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Medicinal plants: Future source of new drugs

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Abstract

India has a long history and strong base for Ayurveda, which is the traditional herbal medical system. Herbal plants play an important role in preventing and treating of human diseases. People have been using plants as a traditional medicine for thousand years ago. Plants have been associated with the development of human civilization around the whole world. However, plants are considered as rich sources of phytochemical ingredients which enable to have medicinal value. Medicinal plants are a potential source for the development of new herbal drugs. In the 21st century, the pharmacological effects of medicinal plants have been considered as a promising future drug/medicine for the management of health care. In recent years, there has been a resurgence of interest to rediscover medicinal plants as a source of potential drug candidate. Therefore, the aim of the present review is to understand the knowledge of the medicinal plants as a future source of herbal drugs.

Keywords: medicinal plants, ayurveda, herbal medicine, phytochemicals, drug development

1. Introduction

From the very beginning of human existence, man has familiarized himself with plants and used them in a variety of ways throughout the ages. Primitive man in search of food and to cope successfully with human sufferings began to distinguish those plants suitable for medicinal purpose from others with definitive pharmacological action. This relationship between plants and man has grown and many plants came to be used as medicines. The growth of knowledge to cure diseases continued at an accelerating pace and a number of new plant-derived drugs increased likewise. Nature has bestowed our country with an enormous wealth of medicinal plants; therefore, India has often been referred to as the Medicinal Garden of the world. The clinical use of plants described in Indian Vedas for curing different diseases. In the present context, the traditional system of medicine is widely accepted and practiced by people worldwide. At this stage, India has a unique position in the world where a number of recognized Traditional system of medicine *i.e.* Ayurveda, Siddha, Unani, Homeopathy, Yoga and Naturopathy ^[1]. Medicinal plants have been recognized as potential drug candidates because they possess drug like properties ^[2].

2. Traditional System of Medicine

Ayurveda is an ancient health care system which evolved in India dates back to about 5000 years ago. As per the ancient literatures on Ayurveda, it was practiced during Vedic period of INDIA. About 700 plants were described in Charaka Samhita and Sushruta Samhita during the 1st millennium BC. This medical system is widely practiced in other parts of the world as a form of complementary medicine. Ayurvedic System of INDIA aims to preserve, promote and sustain good health and preventing diseases through healthy lifestyle practices. The literal meaning of Ayurveda is the "Science of life". It is estimated that about 7,500 plants are used in local health traditions in most rural and tribal villages in India. Herbal treatments are the most popular form of Traditional Medical System ^[3]. The plant-based traditional medicine systems continue to play a crucial role in the health care system. The demand of herbal based medicine, health products, pharmaceuticals, food supplements, nutraceuticals, cosmetics are increasing worldwide. In the 21st century, natural products represent more than 50% of all drugs in clinical use. Up to 50% the approved herbal drugs during the last 3 decades are from either directly or indirectly from natural products including plants, microorganisms, fungi and animals. As per the records of the National Medicinal Plant Board (NMPB), the Indian herbal industry may like to increase in order of Rs. 80 to 90 billion by 2020. However, India is moving forward in popularising of the Traditional Medical System of AYUSH (Ayurveda, Yoga, Unani, Siddha and Homeopathy) in health care sector through global networks.

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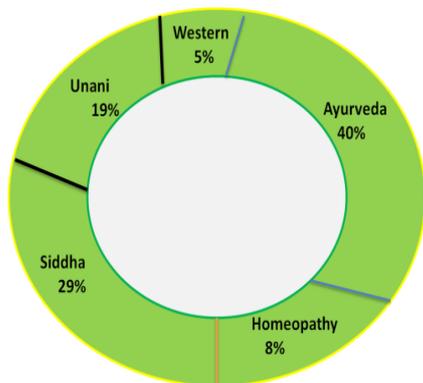


Fig 1.1 Percentage of plant species under different systems of Indian medicine (NMPB 2008)

In spite to advance in the modern medical system, there are many new diseases are emerging in few decades. Looking to the emerging challenges in healthcare system, there is needed to integrate the Ayurveda in medical system for the management and treatment of lifestyle-related diseases.

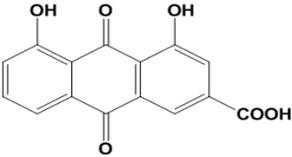
Ayurveda can offer drug free society for curing the diseases and management of quality of life. In order to augment the traditional system of India, Government of India has set up a National Level Policy for growth, promote and development of the Traditional System of Indian Medicine. The Ministry of AYUSH has created the separate Departments for Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy collectively known as AYUSH. Fig. 1.1 shows the percentage of herbal medicines of different medical system in India.

3. Herbal medicine

Herbal medicine or phytomedicine is the use of plants for medicinal and therapeutic purpose for curing of diseases and improve human health. Plants have secondary metabolites called phytochemicals ('Phyto from Greek - meaning 'plant'). These compounds protect plants against *microbial* infections or infestations by pests. Phytochemicals are active ingredients which possess therapeutic properties that are considered as a medicine or drug. Phytochemicals can be classified on the basis of their chemical composition (Table 1.1).

Table 1.1: Classification of phytochemicals

S. No.	Phytochemicals	Chemical structure	Example
1.	Alkaloids	<p>Nitrogen atom in heterocyclic rings</p> <p>Caffeine</p>	Morphine, caffeine, Berberin, codeine ^[3]
2.	Glycosides	<p>Derived from carbohydrates and noncarbohydrates molecules.</p> <p>Andrographolide</p>	Amygdalin, gentiopicrin, and rographolide, polygalin, Cinnamyl acetate ^[4]
3.	Polyphenoles (Flavonoids, Phenolics Tannins)	<p>Aromatic aliphatic ring containing phenols</p> <p>Resveratrol</p>	Quercetin, resveratrol kaempferol and quercitrin, caffeic acid, flavones, rutin, naringin, hesperidin and chlorogenic, tannic acid, gallic acid and ellagic acid ^[5]
4.	Saponins	<p>Sugar attached to triterpene or steroid aglycone</p> <p>Diosgenin</p>	Diosgenin and hecogenin ^[6]
5.	Terpenes (Carotenoids, steroids)	<p>Long unsaturated aliphatic chains (isoprene units)</p> <p>Artemisinin</p>	Artemisinin, α -carotene, β -carotene, lycopene, lutein and zeaxanthin ^[7]

6.	Anthraquinones	<p style="text-align: center;">Derivatives of phenolic and glycosidic compounds</p>  <p style="text-align: center;">Rhein</p>	Rhein, salinos poramide and luteolin ^[8]
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Plants use as food and in traditional medicine are more likely to yield pharmacologically active compounds. The medicinal properties of plants have been investigated in the recent scientific developments throughout the world, due to their potent therapeutic efficacy and antioxidant activities, no side effects and economic viability. Medicinal plants are serving as raw material for drugs which are effective and reasonable health care for people. However, all plants synthesize phytochemicals, which are beneficial for our health as they cannot be synthesized in the human body^[9]. Plants are also rich dietary sources of biomolecules, vitamins and minerals which are crucial for maintaining the healthy body.

It has been observed that numerous plants have pharmacological effects due to the presence of metabolites. Plant-metabolites are organic compounds which can be classified into primary metabolites and secondary metabolites. Primary metabolites are organic compounds include glucose, starch, polysaccharide, protein, lipids and nucleic acid which are beneficial for growth and development of the human body. Plants synthesize secondary metabolites which include alkaloids, flavonoids, saponins, terpenoids, steroids, glycosides, tannins, volatile oils etc., The therapeutic efficacy of plants is because of these secondary metabolites for curing many diseases. Phytochemicals are pharmacologically active compounds. These include alkaloids have an antispasmodic, antimalarial, analgesic, diuretic activities; Terpenoids are known for their antiviral, anthelmintic, antibacterial, anticancer, antimalarial, anti-inflammatory properties; Glycosides are reported for antifungal and antibacterial properties; Phenols and flavonoids have an antioxidant, anti-allergic, antibacterial properties etc. and Saponins are reported to have anti-inflammatory, antiviral, plant defence activities^[10, 11]

A Chinese Pharmacologist, Youyou Tu, discovered and developed a new herbal antimalarial drug "Artemisinin" from *Artemisia annua* (a Sweet Warmwood plant in China). Researchers identified several chemical compounds used in modern medicine, which were derived from plant sources include quinine, digoxin, Aspirin, ephedrine, atropine, and colchicine^[12, 13].

People have been using plants as a medicine without scientific knowledge and proper guidance for thousand years ago. Using plants as medicines it is considered as a natural healing Medical System. It has been scientifically established that every part of plants has medicinal properties include flower, root, and stem, leafs, fruits, seed and whole plants. However, it has been observed that some plants are not safe for health because they contain some toxic compounds which show adverse effects in the body^[14].

5. The importance of plants as a source of new drugs

Herbal medicine is widely practiced in worldwide. For centuries, people have turned to natural remedies to cure common ailments such as colds, allergy, upset stomachs and toothaches and the trend is constantly increasing. Thus, there has been a shift in universal trend from synthetic to herbal medicines, which we can say 'Return to Nature' for the prevention of diseases and ailments. Nature has been a source of medicinal plants. The World Health Organization (WHO) reported that 4 billion people (80% of the world's population) use herbal medicines for some aspect of primary healthcare^[15]. Herbal medicine has been recognized by WHO as essential components for primary health care and about 11% of the 252 drugs are derived from plants^[16].

Since time immemorial, human civilization has been used several plants as food, medicine, clothing and shelter. Vegetarian foods contain high amounts of various "super-nutrients," such as protective antioxidants, phytochemicals, micronutrients, which promote health and protect from diseases. Plants have several pharmacological roles such as antioxidant, antiviral, anticancer, antimicrobial, antifungal and antiparasitic. Plants have free radical scavenging molecules, including flavonoids, phenolics, anthocynins and vitamins, which show antioxidant like activity^[11]. It has been reported that the antioxidant property of phytochemicals may be mitigated the oxidative stress in the biological system. Phytochemicals have been reduced the risk of many human diseases include cardiovascular disease, hepato-renal diseases, diabetes, cancers and neurodegenerative disorders. However, several herbal medicines are being derived directly or indirectly from plants that are considered as an important medicine currently in use for curing various human diseases^[17, 18]

6. Development of Herbal drug and its challenges

The development of plant drug started when development of chemistry, isolation, purification, characterization of plant active compounds. Herbal medicine is effective, lesser side effect, and affordable than the medicines bought from an allopathic medicine. Herbal medicines include herbs, herbal materials, herbal preparations, and herbal products that contain different parts of plants or other plant materials as active ingredients. It has been well documented that herbal plants and their derivatives play critical roles in modern drug development. Medicinal plants are the natural resources in developing of new drugs^[19, 20, 21]. Fig. 1.2 showed the following steps for the development of new herbal drug from plants.

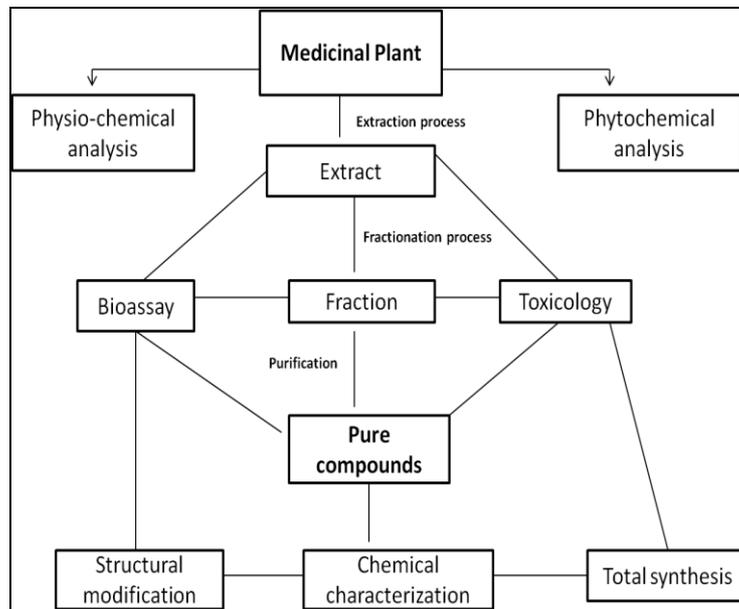


Fig 1.2: Method for obtaining active biological compounds from plants

In spite of the success of drug development research from medicinal plants in the past 2–3 decades, future endeavors face many challenges. The quality of an herbal product is questioned; standardization of raw material emerges as a major issue for herbal industry [22, 23]. Herbal plants can be easily contaminated during growth, processing and collection. Adulteration and heavy metal contamination are the two major problems reported in Herbal medicines. Therefore, it is

necessary to improve the quality and quantity of bioactive compounds for developing new herbal drug and keep pace with other drug discovery efforts [24, 25]. Today, there are several medicinal plants and their bioactive agents have been scientifically and clinically evaluated by Investigators. Table 1.2 showed the list of some plant species and their active components that are being used for the management of various human diseases.

Table 1.2: Top 25 Bioactive Compounds of Medicinal plants

S. No.	Plant species	Common name	Active agents/drugs	Pharmacological action
1.	<i>Taxus brevifolia</i> [26]	Pacific yew	Taxol	Antitumor
2.	<i>Catharanthus roseus</i> [27]	Sadabahar	Alkaloid (Vinblastine and Vincristine)	Anticancer
3.	<i>Camptotheca acuminata</i> [28]	Happy tree	Topotecan and Irinotecan	Anticancer agents (treatment of ovarian and small cell lung cancers)
4.	<i>Podophyllum peltatum</i> [29]	Mayapple	Alkaloid (Etoposide and Teniposide)	Anticancer agents
5.	<i>Curcuma longa</i> [30]	Haldi	Flavonoid (Curcumin)	Anticancer, anti-inflammatory, hepatoprotective
6.	<i>Silybum marianum</i> [31]	Milk thistle	Flavonoid silymarin (Silibinin)	Anticancer, anti-inflammatory, liver tonic for hepatic disorders
7.	<i>Ricinus communis</i> [32]	Castor bean	Alkaloid (ricinine), lectin (ricin)	Hepatoprotective, anti-oxidant, hypoglycemic, anti-tumorous
8.	<i>Terminalia chebula</i> [33]	Harra	Tannins, shikimic acid compounds, triterpenoids, ellagic acid	Anti-oxidant, anti-diabetic, renoprotective, hepatoprotective
9.	<i>Withania somnifera</i> [34]	Ashagwanda	Steroidal lactones, withanolides, notably withaferin A	Chemopreventive, anti-cancerous, memory enhancer and immunomodulatory, used in Parkinson's and Alzheimer's disorders
10.	<i>Zinziber officinalis</i> [35]	Ginger	Mono and sesquiterpenoids, Zingerone and gingerols	Anti-cancerous, Antioxidant, Hepatoprotective, hypercholesterolaemic, anti-atherosclerotic
11.	<i>Azadirachta indica</i> [36]	Neem	Limonoids (nimbidinin), Di- and triterpenoids,	Inhibitor of carcinoma, chemopreventive, inhibit colon cancer, antiallergic, Blood purifier
12.	<i>Piper nigrum</i> [37]	Kali mirch	Piperidine, dehydropiperonaline	Anti-carcinogenic, anti-hyperlipidaemic, Epilepsy
13.	<i>Tinospora cordifolia</i> [38]	Geloy	Diterpenoid furanolactones (tinosporin), isoquinoline alkaloids	Immunomodulator, chemopreventive, Cardioprotective, Antidiabetic
14.	<i>Aloe vera</i> [39]	Gheekumari	Aloin and emodin, campesterol, β -sisosterol	Healing properties, Antiviral and antitumor activity Antidiabetic, Hepatoprotective, Antiseptic effect
15.	<i>Ocimum sanctum</i> [40]	Tulsi	Apigenin, Taxol and Ursolic acid, Citral	Antidiabetic, Hepatoprotective anti-bacterial, anti-fungal, anti-pyretic and anti-cancer properties
16.	<i>Berberis vulgaris</i> [41]	Barberry	Berberine	Antidiabetic, hepatoprotective, antimicrobial.

17.	<i>Bergenia ciliata</i> ^[42]	Pakhenbhed	IS-01246	Anti-arthritis
18.	<i>Digitalis lanata</i> ^[43]	Tilapushpi	Digoxin	Used in heart diseases.
19.	<i>Nigella Sativa</i> ^[44]	Black cumin	Thymoquinone	Antidiabetic, anticancer, antimicrobial, Hepato-renalprotective, and gastro-protective
20.	<i>Cinchona robusta</i> ^[45]	Quina	quinine	Antimalarial, antiparasitic effect
21.	<i>Artemisia absinthium</i> ^[46]	Sweet wormwood	Artemisinin	Antimalarial drug
22.	<i>Swertia chirata</i> ^[47]	Chirayita	Ophelic acid, sawertiamarine, mangeferin and amarogenitine	Antidiabetic effect, antiviral, Hepato-renal protective
23.	<i>Allium sativum</i> ^[48]	Lahsun	Allicin	Cardioprotective, anti-inflammatory
24.	<i>Terminalia arjuna</i> ^[49]	Arjuna	Arjunic acid, tannic acid, tannins, saponins, gallic acid and phytosterols	Cardioprotective, anticancer agents, hepatoprotective
25.	<i>Phyllanthus emblica</i> ^[50]	Amla	Emblicanin A, emblicanin B, punigluconin and pedunculagin	Antiviral, antimicrobial, anticancer, hepatoprotective and anti diabetic

7. Conclusion

In the next few decades, herbal medicine may become a new era of medical system for the management of human diseases. About 80% world population rely on traditional medicine for primary health care. Over the past decade, there has been a resurgence of interest in the investigation of medicinal plant as a source of potential herbal medicine. There is a need to advance research for the development and characterization of new natural drugs with the aid of better screening methods from plants and other natural sources. As science advanced, it became possible to use AYUSH to solve the new challenges of modern healthcare system.

8. Acknowledgement

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