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Review Article

Collection, Identification and Qualitative Phytochemical Testing of Medicinal Plants

Swaminathan V.*, Manivannan R., Suresh Kumar G., Yuvaraj G., Mukil J., Subasri S. V., Jagadeeswaran P., Mothilal M.

Department of pharmaceutics, Excel College of Pharmacy, Komarapalayam, Tamil Nadu, India– 637303.

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ABSTRACT

Medicinal plants have been essential in both traditional and contemporary medicine, providing bioactive compounds with potential therapeutic effects. This review emphasizes the gathering, identification, and qualitative phytochemical analysis of these plants to determine their medicinal worth. The first stage includes the organized gathering of plants from different environments, crucial for preserving biodiversity and promoting the sustainable use of resources. We cover different identification methods, such as morphological characteristics, anatomical aspects, and molecular approaches, that help in the precise classification of plant species. Qualitative photochemical analysis is essential for determining the existence of important bioactive substances including alkaloids, flavonoids, tannins, saponins, and terpenoids. These compounds are frequently associated with particular pharmacological effects, such as anti-inflammatory, antioxidant, and antimicrobial characteristics. The review covers standardized qualitative analysis methods like colorimetric assays and chromatography to enhance the reproducibility and comparability of findings. The article emphasizes the importance of combining traditional knowledge with scientific approaches to improve the comprehension of medicinal plants. It also addresses the difficulties encountered in gathering and identifying these plants, including environmental damage and misidentification, which can affect the reliability of medicinal products. This review seeks to aid further research and development in ethnopharmacology by recording the varied phytochemical profiles of medicinal plants. In conclusion, the information presented here can assist future research in finding new therapeutic agents and encourage the preservation of medicinal plant biodiversity, ensuring traditional practices are maintained and effectively integrated into contemporary healthcare systems.

INTRODUCTION

***Corresponding Author:** Swaminathan V.
Address: , Department of pharmaceutics, Excel College of Pharmacy, Komarapalayam, Tamil Nadu, India– 637303.
Email ✉: swaminathan016@gmail.com
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Pharmacognosy, ethnobotany, and traditional medicine have all relied heavily on the study of medicinal plants and their potential for therapeutic purposes for ages. Throughout the world, medicinal plants play a significant role in the livelihoods of the impoverished, and for many communities, these traditional medications were the most affordable and easily accessible form of therapy available inside the healthcare system. Plants serve meditative purposes for the local populace. According to data from the World Health Organization (WHO), 80% of people on the planet receive their primary medical care from natural medicinal items. Over 10% of the 32,000 higher plant species are utilized in traditional medicine[1,2]. In addition to being utilized as natural medications, medicinal plants have antibacterial properties. Almost every plant part is utilised in the creation of natural medications, and these plant parts—leaves, stems, flowers, fruits, twigs, and roots—are also offered for sale in neighbourhood markets and are used in the production of herbal remedies. Numerous studies have documented the potential of herbal medicines to treat a variety of conditions, including acquired immunodeficiency syndrome (AIDS), severe acute respiratory syndrome (SARS), antimicrobial, anti-inflammatory, anti-allergic, antidiarrheal, and acquired immunodeficiency syndrome (AIDS) [3,4]. Numerous bacteria assault people, plants, domesticated animals, and wild animals. In many of these instances, the germs are highly pathogenic. These bacteria are continually evolving and cause diseases to emerge in the hosts they are intended for. Staphylococcus aureus can cause a variety of diseases, from mild skin infections to more serious conditions like endocarditis, bacteremia, sepsis, and osteomyelitis [5]. Numerous other illnesses, such as cellulitis, keratitis, osteomyelitis, septic arthritis, and mastitis in animals, are also brought on by this bacterium. Gram-positive Micrococcus luteus is a mildly pathogenic coccus bacteria, but in people with weakened immune systems, it can become a serious infection. Numerous illnesses, such as skin infections and prosthetic valve endocarditis (PVE), might be brought on by it. E. Coli is the most common cause of bacterial infections in humans. It also causes pneumonia, cholecystitis, bacteremia, cholangitis, gastroenteritis, and urinary tract infections in newborns. Because these naturally occurring medicinal plants have great antibacterial activity, they are utilized to treat microbial infections[6,7]. As a result of chemotherapy's failure and medicinal plants' potential as antibiotics, microbial agents become resistant. The pathogens' development of resistance prompted the researchers to screen additional medicinal plants in an effort to overcome the resistance and investigate the tremendous antibiotic potential of these plants. While most medicinal plants have been shown to have antimicrobial properties, most of them have not been thoroughly investigated for their potential as chemotherapeutics or as antimicrobials [8].

The growing importance of medicinal plants can be appreciated from the economic stand point when the following facts are considered:

- Global trade in herbs is over USD 100 Billion per annum
- India and China's medicinal plant trade is about two to five billion US dollars annually
- In Germany, it is over one billion US dollars annually
- Rose Periwinkle which is endemic to Madagascar fetches US$100 million per annum
- China trades in 7,000 species and 700,000 tons of medicinal plants per annum
- India trades in 7,000 species of medicinal plants

➢ In the last 5 years, sales of medicinal plants doubled in China, tripled in India and grew by 25% in Europe [9,10,11]

Table-1: Uses Of Medicinal Plants

S. No	Medicinal Plants	Scientific Name	Ingredients	Uses
1)	Aloe vera	Aloe barbadensis	Aloin, Acemannan, Vitamins A, C, E, and minerals.	Skin conditions, hair care, digestive issues, oral health, anti-inflammatory, wound healing, and immune support.
2)	Ashwagantha	Withania somnifera	Withanolides, Alkaloids, Saponins.	Stress relief, anxiety, anti-inflammatory, antioxidant, immune system support.
3)	Turmeric	Curcuma longa	Curcumin, Volatile oil, Resin.	Anti-inflammatory, antioxidant, improves joint health, reduces pain.
4)	Neem	Azadirachta indica	Azadirachtin, Nimbin, Nimbidin.	Insecticide, antiseptic, anti-inflammatory, oral health, digestive issues, fever, and malaria.
5)	Ginger	Zingiber officinale	Gingerol, Shogaol, Zingiberene.	Digestive aid, nausea relief, pain relief, cold and flu remedy, antioxidant, reduces menstrual cramps.
6)	Garlic	Allium sativum	Allicin, Vitamin C, Vitamin B6.	Cardiovascular health, immune system support, antibacterial, antiviral, anti-inflammatory, cancer prevention.
7)	Tulsi	Ocimum sanctum	Eugenol, Ursolic acid, Vitamin K.	Stress relief, anxiety, immune system support, respiratory issues, skin conditions, digestive aid, antioxidant, and antiseptic.
8)	Cinnamon	Cinnamomum verum	Cinnamaldehyde, Cinnamic acid, Coumarin.	Blood sugar control, anti-inflammatory, antioxidant, digestive aid, blood pressure and support immune.
9)	Fenugreek	Trigonella foenum-graecum	Saponins, Fiber, Galactomannan.	Digestive aid, relieves menstrual cramps, supports lactation,

				lowers cholesterol, blood sugar control.
10)	Curry leaf	Murraya koenigii	Volatile oil, Alkaloids, Flavonoids.	Relieves stress and anxiety, anti-inflammatory, antioxidant, supports eye health.
11)	Indian sarsaparilla	Hemidesmus indicus	Saponins, Flavonoids, Steroids.	Natural diuretic, anti-inflammatory, and antioxidant, and to support immune system.
12)	Indian pennywort	Centella asiatica	Asiatic acid, Brahmoside, Madecassoside.	Enhances memory and cognitive function, reduces anxiety and stress, and improves sleep.
13)	Indian mulberry	Morinda citrifolia	Resveratrol, Anthocyanins, Alkaloids.	Anti-aging, antioxidant, supports heart health, lowers cholesterol, and blood sugar control.
14)	Yellow berried nightshade	Solanum xanthocarpum	Alkaloids, Glycoalkaloids, Saponins.	Anti-inflammatory, antioxidant, and antiseptic properties.
15)	Pointed gourd	Trichosanthes dioica	Alkaloids, Glycosides, Saponins.	Digestive aid, anti-diabetic, and antioxidant properties. Treats respiratory issues, fever, and skin conditions.
16)	Indian ipecac	Tylophora indica	Alkaloids (Emetine, Cephaeline), Glycosides.	Expectorant, emetic, and anti-amoebic properties. Treats respiratory issues (cough, bronchitis), amoebic dysentery, and fever.
17)	Indian snakeroot	Rauwolfia serpentina	Alkaloids (Reserpine, Ajmaline), Glycosides.	Antipsychotic, antihypertensive, and anti-arrhythmic properties. Treats anxiety, insomnia, and mental disorders.
18)	Devil's cotton	Abroma augustum	Alkaloids, Flavonoids, Glycosides.	Anti-inflammatory, antioxidant, and antiseptic properties. Also used as a natural remedy for digestive issues.

19)	Sensitive plant	Mimosa pudica	Alkaloids, Glycosides, Flavonoids.	Anti-inflammatory, antioxidant, and antiseptic properties. Treats digestive issues, respiratory problems.
20)	Holy basil	Ocimum tenuiflorum	Volatile oil, Ursolic acid, Flavonoids.	Adaptogenic, anti-stress, and antioxidant properties. Also used as a natural remedy for anxiety, depression, and immune system support.
21)	Indian borage	Trichodesma indicum	Volatile oil, Alkaloids, Flavonoids.	Expectorant, anti-inflammatory, and antioxidant properties. Treats respiratory issues (cough, cold).
22)	Small flowered willow herb	Epilobium parviflorum	Flavonoids, Phenolic acids, Glycosides.	Anti-inflammatory, antioxidant, and antiseptic properties. Treats digestive issues, respiratory problems.
23)	Sweet flag	Acorus calamus	Volatile oil, Glycosides, Saponins.	Carminative, anti-inflammatory, and antioxidant properties. Insomnia, anxiety, and as a nerve tonic.
24)	Dill	Anethum graveolens	Volatile oil, Flavonoids, Vitamins.	Carminative, anti-inflammatory, and antioxidant properties. Treats digestive issues (bloating).
25)	Indian heliotrope	Heliotropium indicum	Alkaloids, Glycosides, Flavonoids.	Anti-inflammatory, antioxidant, and antiseptic properties.
26)	Flaxseed	Linum usitatissimum	Omega-3 fatty acids, Fiber, Lignans.	Anti-inflammatory, antioxidant, and laxative properties. Supports heart health, digestion, and immune system.
27)	Licorice	Glycyrrhiza glabra	Glycyrrhizin, Flavonoids, Saponins.	Anti-inflammatory, antioxidant, and expectorant properties. Treats digestive issues (heartburn, indigestion).

28)	Indian corn	Zea mays	Fiber, Vitamins, Minerals.	Supports digestive health, lowers cholesterol, and regulates blood sugar. Treats constipation, diarrhea, and skin conditions.
29)	Jute	Corchorus olitorius	Vitamins, Minerals, Antioxidants.	Supports digestive health, and regulates blood sugar. Jute seeds are used as a natural hair and skin tonic.
30)	Rose	Rosa centifolia	Vitamins A & C, Flavonoids, Essential oils.	Anti-inflammatory, antioxidant, and antiseptic properties.
31)	Indian nightshade	Solanum indicum	Alkaloids (Solasodine), Glycoalkaloids, Saponins.	Treats skin conditions (eczema, acne), respiratory issues (asthma, cough), and digestive problems. Also used for fever, rheumatism, and as a pain reliever.
32)	Greater galangal	Alpinia galanga	Volatile oil, Gingerols, Flavonoids.	Anti-inflammatory, antioxidant, and antimicrobial properties. Used in traditional medicine and cooking.
33)	Indian thyme	Coleus amboinicus	Volatile oil, Thymol, Flavonoids.	Antimicrobial, antispasmodic, and antioxidant properties. Treats respiratory issues (cough, cold, bronchitis), digestive problems. Also used as a natural remedy for stress, anxiety, and as a disinfectant. Used in cooking and as a medicinal herb.
34)	Wild turmeric	Curcuma aromatica	Curcumin, Volatile oil, Flavonoids.	Anti-inflammatory, antioxidant, and antimicrobial properties. Treats joint pain, arthritis, and skin conditions (acne, eczema).
35)	Tree turmeric	Berberis aristata	Limonoids, Alkaloids, Flavonoids.	Anti-inflammatory, antioxidant, and antimicrobial

				properties. Fever, rheumatism, and as an insect repellent.
36)	Indian aloe	Aloe indica	Aloin, Aloe-emodin, Vitamins A, C, E.	Anti-inflammatory, antioxidant, and soothing properties. Treats skin conditions (acne, eczema).
37)	Golden turmeric	Curcuma montana	Curcumin, Volatile oil, Flavonoids.	Anti-inflammatory, antioxidant, and antimicrobial properties. Treats joint pain, arthritis, and skin conditions (acne, eczema).
38)	Indian squill	Scilla indica	Scillitoxin, Glycosides, Alkaloids.	Expectorant, antispasmodic, and cardiovascular properties. Treats respiratory issues.
39)	Bengal bamboo	Dendrocalamustrictus	Silica, Alkaloids, Glycosides.	Anti-inflammatory, antioxidant, and antimicrobial properties. The shoots and leaves are edible and used in traditional medicine.
40)	Kalmegh	Andrographis paniculata	Alkaloids (Andrographolide), Flavonoids, Saponins.	Anti-inflammatory, antioxidant, and antimicrobial properties. Treats liver and respiratory issues (hepatitis, bronchitis), fever, and digestive problems.
41)	Indian madder	Rubia cordifolia	Alkaloids (Rubiamerin), Glycosides, Anthraquinones.	Anti-inflammatory, antioxidant, and antimicrobial properties. Treats skin conditions (acne, eczema, dermatitis), digestive issues (constipation).
42)	Indian senna	Cassia auriculata	Anthraquinones, Glycosides, Alkaloids.	Laxative, anti-inflammatory, and antimicrobial properties. Treats constipation, indigestion.
43)	Indian globe thistle	Echinops echinatus	Saponins, Flavonoids, Alkaloids.	Treats respiratory issues (cough, cold, bronchitis), digestive

				problems (indigestion, bloating), and skin conditions (acne, eczema). Also used as a natural remedy for fever, rheumatism, and as a diuretic, antioxidant.
44)	Indian ginseng	Withania somnifera	Withanolides, Alkaloids, Saponins.	Enhances physical and mental stress resistance, improves cognitive function, and reduces anxiety and fatigue.
45)	Indian myrrh	Commiphora wightii	Resins (Commiphora), Terpenes, Flavonoids.	Treats oral health (toothache, gum inflammation), digestive issues (indigestion, diarrhea), and skin conditions (acne, eczema).
46)	Chitraka	Plumbago zeylanica	Alkaloids (Chitrakin), Flavonoids, Limonoids.	Digestive aid, anti-inflammatory, and antimicrobial properties. Treats indigestion.
47)	Haridra	Curcuma longa	Curcumin, Volatile oil, Flavonoids.	Treats skin conditions (acne, eczema, dermatitis), digestive issues (indigestion, bloating), and respiratory problems (cough, cold).
48)	Daruharidra	Berberis aristata	Berberine, Alkaloids, Flavonoids.	Supports healthy liver function and has antiseptic properties. Berberine has antibacterial and antifungal effects.
49)	Amalaki	Emblica officinalis	Vitamin C, Tannins, Flavonoids.	Antioxidant, anti-inflammatory, and immunomodulatory properties. Enhances immunity, improves skin health, and supports liver function.
50)	Haritaki	Terminalia chebula	Chebulic acid, Tannins, Flavonoids.	Antioxidant, anti-inflammatory, and antimicrobial properties.

51)	Vibhitaki	Terminalia bellirica	Tannins, Flavonoids, Alkaloids.	Antioxidant, anti-inflammatory, and antimicrobial properties.
52)	Pippali	Piper longum	Piperine, Alkaloids, Flavonoids.	Digestive aid, anti-inflammatory, and antioxidant properties.
53)	Jatamansi	Nardostachys jatamansi	Jatamansone, Valeranone, Flavonoids.	Antioxidant, anti-inflammatory, and neuroprotective properties. Treats anxiety, stress, insomnia, and restlessness.
54)	Kushta	Saussurea lappa	Alkaloids (Conessine), Glycosides, Saponins.	Anti-inflammatory, antioxidant, and antimicrobial properties. Treats skin conditions (acne, eczema, leprosy), respiratory issues
55)	Guduchi	Tinospora cordifolia	Alkaloids (Berberine, Palmatine), Glycosides, Saponins, Tinosporin.	Immune booster, anti-inflammatory, antioxidant, and antimicrobial properties. Treats fever, rheumatism, digestive issues, and skin conditions.
56)	Vasa	Adhatoda vasica	Alkaloids (Vasicine, Vasicinone), Glycosides, Saponins.	Expectorant, anti-inflammatory, antioxidant, and antimicrobial properties.
57)	Yashtimadhu	Glycyrrhiza glabra	Glycyrrhizin, Flavonoids, Saponins.	Expectorant, anti-inflammatory, antioxidant, and antimicrobial properties. Treats respiratory issues
58)	Shatavari	Asparagus racemosus	Saponins, Glycosides, Steroidal compounds.	Galactagogue (promotes lactation), anti-inflammatory, antioxidant, and adaptogenic properties
59)	Ashoka	Saraca asoca	Alkaloids, Glycosides, Saponins, Tannins.	Anti-inflammatory, antioxidant, and antimicrobial properties. Treats menstrual disorders and infertility.

60)	Arjuna	Terminalia arjuna	Alkaloids, Glycosides, Saponins, Flavonoids.	Cardiac tonic, anti-inflammatory, antioxidant, and antimicrobial properties.
61)	Brahmi	Bacopa monnieri	Alkaloids (Brahmine), Glycosides, Saponins, Flavonoids.	Brain tonic, antioxidant, and adaptogenic properties. Enhances memory, cognitive function, and mental clarity.
62)	Shankapushpi	Convolvulus pluricaulis	Alkaloids (Shankapushpine), Glycosides, Saponins, Flavonoids.	Brain tonic, anti-inflammatory, antioxidant, and adaptogenic properties. Enhances memory, cognitive function, and mental clarity.
63)	Mandukaparni	Centella asiatica	Alkaloids, Glycosides, Saponins, Flavonoids.	Brain tonic, anti-inflammatory, antioxidant, and adaptogenic properties. Enhances memory, cognitive function, and mental clarity.
64)	Gokshura	Tribulus terrestris	Alkaloids, Saponins, Flavonoids, Glycosides.	Aphrodisiac, anti-inflammatory, antioxidant, and diuretic properties. Treats urinary issues (kidney stones, incontinence), reproductive problems
65)	Varuna	Crataeva religiosa	Alkaloids, Flavonoids, Saponins, Tannins.	Diuretic, anti-inflammatory, antioxidant, and antimicrobial properties. Treats urinary issues (kidney stones, incontinence), digestive problems
66)	Pashanabheda	Bergenia ligulata	Alkaloids, Glycosides, Saponins, Flavonoids.	Supports healthy urinary tract function, and has antiseptic and anti-aging properties.
67)	Shilajit	Asphaltum punjabinum	Fulvic acid, Humic acid, Uranic acid, Trace minerals.	Adaptogenic, anti-inflammatory, antioxidant, and

				rejuvenating properties. Enhances physical and mental energy, supports immune function, and treats respiratory and digestive issues.
68)	Kapikacchu	Mucuna pruriens	Alkaloids (L-Dopa, Mucunain), Saponins, Glycosides.	Nervine tonic, anti-inflammatory, antioxidant, and aphrodisiac properties. Treats Parkinson's disease, anxiety, stress, and male fertility issues.
69)	Atmagupta	Mucuna puriens	Alkaloids(Dictamine), Flavanoids, coumarins.	Digestive aid, anti-inflammatory and antimicrobial properties.
70)	Kaunch	Mucuna pruriens	Alkaloids (Mucunain,L-Dopa), Saponins, Glycosides.	Aphrodisiac, anti-inflammatory, antioxidant, and nervine tonic properties. Treats male fertility issues, low libido, and stress.
71)	Rishabhaka	Mucuna pruriens	Alkaloids (Glycosides), Saponins, Flavonoids.	Anti-inflammatory, antioxidant, and adaptogenic properties. Treats respiratory issues (bronchitis, asthma).
72)	Shatapushpa	Anethum graveolens	Alkaloids, Flavonoids, Saponins, Volatile oils.	Digestive aid, anti-inflammatory, antioxidant, and antiseptic properties. Treats indigestion, bloating, and respiratory issues (bronchitis, asthma).
73)	Chandana	Santalum album	Santalol, Santalene, Volatile oils.	Coolant, anti-inflammatory, antioxidant, and antiseptic properties. Treats skin conditions (acne, eczema), digestive issues (indigestion, bloating), and stress.
74)	Agaru	Aquilaria agallocha	Agarol, Agarospirol, Volatile oils.	Anti-inflammatory, antioxidant, and antiseptic properties.

				Treats skin conditions (acne, eczema), digestive issues (indigestion, bloating).
75)	Ushira	Vetiveria zizanoides	Alkaloids, Flavonoids, Saponins, Volatile oils.	Diuretic, anti-inflammatory, antioxidant, and antiseptic properties. Treats urinary issues (kidney stones, incontinence).
76)	Tagara	Valeriana wallichii	Alkaloids (Valerine), Flavonoids, Volatile oils.	Sedative, anti-anxiety, and anti-inflammatory properties. Treats insomnia, stress, and anxiety.
77)	Lavanga	Cinnamomum verum	Volatile oils (Eugenol), Flavonoids, and Tannins.	Carminative, anti-inflammatory, antioxidant, and antiseptic properties. Treats digestive issues (indigestion, bloating), respiratory problems.

Collection Of Medicinal Plants:

The weather of the harvested plant, such as the leaves of Mentha, which is used in cooking, the leaves of Eucalyptus species, which is a cash crop, and the leaves of Spearmint, which is used to improve memory in the spring, has a high content of volatile oils, but in hot and cold weather. For instance, the age of medicinal plants Certain varieties of Cinchona trees belonging to the Rubiaceae family contain significant amounts of Quinine, an alkaloid that is used to treat malaria and babesiosis, and Cinchonine, an antipyretic chemical, in their bark. Early years, between the ages of 6 and 9. The stage of a medicinal plant's physiological development that is used: for instance, the leaves of Digitalis, Tobacco, and Senna are gathered when they reach the full physiological maturity phase, while the seeds of Nigella sativa, or black cumin, are gathered when they are both white and black in colour[12,13,14].

Importance Of Collection:

Gathering botanical specimens is not the only thing that goes into collecting medicinal plants; it is a methodical process that incorporates sustainable methods, ethnobotanical knowledge, and biodiversity conservation. It is the first step towards delving into the enormous pool of natural chemicals with potential medicinal uses [15,16].

Biodiversity Documentation:

Botanical expeditions and ethnobotanical surveys are essential for recording the world's biodiversity. The distribution, abundance, and ecological roles of plant species in many environments are better understood as a result of these efforts. Records of endemic species and hotspots for biodiversity are essential for organizing conservation efforts and ecological restoration projects [17].

Ethno Botanical Knowledge:

Working together with indigenous tribes is crucial to procuring medicinal herbs in an ethical manner using their traditional knowledge. Indigenous

ways of using plants for food, medicine, and ceremonial purposes provide important insights. This partnership guarantees both the sustainable management of plant resources and the preservation of cultural heritage[18,19].

Genetic Diversity:

The collection and preservation of plant specimens contribute to maintaining genetic diversity within plant populations. Genetic variability enhances species resilience to environmental stressors and provides a genetic reservoir for breeding programs aimed at improving crop yield and medicinal properties. Seed banks and botanical gardens serve as repositories for genetic resources critical for future research and conservation efforts [20].

Identification Of Medicinal Plants:

The world is home to many different kinds of plants. In medicine, members of all four kinds are beneficial. While some plants are not green, others are. While some have simple, one-celled plant bodies, others have highly ordered, complex plant bodies. While some people create flowers, others do not. Plants worldwide are classified as lower cryptogamic plants and higher phanerogamic plants based on these and other exterior characteristics. Cryptogamic plants can have many cells or only one (unicellular), but they never have blooms. These are further divided into higher cryptogams like bryophytes and pteridophytes and lesser cryptogams like bacteria, viruses, algae, and fungi. Each of these cryptogams reproduces either vegetatively or by producing tiny grains known as spores. When present, the sex organs are frequently tiny and concealed within the body of the plant. Algae are green, single- or multicellular plants that thrive in damp environments. With the use of green colouring material (chlorophyll) found in their bodies, water, carbon dioxide, and sunshine, they are able to synthesize their (autotrophic) food. Certain algae are utilized as food, a source of algin and gelatin, among other things[21,22] Fungi, a singular form of plant, are non-green, saprophytic, parasitic, or dependent on other sources of sustenance (heterotrophic). In medicine, some of these are employed. Unicellular or chemical creatures, bacteria and viruses are minuscule and challenging to view via regular magnifying lenses. While some of them are incredibly helpful to humans, the majority of them are creatures that cause disease. Bryophytes are green, multicellular, non-flowering plants that reproduce both sexually and vegetatively in moist environments. Some of them are recognized to have therapeutic qualities. Higher cryptogams having a well-organized plant body are called pteridophytes. They can reproduce by producing spores, roots, stems, and leaves [23,24,25].

Accurate Taxonomic Identification:

Scientific inquiry, taxonomy, and traditional knowledge all depend on accurate identification of therapeutic plants. To reliably classify plant species, taxonomists use a variety of methodologies, such as morphological, anatomical, and molecular techniques[26].

Morphological And Anatomical Techniques:

Phylogenetic analysis and DNA barcoding have transformed plant identification thanks to advances in molecular biology. In order to provide unique identifiers for plant species, DNA barcoding entails sequencing particular genomic areas. In addition to conventional methods, molecular techniques offer quick and precise species identification, especially for cryptic or morphologically similar species [27].

Validation Of Ethnopharmacological Knowledge:

Medicinal plant safety and efficacy are confirmed when scientific approaches and traditional knowledge are combined. By linking traditional applications with plant identification, ethnobotanical research establishes evidence-based methods for drug development and healthcare. This multidisciplinary strategy

encourages the sustainable use of medicinal plants while improving cultural preservation [28].

Qualitative Phytochemical Testing:

Phytochemicals are naturally occurring chemical substances found in plants that can have either favorable or harmful effects on health. The Greek word phyton means "plant." The richest bio reservoirs of diverse phytochemicals are medicinal plants, which are used to treat a variety of illnesses and maladies. The phytochemical components of plants define their characteristics. Several of the among the significant phytochemicals are tannins, alkaloids, phenolics, flavonoids, saponins, and steroids. Plant parts that are dispersed throughout the plant, such as glycosides, terpenes, etc. The natural world is a distinct source of highly diverse phytochemical compounds that represent phenolics (45%), the three main classes of phytochemicals are alkaloids (18%), terpenoids, and steroids (27%) [29]. While these compounds may not appear to be necessary for the plant that produces them, they are essential for the plant's survival because they mediate ecological interactions with competitors, protect the plant from diseases, pollution, stress, and UV rays, and give the plant its color, scent, and flavor. Plants produce metabolites to defend themselves against biotic and abiotic stressors, and these compounds have been developed into medications that are used to treat a variety of illnesses. Different extraction processes can be used to separate the phytochemicals from the plant material. Maceration, percolation, infusion, digestion, decoction, hot continuous extraction (Soxhlet extraction), and other conventional methods are the most often used ones. However, more recently, environmentally friendly methods like Ultrasound-Assisted Extraction (UAE), Microwave-Assisted Extraction (MAE), Supercritical Fluid Extractions (SFE), and Accelerated Solvent Extraction (ASE) have also been introduced. The extraction method makes use of a variety of solvents, including water, ethanol, methanol, acetone, ether, benzene, and chloroform [30,31]. Pre-extraction factors (plant part used, its origin and particle size, moisture content, drying method, degree of processing, etc.) and extraction-related factors (extraction method adopted, solvent chosen, solvent to sample ratio, pH and temperature of the solvent, and length of extraction) have an impact on phytochemicals from the plant materials. In the past, plant components were utilized directly for medicinal purposes; however, modern technology enables the identification, isolation, and synthetic production of the active ingredients in pure form. The chemical structures obtained from these phytoconstituents can be used as models in the synthesis of novel synthetic medicines. The potential pharmacological action of a plant can be predicted with the use of phytoconstituent identification in the plant material [32].

Characterization Of Bioactive Compounds:

Bioactive chemicals from medicinal plants are extracted, isolated, and characterized as part of qualitative phytochemical testing. The goal of this analytical procedure is to pinpoint the chemical components that give the plants their medicinal qualities [33].

Extraction Techniques:

To produce plant extracts that are enriched with bioactive chemicals, a variety of extraction techniques are used, including maceration, infusion, Soxhlet extraction, and supercritical fluid extraction. Every method has benefits for removing particular groups of substances with the least amount of deterioration and contamination [34].

1)Maceration:

By soaking them in a liquid, such as water or alcohol, solid food components, such as fruits or herbs, are softened and broken down through the process of maceration. This produces a rich extract or infusion that is frequently used in herbal cures,

cookery, and cosmetic treatments. It also releases tastes, oils, and colors.

Maceration extraction process:

1. Plant material and solvent (liquid) are combined.
2. Mixture is left to steep, allowing solvent to extract desired compounds.
3. Mixture is strained, separating solids from liquid extract.
4. Liquid is filtered and concentrated (optional).
5. Resulting extract is used in various applications (food, cosmetics, herbalism) [35].

2) Infusion:

Plant materials, such as leaves or flowers, are infusion-steeped in hot water to release their flavors, fragrances, and nutrients, resulting in a tasty and calming beverage. Infusion, as opposed to maceration, usually extracts more sensitive chemicals by using hotter water and a shorter steeping period.

Infusion extraction process:

1. Plant material (leaves, flowers, etc.) is placed in a container.
2. Boiling water is poured over the plant material.
3. Mixture steeps for 5-30 minutes, depending on the material.
4. Liquid is strained and separated from solids.
5. Resulting infusion is enjoyed hot or cold, sweetened or unsweetened [36].

3) Soxhlet Extraction:

Soxhlet extraction is a laboratory technique used to extract compounds from solid materials, such as plant tissues, with a solvent. It's a reflux method that uses a specialized apparatus to repeatedly circulate the solvent through the material, allowing for efficient and selective extraction of desired compounds with minimal solvent usage. Soxhlet extraction:

1. Plant material is placed in a thimble.
2. Solvent (e.g., hexane) is added to the thimble.
3. Solvent evaporates, condenses, and drips back into the thimble.
4. Process repeats, allowing selective extraction of compounds.
5. Resulting extract is collected and concentrated [37].

4) Supercritical Fluid Extraction:

Supercritical fluid extraction (SFE) is a green extraction method that uses a solvent above its critical temperature and pressure to extract compounds from solids or liquids. Carbon dioxide is commonly used, offering a non-toxic and environmentally friendly alternative to traditional solvents. SFE provides high selectivity, efficiency, and purity of extracts [38].

Isolation And Purification:

Bioactive chemicals are extracted from crude extracts using isolation techniques such as chromatography (e.g., TLC, column chromatography, HPLC) and spectroscopy (e.g., UV-Vis, IR, NMR). These methods make it possible to isolate certain chemicals for biological research and structural clarification [39].

Bioassays And Pharmacological Screening:

Bioassays and pharmacological tests evaluate the biological activities of isolated compounds, such as antimicrobial, antioxidant, anti-inflammatory, and anticancer properties. Understanding the biological activities of bioactive compounds provides insights into their therapeutic potential and mechanisms of action [40].

Phytochemical Screening:

The methanolic extracts of following plants was subjected to different chemical tests for the detection of different phytoconstituents using standard procedures

Test For Tannins:

1 ml of the sample was taken in a test tube and then 1 ml of 0.008 M Potassium ferricyanide was added. 1 ml of 0.02 M Ferric chloride containing 0.1 N HCl was added and observed for blue-black coloration.

Test For Phlobatannins:

When crude extract of each plant sample was boiled with 2 % aqueous HCl. The deposition of a red precipitate was taken as evidence for the presence of phlobatannins.

Test For Saponins:

Crude extract was mixed with 5 ml of distilled water in a test tube and it was shaken vigorously. Add some drops of olive oil. The formation of stable foam was taken as an indication for the presence of saponins.

Test For Flavonoids:

5 ml of dilute ammonia solution were added to a portion of the crude extract followed by addition of concentrated H2SO4. A yellow colouration observed in each extract indicated the presence of flavonoids. The yellow colouration disappeared on standing.

Test For Steroids:

2 ml of acetic anhydride was added to 0.5 ml crude extract of plant sample with 2 ml H2S04. The colour changed from violet to blue or green in samples indicates the presence of steroids.

Test For Alkaloids:

Crude extract was mixed with 2 ml of Wagner's reagent. Reddish brown colored precipitate indicates the presence of alkaloids.

Test For Quinones:

Dilute NaOH was added to the 1 ml of crude extract. Blue green or red coloration indicates the presence of quinones.

Test For Coumarin:

10 % NaOH was added to the extract and chloroform was added for observation of yellow color, which shows the presence of Coumarin.

Test For Terpenoids (Salkowski Test):

5 ml of extract was mixed with 2 ml of chloroform and 3 ml of concentrated H2S04 was carefully added to form a layer. A reddish brown colouration of the inter face was formed to show positive results for the presence of terpenoids.

Test For Cardiac Glycosides (Keller-Kiliani Test):

5 ml of extract was treated with 2 ml of glacial acetic acid containing one drop of ferric chloride solution. This was underlayer with 1 ml of concentrated H2SO4. A brown ring of the interface indicates a deoxy sugar characteristic of cardenolides. A violet ring may appear below the brown ring, while in the acetic acid layer, a greenish ring may form just gradually throughout thin layer [41].

Traditional And Allopathic Medicinal Systems: Integration Into Healthcare Practices:

Throughout the world, medicinal plants have played a crucial role in both allopathic and traditional healthcare systems by providing natural alternatives and innovative drug candidates [42].

Traditional Medicine Systems:

For their holistic approaches to healing, medical systems like Ayurveda, Traditional Chinese Medicine (TCM), and Indigenous Medicine mostly rely on medicinal plants. These systems incorporate a wealth of traditional knowledge on the use of medicinal plants and stress individualized therapies based on cures obtained from plants [43].

Allopathic Medicine:

Plant-derived chemicals are included into medication development and discovery procedures in modern pharmacology. The fact that many pharmaceutical medications have natural product roots emphasizes the therapeutic value of medicinal plants in contemporary medicine [44].

Use And Importance In Developing Suitable Formulations:

Since they have been used for thousands of years in many traditional medical systems, medicinal plants are becoming more and more significant resources for the creation of cutting-edge pharmaceutical formulations. Their bioactive components provide a wide range of therapeutic benefits, which makes them indispensable for the creation of secure and efficient drug formulations [45].

Traditional Medicine Systems:

Ayurveda, Traditional Chinese Medicine (TCM), And Indigenous Medicine:

Medicinal plants have long been used by traditional medical systems around the world, including Ayurveda in India, Traditional Chinese Medicine (TCM) in China, and several Indigenous Medicine practices worldwide, to provide holistic treatment. These systems incorporate herbs into intricate concoctions that are customized to meet the needs of each patient using conventional diagnostic guidelines and medical expertise [46].

Ayurveda:

To extend life, boost vigor, and treat a variety of illnesses, Ayurvedic physicians construct concoctions known as "Ramayana's" and "Kashaya's" using particular herbs [47].

Traditional Chinese Medicine (TCM):

TCM bases its treatment of illnesses on the Five Elements theory and Yin-Yang concepts. It does this by combining herbs into "formulas" that are meant to balance body processes [48].

Indigenous Medicine:

Indigenous groups around the world use native plants to make remedies that honor ecological and cultural knowledge and frequently address issues related to mental, bodily, and spiritual well-being [49]

Modern Pharmaceutical Formulations:

Drug Discovery and Development:

Lead molecules for medication development and discovery can be found in medicinal plants. Through qualitative phytochemical testing, their bioactive compounds were found,

and these constituents have a variety of pharmacological actions, including antibacterial, antioxidant, anti-inflammatory, and anticancer characteristics [50].

Drug Leads:

Plant-based natural compounds are frequently the source of early drug development leads. Novel medications are created by structurally modifying bioactive substances to increase bioavailability, decrease toxicity, and maximize efficacy [51].

Combination Therapies:

By combining medicinal plants in ways that work well together or creating multi-herb formulations, it is possible to increase therapeutic benefits while reducing any adverse effects[52].

Importance In Developing Suitable Formulations:

Phytochemical Profiling And Standardization:

In order to identify and quantify bioactive components for use in the formulation of herbal medicines and nutritional supplements, qualitative phytochemical testing is essential. Standardization of herbal extracts improves reproducibility and efficacy in clinical applications by guaranteeing constant concentrations of active components [53].

Quality Control:

Strict quality control procedures, such as spectroscopic analysis and chromatographic fingerprinting, are employed to confirm the genuineness and purity of plant extracts utilized in formulations [54].

Safety And Efficacy:

Combining pharmacological research with phytochemical data guarantees the safety and effectiveness of herbal products, satisfying regulatory requirements for the wellbeing and health of consumers[55].

Future Perspectives:

Bioprospecting And Ethnopharmacology:

Novel species of medicinal plants and bioactive chemicals with therapeutic potential are continually being discovered thanks to developments in ethnopharmacology and bioprospecting. Ethnobotanists, pharmacologists, and indigenous populations work together to advance sustainable methods for plant harvesting and conservation [56].

Innovative Formulations:

New technologies, such phytopharmaceuticals and nanotechnology, provide creative ways to

improve the effectiveness and delivery of medications made from plants. Enhancing solubility, stability, and targeted distribution of bioactive substances using nanoencapsulation creates new opportunities for precision treatments [57].

Importance Of Pharmacists Having Medicinal Plants Available Locally:

In healthcare systems, pharmacists are essential middlemen between patients and prescription drugs. Pharmacists frequently act as the primary healthcare practitioner in places where access to traditional healthcare services or pharmaceuticals may be limited, particularly in rural and underdeveloped areas. Pharmacists place a high value on the presence of medicinal plants in their community for many reasons [58].

1. Improving Healthcare Access And Affordability:

Because of expense or practical difficulties, access to pharmaceutical medications may be restricted in rural or underdeveloped areas. Medicinal plants offer a more accessible and economical option, enabling pharmacists to create herbal cures or suggest conventional therapies that are both economically viable and culturally appropriate for the community [59].

2. Cultural Relevance And Patient Acceptance:

Local customs and practices have a strong hold on the use of medicinal herbs. Pharmacists who respect and incorporate traditional healing traditions into contemporary healthcare procedures can establish rapport and trust with patients by being informed about indigenous herbal treatments. When treatment plans are adapted to the cultural preferences and beliefs of the patient, this improves patient compliance and satisfaction [60].

3.Supporting Sustainable Healthcare Practices:

Pharmacists support local people' sustainable use and preservation of medicinal plants. Pharmacists support environmental stewardship and guarantee the long-term supply of vital herbal resources by encouraging ethical sourcing, ethical harvesting methods, and biodiversity conservation [61].

4. Facilitating Holistic Healthcare Approaches:

Pharmacists can embrace holistic healthcare approaches that take into account the physical, psychological, and spiritual components of health by incorporating medicinal plants into their practice. In addition to traditional drugs, herbal medicines provide patients with individualized treatment plans that cater to their various needs [62].

5. Promoting Public Health and Wellness:

Pharmacological characteristics and therapeutic advantages of medicinal plants have been shown to assist in the management and prevention of disease. Herbal medicine-trained pharmacists can inform the public about self-care techniques and preventive healthcare measures, enabling people to actively participate in their own health management [63].

6. Economic Opportunities And Community Development:

The availability of therapeutic plants nearby encourages economic growth in local towns. Together, local growers, herbalists, and traditional healers may help pharmacists cultivate medicinal plants sustainably, produce herbal products for local markets, and encourage herbal medicine entrepreneurship [64,65].

Future Directions Include:

- ➢ Advancing phytochemical testing methods for more accurate and efficient analysis
- ➢ Developing sustainable cultivation practices for high-demand medicinal plants
- ➢ Exploring new medicinal plant species and their potential applications
- ➢ Strengthening regulatory frameworks for quality control and standardization
- ➢ Encouraging interdisciplinary research and collaboration for holistic approaches to herbal medicine development.

We can fully utilize medicinal plants and improve human health and well-being by fusing traditional knowledge with cutting-edge scientific methodologies.

CONCLUSION:

To guarantee the effectiveness and quality of herbal remedies, it is essential to gather, cultivate, and analyze medicinal plants for phytochemicals. It is possible to maximize the bioactive components in medicinal plants and reduce the danger of contamination by using appropriate procedures for collecting and cultivation. Qualitative phytochemical testing offers important information for future study and development by assisting in the identification and characterization of the bioactive chemicals found in the plants. Through the use of sustainable and standardized methods for phytochemical testing, cultivation, and collection, the medicinal plant sector can:

- Make sure herbal products are consistently high-quality and effective;
- Encourage the preservation and sustainable use of medicinal plant resources.
- Promote the study and creation of novel herbal remedies.
- Encourage the use of traditional medicine and community healthcare.
- Make a positive impact on the global healthcare industry and economy.

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