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Conventional & recent techniques of extraction of active constituents from drugs

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Abstract
Extraction of phytoconstituents from medicinal plants is of major importance in gaining benefit from them. There are numerous conventional and novel extraction techniques of extraction. The present paper describes a detailed account on methods, uses and their applications.

Keywords: extraction, phytoconstituents, conventional, novel, techniques

Introduction

Extraction

Extraction is the process of separating active principles from powdered crude drugs by suitable solvents. It is the crucial first step in the analysis of medicinal plants, because it is necessary to extract the desired chemical components from the plant materials for further separation and characterization (Sasidharan *et al*., 2011) [11].

Factors affecting extraction

- Quantity and nature of drug
- Degree of comminution
- Moisture content
- Nature & volume of solvents
- Mixing ratios
- Imbibation of drugs
- Temperature
- pH of the extracting solvent
- Interaction between dissolved constituents
- Lipophilicity of the solvent mixture
- Operation governing separation
- Speed of establishment of equilibrium (Chaudhary, 2012)

Conventional techniques of drug extraction

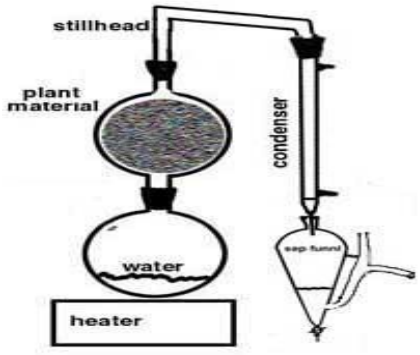
- Mechanical pressing
- Hydro distillation
- Enfleurage
- Infusion
- Decoction
- Digestion
- Steam distillation
- Maceration
- Percolation
- Successive solvent extraction (Gupta *et al*., 2011)

Mechanical pressing

This method is applied to the extraction of oils from oil seeds. This method needs no extraction medium. This process may be combined with some form of pretreatments like cleaning before extraction but in general the only equipment needed is hydraulic press. Example: Azadirachtin from *Azadiracta indica* (Verma, 2009) [12].

Hydro distillation

In this method the botanicals are fully submerged in water, producing a soap, the steam of which contains the aromatic plant molecule. Example: lime oil.



Enfleurage

This is an extraction with cold fat. It is used mainly for the extraction of fragrance from flowers. Example: essential oil of rose, pine and orange.

Infusion

The drug to be extracted is placed at the bottom of the infusion pot, water is added and the contents are required to be stirred occasionally. Alternatively the drug, wrapped in a muslin cloth, may be suspended just below

the level of water for about fifteen minutes. It is a simple and speedy process used for the soft drugs whose active constituents are water soluble. The active Infusion must be freshly prepared and consumed within 24 hours of its preparation. Concentrated infusion can also be prepared using alcohol and can be stored for an appreciable period of time. Example: infusion of senna and infusion of quassia.

Decoction

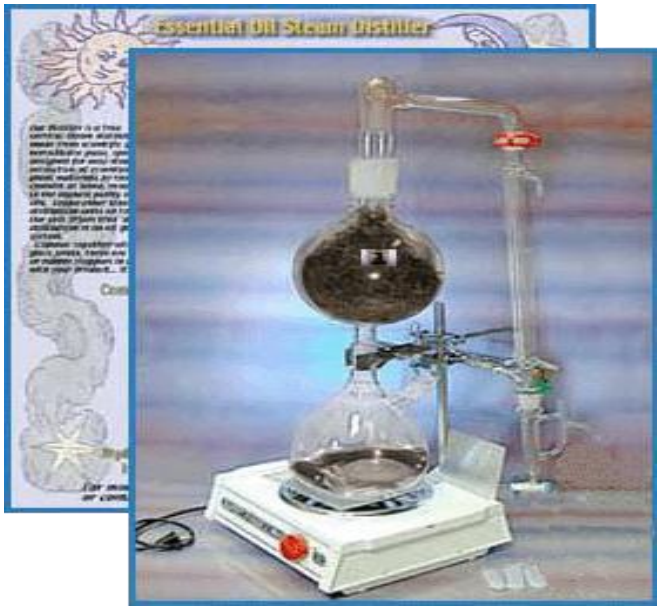
This process extracts water soluble and heat stable constituents from crude drugs by boiling in water for 15 minutes, cooling, straining and passing sufficient cold water through the drug to produce the required volume. Only freshly prepared decoction is dispensed and consumed. At present no decoction is official in I.P. or B.P. Example: tea made from tea leaves.

Digestion

In this process the crude drug is gently heated. This method is a modified maceration process. Here the efficiency of the menstrum is increased. This method cannot be used for the thermolabile constituents.

Steam distillation

This method is primarily used to obtain essential oils from plant materials. In this method, a packed bed of plant materials is continuously flushed with steam and the volatile organic compounds present in the material are taken up by the vapour phase. Compounds carried by the vapour steam are then separated after decreasing the temperature of the vapour by condensation. Example: clove oil.



Maceration

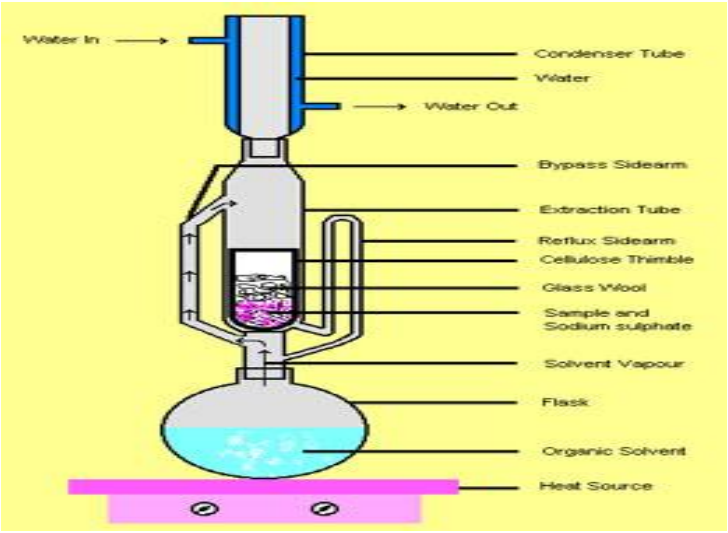
In this process the drug is placed in contact with the menstrum in a stoppered container for 2-7 days with frequent stirring. Then filtration is done, after draining most of the liquids, the filter residue is washed with sufficient quantity of solvent and the filtrates are combined and for more effective extraction multiple maceration can be done for both organised and unorganised drugs. This process is more advantageous as thermolabile constituents can also be extracted with ease. Example: tincture of lemon, tincture of squill etc.

Percolation

In this process a suitable comminuted drug is made evenly and uniformily damped with the prescribed solvents, and then it is packed in percolator. The drug is allowed to macerate for 24 hours and then after adding more of menstrum percolation is started. This process is not suitable for soft drug which may block the percolator. Example: tincture of belladonna, compound tincture of cardamom and strong tincture of ginger (Cannell, 1998) [3].

Continuous hot percolation or soxhlet extraction

This process is used for those drugs where the imbibition of the menstrum into the cellular tissues is very slow and the solute is not readily soluble into the solvent and the menstrum quantity is less. This process uses soxhlet extractor, where small volume of hot menstrum is passed over the drug repeatedly in order to exhaust the drug. The method is restricted to pure boiling solvent or to azeotropes. Example: extract of *Datura fastuosa.*



Improved/Non-Conventional Techniques of Extraction

The very first step in process of obtaining secondary metabolites from biogenic material is to release them from the matrix by means of extraction. The choice of extraction method is of great importance because of the very complex compositon of the material and the minute amount of some of the constituents present. It is obvious that an incorrect choice will cause the entire isolation to fail if some or all of the desired components of the material cannot be released satisfactorily from the matrix. Thus all efforts in developing improved extraction methods need to be focussed in order to increase the extraction efficiency, which leads to increased yield and / or shorter extraction time.

Ultrasound extraction (UE) method

Ultrasound is like the ordinary sound that we hear except that its pitch is beyond our range. Ultrasound extraction uses the energy of ultrasound for accelerating the rate of extraction. Ultrasound, i.e., frequencies above 20000 Hz, may be produced with:

i) Magnetostrictive ultrasound transmitters.
ii) Piezoelectric ultrasound transmitters.

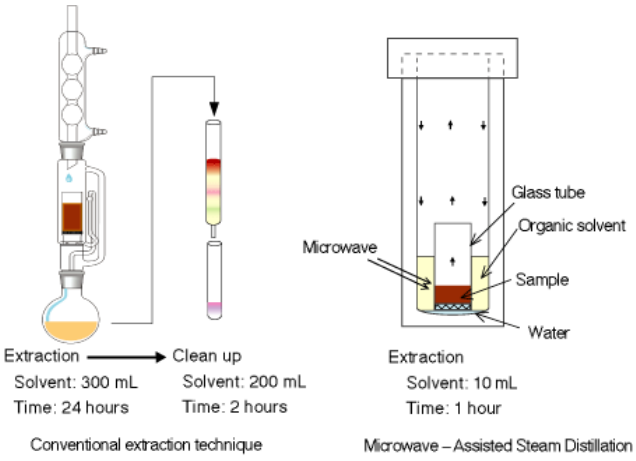
Magnetostrictive ultrasonic transmitters are based on the changes in length undergone by the ferromagnetic substance due to magnetization. The high frequency alternating current produces magnetic field which makes the frequency of alternating current matches with that of the frequencies of vibrating rod (Vinatoru, 2001) [13].

The therapeutic ultrasound equipment consists of sinusoidal voltage generator for driving a piezoelectric crystal (occurs naturally as quartz). The electrical forces on the crystal atoms causes the atoms to move. Since the applied voltage is sinusoidal, it sets up sinusoidal vibrations in the crystal which results into ultrasound production. Ultrasound causes mechanical perturbation and heat production.

Ultrasound causes rapid extraction due to increased permeability of the cell wall, spontaneous formation of bubbles in the liquid below its boiling point i.e. cavitation effect, dynamic stressing, increase in the mechanical stressing, i.e., internal friction of the cells and shortens the extraction time to 5-15 minutes from several hours to few days (Alupului *et al.*, 2008) [1].

Microwave assisted extraction (MAE) method

Microwaves are high frequency electromagnetic waves in the same frequency band as radar waves. The most frequently used microwave frequency for industrial and scientific use is 2.45 GHz. Microwave energy heats the material from the inside out. The benefits of using microwave for heating are time minimization, energy minimization. When the microwave radiation is switched off, the source of heat is immediately removed from the object. This method uses the energy of microwave radiation to heat solvents quickly and efficiently. Extraction can be performed at higher temperatures and extraction time can be reduced drastically (Jain *et al.*, 2009) [7].



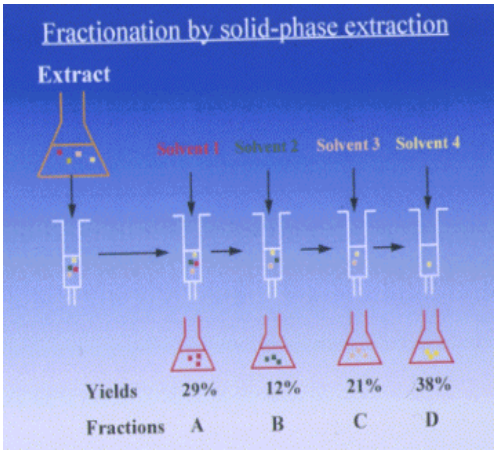
Supercritical fluid extracrion (SFE) method

A supercritical fluid is any substance at a temperature and pressure above its thermodynamic critical point. It has a unique ability to diffuse through solids like a gas and dissolve materials like a liquid. Moreover, it can readily change in density by minute changes in temperature and pressure. These properties make it suitable as a substitute for organic solvents in SFE. Carbon dioxide and water are the most commonly used supercritical fluids (King, 1990) [9].

The supercritical fluid extract of *Curcuma aerogenosa, Citrus hystrix* and *Azadirachta indica* can be applied as a constituent of cosmetic product and medicine because of their antimicrobial activity. The yield of naringin from the peel of *Citrus paradise* is reported to be higher than that attained by the conventional technique.

Solid phase extraction (SPE) method

This method involves the usage of a small bed of a specific adsorbent material contained in the barrel of a disposable hypodermic syringe. Example: extraction of roots of *Salvia miltiorrhiza* (Gupta *et al*., 2012) [5].



Solid phase micro extraction (SPME) method

This method uses a thin silica capillary fibre coated on the outer surface with a layer of stationary phase. The silica capillary is immersed into a small volume of stirred water sample for 2-15 minutes during which organic material partitions into the stationary phase (Prosen and Zupancic, 1999) [10]. It is the most time saving method for the rapid determination of the aroma compound composition. Example: marjoram, caraway, sage and thyme.

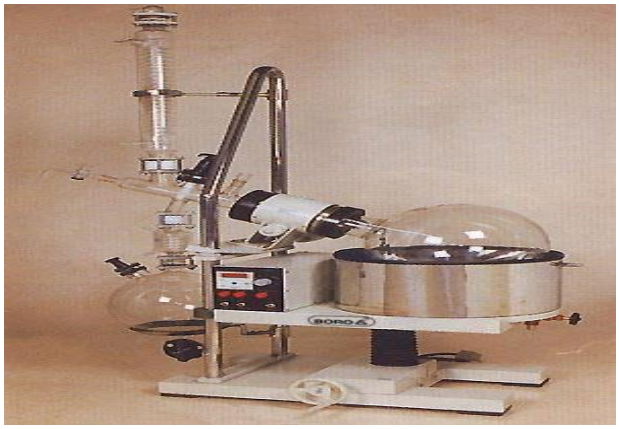
Circulatory extraction

The efficiency of the extraction in a maceration process can be increased by arranging for the solvents to be continuously circulated through the drug. It is of following types:

1. Multiple stage extraction: The extractor is filled with drug, solvent is circulated and is run off to the first receiver. Extractor is refilled with the solvent, procedure is repeated. Now the drug is removed from the extractor and is recharged. The first solution is made to extract the fresh drug and is removed to evaporate. Then second solution extracts the drug and becomes solution one. Similarly solution three becomes solution two. Fresh solvent is added and is run off to receive three. Drug is removed, recharged and the cycle is repeated.
2. Extractor battery: This equipment is based on the countercurrent movement of solvent and the drug. In this, the solution contacts the fresh drug before discharge, giving maximum concentration and the drug contacts fresh solvent before dumping, ensuring exhaustion. The apparatus consists of number of vessels with interconnecting pipe works, such that solvent can be added to and product taken from any vessel. The vessels can be arranged into series with any of the vessels as the first of the series (Handa *et al*., 2008) [6].

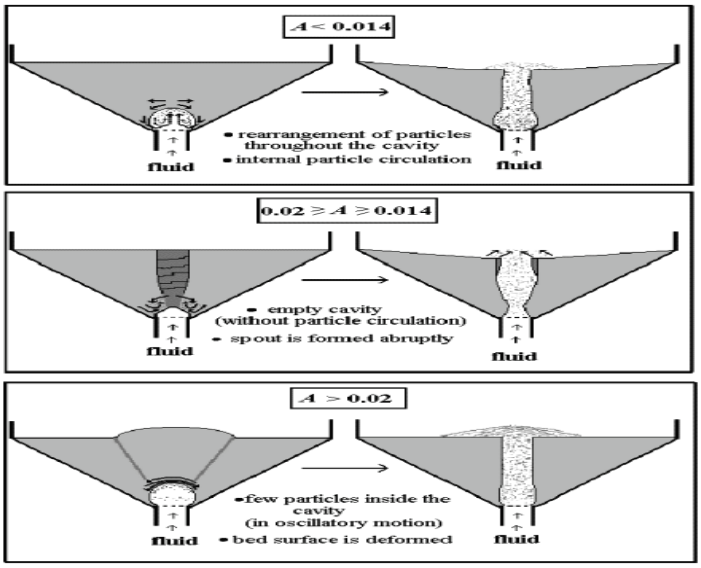
Rotary film evaporator

It consists of a narrow cylindrical vessel with a bladed rotor is placed inside. In this, a film is formed and agitated mechanically due to which there is a good heat transfer. Evaporation occurs as the liquid passes down the wall, vapour is taken off to a condenser and the concentrated is withdrawn at the bottom of the vessel.



Spouted bed extraction

It consists of a cylinder tapered at both ends and containing the drug to the lower end through which a jet of hot air is forced. The drug is propelled into the space above from where it fall back to the recirculated and annatto powder is collected. Example: seeds of *Bixa orellana*.

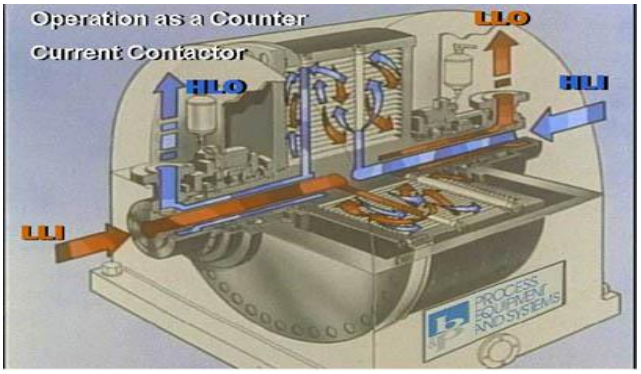


Bio-chelation

Bio-chelation includes the use of cold extraction, where the plant parts are extracted without being exposed to excessive amount of heat. In addition the process incorporates the use of an exclusive technique that removes much of the alcohol used during the maceration phase, replacing it with vegetable glycerine.

Phytonic extraction

This method uses a new type of benign non-chlorofluorocarbon (CFC) gaseous solvents, also called as florasols.

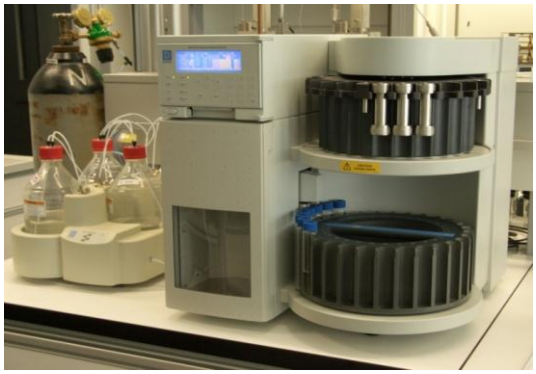


Forced flow solid-liquid extraction (FFSLE)

Such type of technique is employed by many methods like medium pressure solid liquid extraction and rotation planer extraction. Here the extraction solvent is forced through the sample bed either by means of pressure or by centrifugal force thus increasing the efficiency of the extraction process.

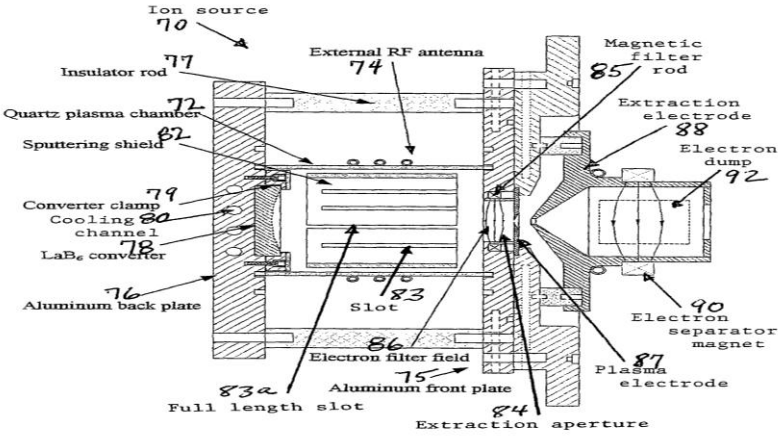
Pressurized liquid extraction or accelerated solvent extraction

This method works according to the principle of static extraction with superheated liquids. The method uses an organic solvent at high pressure and temperature above the boiling point. There is increased efficiency because of higher solubilities of analytes in solvents at higher temperature, higher diffusion rate and disruption of the strong solute-matrix interaction. Example: extract of kavain from the powdered roots of *Piper methysticum* (Kaufmann and Christen, 2002) [8].



Electrical discharge extraction technique

In this method, cavitation phenomenon is achieved by the electrical discharge. The electrical source charges the capacitor which discharge through the spark gap and electrodes. This high frequency discharge causes cavitation (Boussetta *et al.*, 2009) [2]. Example: *Rauwolfia* extract and *belladonna* extract.



Conclusion

Conventional as well as novel extraction techniques both extract phytoconstituents from herbal drugs. But when we compare the conventional and novel extraction techniques, novel extraction techniques are more efficient in terms of time, power consumption, solvent consumption etc. so, to enhance the efficiency experiments through novel exraction techniques should be done.

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