REVIEW ARTICLE

Conventional extraction methods versus novel extraction methods of bioactive compounds from some medicinal plants

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Abstract

Extraction methods of chemical constituents, plant metabolites, phenolic compound, and essential oil are still interested part for recognition of novel drug compound from medicinal plants. Plants extraction methods have existed from ancient times to present era. Extraction method is a major step in the preparation of any pharmaceutical dosage from as well as searching for a new molecule for the preparation of drugs. The extraction methods should be less time consuming, easy, and cheap, give more yield with or without less solvent, solvent recovery without any changes in yield and separation of chemical constituents should be easy. There are many extraction methods which are available nowadays from conventional method to novel extraction method. In these review paper, we are focus about conventional methods and novel methods of extraction of plants, advantages and disadvantages, factors affecting the extraction of medicinal plants, and also discussing some points about which method is superior and satisfactory methods for the extraction of bioactive compounds of plants.

Key words: Bioactive compounds, extraction methods, medicinal plants, metabolites, phytochemicals

INTRODUCTION

Phytochemicals derived from medicinal plants provide a vast chance to launch new drug molecules and new drug discoveries for diseases that do not have any kind of drug treatment still. Medicinal plants are used in herbal formulations, in herbal cosmetics preparation and bioactive compounds are used in drug formulations.[1] In plants, secondary metabolites have a therapeutic effect against a variety of diseases. Some examples of secondary metabolites are glycosides, alkaloids, volatile oil, flavonoids, tannins, terpenoids, and resins. Extraction of bioactive compounds is a very significant step for the isolation, purification, and restoration of active chemical constituents after the identification and collection of medicinal plants.[2,3] These active chemical constituents from medicinal plants have antiviral, antifungal, antibacterial, and anticancer activity against humans.[4] For the extraction of phytochemicals, there are many conventional methods and novel extraction according to the solubility of active phytochemical ingredients from medicinal plants and the choice of solvents. Some traditional or conventional methods are Soxhlet extraction, hydrodistillation, percolation, and maceration and some novel extraction techniques are microwave-assisted technique Microwave-assisted extraction (MAE), supercritical fluid extraction (SFE), pressurized liquid extraction (PLE), ultrasound-assisted extraction (UAE), etc.[5,6] Conventional methods of extraction are time consuming, requires a large amount of solvent, takes more energy, and gives less yield of phytochemical constituents from medicinal plants. It is reasonable that novel extraction techniques take more attention from researchers because it is less time consuming, have less solvent requirement, and higher yield of bioactive compounds. Novel methods of extraction such as MAE and SFE have some advantages such as short-time duration of extraction, low cost, energy consumption, and higher yield also.[7]

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CONVENTIONAL OR TRADITIONAL METHODS OF EXTRACTION

Percolation

In this technique, a cone-shaped, narrow vessel apparatus is used for extraction known as a percolator. It is open at both ends. In percolation, solid material is used after being moistened with a specific solvent for the extraction of active pharmaceutical ingredients for the preparation of tinctures. The advantages of the percolation method are less time taken in comparison to maceration, thermolabile active constituents can be extracted, and useful for the extraction of costly and potent drugs. The percolation method has also some disadvantages such as a high solvent requirement, more time taken than Soxhlet extraction, a trained person is required, and the particle size of the solid drug is taken special attention.[8,9]

Maceration

In maceration technique, coarse or whole powder crude drug is placed with a specific solvent in a stoppered container and allowed for a specific time (3 days) at room temperature with frequent agitation till the soluble bioactive material has dissolved. After 3 days, filter the whole mixture with solvent and collect the soluble bioactive compounds. Some merits of maceration are that it is easy to operate, and a cheap, wide variety of compounds can be extracted. The demerits of this method are time-consuming process, require a large volume of solvents, and follow other additional steps of filtration and centrifugation to get clear filtrate.[10,11]

Soxhlet Extraction (Hot Continues Method)

Soxhlet extraction is also known as solid-liquid extraction because medicinal plants are used in solid (powder) form with a specific solvent with heat for the extraction of phytochemicals. This technique is operated by the apparatus known as the Soxhlet apparatus and consists of glass. It has been used since ancient times. A most special feature of Soxhlet extraction is that the crude drug powder is continuously in contact with a fresh solvent which increases the efficiency of the extraction method. This method has advantages is that thermolabile compounds can be extracted, commonly used for nutraceuticals, fresh solvent contact with powder drug makes more efficient to this method, low cost and disadvantages such as long-time duration, high solvent requirement, chances of thermal decomposition, and agitation of powder sample is not possible.[12-14]

SFE

SFE is using supercritical fluid (SCF). SCF consists of the most common solvents for the extraction of bioactive compounds from medicinal plants such as ethanol, benzene, carbon dioxide, propane, ammonia, and methane all from it carbon dioxide is the most useful solvent because of some properties such as low cost, chemically stable, and zero surface tension. SCF solvent is the most popular combination for extraction.[15] SFE is a systematic method of extraction used in nutraceuticals, pharmaceutical, and cosmetic industries for the extraction, separation, and isolation of bioactive compounds.[16] Some suitable environments example elevation of temperature or use of modifiers produces higher yield recovery than other convention methods.[17] SFE is planned to displace the various steps in the conventional method, make it less time consuming, and make less sample preparation in different steps and a small number of organic solvents consumption. SCF solvents are the most useful solvents because of their properties such as higher diffusivity, lower viscosity, and density. CO_2 is the most common solvent used in this method because of its low cost, easily available, and safe. The SCF also has the property to penetrate the solid powder mass more than other organic solvents. SFE technique is the most common method to extract a variety of bioactive components.[18-20] Some drawback of this method is temperature, environment, operating method should be handled carefully to get a higher yield.[21]

NOVEL (GREEN) EXTRACTION METHODS

There are most of the conventional methods of the extraction of bioactive compounds from plants which are available for decades. Conventional methods of extraction are time consuming, need a high number of solvents, many additional steps to extract any phytochemical, high-energy requirements which all make them less suitable and efficient. To banish all these drawbacks, novel or green extraction techniques are nowadays applied to the extraction of bioactive compounds. Novel techniques are used not only to save energy or time while it is also used for the less solvent requirement, more recovery of solvents, and improve the quality, sensitivity, and efficacy of the extraction process, there are some most commonly green extraction methods which are used such as MAE, UAE, PLE, and accelerated solvent extraction (ASE); we are discussing some novel techniques of extraction.[22-24]

MAE

MAE is one of the best novel extraction methods which is the combination of microwave and conventional solvent extraction methods. In the MAE technique, the extraction of phytochemicals can be done by with water or without organic solvent in a microwave reactor. MAE technique takes less time, has less solvent requirement improved the quality of extract, and gives a higher number of bioactive compounds. MAE is used for the extraction of nutraceuticals from plants and seaweeds. In green technology, solvent-free, microwave-assisted extraction (SFAE) is one of the best novel techniques of extraction because extraction of plant material can be

Table 1: Comparative study of some medicinal plant's extraction by conventional and novel extraction technique

Name of plants	Part used	Technique	Bioactive compound	Time In h/ min	Micro-wave power in W	Temp. in °C	Sample taken for extraction	Yield %or mg/g	Ref.
Robinia pseudoacacia (black locust)	Flower	UAE Maceration Soxhlet - extraction	Total phenolic compound	0.5 24 6	- - -	59 25 90	2 g 2 g 5 g	3.12 mg 2.54 mg 3.22 mg	[40]
Carum carvi (caraway seeds)	Seed	Soxhlet-extraction UAE MAE	Total volatile oil	5 1 1	- - -	69 20–38 69	5 g 2.5 g -	50.45 mg 44.45 mg 45.78 mg	[41]
Petroselinum crispum (parsley leaves)	Leaves	Soxhlet-extraction UAE MAE	Apigenin	6 30 min 2 min	- - 180 w	70 40 -	6 g - 0.5 g	18.51 mg 9.48 mg 7.90 mg	[42]
Camellia sinensis (Green tea)	Leaves	Soxhlet-extraction Ultrasonic extraction HPE	Total Polyphenolic compound	20 h 90 min 1 min	- 250 W -	Room temp - 20-40	100 g 100 g 100 g	76.6% 76% 77%	[43]
Synedrella nodiflora	Weed	Maceration Soxhlet extraction HAE UAE	Total Polyphenolic compound	24 h 6 h 5 min 1 h	- - - -	Room temp Room temp - 30	5 g 5 g 5 g 5 g	34.84 mg 44.49 mg 39.29 mg 33.69 mg	[44]
Melissa officinalis (Lyophilized powder)	leaves	Maceration UAE MAE	Catechin	24 h 20 min 5 min	- 150 W 407 W	40 - -	1 g 2.5 g 1 g	3.45 mg/g 2.01 mg/g 1.353 mg/g	[45]
Ganoderma atrum	Fungus	MAE SFE UAE	Terpenoid saponin	5 min-10 min - 15 min	800 W - -	78 55 Room temp	- 80 g -	5.11% 1.52% 1.72%	[46]
Cymbopogon citratus (Lemongrass)	Leaves	Conventional HD Enzymatic pre-treatment (Before HD with cellulose + β galactosidase)	Essential oil	6 h 6 h	- -	50 50	200 g 200 g	0.41% 0.97%	[47]
Rosa rubiginosa	Flower	SFME OAH HD	Essential oil	25 min 3 h 18 min	400 W - -	- - -	100 g 100 g -	0.056% 0.033 0.047	[48]
Agaricus bisporus (Mushroom)	Fungus	Soxhlet extraction UAE MAE	Ergosterol (In ethanol)	4 h 5 min -	- 375 W 500 W	- - -	100 g 100 g 100 g	676 mg 671 mg 577.2 mg	[49]

UAE: Ultrasound-assisted extraction, OAH: Ohmic-assisted hydrodistillation, HD: Hydrodistillation, HAE: Homogenizer-assisted extraction

done without any solvent. MAE and SFAE are commonly used for the extraction of phenolic compounds, essential oil, and antioxidants. In the 21st century, the green techniques of extraction are used for extraction just because of their properties. Some advantages of MHG are very less time taken for extraction, higher amount of yield, less solvent consumption, cost effective, and presence of methanol solvent in water is beneficial for extraction and permits faster extraction than the organic solvent alone. But also, some drawbacks of MHG are the risk of degradation of thermolabile components, the nature of plant material and particle size affect the extraction, and chances of ignition of material if temperature and microwave radiation are not checked from time to time.[25-28]

UAE

In green extraction techniques, UAE gains more attention due to its environment-friendly nature, and use of clean, non-toxic,

and green solvent. Nowadays, this green technique is used for the extraction of bioactive compounds from plants, algae, fungi, fruits, and even bacteria also at the laboratory as well as in industries. UAE differs from other novel extraction methods due to its properties such as energy generated during the extraction and applied per molecule, time duration of extraction, temperature, and ease of installation.[29,30] Cavitation is a driving force in UAE for the extraction of materials.[31] MAE method is used for these advantages like it is energy saving technique, also can use for thermolabile materials, high-power ultrasound, and low temperature increases the number of bioactive constituents. It is the most effective method in green technology extraction techniques due to less solvent requirement and short-time duration of extraction.[32] A common disadvantage of ultrasound-assisted extraction in an ultrasound bath is the situation of the container that carries the solvent and matrix which have to be extracted. The ultrasound waves can change the efficiency of the extraction of material.[33]

PLE

The PLE method is consisting of basic steps like the extraction vessel is loaded with material to be extracted with a preselected solvent with temperature and pressure for a specific time duration. The solvent is injected through the vessel for contact of the fresh solvent with the sample and the vessel is purified by the inert gas to confirm the total removal of the solvent from the tube and vessels of the PLE system.[34] PLE is used mainly to extract the bioactive components from plants and extraction of nutraceuticals and pollutants present in the environment.[35] Some merits of PLE are that it is the most popular technique for the extraction of bioactive compounds, polyphenolic components, and nutraceuticals due to rapid extraction, less time requirement, fewer solvent requirements, and high yield of compounds with one common drawback that is the high temperature which is used for extraction.[36]

ASE

ASE techniques have also known as pressurized fluid extraction.[37] This method is a fully automated and reliable technique. The advantages of this method over traditional or conventional methods are the drastic reduction of the solvent used for the extraction and less time is taken to process, a wide range of applications, small sample size, etc.[38,39] In the ASE technique, the solvents are used at high pressure and temperature to increase the effectiveness of the extraction. However, a high temperature is also the disadvantage of this method because it can rupture the plant matrix.[39]

CONVENTIONAL VERSUS NOVEL EXTRACTION TECHNIQUES

As mentioned in Table 1, we can clearly see the differences between both traditional and novel methods of extraction. Medicinal plants play an important role in the discovery of new molecules and drugs, and for this purpose, the first step is to identify the plants and after that extraction of bioactive components which have therapeutic effects. There are various extraction methods for the extraction of medicinal plants from traditional to novel methods. According to many studies, we have seen sometimes the yield of bioactive compounds is more in conventional methods like Soxhlet extraction and significantly less amount in novel methods such as UAE and MAE. However, if we give attention to both methods, we found that the conventional methods are time consuming, more energy taking, and more solvent necessity. In the same amount of time, we extract once from the plant with the old method, we can extract the phytochemicals from the novel method many times without taking longer time, saving energy, less solvent, and power requirement.

CONCLUSION

The extraction of phytochemicals is affected by the nature of solvents, temperature, microwave power, cost and recovery of solvent, etc. In this review article, we have seen that sometimes, the number of phytochemicals in the conventional method is more than in the green or novel extraction technique but the bioactive compound is more in novel methods, as per the data given in Table 1, we have seen that the yield of bioactive compounds is more than the conventional method without wastage of solvent, energy, and time. It is also cost-effective, non-toxic, and renewable. In green techniques of extraction, we should get more yield from the plants, algae, and fungi, if we know about the optimum temperature and microwave energy for the extraction of the sample. Hence, novel extraction method is more useful for the extraction of bioactive compounds.

FUTURE PROSPECTUS

According to many studies by researchers, the yield of phytochemicals is found in more amounts by novel extraction methods within less duration of time, without wastage of extra solvent and energy. Due to many properties such as being cost effective, less time consuming, easy to operate, high purity of yield, and especially for the extraction of bioactive compounds in higher amounts as compared to the conventional methods, such as essential oils, phenolic compounds, antioxidants, and flavonoids, it is used. Nowadays in pharmaceutical industries, in herbal preparation, nutraceuticals, and cosmetic preparation, green techniques are used for the extraction of bioactive compounds. Hence, researchers should also give attention to how to escape the drawbacks of novel methods of extraction though these methods are got more effective and efficacious and still have some drawbacks which need to maintain or remove from them.

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