

A REVIEW ON THE IN DETAIL OF ADVANCED HERBAL TECHNOLOGY

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ABSTRACT

Due to their many advantages, people are becoming more interested in herbal medications these days. Herbal remedies are widely accepted as therapeutic agents for a variety of illnesses. Despite the fact that the majority of these uses are artificial, it is a well-known fact that over 80% of people worldwide rely on herbal products and medicines to lead healthy lives. This growth in the usage of herbal goods has once more increased the possibility of product impurities and misuse, which can have deadly consequences in certain cases and leave producers and customers unhappy. One of the biggest challenges facing scientists is the creation of novel analytical techniques that can accurately profile the phytochemical arrangement. These techniques include quantitative assessments of marker/bioactive chemicals and other important components. Standardisation is a crucial phase in the implementation of a quality assurance program, a consistent chemical profile, or a consistent biological activity for the production and distribution of herbal medications.

Keywords: Advanced Herbal Technology, Standardization, herbal drug, DNA fingerprinting, chromatographi

1. INTRODUCTION

What herbs are these? The names of a few fresh herbs that are most frequently used in recipes are usually known to most people. Given their unique appearances, it's easy to recall what rosemary, thyme, and basil are. Worldwide, people have been using herbal medicines to treat and preserve their health DNA technology has been widely used to identify herbal therapeutic components since the mid-1990s. Nature provides the fundamental ingredients for medications. They are outdated medications from bygone eras. Due to their various benefits, people are becoming more interested in herbal medications these days (1). Natural products have historically been the main topics of interest in drug discovery procedures, offering particular attention to infectious diseases and cancer as well as other medical problems including multiple sclerosis and cardiovascular ailments. Over time, these nanoparticles undergo structural optimisation to modulate the endogenous defence system and exogenous interactions with pathogenic organisms, hence increasing their therapeutic importance for cancer and other infectious diseases. Ayurveda, Siddha, Unani, and homoeopathy make up India's medicinal System, which uses 6000–7000 different species of medicinal plants—roughly 35–40% of all medicinal plant species(2) Herb drugs comprise finished herbal products, herbal ingredients, herbal preparations, and herbs.

Herbal remedies may, by custom, use naturally occurring organic or inorganic active components (such as minerals and animal parts) that are not derived from plants. Crude plant material, which can be whole, fragmented, or powdered, such as leaves, flowers, fruit, seeds, stalks, wood, bark, roots, rhizomes, or other plant parts, is referred to as herb. Herbal materials encompass not only actual herbs but also fresh juices, gums, essential oils, fixed oils, resins, and dry herb powders. These materials may be prepared using a variety of regional techniques in some nations, like stirring-baking, roasting, or steaming with honey, alcoholic drinks, or other ingredients. Completed herbal goods are made from herbal preparations, which can contain powdered or comminuted herbs(3).

Microscopic

When using botanical material for study or commercial production, it is imperative that the material be authenticated. Identification of the herbal constituents can be done accurately and economically by evaluating and comparing microscopic samples of whole, chopped, or powdered plant material that have been authenticated and unauthenticated. Microscopy can be a helpful technique for identifying pharmaceutical medications, inorganic pollutants, and microbiological contamination, among other non-botanical and botanical adulterants. Improvements in light, fluorescence, phase contrast, scanning electron, and other microscope technologies have raised the precision and utility of microscopy as a method of botanical authentication. When combined with cutting-edge microscope technology, organoleptic analysis increases the accuracy of botanical authentication(18).

Extraction methods of plant

- Maceration
- Percolation
- Digestion
- Infusion
- Decoction

Maceration

Unhindered plant cell observation with objective lens microscopy is essential for obtaining anatomical data and is a valuable tool in botanical education. The quality of microscopic images can be enhanced by removing obstructions using histology procedures. Clear microscopic images can be obtained if the material is not being sectioned. Methods like as cell isolation, precise dissection to reveal particular tissue regions, and epidermal peels can all help. When it comes to taxonomically significant leaf surface features, images can be produced for a fraction of the cost using epidermal peels, or at a high cost using scanning electron microscopy (SEM) (Bussotti and Grossoni, 1997; García-Gutiérrez et al., 2020; Leandro et al., 2020). To obtain individual cell morphometric data, the plant tissue needs to be dissected without jeopardising the cell's structural integrity. There are contemporary approaches that employ cutting-edge instruments like lasers to accomplish internal imaging without dissection, such as X-ray computed tomography (Millar et al., 2015; Piovesan et al., 2021), but these methods are pricy and impractical for involving students in a learning environment. In this work, maceration is defined as any dissection that depends on the cellular level separation of tissues, including those with varying degrees of deterioration(15).

Percolation

A sizable portion of the carbon taken up by photosynthesis is released into the soil by plant roots. The mucilaginous portion of root exudates has a notable and dynamic effect on the hydraulic characteristics of the soil in the rhizosphere, which is the area around the roots. Mucilage turns hydrophobic after drying, which prevents the rhizosphere from being wetter again. Here, our goal is to establish a quantitative relationship between the concentration of mucilage, particle size, soil matric potential, and rhizosphere rewetting. We employed a pore-network model wherein the mucilage was dispersed at random inside a cubic lattice. The basic theory was that the quantity of mucilage on each solid soil surface increases the contact angle between the liquid and solid phases, which in turn restricts the rewetting of mucilage-covered pores. A large portion of the carbon taken up by photosynthesis is released by plant roots into the soil. For a range of particle sizes and matric potentials, we computed the mucilage concentration at which pores become unwettable using the Young-Laplace equation. Next, we replicated the process of water seeping through a cubic lattice. According to our models, water would not be able to pass through the porous media above a certain mucilage concentration. As particle size increased and matric potential fell, the critical mucilage concentration reduced as well. The capillary rise studies conducted in soils with varying particle sizes and concentrations of mucilage were compared to the model. The rhizosphere rewetting's percolation behaviour was verified by the experiments. At concentrations greater than 0.1 mg/cm², mucilage became hydrophobic. For fine sand, the critical mucilage content was around 1% [g/g] and for coarse sand, 0.1% [g/g] at matric potential of -2.5 hPa. Our conceptual model is a first step towards a better understanding of the water dynamics in the rhizosphere during rewetting and can be used to predict in which soil textures rhizosphere water repellency becomes a critical problem for root water absorption(16).

Digestion

Animals mostly obtain their dietary fibre from plant cell walls. The cell walls' polysaccharides are resistant to degradation by mammalian enzymes. Animals, on the other hand, rely on microbial fermentation, with ruminants being particularly well-suited to using plant fibre as an energy source. In fodder crops, fibre, expressed as neutral detergent fibre (NDF), typically makes up 30–80% of the organic matter. Cell solubles, the leftover organic matter, are nearly entirely edible. However, the nutritional value of fibre to cattle varies significantly based on its composition and structure. Although the main factor limiting the digestion of fibre has been found to be lignin, physical limitations at the level of cellular organisation also limit the utilisation of fibre. fibre amount in plants Most plant species have higher concentrations of fibre in their stems than in their leaf blades, and grasses typically have higher fibre contents than legumes. The primary element influencing the digestibility of dry matter in plants is their maturity, which also leads to an increase in fibre concentration. When lucerne (*Medicago sativa* L.) and red clover (*Trifolium pratense* L.) are in the mid-flowering stage of maturity, around 25% of the bulk of their leaf blades are made up of neutral detergent fibre (Buxton et al. 1995a). This is in contrast to 40–55% NDF in these species' stems. Cool-season grasses that follow the C3 photosynthetic pathway, such smooth brome grass (*Bromus inermis* Leyss.), tall fescue (*Festuca arundinacea* Schreb.), and orchardgrass (*Dactylis glomerata* L.), have roughly 50% NDF in their leaf blades at a similar maturity. And stems in the amount of fibre. Because stems have more conducting and structural tissues than leaves and because mesophyll cells with thin walls make up a bigger share of leaves, stems have higher amounts of fibre. Generally speaking, grasses have less variation in digestibility between leaves and stems than legumes. With increased plant maturity, stems lose digestibility more quickly than leaf blades. Additionally, digestibility decreases along stems; in birdsfoot trefoil (*Lotus corniculatus* L.) and lucerne, this rate is 20 g/kg per node (Buxton et al. 1995a). As plants develop, the ratio of leaves to stems falls, which results in an increase in fibre concentration not just within stems and most leaves but also in the overall forage(17).

Infusion

Standards of Practice for Infusion Therapy (the “Standards”) The American Society for Parenteral and Enteral Nutrition (ASPEN) published updated guidelines on parenteral nutrition (PN) filtration in January. This clinical practice brief was put together by Patricia Worthington, MSN, RN, CNSC, ASPEN Board of Director, and PN Safety Committee member, and Lisa Gorski, MS, RN, HHCNS-BC, CRNI®, FAAN, INS Standards of Practice Committee Chair. It also includes a history of filtration and a summary of some important information from ASPEN’s 2021 recommendations, which will update the recommendations in the Standards. It is recommended that clinicians read the ASPEN Position Paper in order to have a comprehensive conversation regarding particulate matter and the difficulties and problems associated with PN filtering. An overview of filtration’s brief history is as follows: 2. ASPEN, Inc. has advised filtration since 2004(20).

Decoction

Many water-soluble contaminants are present in the decoction extract. It is not possible to extract volatile or thermolabile components from a decoction. During the decoction process, the ginsenosides in ginseng undergo addition reactions, hydrolysis, dehydration, and decarboxylation. Zhang et al. looked into the chemical changes made to Danggui Buxue Tang, a well-known TCM medicine made of a herbal infusion that includes Astragali and Angelicae Sinensis radix. It was discovered that during decocting, two flavonoid glycosides in Astragali Radix, calycosin β -D-glucoside and ononin, may be hydrolysed to produce calycosin and formononetin, respectively. There was a significant correlation between the amount of herbs, pH, and temperature with the hydrolysis efficiency. Three factors significantly impacted the hydrolysis efficiency: pH, temperature, and the quantity of herbs used. For thousands of years, China has utilised two TCM substances, Sanhuang Xiexin Tang (SXT) and Fuzi Xiexin Tang (FXT), to cure ailments including diabetes. SXT is made up of Scutellariae Radix, Coptidis Rhizoma, and Rhei Radix et Rhizoma. FXT is created by mixing Aconiti Lateralis Radix Preparata, another TCM, with SXT. Zhang et al. used a UPLC-ESI/MS technique to track 17 active ingredients in the macerations and decoctions of SXT and FXT. When compared to the maceration procedure, the decoction method may improve the solubility of several bioactive chemicals. Elements were found in decoctions: aloe-emodin⁴³ and emodin⁴⁴, baicalin⁴⁵ wogonoside⁴⁶; benzoylaconine³⁶, benzoylhypaconine³⁷, benzoylmesaconine³⁸, berberine³⁹, coptisine⁴⁰, palmatine⁴¹, jatrorrhizine⁴², and so on. Were notably greater than those seen in macerations of SXT and FXT. The hydrolysis of the glucuronic acid group from glycosides (baicalin and wogonoside) to transfer into aglycones [baicalein⁴⁷ and wogonin⁴⁸] may be catalysed by the β -glucuronidase found in herbs. The higher levels of baicalin and wogonoside in decoctions and macerations were found to be caused by the high temperature during the decoction process, which also inhibited the conversion of glycosides to their aglycones and deactivated the activity of β -glucuronidase. It was also noted how the compounds from various herbs interacted with one another. The diesterditerpenoid alkaloid hypaconitine⁴⁹ was discovered in the decoction of the single herb, while the diesterditerpenoid alkaloids were not detected in the maceration or decoction of FXT(19).

2. ISOLATION AND PURIFICATION TECHNIQUES

HPLC

The pharmaceutical industry uses analytical and preparative HPLC extensively for the separation and purification of herbal constituents. Preparative HPLC can be broadly divided into two categories: high pressure HPLC (pressure >20 bar) and low pressure HPLC (usually < 5 bar) 93,94. In analytical HPLC, the critical factors to be taken into account are resolution, sensitivity, and quick analysis time, while the level of solute purity as well as the quantity of substance that can be produced in a preparative HPLC 95 unit of time, or through put(4).

HPTLC

The typical fingerprint method for herbal analysis is TLC. TLC of the resins¹⁰⁰ allowed for the simple identification of four species of herbal remedies. This method allows for the evaluation of the consistency and stability of preparations of different manufacturers of ginseng and Radix Procreative, as well as the authenticity of distinct species¹⁰¹. Although the primary application of HPTLC fingerprinting is in the analysis of substances with low to moderate polarity, Di et al. used automated repeated development to create a fingerprint of fungal polysaccharide acid hydrolysate(4) .

Liquid chromatography and Mass Spectroscopy

Mass spectrometry (MS) and high-performance liquid chromatography (HPLC) combine to provide analytical chemists with one of the most potent analytical methods available today. After years of development, these methods now stand as two of the most significant instruments for characterising organic molecules. Regrettably, integrating these methods (LC/MS) has proven to be more difficult than combining gas chromatography and mass spectrometry (GC/MS). High sensitivity and an abundance of structural information are provided by MS for the investigation of materials containing organic chemicals(5).

Liquid chromatography- Nuclear magnetic resonance (LC-NMR)

The solvent or solvent UV detection volumes, which are on the order of 8 mixture of the collected fraction is evaporated, are much larger than conventional chromatography (HPLC) separation. In a conventional routine NMR investigation of a routine application, the detection volumes are the unknown peak in a high-performance liquid chromatography between 40 and 120 ml. These extraordinarily large detection volumes are required for two reasons: the molecule is redissolved in a deuterated solvent. The solution is first moved to a 5-mm NMR tube while it is flowing. Typically, the NMR acquisition is carried out during a specific residence period, t_r of the NMR tube nuclei inside the NMR detecting cell. Time is defined by the ratio and this residence is rotated to eliminate magnetic field inhomogeneities(6).

Gas chromatography (GC) and gas Chromatography-mass spectroscopy (GC-MS)

The uses for gas chromatography are extremely varied. However, the separation and analysis of multi-component mixtures, such as those including solvents, hydrocarbons, and essential oils, is its primary application. Fundamentally, gas chromatography can quantitatively identify compounds present at very low concentrations by using the extremely sensitive flame ionisation detector and electron capture detector. Thus, forensic work, general trace analysis, and pollution research represent the second most significant application area. One of the most crucial instruments in chemistry is gas chromatography, which separates components of mixtures with ease and efficacy due to its sensitivity, simplicity, and efficiency(7).

Supercritical fluid extraction

Certainly dating back to the Palaeolithic era, solvent extraction is among the oldest known techniques for separation. Over an extended duration, the field of solvent extraction research has undergone significant advancements in comprehending solvation and the characteristics of liquid mixtures employed in extraction procedures. Early observations of solute dissolution in supercritical fluid (SCF) media by Hannay and Hogarth (1879) raised the prospect of a novel solvent medium. Nevertheless, thorough research on the commercial process applications of supercritical fluid extraction has only been conducted relatively lately (around 1960) (8).

microwave-assisted extraction

Both qualitative and quantitative analysis determine the amount of solvent used and the feasibility of the sample preparation process. The extraction step running multiple samples. These are of course miniis the least evolved part of most analytical pro- mum criteria for modern sample preparation techcedures, and still today Soxhlet extraction (deniques and are all fulfilled to a great extent by MAE. Veloped by F. Soxhlet (1879) is useful in a variety of As a result, MAE is a desirable substitute for standard laboratories. In the last decade there has been conventional techniques, as seen by the increasing an increasing demand for new extraction techniques, number of scientific papers published during the last amenable to automation, with shortened extraction years(9)

Ultrasound assisted extraction

The phyto-pharmaceutical extraction sector has acknowledged the potential industrial application of ultrasound for a variety of herbal extracts. An overview of the UAE's bioactive principles derived from herbs was provided by Vinatoru (2001). In terms of fennel, hops, marigold, and mint, the extractive values improved by UAE as compared to traditional procedures were 34%, 18%, 2%, and 3% in water, and 34%, 12%, 3%, and 7% in ethanol. Jian-Bing et al. (2006) looked into an aqueous extraction of geniposide from Gardenia fruit in another investigation. Compared to a static method utilising 40 ml/g of the solvent volume to fruit weight, the extraction yield of geniposide rose by 16.5% when ultrasonic was applied at 0.15 W cm⁻². The unpredictability(10)

Solid-phase and microwave assisted extraction

Since olive oil has been produced for thousands of years in the Mediterranean region, these nations view it as a staple meal because of its nutritional qualities and the health benefits it provides from high levels of antioxidant and monounsaturated fatty acids. The demand for this item has expanded globally due to all of these beneficial attributes. Several nations with Mediterranean climates, including Chile, are producing olive oil to meet the growing demand and give consumers more options. Olive trees are susceptible to several pest attacks, mostly from the olive fruit fly *Bactocera* (*Dacus*) *Oleae*, which necessitates the use of pesticides for control. The most often utilised ones are organophosphorus insecticides (OPPs), which offer treatments that are well-studied and reasonably priced(11).

Chromatographic techniques

- HPLC (high performance liquid chromatography.)
- HPTLC (high performance thin layer chromatography)
- TLC-MS (thin layer chromatography & mass spectrosctoscopy)
- GC-MS (Gas chromatography & mass spectrosctoscopy)
- Extraction and purification

Purification techniques for isolated phytoconstituents

Phytochemical separation is the process of physically and chemically separating individual components of plant extracts or active portions and purifying them into monomer molecules. These days, traditional isolation techniques including solvent extraction, precipitation, crystallisation, fractional distillation, salting out, and dialysis are still often employed. However, contemporary separation techniques including ultrafiltration, high performance liquid drop counter current chromatography, column chromatography, and high performance liquid chromatography also have a significant impact on phytochemical separation. This section outlines popular techniques and their particular uses in phytochemical isolation(12)

3. STANDARDIZATION OF HERBAL FORMULATION

Good Manufacturing Practices must be implemented in order to standardise herbal formulation (GMP). Furthermore, it is thought to be crucial to investigate a number of parameters, including pharmacodynamics, pharmacokinetics, dose, stability, self-life, toxicity evaluation, and chemical profiling of herbal formulations. Other equally important criteria include pesticide residue, aflatoxine concentration, heavy metal contamination, and the use of Good Agricultural Practices (GAP) in the standardisation of herbal drugs(12)

Standardization Of Polyherbal Formulation

Standardisation is a crucial component in preserving and evaluating the quality and safety of polyherbal formulations, which are mixtures of many herbs to achieve the intended therapeutic effect. Standardisation reduces variation from batch to batch and ensures the quality, safety, and acceptability of the polyherbal compositions. The standardisation of several herbal and polyherbal formulations that are sold, such as Madhumehari Churna (Baidynath), which is a blend of eight herbs. A traditional composition called Dashamul Arishta is used to help physiological systems return to normal after childbirth. The identity, purity, and strength of the polyherbal formulation were determined using TLC and HPTLC fingerprint profiles, which were also utilised to set standards for this Ayurvedic formulation(12)

Introduction to different techniques of characterization of bioactive constituent

The initial step in the process of finding new drugs from plants is extraction. For the purpose of generating extracts that exhibit a variety of polarity and/or are enriched in the most prevalent secondary metabolites, including saponins and alkaloids, a number of generic techniques have been presented. Apart from the conventional methods of solid-liquid extraction, which include boiling under reflux, infusion, decoction, and maceration, other contemporary approaches have been developed in recent years. These consist of pressurised liquid extraction (PLE), supercritical fluid extraction (SFE), ultrasound assisted extraction (UAE), and microwave-assisted extraction (MAE). For instance, in the MAE, microwaves are used in conjunction with conventional solvent extraction; according to Zhang et al., this unconventional heating method may improve solvent penetration into the plant powder and encourage the solubility of the bioactive chemicals(13).

Importance of standardization

WHO (1996a ab, 1992) states that the process of standardising and quality control for herbs involves the physicochemical evaluation of a raw drug. This includes aspects like raw material selection and handling, safety assessment, efficacy and stability of the finished product, experience-based safety and risk documentation, as well as consumer education and product promotion. Standardising herbal medical products is necessary since the process of manufacturing, formulating, storing, packing, transporting, and distributing a medicinal product might alter its efficacy, safety, and stability. All information that can be produced about the chemical fractions that are present in the herbal medicinal product is included in the phytochemical standardisation process(14).

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