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A Review on: Modern Vs Conventional Extraction Techniques

Ms.Chandele Priya Pratapsingh [*1], Mr. Gaikwad Vishal Shivaji *2 , Mr. Jadhav Vaibhav Appasaheb [*3]

***1-Author Student at Pratibhatai Pawar College of Pharmacy.**

***2&*3-Co-Author Assistant Professor at Pratibhatai Pawar College of Pharmacy**.

Abstract

Phytochemicals have proved extremely beneficial to societies all throughout the world. Healthcare organizations have employed these metabolites as medications to treat a range of illnesses. Moreover, phytochemicals are employed as lead molecules in pharmaceutical synthesis. The foundation of research on natural products is the extraction of chemicals from plant materials. The search for more effective extraction techniques has been ongoing. Similarly, a number of exciting new green extraction techniques are beginning to take centre stage. These include enzyme-assisted extraction, accelerated solvent, supercritical fluid, ultrasound, and microwave techniques. The many extraction methods that are used to extract phytochemicals from various plant sections are described and discussed in this article. Among these extraction methods are the traditional solvent-based methods as well as the more resilient contemporary and environmentally friendly methods. The review examines the extraction circumstances critically.

Keywords : Extraction**,** Conventional and modern techniques , Principle and Mechanism , soxhlet apparatus , solvent extraction.

Introduction

Since of their unique qualities, medicinal plants are currently viewed as being very important since they represent a major source of therapeutic phytochemicals that have the potential to be developed into new medications. It has been shown that the majority of phytochemicals derived from plants, including flavonoids and phenolics, improve health and prevent cancer. Pre-extraction and extraction techniques are the first steps in the study of medicinal plants. They are crucial in the extraction of the bioactive components from plant materials [10].

Today, it is vital to create efficient and focused procedures for the extraction and separation of those naturally occurring bioactive substances. The "active ingredients" or "active principles" of natural medicines are substances that are recognized to provide therapeutic advantages. The main resources for developing new drugs have been natural ingredients. Almost half of the FDA-approved chemical medications for the treatment of human diseases between the 1940s and the end of 2014 were developed from or inspired by natural sources [1].

One of the most important steps in developing analytical techniques for phytochemistry is the extraction of active chemicals from plant material. A straightforward, safe, repeatable, low-cost extraction technique that is appropriate for industrial use is what makes it ideal [5]. Many different types of bioactive substances, including lipids, phytochemicals, pharmaceutics, tastes, perfumes, and pigments, are found in plants. In the culinary, pharmaceutical, and cosmetics industries, plant extracts are widely employed. Many studies have been conducted on extraction methods to extract these important natural chemicals from plants for commercial use [4].

The appropriate extraction technique is largely responsible for the results of both qualitative and quantitative investigations of bioactive compounds from plant sources [3]. Plant materials can be extracted using a variety of extraction techniques [2]. While the advancement of chromatographic and spectrometric techniques has made the identification of bioactive compounds easier than in the past, the precise nature of plant parts, input parameters, and extraction processes remain critical to the success of the process [2].

Extraction

To extract the desired natural compounds from the raw materials, the first step is extraction. Sublimation, pressing, distillation, and solvent extraction are examples of extraction techniques based on the extraction principle.

The most used approach is solvent extraction. Natural product extraction proceeds as follows:

(1) Solvent permeates the solid matrix

(2) Solute dissolves in solvents

(3) Solute diffuses from the solid matrix

(4) Extracted solutes are collected [1].

To determine the extraction selectivity from different natural sources, different extraction procedures should be employed under different situations. Various methods, many of which

have remained virtually unchanged for hundreds of years, can also be employed to extract bioactive substances. All these techniques have some common objectives which are as follows:

(a) To extract targeted bioactive compounds from complex plant samples

(b) To improve analytical methods' selectivity

(c) To boost bioassay sensitivity by increasing the concentration of targeted compounds

(d) To transform the bioactive compounds into a form better suited for separation and detection

(e) To offer a robust and repeatable method that is unaffected by changes in the sample matrix [2].

In order to extract such valuable natural chemicals from plants for commercialization, extraction techniques have been extensively studied. Soxhlet extraction is one of the numerous decades-old traditional processes that takes a lot of time and relatively big amounts of solvents [4].

Extraction techniques

Extraction is the process of separating the parts of a plant that have medicinal properties using certain solvents and accepted practices. Every extraction process aims to extract the soluble plant metabolites while discarding the insoluble cellular waste. Many plant metabolites, including alkaloids, glycosides, phenolics, terpenoids, and flavonoids, are present in complex mixtures in the initial crude extracts obtained by these procedures. It may be possible to employ some of the first extracts obtained as tinctures and fluid extracts as therapeutic agents, but other extracts require additional processing. Several of the commonly used extraction methods are discussed below:

There are mainly two types of extraction techniques for extracting phytochemicals from medicinal plants which are as follows:

(1) Conventional or Traditional extraction techniques.
(2) Modern extraction techniques

Conventional Extraction Techniques

Traditional techniques, such infusion, decoction, percolation, or maceration—that is, straightforward solvent extraction supported by no additional energy source—remain widely employed in phytochemistry labs. Up to the development of novel extraction techniques, these procedures—along with extraction under reflux and Soxhlet extraction—had been the most widely utilized ways to extract active chemicals from plant material [5]. The traditional extraction techniques, such as maceration, percolation, and reflux extraction, typically call for a substantial amount of solvents and a lengthy extraction period and include the use of organic solvents [1].

Maceration

Maceration is a straightforward extraction technique that entails soaking the coarsely ground or powdered plant raw material in a suitable solvent for at least three days at room temperature with periodic stirring. Following the extraction process, the mixture is strained using a net with microscopic pores or sieves. The marc is then squeezed, and after standing, the liquid extract is cleaned by either filtration or decantation. To reduce solvent loss from evaporation, maceration should ideally be done in a stoppered container. During the extraction process, it is not desired to produce an extract that is already concentrated due to solvent evaporation. Vacuum evaporation is commonly used to concentrate the substance. Choosing the right maceration solvent is essential since it will identify the classes of phytochemicals that can be recovered from the samples. The extraction of phytochemicals that are thermolabile may also be made possible by the solvent. Low efficiency and a lengthy extraction process are the procedure's main drawbacks [17].

The drawbacks of this straightforward extraction technique include its extended extraction duration and poor extraction efficiency. It might be applied to the extraction of components that are thermolabile.[1] One of the most basic extraction methods is maceration, which involves soaking coarsely ground plant material in solvents including methanol, ethanol, ethyl acetate, acetone, hexane, etc. It is a well-liked and reasonably priced method for removing various bioactive substances from plant matter. Nevertheless, there are certain drawbacks to the maceration process, including limited extraction yield, decreased efficiency, and the usage of a lot of solvents, which can be harmful to one's health. Additionally, choosing the right solvent is crucial for the extraction process of a specific plant extract.

The maceration procedure grinds the plant material into smaller particles to increase its surface area for easy solvent mixing and efficient component extraction. This mixture of plant material and solvent is

processed after being stored for a longer time, being periodically agitated, and being filtered through a filtration medium. The degree to which the bioactive compounds are extracted from the material will depend on the kind of solvent and plant material utilized. The polarity of the solvent is a crucial element that influences the extraction efficiency. This method mixes different solvents with time-temperature combinations for efficient extraction. By dissolving the cell structure and allowing the chemical compounds to react with the solvent, the maceration procedure eliminates plant components. [9, 10,11,12,15,16]

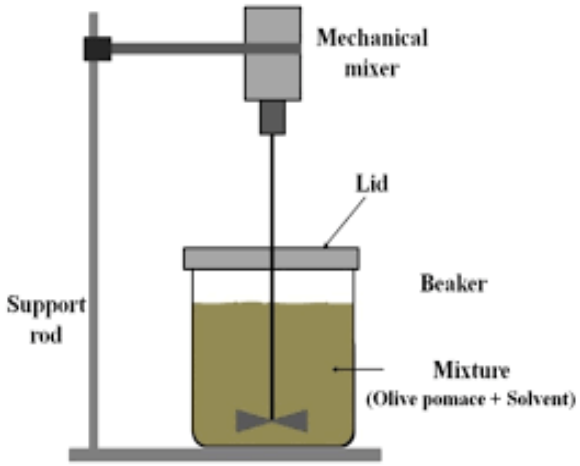

Fig.no1 Maceration

For a very long time, homemade tonic preparation involved maceration. It became a well-liked and affordable source of bioactive chemicals and essential oils. Generally speaking, maceration involves multiple processes for small-scale extraction. In order to properly blend plant materials with solvent, it is first necessary to crush the materials into small particles. Second, a suitable solvent called menstrum is applied to a closed vessel during the maceration process. Thirdly, a significant percentage of occluded solutions are recovered by pressing the marc, the solid residue left over from the extraction procedure, while the liquid is strained off. Filtration is used to separate the obtained strained and press-out liquid from contaminants.[2] The process of maceration, which is used to make wine, has been embraced and extensively employed in studies on medicinal herbs.

Plant materials (coarse or powdered) were macerated by soaking them in a solvent in a stoppered container and letting them stand at room temperature for at least three days while stirring them often. The goal of the technique was to liberate the soluble phytochemicals by breaking down and softening the plant's cell wall. The mixture is pressed or strained through filtering after three days. Heat is transported by

convection and conduction in this traditional approach, and the kind of substance recovered from the samples depends on the solvent selection [7].

Digestion

Digestion is an extractive technique that involves a small amount of heat throughout the extraction process, much like maceration. However, care must be taken to prevent temperature changes from affecting the bioactive phytochemicals in the specific plant material. As a result, heat causes the extraction solvent to be used more efficiently. Temperatures are typically maintained between 35 and 40 °C, but they can be raised to a maximum of 50 °C for harder plant materials, like bark, and materials that contain poorly soluble phytochemicals. The chosen plant components are added to a container containing the suitable solvent that has been heated to the specified temperatures in order to begin the extraction process. By shaking the container frequently, the ideal temperature is kept for a duration that might vary from 30 to 24 hours [17].

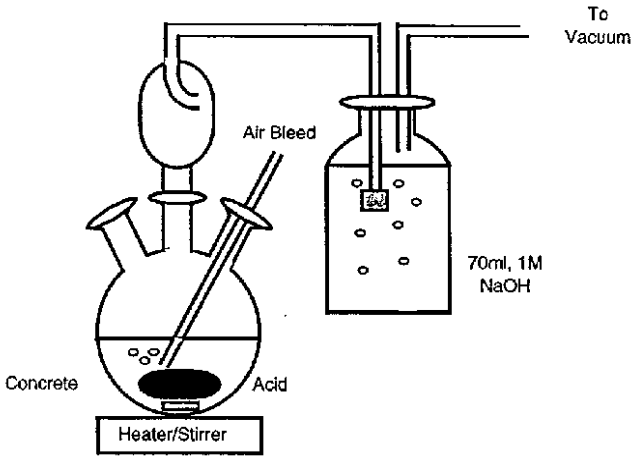

Fig.no.2 Digestion

Infusion

A diluted solution of the plant material's readily soluble components is referred to as an infusion. The plant material is submerged in a boiling solvent, usually water, and allowed to stand in a stoppered container for approximately fifteen minutes. Following this time, the extract (tea) is drained off and separated from the marc using a filter [9].

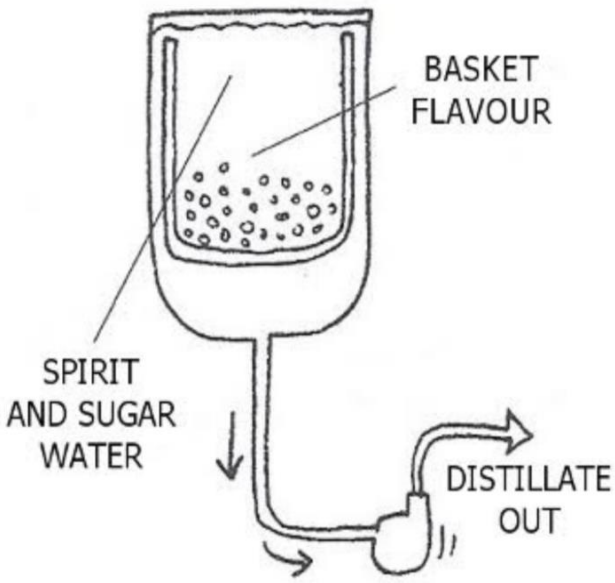

Fig.no.3 Infusion

One could argue that tea is the best example of an infusion. For instance, at brewing times of two to thirty minutes and temperatures ranging from thirty to ninety degrees Celsius, caffeine has been extracted from dried crushed leaves of tea brands such as Alokozay, Lipton, Tapal, and Tetley [17].

Percolation

Percolation is another interesting technique, more effective than maceration but similar to infusion. Making tinctures and other liquid extracts is most commonly done via percolation. "To pass a liquid through a solid material drop by drop" is what percolation is defined as. A fresh solvent is added from the top and works its way down the plant material while the solvent, usually ethyl alcohol, gently percolates into the material and eventually packs itself with phytochemicals. Plant material must be finely chopped, taking care not to shred the material into tiny pieces, before adding it to the percolator. Removing the fine particles from the extraction solution will be more difficult if the particles are too fine. Due to residue collecting at the percolator's bottom, the extract would be hazy as a result. Even so, it's suitable. Following the process, the plant material is pressed to extract the solvent that was residually absorbed, and the leachate (extract) is then mixed with the residual solution. When a colourless liquid free of phytochemicals emerges from the percolator, the extraction process is complete [17].

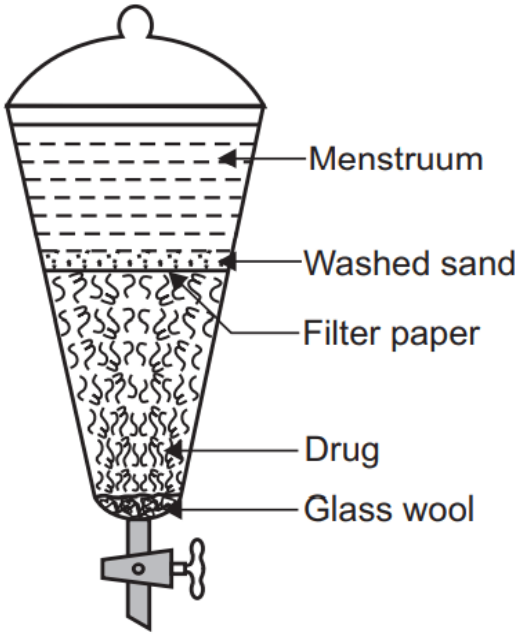

Fig.no.4 Percolation

Since percolation is a continuous process where new solvent is constantly added to the saturated solvent, it is more efficient than maceration [5].

Decoction

Many water-soluble contaminants are present in high concentrations in the decoction extract. Volatile or thermolabile components cannot be extracted via decoction.

This method of extraction works well for phytochemicals that don't change or break down as the temperature rises. Plant material is cooked in water for 15 to 60 minutes during the decoction process. The type of plant tissues and the phytochemicals being extracted will determine how long the boiling process takes. Typically, vulnerable plant components like leaves, stems, blossoms, and roots are cooked for fifteen minutes. For example, decoction and infusion methods have been used to extract phenols and flavonoids from fruits, rhizomes, and leaves at 100 °C. Alternatively, hard plant elements like bark from trees and branches may be exposed to boil for one hour. When the combination reaches the desired level of solution, it is filtered, chilled, and then added cold water. To acquire the liquid extract, the mixture is filtered once the decoction process is finished.

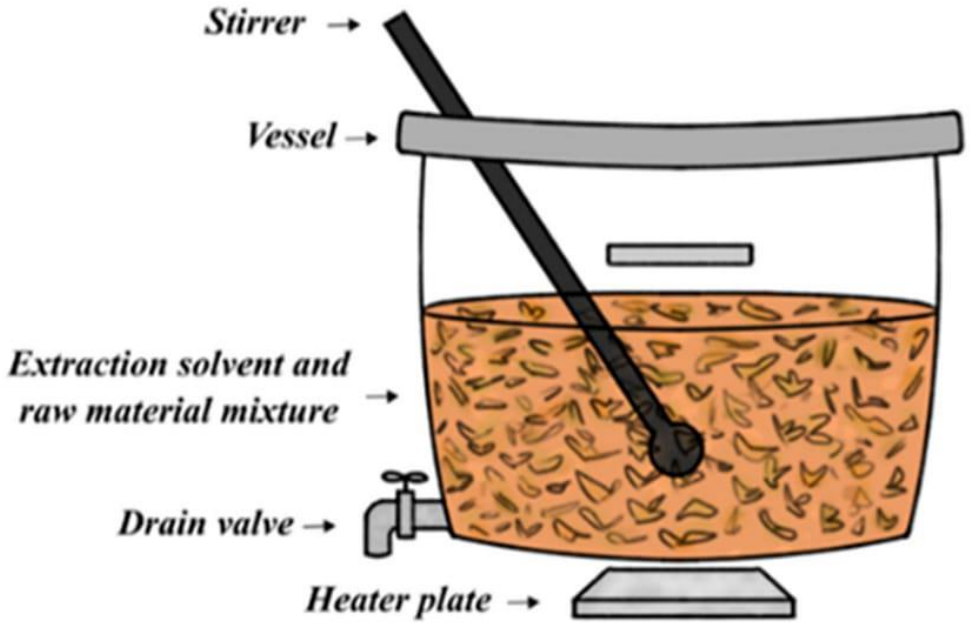

Fig.no.5 Decoction

It should be mentioned that this approach is not the best one for chemicals that are thermoliable. According to reports, the S. Cumini bark extract obtained by decoction as an extractive method showed notable antiglycation and antioxidant activity [17].

Soxhlet extraction

Using a heated solvent, soxhlet extraction is a continuous method of obtaining phytochemicals. The ground plant material is put inside a thimble, or porous bag, that is constructed of cellulose or stiff filter paper. The container housing the Soxhlet apparatus contains the thimble filled with ground plant material. The bottom flask is filled with extraction solvent, such as methanol or ethanol. Phytochemicals are extracted by heating and vaporizing the solvent in the sample thimble, letting it condense in the condenser above the device, and then letting it drip back. In comparison to extraction methods based on maceration, an increased yield is achieved. Using this method, fatty acids were [17]. The most common method for assessing the effectiveness of several solid-liquid extraction (or leaching) techniques is Soxhlet, which has been in use for a long time. The exception of a small number of applications where it is used to extract substances that are thermolabile, soxhlet extraction is a widely used and proven approach that outperforms other traditional extraction methods in terms of performance [4].

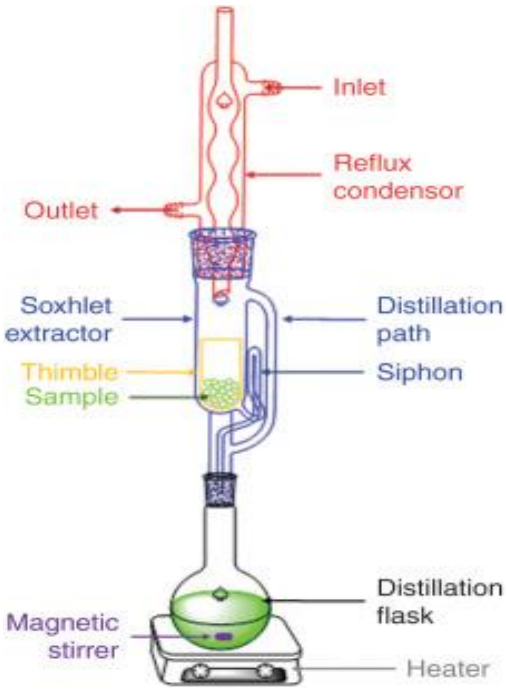

Fig.no.6 Soxhlet Apparatus

Advantages of Soxhlet extraction

The advantages of conventional Soxhlet extraction include

(1) The displacement of transfer equilibrium by repeatedly bringing fresh solvent into contact with the solid matrix

(2) Maintaining a relatively high extraction temperature with heat from the distillation flask

(3) No filtration requirement after leaching. Also, the Soxhlet method is very simple and cheap

Disadvantages of Soxhlet extraction

The main disadvantages of conventional Soxhlet extraction include

(1) The extraction time is long

(2) A large amount of solvent is used

(3) Agitation cannot be provided in the Soxhlet device to accelerate the process

(4) The large amount of solvent used requires an evaporation/concentration procedure

(5) The possibility of thermal decomposition of the target compounds cannot be ignored as the extraction usually occurs at the boiling point of the solvent for a long time. The long time requirement and the requirement of large amounts of solvent lead to wide criticism of the conventional Soxhlet extraction method.

Disadvantages associated with conventional extraction techniques

Long extraction times, large solvent usage, and occasionally numerous extraction steps are drawbacks of traditional solvent extraction methods. Furthermore, it turns out that heating breaks down or degrades a large portion of thermolabile phytochemicals. Nevertheless, because of their ease of use, these extraction methods are still employed to extract fragrance and aroma oils from plants [17].

Modern extraction techniques

Accelerated solvent extraction (ASE)

Principles and mechanisms

The solid-liquid extraction method known as "accelerated solvent extraction" (ASE) is carried out at high temperatures typically between 50 and 200 8C and pressures between 10 and 15 MPa. As a result, SFE and rapid solvent extraction are comparable types of pressured solvent extraction. Under pressure, the extraction process keeps the solvent liquid at a high temperature. During ASE, the solvent is still below its critical state. A safe and quick extraction is achieved by raising the temperature, which speeds up the extraction kinetics, and maintaining the solvent's liquid condition with high pressure. Furthermore, pressure makes it possible to fill the extraction cell more quickly and aids in pushing liquid into the solid matrix. Higher temperatures improve the solvent's diffusivity, which accelerates the extraction process [4].

Because of its advantages such as its high production, minimal solvent demand, and very short time requirements this approach has become increasingly important. An advantage of the ASE procedures is the greater solvent temperature and pressure. Maceration or Soxhlet extraction are less reliable solvent extraction methods than this one. Substantial ASE performance is supported by examples. For example, comparative studies using ASE and Supercritical Fluid Extraction (SFE) revealed improved recovery of lipophilic and hydrophilic phytochemicals from raspberry pomace. A 25% recovery of lipophilic and hydrophilic chemicals was obtained in ASE, although temperature and extraction time had a substantially smaller impact on the yield than in SFE (15%). This procedure involves packing the material into a stainless steel extraction cell and then filling it [17].

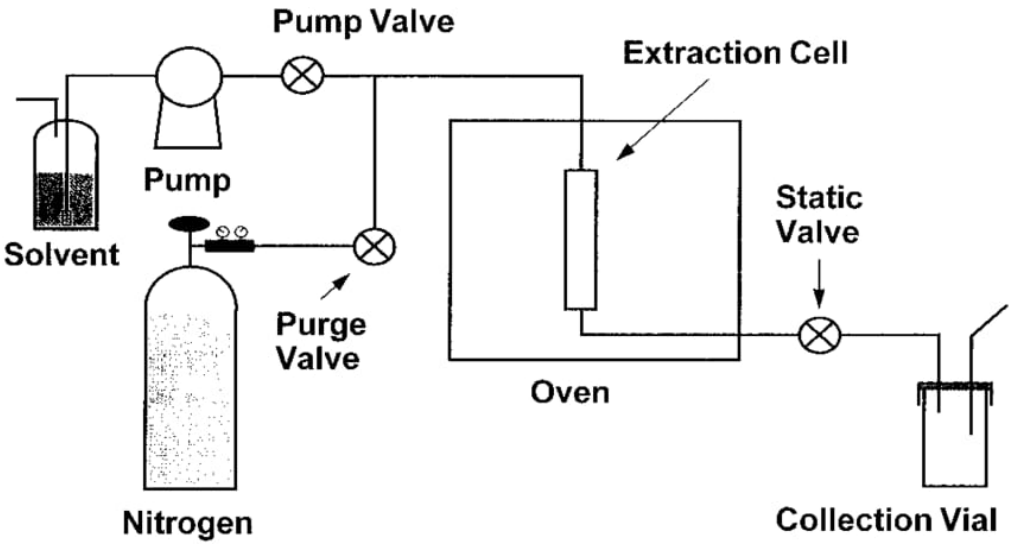

Fig.no.7 Accelerated Solvent Extraction

Microwave-assisted extraction

Food lipids and pesticides from the soil were extracted using MAE, which was initially used in 1986 by Ganzler et al.[5].

Microwave extraction, or microwave-assisted extraction, is a relatively new method of extracting natural compounds that uses solvents and microwaves in the extraction process. The 300 MHz to 300 GHz microwave frequency band is used. Microwaves accelerate the kinetics of extraction by heating the plant tissue and solvent during the extraction process. The polar molecules in the sample are directly heated by the microwaves. The process of converting microwave energy into heat requires dipolar rotations. The solvents' dielectric constant is directly correlated with heating. The extraction process is greatly impacted by the solvent's viscosity, since a lower viscosity promotes ion dispersion and solvation.

The method effectively maintains the biological activity of the extracts. For instance, the optimization of MAE in the extraction of green tea verified the enhancement of the phytocompounds antioxidant activity and enhanced the extract's overall phenolic content and desired colour quality. Many phytochemicals, including sterols from dried mushrooms, flavonoids from leaves, polyphenolic antioxidants from leaves, and saponins from seeds, have been extracted using the MAE method. Notably, microwaves have a direct effect on the polar phytochemicals that MAE extracts, such as flavonoids, polyphenols, and saponins, making the extraction process considerably efficient**.** Pressurized microwave-assisted extraction (PMAE)

and solvent-free microwave-assisted extraction (SFMAE) are two examples of progressive and reliable MAE tools and techniques.

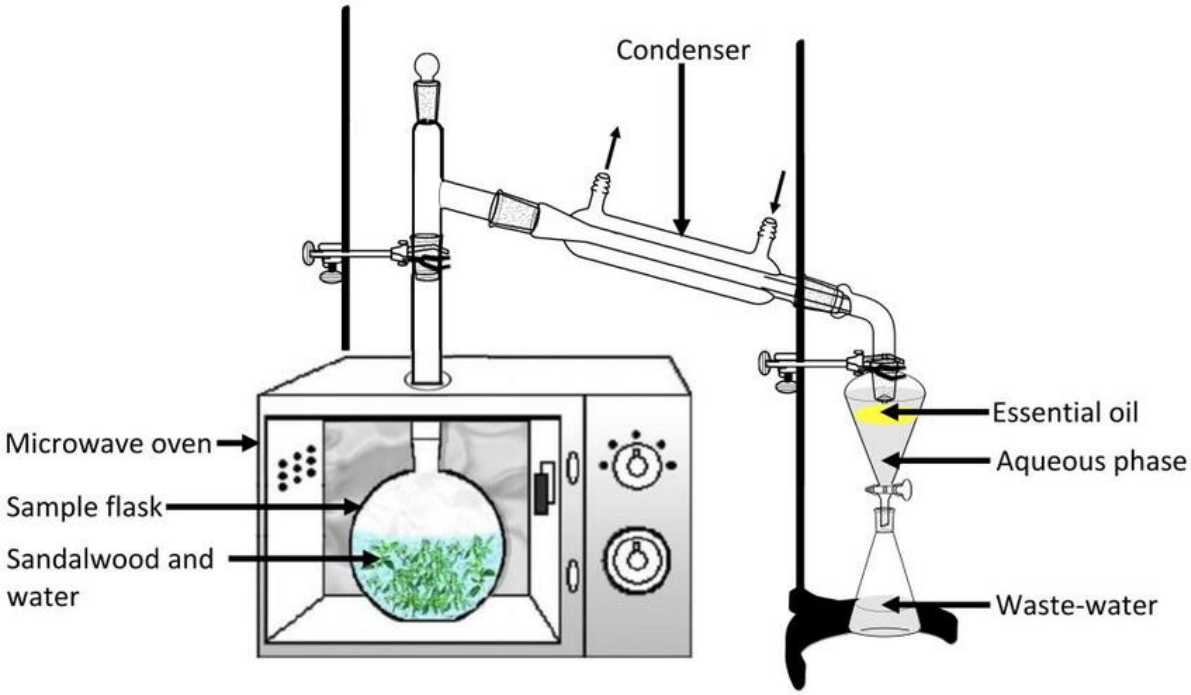

Fig.no.8 Microwave-assisted Extraction

The minuscule, minuscule amounts of fluid present in plant cells are the aim of heating dry plant material. Evaporation occurs when the moisture within the plant cell is heated by microwaves. Significant pressure builds up on the cell walls during evaporation in dried plant cells, pushing the cell walls from the inside out. Thus, the cell wall lengthens and finally rips, releasing the bioactive substances. The output of phytochemicals is increased by this procedure. Before MAE further yields, the plant material should be soaked in an appropriate solvent. The cellulose's glycosidic (ether) linkages are further hydrolyzed into soluble fractions by the solvent. Additionally, the temperature rises, increasing the phytochemical [**17].**

Advantages of MSE

When compared to conventional solvent extraction methods, the MAE has a number of benefits. MAE offers a higher extraction rate, is more affordable, quick, and requires less solvent. However, due to their stability characteristics at microwave temperature ranges, isoflavines, quacertines, and somewhat smaller phenolic molecules are more suited for this extraction approach. It should be mentioned that MAE works best for recovering phytocompounds that are lost in large quantities while using traditional techniques. For instance, flavonoids are remarkably lost during food preparation. As a result, MAE can be used to extract

flavonoids that have been supplemented as food additives. Furthermore, chromatographic analysis reveals that the majority of extracts made with standard methods contain interferences. Consequently, during extraction, interferences are eliminated in the development of MAE. After being added to GC or HPLC columns, the final extract mostly consists of analytes with the majority of interferences removed [17].

MAE has been explored as a possible substitute for conventional solid-liquid extraction in the process of extracting plant metabolites. Nutraceuticals have been extracted using it for a number of reasons, including: (1) shorter extraction times; (2) less solvents needed; and (3) higher extraction yields. Because of its low cost and simple process, MAE is also comparable to other contemporary extraction techniques like supercritical fluid extraction. MAE is a potent innovative extraction technique for the extraction of nutraceuticals since it takes into account practical and financial factors [4].

The main benefits of MAE over traditional techniques are its great precision and repeatability, together with its quick turnaround time, low solvent usage, and high efficiency. [5].

Ultrasound-assisted extraction, UAE (sonication extraction)

Changes in processing conditions, such as a drop in temperature and pressure from extractions conducted without ultrasound, are made possible by the use of ultrasonography [4]. Ultrasonic wave energy is used in ultrasonic-assisted extraction (UAE), often known as ultrasonic extraction or sonication [5].

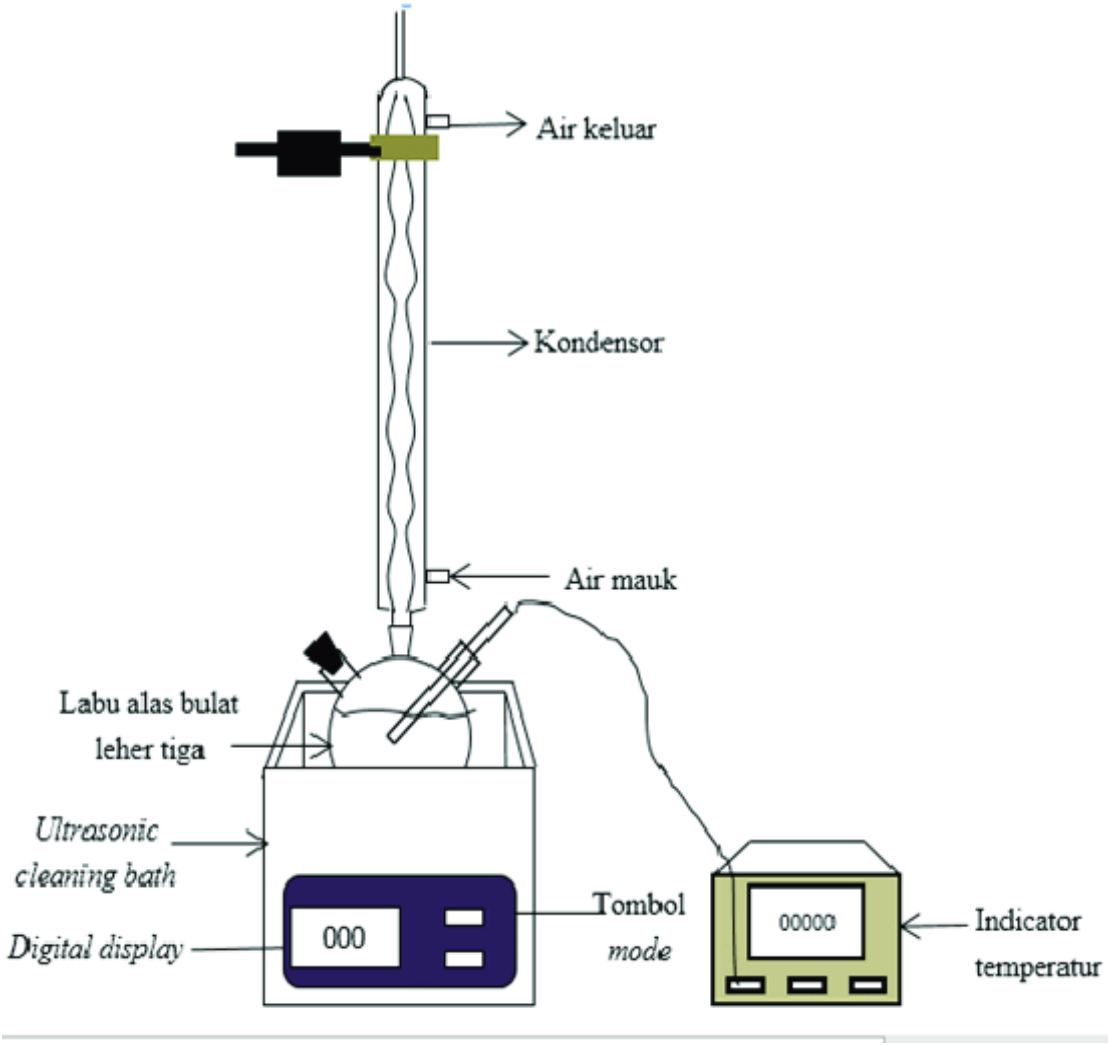

Fig.no.9 Ultrasound-assisted Extraction

Electromagnetic waves having frequencies higher than those perceptible to the human ear are called ultrasounds. The ultrasonic frequency range that is used is 20 kHz–2000 kHz. It moves in a medium that experiences expansions and contractions in a wave-like fashion. The mechanical impact of ultrasonic cavitation's acoustic cavitation expands the solvent-plant sample surface area of contact as well as the cell walls' permeability. Cavitation is the word used to describe the development, expansion, and collapse of bubbles. According to certain research, the frequency used can alter and positively influence the extraction of compounds from the sample. In order to reduce the extraction time, UAE has also been employed in conjunction with other procedures. Because it saves time and reduces hydrotrope concentration, Ultrasound-assisted hydrotropic extraction, for instance, has been proven to be a considerably more

sustainable alternative to hydrotropic extraction. UAE is additionally impacted by the type of solvent used. A better method is to use ionic liquids with ultrasound extraction assistance rather than traditional organic solvents [17].

The UAE requires less energy, utilizes fewer solvents, and has a shorter extraction time. One of UAE's specialties is the recovery of concentrated green extracts free of contaminants, residual solvents, and flaws. The application of ionic liquids as solvents significantly increases the extraction potential. Another appealing aspect of this technology is the reduced process periods and temperatures, which are essential for extracting thermolabile phytochemicals such phenolic [17].

Advantages and disadvantages of sonication-assisted extraction

Ultrasound-assisted extraction is an inexpensive, simple and efficient alternative to conventional extraction techniques. The main benefits of use of ultrasound in solid– liquid extraction include the increase of extraction yield and faster kinetics. Ultrasound can also reduce the operating temperature allowing the extraction of thermolabile compounds. Compared with other novel extraction techniques such as microwave-assisted extraction, the ultrasound apparatus is cheaper and its operation is easier. Furthermore, the ultrasound-assisted extraction, like Soxhlet extraction, can be used with any solvent for extracting a wide variety of natural compounds [4].

Supercritical fluid extraction (SFE)

Principles and mechanisms

Supercritical state is achieved when the temperature and the pressure of a substance is raised over its critical value. The supercritical fluid has characteristics of both gases and liquids. Compared with liquid solvents, supercritical fluids have several major advantages: (1) the dissolving power of a supercritical fluid solvent depends on its density, which is highly adjustable by changing the pressure or/and temperature; (2) the supercritical fluid has a higher diffusion coefficient and lower viscosity and surface tension than a liquid solvent, leading to more favorable mass transfer [4]

The commercial extraction of valuable molecules from diverse sources is a wider use of SFE technology. The extraction of valuable chemicals from food products is a promising use of this technology. The temperature and pressure adjustments necessary to turn a gas into a liquid—a state in which it is impossible to distinguish between the two phases—can be used to define the SFE. At its critical point, the physical properties of a supercritical fluid material are similar to those of gas and liquid phases.

Temperature and pressure define a supercritical fluid's critical area. The gas and liquid phases blend together at the critical point, which is reached above the critical temperature (Tc) and critical pressure (Pc). The process entails separating and solubilizing compounds that can be extracted. Chemicals in the sample are dissolved by the solvent while flowing through the packed bed [17].

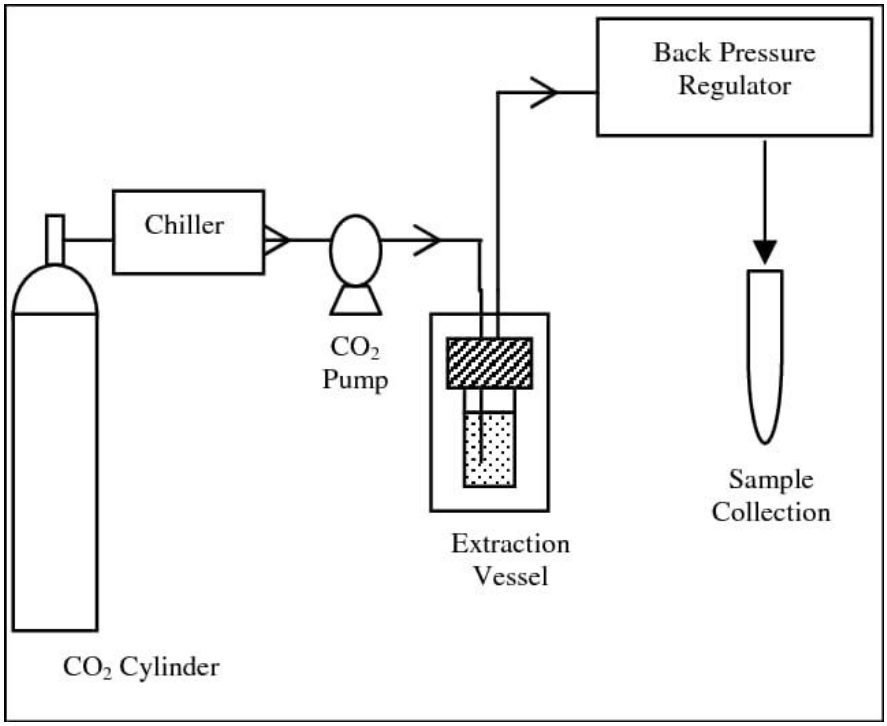

Fig.no.10 Supercritical Fluid Extraction

When compared to traditional extraction methods, SFE has various benefits. In the first place, SFE outperforms traditional methods like Soxhlet in terms of yield production while maintaining the biological activity of the extracts. In addition to extracting more oils from apple seeds than Soxhlet extraction, SFE extracts also exhibited greater oxidative stability. SFE also generates high yields, is quick and easy to use, leaves no organic solvent residue behind, and runs effectively. Secondly, the dissolving characteristics of supercritical fluid can be easily improved by adjusting the pressure at a particular temperature. Thirdly, SFE is an environmentally friendly extraction method that doesn't pollute the environment because it's neither flammable nor explosive. Fourthly, recycling the extraction medium in SFE is a cost-effective way to improve the solubility of polar phytochemicals by modifying the polarity of the extraction medium by the addition of modest amounts of entrainers. Lastly, SFE can be utilized in conjunction with spectrometric or chromatographic spectroscopic methods, such as GC, IR, GC–MS, and HPLC, to quickly and effectively extract, isolate, and clarify natural compounds. However, there are a few fundamental drawbacks to SFE.

These include the low solubility of water-soluble phytochemicals and the solubility of fat-soluble components. Additionally, the equipment is costly and difficult to clean, making production unfeasible [17].

Supercritical fluid (SF) is the extraction solvent used in supercritical fuid extraction (SFE). Similar in solubility to liquid and difusivity to gas, SF may dissolve a broad range of naturally occurring substances [5].

Enzyme-assisted extraction (EAE)

The EAE is used in conjunction with other extraction methods because the enzymes increase the solvent's accessibility to non-extractable phytochemicals, making them more susceptible to extraction. For instance, the use of enzymes during microwave processing resulted in a higher extraction temperature and faster heating strategy for phenolic compounds from olive pomace, whereas conventional solvent extraction using water produced a lower phytochemical recovery yield. Since the enzymes in the EAE make non-extractable phytochemicals more accessible to the solvent and thus more amenable to extraction, it is employed in conjunction with other extraction techniques. For example, using enzymes during microwave processing led to a higher extraction temperature and a faster heating approach for phenolic compounds from olive pomace, whereas using water as a typical solvent extraction gave a lower yield of phytochemical recovery [17].

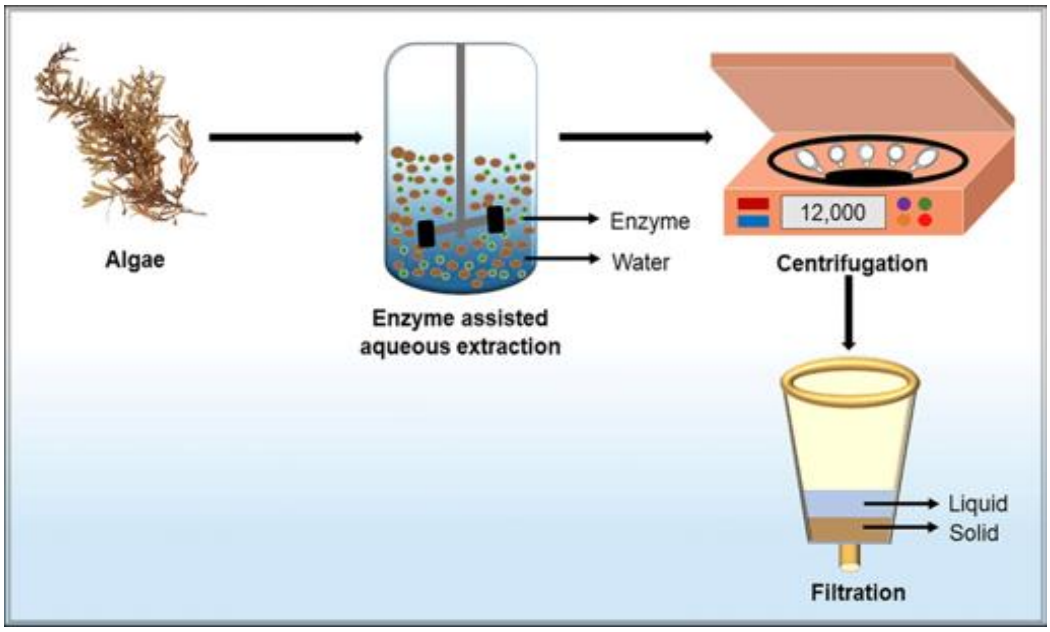

Fig.no.11 Enzyme-assisted Extraction

Pressurized liquid extraction (PLE)

PLE was found to significantly reduce the amount of time and solvent used when compared to standard soxhlet extraction [2].

In 1996, Richter et al. first described PLE. This method is now known by several names; pressurized fluid extraction (PFE), accelerated fluid extraction (ASE), enhanced solvent extraction (ESE), and high pressure solvent extraction (HSPE).[2] Several research groups have also referred to pressurized liquid extraction (PLE) as high pressure solvent extraction, accelerated solvent extraction, pressurized fluid extraction, and enhanced solvent extraction.[5**]** Applying high pressure to keep solvents liquid over their typical boiling point is the idea behind PLE. The extraction process is facilitated by high pressure. The primary driver behind the increased advancement of PLE-based methods, as well as the reduction in extraction time and solvent requirements, is automation approaches. Because the PLE method produces faster extraction through the application of high pressure and temperatures, less solvent is used. By raising solubility and mass transfer rate as well as lowering solvent viscosity and surface tension, a greater extraction temperature can increase analyte solubility and improve extraction rate [2].

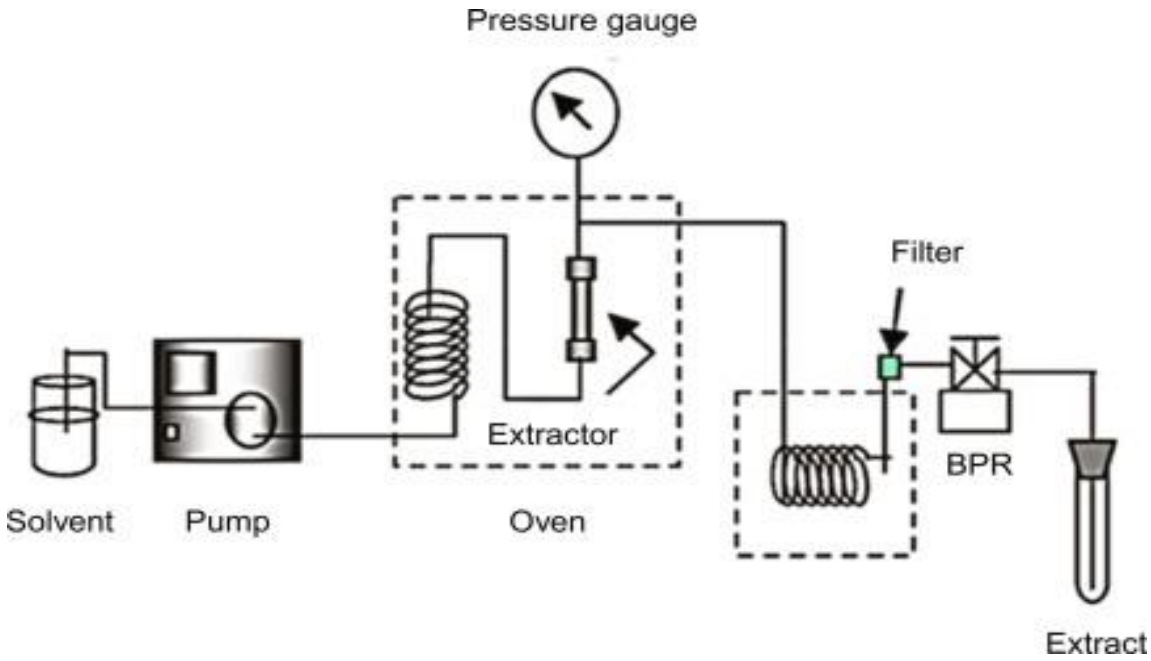

Fig.no.12 Pressurized Liquid Extraction

PROPERTIES OF SOLVENT OF EXTRACTIONS

A] Water :- It is the most polar solvent and is applied to a variety of polar chemical extractions. Advantage - In addition to being inexpensive, nontoxic, nonflammable, and highly polar, it dissolves a broad variety of compounds. .Disadvantages - It encourages the growth of mold and bacteria, may result in hydrolysis, and concentrates the extract with a lot of heat.

B] Alcohol :- It is also polar in nature, miscible with water, and could extract polar secondary metabolites. Advantages - It is self-preservative at a concentration above 20%. It is nontoxic at low concentration, and as small amount of heat is required for concentrating the extract. Disadvantages- It does not dissolve fats, gums, and wax; it is flammable and volatile [18,19].

C] Chloroform :- It is a nonpolar solvent that is helpful for extracting substances including oils, lipids, terpenoids, and flavonoids. Advantages- It smells nice, is colourless, and dissolves in alcohol. the body metabolizes and absorbs it well. Disadvantages- It has sedative and carcinogenic properties [19,20].

E] Ionic liquid (green solvent) :- Extremely polar and heat stable, this is a unique extraction solvent. Wherever high temperatures are relevant, it can be used because it can stay liquid even at 3,000 degrees Celsius. With water and other solvents, it is extremely miscible and works well for extracting polar molecules. Advantages- It is appropriate for microwave-assisted extraction because of its superior solvent, which both attracts and transmits microwaves. It is extremely polar, nonflammable, and helpful for extracting liquid from liquid. Disadvantages- It is not the best for making tinctures [21].

FACTORS TO BE CONSIDERED IN SELECTING SOLVENTS OF EXTRACTION

When selecting an extraction solvent, the following aspects should be taken into account.

(i) Cost- It should be as cheap as possible.

(ii) Reactivity- The extract and the appropriate extraction solvent shouldn't react.

(iii) Recovery- It is imperative to promptly retrieve and isolate the extraction solvent from the extract.

(iv) Viscosity- Low viscosity is necessary to facilitate easy penetration.

(v) Boiling temperature- The boiling point of a solvent should be as low as feasible to avoid heat-induced deterioration.

(vi) Safety- The ideal extraction solvent should be nonflammable and nontoxic [11,18,22].

Conclusion

Currently, extraction utilizes either conventional modern and environmentally friendly extraction technologies or traditional solvent extraction techniques to separate the medicinally active molecular components of plant tissues from the inert components. The selection of the extraction strategy is essential because it impacts the dependability and caliber of the analytical tasks that follow. Achieving economic sustainability, environmental friendliness, faster extraction times, and higher yields of bioactive chemicals without sacrificing biological activity is the primary goal of extraction. According to reports, there are numerous advantages between modern and traditional procedures. Conventional extraction methods exhibit several drawbacks, including extended extraction times, increased solvent requirements, potential bioactivity, and reduced yield. Many benefits of current approaches include shorter reaction times, lower solvent requirements, improved biological activity retention, higher yields, and lower energy consumption**.**

Finally, it is essential to properly comprehend and apply these strategies. Regular advancement and adjustment of these techniques will facilitate research procedures and enhance the results.

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