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A review on Extraction Techniques used in advanced herbal drug technology

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Abstract : Recently peoples are getting attracted towards herbal medicines due to many advantages. Herbal formulations have reached extensive acceptability as therapeutic agents for several diseases. Although, most of these applications are unorthodox, it is however a known fact that over 80% of the world population depends on herbal medicines and product for healthy living. This rise in the use of herbal product has also given rise to various forms of abuse and adulteration of the products leading to consumers' and manufacturers' disappointment and in some instances fatal consequences. The development of authentic analytical methods which can reliably profile the photochemical composition, including quantitative analyses of marker/bioactive compounds and other major constituents, is a major challenge to scientists. Standardization is an important step for the establishment of a consistent biological activity, a consistent chemical profile, or simply a quality assurance program for production and manufacturing of herbal drugs. In present review article various conventional methods as well as newer advances are described. Capillary electrophoresis and chromatographic techniques contributions towards standardization of herbal drugs is also reported.

IndexTerms-Identification , Authentication, Standardization of herbal drug, Extraction, chromatographic techniques.

I. INTRODUCTION

Today modern drug discovery utilizes several advanced techniques like MST technology which is used to measure molecular interactions.The use of herbs as medicine is the oldest form of healthcare know to humanity and has been used in all culture throughout history. Herbal drug have been used since times as medicine for treatment of a range of diseases medicinal plant have play a key role in world health. In spite of the great advance observed in modern medicine recent decade plants still make an important contribution to healthcare.

Different extraction methods including advanced extraction techniques:-

Extraction: Extraction can be defined as the removal of soluble material from an insoluble residue, either liquid or solid, by treatment with a liquid solvent. It is therefore, a process and depends on the mass transfer phenomena. The controlling factor in the rate of extration is normally the rate of diffusion of the solute through the liquid boundary layer at the interface.

The principle methods of extraction are –

- Maceration
- Infusion
- Digestion
- Decoction
- Percolation
- Reflux
- Tincture

a)Maceration: In this process, the whole or coarsely powdered crude drug is placed in a stoppered container with the solvent and allowed to stand at room temperature for a period of at least 3 days with frequent agitation until the soluble matter has dissolved. The mixture then is strained, the marc (the damp solid material) is pressed, and the combined liquids are clarified by filtration or decantation after standing.

b)Infusion: Fresh infusions are prepared by macerating the crude drug for a short period of time with cold or boiling water. These are dilute solutions of the readily soluble constituents of crude drugs.

c)Digestion: This is a form of maceration in which gentle heat (40- 60oC) is applied during the process of extraction. It is used when moderately elevated temperature is not objectionable .The process may be modified by mixing the material with the solvent using magnetic stirrer, mechanical stirrer or by shaking occasionally by hand. After 8 to12 hours, the extract is filtered and fresh solvent is added and the process repeated till all the desired products are extracted.

d)Decoction: In this process, the powdered plant material is boiled in a specified volume of water for a defined time; it is then cooled and strained or filtered. This procedure is suitable for extracting water-soluble, heat-stable constituents. This process is typically used in preparation of Ayurvedic extracts called "quath" or "kawath". The starting ratio of crude drug to water is fixed, e.g. 1:4 or 1:16; the volume is then brought down to one-fourth to its original volume by boiling during the extraction procedure. Then, the concentrated extract is filtered and used as such or processed further .

e)Percolation: This is the procedure used most frequently to extract active ingredients in the preparation of tinctures and fluid extracts. The plant material is taken in a percolation tube plugged with cotton or fitted with a filter and a stopcock. Solvent is added into the plant material allowed to stand for approximately 4 hour in a well closed container, after which the mass is packed and the top of the percolator is closed. The whole system is kept for 24 hour at room temperature and the solvent along with the extracted material is collected by opening the stopper below and mixed liquid is clarified by filtration or by standing followed by decanting.

f)Reflux: In this hot extraction process, the material is treated with boiling solvent. The solvent vapor is recycled by a condenser fitted on top of the container, preferentially a round bottomed flask. It cannot be used for the extraction of thermolabile natural products.

g)Tincture: It is the extract of plant material in alcohol. Usually the plant material (fresh) and ethyl alcohol are taken at the ratio of 1:5. Because of the alcohol content, the tinctures can be stored at room temperatures without being decomposed.

Advanced Extraction Techniques:-
A] Supercritical Fluid Extraction (SFE):-

Any substance at a temperature and pressure higher than its critical point is called a supercritical fluid. It has the ability to dissolve materials like a liquid and diffuse through solids like a gas. Furthermore, around the critical point, minor variations in temperature or pressure cause significant variations in density, enabling the "fine-tuning" of numerous supercritical fluid properties. Supercritical fluids can be used in a variety of industrial and laboratory operations in place of organic solvents. The most often utilized supercritical fluids are carbon dioxide and water, which are used for power production and decaffeination, respectively. CO2 is the type of solvent used in plant extraction. It doesn't leave any harmful behind. With small adjustments to temperature and pressure, its extraction properties may be precisely and broadly controlled.

B] Microwave Assisted Extraction (MAE):-
Principle of microwave assisted extraction-

Microwaves are part of electromagnetic spectrum of light with a range of 300 MHz to 300 GHz and wavelengths of theses waves range from 1cm to 1m (Mandal etal., 2007). These waves are made up of two perpendicular oscillating fields which are used as energy and information carriers. First application of microwaves includes its interaction with the specific materials which can absorb a part of its electromagnetic energy and can convert it into heat. Commercial microwaves use 2450 MHz of energy for this purpose which is almost equivalent to 600-700W. It simply termed as microwave extraction, that combines microwave and traditional solvent extraction. Revolution in organic compound synthesis has been promoted by microwave assisted organic syntheses (MAOS) by which small molecules are built up into large polymers in a fraction of time. Heating the solvents and plant tissue using microwave increases the kinetic of extraction to facilitate partition of analytes from the sample matrix into the solvent. Microwave radiation interacts with dipoles of polar and polarizable materials causes heating near the surface of the materials and heat is transferred by conduction. Dipole rotation of the molecules induced by microwave electromagnetic disrupts hydrogen bonding; enhancing the migration of dissolved ions and promotes solvent penetration into the matrix. In non-polar solvents, poor heating occurs as the energy is transferred by dielectric absorption only.

C] Ultrasound Assisted Extraction:-

Extraction has been used probably since the discovery of fire. Egyptians and Phoenicians, Jews and Arabs, Indians and Chinese, Greeks and Romans, and even Mayas and Aztecs, all possessed innovative extraction and distillation processes used even for perfumes, cosmetics or food.

Nowadays, we cannot find a production line in food, pharmaceutical, cosmetic, nutraceutic, or bioenergy industries, which do not use extraction processes, such as (maceration, solvent extraction, steam or hydrodistillation, cold pressing, squeezing…). With the increasing energy costs and the drive to reduce greenhouse gas emissions, food and plant-based chemical industries are challenged to find new technologies in order to reduce energy consumption, to meet legal requirements on emissions, product/process safety and control, and for cost reduction and increased quality as well as functionality. For example, existing extraction technologies have considerable technological and scientific bottlenecks to overcome: often requiring up to 50% of investments in a new plant and more than 70% of total process energy used in food industries [1]. In the last two decades, these shortcomings have led to the consideration of the use of enhanced and efficient extraction techniques amenable to automation such as ultrasound-assisted extraction. Shorter extraction times, reduced organic solvent consumption, energy and costs saved, were the main tasks pursued.

Driven by these goals, advances in ultrasound-assisted extraction have resulted in a number of innovative techniques such as ultrasound-assisted Soxhlet extraction, ultrasound-assisted Clevenger distillation, continuous ultrasound-assisted extraction, and combination of ultrasound with other techniques such as microwave, extrusion, and supercritical fluid extraction.

D) Ultrasonic Extraction:-

In this process, natural compounds are liberated from the plant tissues by high frequency sound, which damage the cell wall. Ultrasound assisted extraction can be used with mixtures of immiscible solvents such as hexane with methanol/water. The process creates heat so that heat labile compounds may decompose. In such cases the extraction container is placed in ice bath to reduce the temperature.

E) Soxhlet Extraction:-

Named after 'Franz Ritter von Soxhlet', a German agricultural chemist, it is the best method for the continuous extraction of a solid by a hot solvent. Soxhlet apparatus is a specialized glass refluxing unit mainly used for organic solvent extractions. The powdered solid material is placed in a thimble made up of filter paper and is placed inside the soxhlet apparatus. The apparatus is fitted to a round bottomed (RB) flask containing the solvent and to a reflex condenser. The solvent in the RB flask is boiled gently, the vapour passes up through the side tube, condensed by the condenser and falls into the thimble containing the material and slowly fills the soxhlet. When the solvent reaches the top of the attached tube it siphons over into the flask, thus removes the portion of the substance, which it has extracted

F) Expression-

Expression, also referred to as cold pressing, is a method of extraction specific to citrus essential oils. In older times, expression was done in the form of sponge pressing, which was literally accomplished by hand. The oil release in this process is absorbed by sponge and it was recovered back by squeezing the sponge. It is reported that oil produced this way contains more of the fruit odour character than oil produced by any other method.

Enfluerage: This technique is employed for the extraction of delicate fragrances from flowers. The flower petals are spread over a layer of refined fat that picks up the odour of the flowers and the saturated fat is treated with a solvent, usually alcohol in which the fragrant components are soluble. The residual fat dissolved in alcohol may be removed by cooling the alcohol extract to 20oC, when fat separates out. The alcohol is evaporated under reduced pressure and pure oils are obtained.

H) Steam Distillation:-

It is the standard process employed for the isolation of volatile oil from crude plant material. Steam distillation is simple vaporization achieved by passing steam directly through the material. Here the stem volatile essential oil is recovered by condensation, where oil separates out from water.

I) Pressurized Liquid Extraction (PLE):-

The method is also known as accelerated solvent extraction system (ASE) or enhanced solvent extraction system (ESE). The method uses elevated pressure and temperature, where the increased temperature accelerates the extraction process by increasing thediffusivity of the solvent, whereas the increased pressure keeps the organic solvent in liquid state without boiling and also forces the solvent to penetrate the matrix pores.

J) Accelerated Solvent Extraction:-

This methodology uses high to take care of the solvent in a liquid state a heat. Combine the small-grained material with some sea-sand during a 4:1 ratio. Load the plant-sand mixture (ca. forty g) into a one hundred cubic centimetre ASE extraction cartridge. Place the extraction cartridge within the ASE one hundred extractor. Fill within the reservoir bottles with an acceptable extraction solvent. Program the ASE one hundred system to extract at a pressure of1,500 psi and temperature of 100°C in four static cycles (static time of eight min/cycle) with a flush volume of 60% and a purge time with gas of one hundred fifty s.6. Collect the extract that is mechanically filtered, within the receiving flask.

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