for that are conducted for quality control, starting from raw materials, in process during manufacturing, finished product etc. Standardization refers to the quantification of the drug for ensuring the quality and is used to describe all measures which are taken during the manufacturing process & quality control leading to a reproducible quality, safety and efficacy. There is a need of systematic and well-organized coordination of allied sciences such as Chemistry, Pharmacology, Biochemistry etc along with adequate and proper infrastructure and facilities to solve various problems related to Ayurvedic formulation towards making it standard.[30]

As discussed earlier, Ayurvedic Pharmaceuticals known as Dravyaguna and Bhaisajya Kalpana branches are serving the community by providing the effective drugs without any toxicities or the adverse effects by following the ancient practices of preparation such as shodhana, bhavana and marana etc processes and authentication of the medicinal drugs successfully. With the advent and integration of the Modern pharmacological techniques to the ancient practices of Ayurveda would benefit both interdependently by opening new horizons for the development of pharmaceuticals, drug discovery and development thereby re-validating the concepts and the practices of the science. Proper pharmacological techniques help in identifying the hidden constituents of both the single poly herbal formulations and characterization and toxicological evaluation ensure the safety, efficacy and quality of the preparations.

Using these hyphenated techniques, the standardization of herbal preparations can be made possible starting from the production till supply of the medicines. The present study has made an attempt in analysing the analytical techniques of pharmaceutical industry and their application in Ayurvedic pharmaceuticals.

CONCLUSION

Pharmacology is the study of drug interaction and effects on the human body whereas pharmaceutics refers to the quantitative aspects of the drug delivery that involves both the single or the poly herbal formulations, their combinations and the dosage form. In Ayurvedic science, these both are studied under the branches Dravyaguna and Bhaisajya Kalpana that involves the list of methods beginning from the identification and the collection of the

medicinal plants till the completion of the product. Due to the resurgence of the use of Ayurvedic medicines across the world, regulatory bodies are anticipating the rigorous pharmaceutical research of the medicinal plants. Application of these analytical studies in Ayurvedic pharmaceuticals may help in authentication, scientific validation and revalidation of the concepts of science and pave a new pathway for the innovation of drug development and standardization.

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