Conventional Extraction Methods Use in Medicinal Plants, their Advantages and Disadvantages

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Abstract: ***Medicinal plants are gaining much interest because of their use to treat and cure common as well as chronic diseases. The study on medicinal plants started with extraction procedures that play a critical role. A wide range of technologies with different methods of extraction is available nowadays. These techniques are conventional (traditional using from long ago) and Modern (developed more recently). The conventional extraction methods use solvents and require long extraction time whereas modern extraction methods have also been applied in natural products extraction. The modern extraction methods are complex, not easily available and costly whereas Conventional extraction methods are simple, easily available and low cost. A domestic application of conventional extraction is quite familiar to everybody in daily life from the making of coffee or tea at home. It is very crucial to develop effective and selective conventional extraction methods so that practitioners and researcher inspire and improve efficiency. This review presents a detailed description of the various Conventional extraction methods for better understanding and summarizes the potential, to help evaluating the suitability and economic feasibility of them. A comparison of the performance, advantage and disadvantage of these methods is also presented.***

Keywords: ***Conventional extraction method, medicinal plants, percolation, maceration, decoction, soxhlet extraction.***

I. INTRODUCTION

The qualitative and quantitative studies of bioactive compounds from plant materials mostly rely on the selection of proper extraction method [1, 2]. Plants materials are on increasing interest for their applications in pharmaceutical, nutritional and cosmetic application. They are the source of useful bioactive ingredients known for long times ago by traditional uses for medical purposes [3]. The use of traditional medicine and medicinal plants in most developing countries has been widely observed and about 80% of the world's population relies on herbal medicines than current modern medicine [4]. Plants contain many active compounds such as alkaloids, steroids, tannins, glycosides, volatile oils, fixed oils, resins, phenols and flavonoids which are deposited in their specific parts such as leaves, flowers, bark, seeds, fruits, root [5]. There are several extractions methods exist to extract compound from plants [6]. These techniques can be call conventional (traditional using from long ago) and new (modern and developed more recently). Conventional methods are the ones using organic solvents or water and at atmospheric pressure while new methods using pressure and / or elevated temperatures [7]. Methods used for extraction are necessary for the differentiation of active components of plant tissues from the originated components by using appropriated solvents. During this process, the solvents move into the solid plant materials and solubilize the compounds with similar polarity [8]. It should be noted that choice of appropriate solvent is of essential importance along with application of a compatible extraction method. For selection of solvents 'like dissolves like' principle is applicable. Thus polar solvents will extract out polar substances and non-polar substances by non polar solvents. The initial crude extracts contain complex mixture of many plant metabolites (Table 1). To obtain bioactive compounds from plants, the conventional (traditional) methods commonly uses are: Percolation, Maceration Decoction, Soxhlet extraction and Hydro distillation (Table 2) [9]. Conventional methods such as Maceration and Soxhlet extraction are commonly uses at the small research setting or at Small Manufacturing Enterprise (SME) level. Moreover, modifications on the methods are continuously developed. With such variety of methods present, selection of proper extraction method needs meticulous evaluation. The present paper is aim to provide a comprehensive review of different conventional extraction methods of bioactive compounds from medicinal plants and describes their advantage and disadvantages for the selection of proper methods.

II. EXTRACTION METHODS

Extraction, as the term is uses pharmaceutically, involves the separation of medicinally active compounds of plant or animal tissues from the inactive or inert components (desired and undesired) by using selective solvents in standard extraction procedures [10]. The products so obtained from plants are relatively impure liquids, semisolids or powders intended only for oral or external use. Some of the initially obtained extracts may be ready for use as medicinal agents in the form of tinctures and fluid-extracts but some need further processing. The conventional extraction methods, including Maceration, Percolation and Soxhlet extraction, usually use organic solvents and require a large volume of solvents and long extraction time whereas decoction and Hydro distillation methods use water as a solvent. The common conventional extraction methods uses has been discussed below:

Revised Version Manuscript Received on 20 March, 2019.
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Table 1: Solvents used for active component extraction.

Water	Ethanol	Methanol	Chloroform	Dichloromethanol	Ether	Acetone
Tannins Anthocyanin Terpenoids Saponins	Tannins Terpenoids polyphenol Flavonoids Alkaloids	Tannins Terpenoids polyphenol Saponins Anthocyanin	Flavonoids Terpenoids	Terpenoids	Alkaloids Terpenoids	Flavonoids

A. Maceration

It is an old method used for medicinal preparation. It is consider as a widely and low-cost way to get natural products from plant material. The maceration is a method of solid–liquid extraction. In this process, the powdered solid materials is placed in a closed vessel (Fig. 1) and the solvent is added. It is allowed to stand for a long time (varying from hours to days) with occasional shaking. Sufficient time is allowed for the solvent to diffuse through the cell wall to solubilize the constituent present in plant. The process takes place only by molecular diffusion. After the desired time, the liquid is strained off; the solid residue is pressed to recover as much solvent as possible. When the solvent is water and the period of maceration is long, a small quantity of alcohol may be added to prevent microbial growth [9]. Maceration involve three principals' steps. Firstly, plant materials is convert to powder form by grinding. This allow good contact between solvent and materials. After grinding, a chosen solvent is added in a closed vessel. Then, the liquid is strained off but the solid residue of this extraction process is pressed to recover large amount of occluded solutions. During the process of maceration occasional shaking facilitate extraction by increasing diffusion and remove concentrated solution from the sample surface for bringing new solvent to the menstruum for more extraction yield [11].

Fig. 1. Maceration extraction apparatus

Advantages:

1. Maceration is a simple method using non-complicated utensil and equipment.
2. Skilled operator not required.
3. Energy saving process.
4. For certain substances which are very less soluble in solvent and requires only prolonged contact with solvent is ideal..
5. Suitable method for less potent and cheap drugs.

Disadvantage:

1. Unfortunately, the duration of extraction time is long and sometimes takes up to weeks.
2. Not exhaustively extract the drug.
3. It is very slow process and time consuming.
4. Solvent required is more.

Table 2. Comparison of various extraction methods for natural products:

Method	Solvent	Temperature	Pressure	Time	Volume of solvent
Maceration	Water, aqueous and non-aqueous solvents	Room temp.	Atmospheric pressure	Long	Large
Percolation	Water, aqueous and non-aqueous solvents	Room temp. occasionally under heat	Atmospheric pressure	Long	Large
Decoction	Water	Under heat	Atmospheric pressure	Moderate	None
Soxhlet	Organic Solvents	Under heat	Atmospheric pressure	Long	Moderate
Hydro distillation	Water	Under heat	Atmospheric pressure	Long	None

B. Percolation

This is the procedure used most frequently to extract active ingredients in the preparation of tinctures and fluid extracts. A percolator (a narrow, cone-shaped vessel open at both ends) is generally used (Fig. 2).

The solid ingredients are moistened with an appropriate amount of the solvent and allowed to stand for approximately 4 h in a well closed container, after which the mass is packed and the top of the percolator is closed. Additional solvent is added to form a shallow layer above the mass, and the mixture is allowed to macerate in the closed percolator for 24 h. The outlet of the percolator then open and the liquid contained there is allowed to drip slowly. Additional solvent is added as required, until the percolate measures about three-quarters of the required volume of the finished product [9]. The extract is then pressed and the liquid is added to the percolate. Sufficient solvent is added to produce the required volume, and the mixed liquid is clarified by filtration or by standing followed by decanting. The process is repeated until a drop of the solvent from the percolator when evaporated does not leave a residue [3].

Fig. 2. Percolation extraction apparatus

Advantages:

1. Requires less time than maceration.
2. Extraction of thermolabile constituents can be possible.
3. Suitable method for potent and costly drugs.
4. Short time and more complete extraction.

Disadvantages:

1. Requires more time than soxhalation.
2. More solvent is required.
3. Skilled person is required.
4. Special attention should be paid on particle size of material and throughout process.

C. Decoction

It a suitable method for the extraction of the constituents soluble in water and that cannot also been destroyed by the effect of heat [12]. Decoction is a water-based preparation to extract active compounds from medicinal plant materials. In this process, the liquid preparation is made by boiling the plant material with water (Fig. 3). Decoction is the method of choice when working with tough and fibrous plants, barks and roots and with plants that have water-soluble chemicals. The plant material is generally broken into small pieces or powdered. Different methods have been described for the preparation of decoctions. In the Ayurvedic method, traditionally known as *kwatha*, the crude drug in form of *yavakuta* (small pieces) is placed in earthen pots or tinned copper vessels with clay on the outside. Water is added and the pot is heated on a fi re. If the material is soft, four times water is used per 1 part drug; if the drug is moderately hard, eight times water is used and if the drug is very hard, sixteen times water is recommended. The mixture is then boiled on low flame until it is reduced to one-fourth starting volume, in case of soft drugs, and one-eighth in case of moderately or very hard drugs. The extract is then cooled and strained and the filtrate is collected in clean vessels [9].

Fig. 3. Decoction extraction apparatus

Advantages:

1. Suitable for extracting heat-stable compounds.
2. This method does not required more and expensive equipment.
3. It is easy to perform.
4. No need trained operator.

Disadvantage:

Unfortunately, it is not advised for the extraction of heat sensitive constituents.

D. 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 [13]. Soxhlet apparatus is a specialized glass refluxing unit mainly used for organic solvent extractions (Fig. 4). Soxhlet extraction is a general and well-established technique, which surpasses in performance other conventional extraction methods except for, in limited fields of application, the extraction of thermolabile compounds. 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 reflux condenser. The solvent in the RB flask is boiled gently, the vapor 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. The operation is repeated until complete extraction is achieved [3].

Advantages:
1. Large amount of plants materials can be extracted at a time.
2. Repeatedly can use solvent
3. This method does not require filtration after extraction
4. This method does not depend upon the type of matrix.
5. It is a very simple technique.
6. The displacement of transfer equilibrium by repeatedly bringing fresh solvent into contact with the solid matrix.

Disadvantages:
1. The samples are heated to a high temperature for a relatively long period thus the risk of thermal destruction of some compounds cannot be overlooked if the plant material contains heat labile compounds.
2. The extraction time is lengthy and the process is labor intensive
3. The process allows manipulations of limited variables. The time and the requirement of a large amount of solvent result in wide criticism of Soxhlet extraction technique [14].

Fig. 4. Soxhlet extraction apparatus

E. Hydro distillation

Hydro distillation is a traditional method for extraction of plants materials that doesn't used organic solvents. In hydro distillation, plant materials are packed in a still compartment and water is added in sufficient amount, and then brought to boil (Fig.5). Alternatively, direct steam is injected into the plant sample. Hot water and steam act as the main influential factors to free bioactive compounds of plant tissue. Indirect cooling by water condenses the vapor mixture of water and oil. Hydro Distillation is potentially a very useful method to extract essential oil from various plants and from their different parts. The yield is dependent on various parameters like weight of raw material, volume of water, size of raw material and nature of raw material [15]. Hydro distillation involves three main physio chemical processes; Hydro diffusion, hydrolysis and decomposition by heat. At a high extraction temperature some volatile components may be lost. This drawback limits its use for thermolabile compound extraction.

Fig. 5. Hydro distillation apparatus

Types of Hydro distillation:
There are three types of hydro distillation for isolating essential oils from plant materials:
1. Water distillation
2. Water and steam distillation
3. Direct steam distillation

Water Distillation:
In this method, the material is completely immersed in water, which is boiled by applying heat by direct fire, steam jacket, closed steam jacket, closed steam coil or open steam coil. The main characteristic of this process is that there is direct contact between boiling water and plant material.

Water and Steam Distillation:
In water and steam distillation, the steam can be generated either in a satellite boiler or within the still, although separated from the plant material. Like water distillation, water and steam distillation is widely used in rural areas. Moreover, it does not require a great deal more capital expenditure than water distillation. Also, the equipment used is generally similar to that used in water distillation, but the plant material is supported above the boiling water on a perforated grid. In fact, it is common that persons performing water distillation eventually progress to water and steam distillation.

Direct Steam Distillation:
As the name suggests, direct steam distillation is the process of distilling plant material with steam generated outside the still in a steam generator generally referred to as a boiler. As in water and steam distillation, the plant material is supported on a perforated grid above the steam inlet. A real advantage of satellite steam generation is that the amount of steam can be readily controlled. Because steam is generated in a satellite boiler, the plant material is heated no higher than 100° C and, consequently, it should not undergo thermal degradation. Steam distillation
is the most widely accepted process for the production of essential oils on large scale. Throughout the flavor and fragrance supply business, it is a standard practice.

Advantages:

1. Higher oil yield.
2. Components of the volatile oil are less susceptible to hydrolysis and polymerization (the control of wetness on the bottom of the still affects hydrolysis, whereas the thermal conductivity of the still walls affects. polymerization).
3. If refluxing is controlled, then the loss of polar compounds is minimized.
4. Oil quality produced by steam and water distillation is more reproducible.
5. No organic solvent needed so this process is cheap and environment friendly.

Disadvantages:

1. Complete extraction is not possible.
2. As the plant material near the bottom of the still comes in direct contact with the fi re from the furnace, it may char and thus impart an objectionable odor to the essential oil.
3. The prolonged action of hot water can cause hydrolysis of some constituents of the essential oil, such as esters.
4. Heat control is difficult, which may lead to variable rates of distillation.
5. It requires a greater number of stills, more space and more fuel. Thus, the process becomes uneconomical.

III. CONCLUSION

The ever-growing demand to extract plant bioactive compounds encourages continuous search for convenient extraction methods. The conventional methods are bases on the solubility of solute from plant materials into solvent. Therefore, it often utilizes a large quantity of solvent to extract the desired compound, even though sometimes assisted with elevated temperature and mechanical stirring or shaking. It can be concluded that, no universal extraction methods is the ideal method and each extraction procedures is unique to the plants. Proper choice of standard methods also influences the measurement of extraction efficiency. On the other hand, the increasing economic significance of bioactive compounds and commodities rich in these bioactive compounds may lead to find out more sophisticated extraction methods in future.

ACKNOWLEDGEMENT

I would like to record my gratitude to Dr. Pranab Ghosh, Department of Chemistry, University of North Bengal, India and Dr. Hamdi Khalil, Qaseem Private Colleges for their support.

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