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A Review on Advance Herbal Technology

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Abstract*: This review article explores the interface between conventional herbal knowledge and contemporary scientific discoveries as it digs into the most cutting-edge advancements in herbal technology. Despite the fact that over 80% of the world's population relies on herbal products and medicine for a healthy lifestyle, people are only recently becoming interested in*
herbal medicine We examine the advancements in herbal technology. Despite the fact that over 80% of the world's population relies on the herbal products and medicine for a healthy lifestyle, people are only recently becoming interested in herbal medicine we examine the advancements made in boosting the effectiveness, bioavailability, and sustainability of herbal products, from novel extraction methods to the incorporation of nanotechnology in herbal formulations.
Additionally, the application of data analytics and artificial intelligence to the development of
customized herbal therapies is looked at this review attempts to provide a detailed overview of the developing environment of herbal technology by combining data from several disciplines, illuminating its potential to transform healthcare and contribute to a more sustained future. Due to the numerous benefits herbal formulations have as therapeutic agents for various diseases.
The qualitative analysis of a marker or bioactive compound and other major constituent is a
major challenge to scientists. Standardization is an important step to for the establishment of a consistent biological activity a result of the increase in the use of herbal products, which has also given rise to various forms of abuse and adulteration of the product leading to the consumer and manufacture this disappointment and in some instant fatal consequence.

Keywords: Advance technology, Herbal medicine, Effectiveness, Identification, Extraction Method

I. INTRODUCTION

1.1. History

Hippocrates, the father of medicine, classified herbs by essential qualities and developed a diagnostic system. Analytical methods development, including quantitative analysis, is crucial for quality confirmation and consistent chemical profile. Standardization is essential for ensuring biological activity and quality assurance in herbal drug expositing and manufacturing. Advancements in standardization including DNA fingerprinting differential vibration polarography and X-ray diffraction.

1.2. Ancient Roots

Ancient civilizations like China and India extensively documented herbal remedies in their traditional medicine systems, such as Ayurveda and traditional Chinese medicine (TCM).

Herbal knowledge was passed down through generations, relying on experiential wisdom rather than scientific understanding.

1. Medieval and Renaissance periods: Herbalism flourished in medieval Europe, with monasteries playing a key role in preserving and expanding herbal knowledge. The Renaissance saw the rise of herbal encyclopaedias like those by herbalists like John Gerard and Nicholas Culpeper.
2. 18th to 19th Century: The discovery of active compounds, like morphine from optimum, marked a shift toward isolating specific elements for medicinal purposes. Technological advances, such as distillation and improved microscopy, enhanced the study of plant compounds.

3. 20th Century: The pharmaceutical industry integrated herbal knowledge with modern science, leading to the development of drugs like aspirin derived from willow bark. Advancements in extraction techniques, like Soxhlet extraction, improved the efficiency of obtaining plant compounds.
4. Late 20th Century to present: Analytical technologies, such as chromatography and mass spectrometry, revolutionized the identification and quantification of herbal constituents. Biotechnology and genetic engineering contributed to the cultivation of herbs with optimized medicinal properties. Nanotechnology enabled the development of Nano-formulation, enhancing the bioavailability of herbal compounds.
5. Digital Era: Online databases and bioinformatics tools facilitate the sharing of herbal knowledge globally. Advanced research in photochemistry and pharmacognosy continues to unveil the therapeutic potential of herbs.
6. Current Trends: Precision farming and controlled environments optimize the growth conditions of medicinal herbs. Innovative delivery systems, like Nano carriers, improve the targeted delivery of herbal extracts. Integration of artificial intelligence accelerates drug discovery from herbal sources.

II. OBJECTIVE

1. Standardized extraction methods: Development of standardized methods for extracting active compounds from herbs.
2. Identification of bioactive compounds: Focus on identifying and understanding the bioactive compounds present in herbs.
3. Formulation of effective delivery systems: Creating innovative delivery systems to ensure the effectiveness of herbal medicines.
4. Full potential Utilization: The overarching goal is to harness the complete potential of herbal medicines.
5. Chemical structure diversity: Herbal medicines exhibit diversity in their chemical structures.
6. Biodiversity utilization: leveraging the biodiversity of herbs for medicinal purposes
7. Revolutionized Natural product screening: Introduction of new technologies has revolutionized the screening of natural products.
8. Discovery of new drugs: Facilitating the discovery of new drugs through advanced screening methods.
9. Human health benefit: The aim is to contribute to human health by utilizing the advancements in herbal technology.

III. IDENTIFICATION

3.1. Identification

Identification in herbalism is the act of recognizing and determining the specific identity of a plant or herb through the examination of its distinctive features, including but not limited to botanical characteristics, physical attributes, fragrance, taste, and in some cases, chemical composition.

This process is essential for the proper and safe utilization of herbs in various applications such as medicine, culinary practices, or other cultural uses.

1. Traditional method: Historically, herbal identification relied on visual characteristics such as leaf shape, colour, and flower morphology. Traditional healers and herbalists passed down knowledge through hands on training, emphasizing sensory details.
2. Botanical classification: Linnaean taxonomy introduced systemic classification based on plant characteristics, aiding in precise herb identification. Botanical keys and field guides became essential tools for botanists and herbalists.
3. Chemical analysis: Advancements in chemistry enabled the identification of active compounds through methods like chromatography and spectroscopy. Phytochemical analysis helps determine the chemical composition of herbs, aiding in authentication.
4. Molecular Techniques: DNA barcoding involves analysing specific DNA regions for accurate species identification, overcoming challenges in morphological similarities. Polymerase chain reaction (PCR) and DNA sequencing play crucial roles in modern herbal authentication.

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5. Spectroscopy: Infrared (IR) and nuclear magnetic resonance (NMR) spectroscopy provide non- destructive methods to analyse molecular structure, aiding in herb identification. Mass spectrometry helps identify and quantify compounds, ensuring the authenticity of herbal products.
6. Digital tools: Image recognition software and apps assist in herb identification based on photographs, making it accessible to a broader audience. Online databases and platforms contribute to the sharing of botanical information and aid in cross-referencing.
7. Block chain technology: Pharmacopoeias and regulatory bodies establish standards for herbal identification, emphasizing parameters like purity, potency, and absence of contaminants. High performance liquid chromatography (HPLC) is commonly used to quantify specific compounds, ensuring consistency in herbal product.
8. Challenges: Similarities in plant morphology and adulteration pose challenges in accurate identification. Lack of standardized methods across regions can lead to inconsistencies in herbal authentication.

Fig.1 Medicinal Plant

3.2. Authentication

Authentication of herbs refers to the process of confirming the identity, purity, and quality of herbal products. This involves employing various scientific and traditional methods to ensure that the herbs being used or solid are indeed what they are claimed to be. Authorization is crucial to prevent misidentification, adulteration, or contamination of herbal materials, ensuring that they meet established standards and are safe for consumption or use in traditional medicine, supplements, or other applications.

Methods for authentication include macroscopic and microscopic examinations, chemical profiling, molecular techniques, spectroscopy, organoleptic evaluation, and adherence to regulatory standards. Herb authentication involves confirming the identity and quality of herbal product, ensuring. They meet specified standards.

Various methods are employed for this purpose:

1. Macroscopic examination: Visual inspection of physical characteristics such as leaf, shape colour and overall morphology aids in initial identification.
2. Microscopic analysis: Microscopic examination of plant tissues such as stomata and the trichrome, can provide a distinguishing feature for authentication.

3. Chemical profiling: chromatographic techniques like high- performance liquid chromatography (HPLC) and thin layer chromatography (TLC)are used to identify and quantify by the specific chemical marker.
4. Molecular technique: DNA barcoding involves analysing specific DNA regions to confirm the species. Polymerase chain reaction (PCR) and DNA sequencing contribute to accurate identification.
5. Spectroscopy: Infrared (IR) and nuclear magnetic resonance (NMR) spectroscopy provide insights into the molecular composition of herbs, aiding in authentication.
6. Organoleptic evaluation: Sensory analysis, including the taste and smell is utilized in traditional and modern settings. To assess the characteristic qualities of herbs
7. Isotope analysis: stable isotope analysis can help determine the geographical origin of herbs, adding a layer of authenticity verification.
8. Radiographic techniques: X-ray imaging or radiography can reveal internal structures, assisting in the identification of certain botanical features.
9. Digital tools: Image recognition software and apps enable quick visual comparison, aiding in herb identification based on photographs.
10. Notification by the geographical indication (GI): Recognizing herbs on their geographical origin and unique environmental condition, protecting products with specific qualities linked to their origin.
11. Block chain technology: utilizing block chain for a transparent and tamper-proof record of the herb's journey from the cultivation to the end product, ensuring authenticity and traceability.
12. Regulatory standards: Compliance with pharmacopoeia standards and regulations set by authorities ensure that herbal products meet defined quality parameters.

These methods, often used in combination, help establish the authenticity and quality of an herbal product, Addressing challenge, such as adulteration and misidentification. It's important to note that the specific methods chosen may depend on characteristics of the herb and the intended application.

IV. EXTRACTION

Herbal extraction is a process that involves obtaining bioactive compounds from plant material. The term extraction is used to isolate and concentrate specific substances, such as essential oils, antioxidants or beneficial compounds, for various applications. The extracted substance may be further used for processing in any dosage form such as tablets or capsules, emulsion, cream etc. Thus, extraction procedures contribute significantly to standardization of quality of herbal drug.

Fig.2 Extraction

The extraction process includes the following steps:- Selection of plant material: select the specific part of the plant containing the desired compound, such as leaves, roots, flowers etc.

1. Preparation: wash and clean of plant parts and remove the impurities and unwanted substances.

2. Grinding or crushing: it help to increase the surface area of the plant material to facilitate the extraction process
3. Selection of solvent: select the solvent based on the nature of the compounds you want to extract. Solvent such as used mostly water, ethanol, methanol, or the organic solvent
4. Extraction: the process of isolation of soluble material from an insoluble residue, which may be liquid or solid by treatment with solvent based on the physical nature (solid or liquid) of crude drug to be extracted.
5. Filtration: filtration means separation of liquid extract from solid plant material to obtain a crude extract concentration: remove the solvent from extract to concentrate the desired compounds. This can do through methods like evaporation or distillation.
6. Purification: further refine the extract to remove undesirable components.
7. Storage: Preserve the final extract in suitable conditions to maintain its stability and efficacy.

V. METHOD OF EXTRACTION

5.1. Traditional method:

1. Maceration
2. Digestion
3. Decoction
4. Infusion
5. Percolation
6. Continuous hot extraction (Soxhlet extraction)
7. Expression

1. Maceration:

In this process solid ingredients are placed in a stopped container with the whole of the solvent and allowed to stand for a period of at least 3 days (3-7days) with frequent agitation, until soluble matter is dissolved. The mixture is then strained (through sieves/nets), the marc pressed, and the combined liquids clarified (cleaned by filtration) or by decantation, after standing it.

2. Digestion:

It is a process of extracting the desirable chemical constituents, consists of the application of gentle beat to the substance / crude drugs powder which is being extracted. Digestion is a modified form of maceration. It is only applicable when moderately elevated temperature is not objectionable. suitable for only heat. This will increase the penetration power of the solvent.

3. Decoction:

Decoction in this process, the crude drug is boiled in a specified volume of water for a defined time, usually 10-15 minutes and then strained or filtered, this method is suitable for drugs that are hard and woody in nature such as root, wood, seeds etc. containing thermo-state watersoluble chemical constituents (constituent thermo- stable water-soluble chemical.2,3 constituents (constituents that are not affected by prolonged heating). These are mainly useful for making "herbal tea". It should be consumed within 24 hrs.

4. Infusion:

Infusion is a very simple method of extraction used for volatile ingredients, vitamins and soft ingredients which the powdered crude drug is extracted for a short period of time with cold or hot water.

5. Percolation:

The word percolation means " pass through". Percolation implies a slow passage of the menstruum under the influence of gravity through the column of the drug powder and during this movement it goes on extracting the drug molecules

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layer wise. in percolation the drug plant material is exhaustively extracted by fresh solvent. The extraction is continued until the sufficient compound is extracted. If necessary, the same material can be extracted with a second solvent.

6. Continuous hot extraction/ Soxhlet extraction:

Soxhlet extraction operates on the principle of continuous solvent cycling to efficiently extract continuous from solid samples. The process involves a cyclic sequence where a selected solvent is heated, vaporized, condensed, and then dripped onto the solid sample in a thimble. This continuous cycle ensures that the sample remains in constant contact with fresh solvent, promoted through extraction. The solvent, now enriched with dissolved compounds, returns to the boiling flask, creating a closed-loop system. This recycling of the solvent enhances extraction efficiency by preventing superheating and maintaining a consistent temperature. The repeated cycle lead to the gradual accumulation of extracted compounds in the boiling flask, maximized the overall yield. Soxhlet extraction effectiveness lies in its ability to create a continuous and controlled environment, optimizing the interaction between the solvent and the sample for comprehensive compound extraction.

Advantages

Soxhlet extraction requires less solvent than other methods.

Disadvantages

Soxhlet extraction can produce toxic gaseous emissions, and it can take a long time. It also requires solvent evaporation and concentration steps, and the target compounds could thermally decompose.

7. Expression

Expression, or cold-press extraction, is an ancient method for extracting essential oils from citrus peels. The process involves soaking the peels in warm water and then squeezing them by hand to burst the oil glands.

5.2. Modern methods

1. Supercritical fluid extraction
2. Microwave assisted extraction
3. Pressurized liquid extraction
4. Ultrasound assisted extraction
5. Enzyme assisted extraction
6. Pulse electric field assisted extraction

1. Supercritical fluid extraction (SFE)

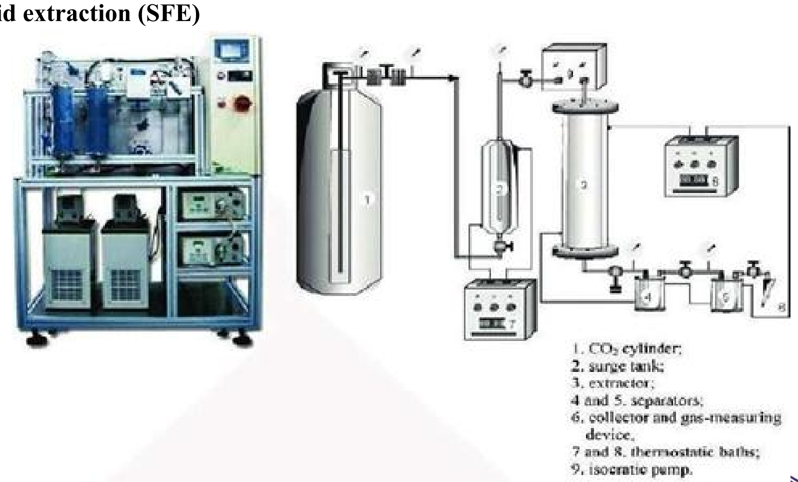

Fig.3 Supercritical fluid extraction

It is a method that uses supercritical fluids, typically carbon dioxide, to extract compounds from a sample. The fluid is brought to a supercritical state, where it exhibits both gas and liquid properties. This process is often employed in extracting essential oils, flavours, advantages such as selectivity and the ability to avoid thermal degradation. utilizes supercritical carbon dioxide as a solvent under high pressure to extract compound Without leaving residual solvent.

Extraction vessel: A chamber where the sample to be extracted is placed.
Supercritical fluid pump: pumps carbon dioxide to reach its supercritical state. Co2 reservoir: holds carbon dioxide in its liquid state before entering the pump. Heating system: raises the temperature and pressure to make co2 supercritical.
Separator: After extraction, the supercritical fluid and extracted compounds go to a separator
where pressure is reduced, and the fluid returns to a gaseous state, leaving behind the extracted material.
Collector vessel: collects the extracted compounds.

Advantage

1. SFC is emerging as a separation technique that is superior to both gas chromatography and liquid chromatography for analysis of thermal liable or non- volatile compounds.
2. Low viscosity
3. Lower operating temperature
4. High diffusion co-efficient
5. High resolution at low temperature.
6. Complete separation of solvent from extract and raffinate.

Disadvantage

1. SFC is pressure operating conditions. high -pressure vessels are expensive and bulky.
2. Maintaining pressure in SFC is difficult
3. Supercritical fluids are highly compressible, and their physical properties change with pressure
4. Cleaning will be time consuming.
5. High costs of investment.

2. Microwave assisted extraction (MAE) :

Microwave are non- ionizing electromagnetic waves (frequency range of 300 MHz to 300 GHz) Which are useful in the extraction of phytoconstituent. The prefix micro in microwave indicates that microwave are the waves with shorter wavelength compared to radio waves. Microwaves are made up of two oscillating perpendicular fields which are electric fields and magnetic fields. Microwave assisted extraction involves the uses of microwave energy to heat a solvent in contact with a sample, to remove the analyses from the sample Matrix into solvent.

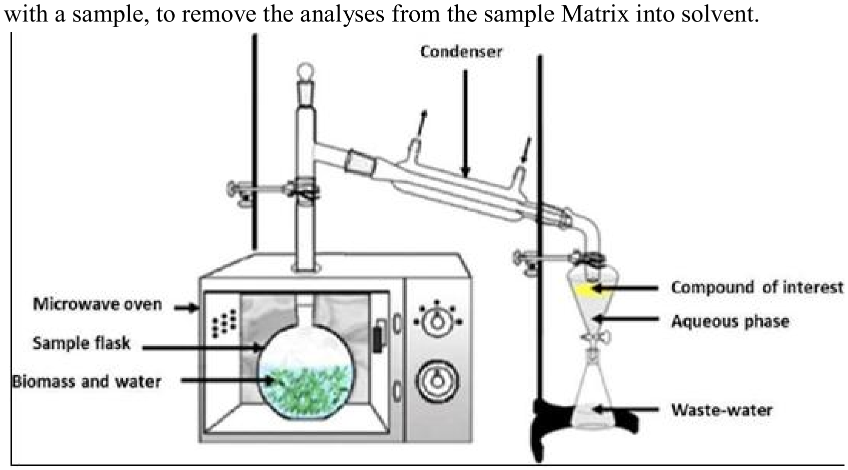

Fig.4 Microwave assisted extraction

Microwave assisted extraction (MAE) process :

1. Penetration of the solvent into the solid Matrix
2. Solubilization and breakdown of components
3. Transport of the solute out of the solid Matrix
4. Migration of the extracted solute from the external surface of the solid into the bulk solution
5. Movement of the extract with respect to solid 6. Separation and discharge of the extract and solid.

Type of MAE

a. Closed vessel system: The extraction is carried out in a sealed vessel under uniform microwave heating. High working pressure and temperature of the system allow fast and efficient extraction. The pressure inside is such that it does not exceed the working pressure of the vessel while the temperature can be regulated above the normal boiling point of the extraction solvent.

b. Open vessel system: Open system operates at atmospheric conditions and only part of vessel is directly exposed to the propagation of microwave radiation. The upper part of the vessel is connected to a reflux unit to condense any vaporized solvent.

Advantages

1. Applies microwave energy to enhance the extraction process.
2. Accelerates the release of active compounds from plant material.
3. Reduce thermal gradient
4. Shorter extraction times compared to traditional methods.

Disadvantage

1. Uneven heating: Microwave-assisted extraction may lead to uneven heating of the sample, resulting in localized hotspots and potential degradation of heat- sensitive compounds.
2. Limiting penetration: microwaves may have limited penetration depth in certain materials, restricting their effectiveness in uniformly extracting compounds from samples with complex structures.

3. Pressurized liquid extraction (PLE):

Principle: Pressurized liquid extraction, also known as accelerated solvent extraction (ASE), operates on the principle of using high pressure and temperature to enhance the efficiency of the extraction process. The elevated pressure raises the boiling point of the solvent, allowing it to exist in liquid form at higher temperatures.

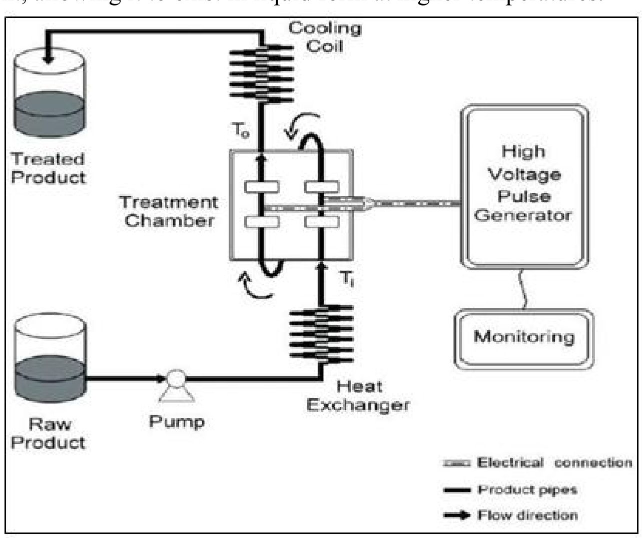

Fig.5 Pressurized liquid extraction

In this techniques of extraction high pressure in the range of 10 to 15 Mpa is applied over the solvent in contact with source materials.

1. Extraction cell : this is a stainless-steel vessel where the sample is placed
2. Pump: it delivers the liquid solvent at a controlled flow rate
3. Heating system: raises the temperature of the extraction cell
4. Pressure control system: maintains the desired pressure within the extraction cell.
5. Collection vessel: collects the extracted analytes.

Procedure

1. Loading the sample: the solid sample is placed into the extraction cell
2. Adding solvent: a liquid solvent, chosen based on its affinity for the target analytes, is added to the extraction cell
3. Pressurization : the extraction cell is sealed, and the system is pressurized with an inert gas (commonly used nitrogen) to prevent solvent boiling at ambient condition

Extraction Dynamics

1. Enhanced mass transfer: elevated pressure and temperature enhance the mass transfer of analytes from the solid matrix to the liquid solvent
2. Short extraction times : PLE is known for shorter extraction times compared to traditional method.

Advantage

1. Operates under elevated pressure and temperature conditions.
2. Efficiently extracts a wide range of compounds
3. Reduces extraction time and solvent usage

Disadvantage

1. High equipment costs
2. Operating and maintenance expenses
3. Skilled personnel required for operating

4. Ultrasound assisted extraction:

In this extraction process, mechanical energy generated by ultrasound waves is applied to the samples to accelerate the extraction. This technique is based on the application of highfrequency sounds and a limited amount of solvent to produce an effective extraction of the compounds contained in a solid matrix.

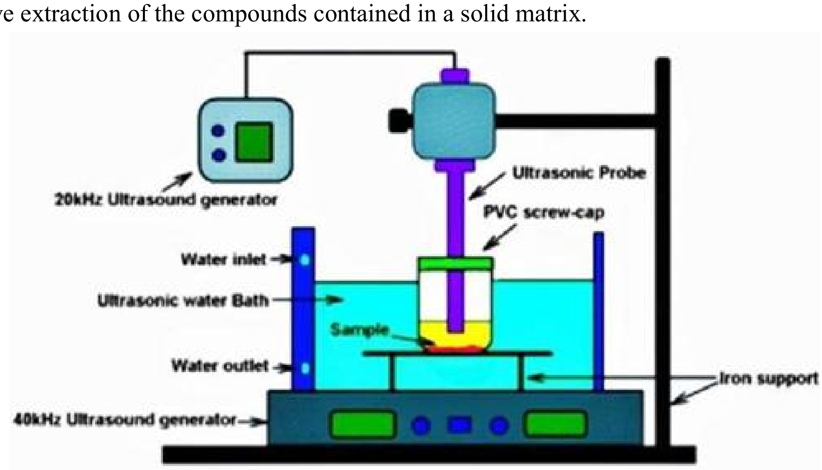

Fig.6 Ultrasound assisted extraction

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Principal of ultrasound-assisted extraction (UAE)

The main driving force for the extraction effects of sonication is acoustic cavitation's. when ultrasonic energy in the form of waves passes through a liquid solvent containing solid particles. induces a series of compressions and rarefactions in the molecules of the medium. such alternating pressure changes cause the formation and, ultimately, the collapse of bubbles in a liquid medium. This phenomenon of creation, expansion, and implosive collapse of microbubbles in ultrasound-irradiated liquids is known as "Acoustic cavitation ". When cavitation bubbles oscillate and collapse, several physical effects are generated (e.g. shock waves, micro jets, turbulence, and shear force). implosion at the solid sample resulting in localized high temperatures (about 4500◦C) and pressures (about 50 Mpa). temperature and pressure changes that occur from these implosions cause increase mechanical stressing of the cells thinning of cell membranes and cell disruption increases the permeability of the cell walls,

Advantage

1. Faster reaction accelerates chemical and physical processes due to the combined effect of ultrasound and microwave.
2. Improved homogeneity: facilitates uniform distribution of energy, ensuring consistent results throughout the reaction.
3. Enhanced efficiency: improves energy efficiency by promoting uniform heating and reducing reaction times.
4. Reduce the use of solvent.

Disadvantage

1. Temperature sensitivity: induce heat, potentially causing degradation of temperaturesensitive compounds within sample.
2. Equipment cost: acquiring and maintaining high- quality ultrasound equipment can be expensive, posing a financial challenge for laboratories or industries adopting this extraction method.
3. Limited scalability: scaling up ultrasound-assisted extraction for industrial purposes may be constrained, as the efficiency of the process might decrease with larger volume, limiting its applicability in large-scale production.

5. Enzyme assisted extraction:

Enzymatic pre-treatment has been considered as an effective way to release bounded compounds inside the cell wall and increase overall yield. Lipophilic compounds in biological materials, mainly present in the plant matrices and are dispersed in cell cytoplasm retained by hydrogen or hydrophobic bonding. So cannot be easily assessable to the solvent in a routine extraction process. Enzyme assisted extraction is grounded in the targeted action of enzymes on cell wall components, such as cellulose and hemicellulose, facilitating the liberation of bioactive compounds from plant materials. The specificity of chosen enzyme ensures a focused breakdown, preserving the quality of extracted compounds. Operating under mild conditions prevents the degradation of sensitive substances and promotes a more environmentally friendly process. This method not only increases the overall yield of desired compounds but also reduces processing time. Compared to traditional extraction techniques. The selectivity of enzymes allows for the extraction of specific compounds, contributing to the versatility and efficiency of this approach in obtaining valuable bioactive substances from natural sources.

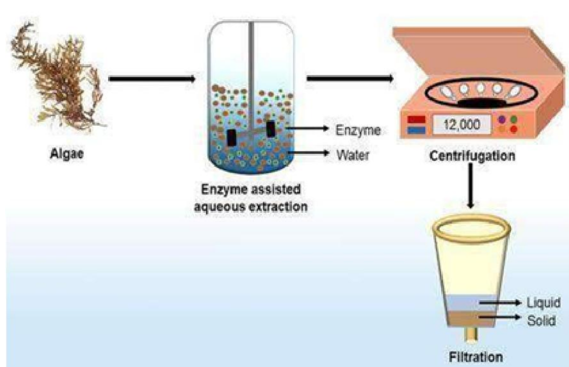

Fig.7 Enzyme assisted extraction

The addition of specific enzyme
1. Cellulase
2. A-amylase
3. Pectinase
During extraction enhances recovery by partial breaking the cell wall and hydrolyzing the structural polysaccharides and lipid bodies change the semipermeable nature of the cell wall.
Enzyme assisted extraction type may performed by:
1. Enzyme – assisted aqueous extraction (EAAE)
2. Enzyme-assisted cold pressing (EACP)
Usually, EAAE methods have been developed mainly for the extraction of lipophilic compounds i.e. Oils from various seeds as it has significant density difference in density of extraction compound and water.
In EACP techniques: Enzyme are used to hydrolyze the seed cell wall, because in this system polysaccharide- protein colloid is not available, which is obvious in EAAE. It is a sophisticated technique used to enhance the extraction of bioactive compounds from biological materials Advantages
1. Uses enzymes to break down cell walls and enhance extraction.
2. Facilitates the release of bioactive compounds.
3. Particularly effective for intracellular compounds.

Disadvantage
1. Enzymatic pre-treatment has been considered as an effective way to release bounded compounds inside the cell wall and increase overall yield
2. Lipophilic compounds in biological materials, mainly present in the plant matrices and are dispersed in cell cytoplasm retained by hydrogen or hydrophobic bonding. So cannot be easily assessable to the solvent in a routine extraction process.

6. Pulse electric field extraction (PEF):
Non- thermal emerging extraction techniques . During processing food is placed between two electrodes and exposed to a pulsed high voltage field (typically 20- 80kV cm) for the treatment times in order of less 1μm multiple short duration pulses typically less than 5μm
Principle: The principle behind pulsed electrical field extraction is that it ruptures cell membrane structure and change the semipermeable nature of the cell wall to partially permeable by formation of small holes called electro pore and process called electroporation which helps to release the lipophilic component of the cell membrane to the solvent.

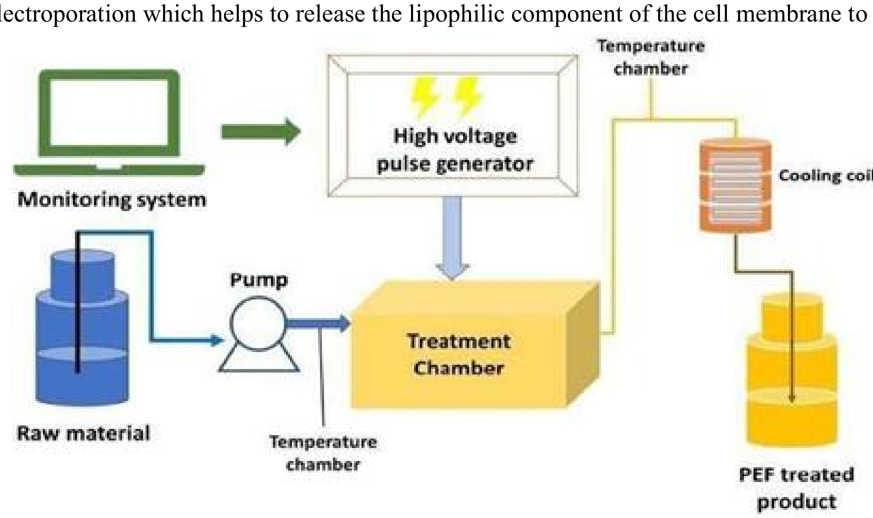

Fig.8 Pulse electric field extraction

Working principle

1. Preparation of raw material: The raw material, typically plant tissues or other biological samples, is prepared for extraction.
2. Loading into treatment chamber: the prepared raw material is loaded into the treatment chamber of the PEF system.
3. Electrode configuration: the electrode system is configured to surround or immerse the raw material in the treatment chamber.
4. Pulse generation: the pulse generator produces short bursts of high-voltage electrical pulses.

Advantage

1. Improved extraction efficiency
2. Reduced thermal degradation
3. It required short processing time
4. Improved product quality

Disadvantage

1. It required more energy consumption.
2. Skilled person required for handled of PEF.

VI. REVIEW OF LITERATURE

The field of advanced herbal technology has witnessed significant growth over the last few decades due to increasing interest in natural, sustainable, and health-promoting solutions. This review summarizes key developments in advanced herbal technology, focusing on extraction techniques, formulation innovations, bioavailability enhancement, and clinical applications.

1. Advancements in Herbal Extraction Techniques

Traditional extraction methods, such as maceration and decoction, have been replaced or supplemented by modern techniques to improve the yield and purity of bioactive compounds:

Supercritical Fluid Extraction (SFE): SFE, particularly with CO_2, has been highlighted for its efficiency in extracting heat-sensitive bioactive components without using toxic solvents.

Ultrasound-Assisted Extraction (UAE): UAE enhances extraction rates and reduces time by disrupting cell walls, thereby improving the release of phytochemicals.

Microwave-Assisted Extraction (MAE): This method uses microwaves to heat plant material, increasing permeability and facilitating compound extraction.

2. Formulation Innovations

Advances in formulation technologies aim to enhance the stability, efficacy, and consumer acceptability of herbal products:

Nanoformulations: Nanoparticles, liposomes, and nanoemulsions are employed to deliver herbal bioactives efficiently. For instance, curcumin-loaded nanoparticles have shown improved solubility and therapeutic efficacy.

Hydrogel-Based Systems: Herbal hydrogels provide controlled release and targeted delivery for dermatological and wound-healing applications.

Encapsulation Techniques: Encapsulation in polymeric systems or biopolymers protects sensitive herbal compounds from degradation and improves their bioactivity.

3. Bioavailability and Pharmacokinetics

Herbal compounds often suffer from poor bioavailability due to their hydrophobic nature and large molecular size. Advanced delivery systems have been developed to overcome these challenges:

Phytosome Technology: This involves complexing herbal extracts with phospholipids to enhance their absorption and bioavailability.

Solid Lipid Nanoparticles (SLNs): SLNs improve the stability and bioavailability of poorly soluble herbal constituents.
Drug-Polymer Conjugates: Conjugating active compounds with polymers enables slow and sustained release, improving therapeutic outcomes.

4. Clinical Applications

Anti-Cancer Therapies: Research has demonstrated the efficacy of nano-encapsulated herbal extracts, such as curcumin and resveratrol, in targeting cancer cells while reducing systemic toxicity.
Neuroprotection: Herbal nanomedicines like ginsenoside-loaded nanoparticles have shown promise in treating neurodegenerative disorders.
Cosmeceuticals: Herbal-based formulations with advanced delivery mechanisms are widely used in skincare and anti-aging products.
Wound Healing: Aloe vera-based hydrogels and herbal biofilms are widely studied for promoting rapid wound healing and reducing infections.

5. Quality Control and Standardization

The adoption of advanced technologies in quality control and standardization is critical for ensuring the safety and efficacy of herbal products:
Chromatographic Techniques: High-performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GC-MS) are used for identifying and quantifying bioactive components.
DNA Barcoding: This ensures the authenticity of herbal raw materials by analyzing genetic markers.
Omics Technologies: Genomics, proteomics, and metabolomics are employed to study the biological impact of herbal extracts comprehensively.

6. Challenges and Future Directions

Scalability: Translating lab-scale innovations to industrial-scale production remains a challenge.
Regulatory Frameworks: Regulatory approvals for advanced herbal formulations are often time-consuming and vary across regions.
Sustainability: Ethical sourcing and the environmental impact of herbal extraction need further attention.

VII. CONCLUSION

Advance herbal technology stands at the forefront of innovation in herbal medicine. Through the integration of cutting edge techniques and scientific advancements, it strives to elevate the quality, efficacy and safety of herbal medicine. This progressive approach not only enhances the credibility of herbal medicine but also fosters widespread acceptance, contributing to the overall betterment of human health. The dynamic synergy between traditional wisdom and modern scientific methods positions advanced herbal technology as a pivotal force in shaping the future of healthcare.

REFERENCES

[1]. Gangawane RM, Gaikwad S. Advanced herbal technology. Int J Res Publ Rev. 2022;10(1):1–18.
[2]. Gavali S, Garute S. advance herbal technology. Int J Creative Res Thoughts. 2022;10(1):1– 18.
[3]. Pauzi A, Muhammad N. Current authentication methods of herbs and herbal products: a systematic review. Food Res. 2022;6(4):455–65.
[4]. Chibuye B, Singh S. A review of modern and conventional extraction techniques and their applications for extracting phytochemicals from plants.
[5]. Sapkale GN, Patil SM. supercritical fluid extraction. International journal chemical science. 2010;.
[6]. Kumar K. Shivmurti Srivastava ultrasound assisted extraction (UAE) of bioactive compounds from fruit and vegetable processing by products : A review. . Nat Libr Med. 2022;82:105806. doi:10.1016/j.ultsonch.2021.105806.
[7]. Eskilsson CS. 2000 of Analytical-scale microwave -assisted extraction by PubMed. J Chromatogr A; Basheer C, K H.

[8]. Puri M. Deepika Sharma Enzyme -assisted extraction of bioactives from plants of trends in biotechnology. Saudi J Biol Sci. 2022;29(3):1565–76.

[9]. Muhammad MAN, Raanjha R. A Critical Review on Pulsed Electric Field: A Novel Technology for the Extraction of Phytoconstituents. Mol. 2021;26(16):4893.

[10]. Text book of Pharmacognosy (Nirali prakashan) page no 48-49.

[11]. Adam's KL, Palmer JD. Evolution of mitochondrial gene content: gene loss and transfer to the nucleus. Molecular Phylogenetics and Evolution. 2003;29(3):380-395.

[12]. Alvarez I, Wedel JF. Ribosomal ITS sequences and plant phylogenetic inference. Molecular Phylogenetics and Evolution. 2003;29(3):417-434.

[13]. Abdel Kawy MA, Haggag EG, Abdel Motaal AA, Eissa NA. Quality control of certain slimming herbal products present in the Egyptian market. Life Sci. J. 2012;9(3):2273-2285.

[14]. Abourashed EA, Khan IA. High‐performance liquid chromatography determination of hydrastine and berberine in dietary supplements containing goldenseal. J. Pharm. Sci. 2001;90(7):817-822. DOI:10.1002/jps.1035

[15]. Ahmed R, Ali Z, Wu Y, Kulkarni S, Avery M, Choudhury M, et al. Chemical characterization of a CommercialCommiphora wightiiResin sample and chemical profiling to assess for authenticity. Planta Med. 2011;77(9):945-950. DOI:10.1055/s-0030- 1250674

[16]. Manach VC, Albert ASC, Morand C. Polyphenols: food sources and bioavailability. Am. J Clam Nutr. 2004;79(5):727-747.

[17]. Venkatesan N, Babu BS, Vyas SP. Protected particulate drug carriers for prolonged systemic circulation–a review. Indian J Pharm. Sci. 2000;62(5):327-333.

[18]. Longer MA, Ching HS, Robinson JR. Oral delivery of chlorthiazide using a bioadhesive polymer. J Pharm. Sci. 1985;74(4):406-411

[19]. Sharma S, Sikarwar M. Phytosome: a review. Planta Indica. A major pharma giant Indena

[20]. S. P. A. Milan, Italy. Phytosomes technology. 2005;1:1-3. Available at www.indena.com.

[21]. Bombardelli E, Curri SB, Loggia Della R, et al. Complexes between phospholipids and vegetal derivatives of biological interest. Fitoterapia. 1989;60:1-9.

[22]. Bombardelli E, Crostini A, Morazzoni P. Phytosomes in functional cosmetics. Fitoterapia. 1994;65(5):387-401.

[23]. Dubey D, Shrivastava S, Kapoor S, et al. Phytosome: a novel dosage structure, http://www.pharmainfo.net/reviews/phytosome-novel- dosagestructure; c2007.

[24]. Gupta A, Ashawal MS, Saraf S. Phytosomes: a novel approach towards functional cosmetics. J. Plant Science; c2007. p. 644-649.

[25]. Abo KA, Ogunleye VO, Ashidi JS. Anti microbial potential of Spondees mombin, Croton zambesicus and Zygotritoni crocea. Journal of Pharmacological Research. 1991;5(13):494497.

[26]. Adedapo AA, Shabi OO, Adedokun OA. Anti helminthic efficacy of the aqueous extract of Eu-phobia hirta (Linn.) in Nigerian dogs. Veterinary Ar-chives. 2005;75(1):39-47.

[27]. Adekunle AS, Adekunle OC. Preliminary assess-ment of antimicrobial properties of aqueous extract of plants against infectious diseases. Biology and Medicine. 2009;1(3):2024.

[28]. Bohlin L. Natural Products Isolation, Drug Discovery today. 1998;3(12):536-537. Bohlin,

[29]. L. & Bruhn, J.G. bioassay methods in natural product research and drug development. 1993;43:288-356.