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Review Article

MEDICINAL PLANTS: POTENTIAL TO FIGHT SUPERIORITY DISEASES

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ABSTRACT

Since the beginning of human civilization, medicinal plants have been used by mankind for its therapeutic value. The history of medicine and pharmacy begins with Hippocrates, the father of medicine. He mentioned nearly 400 plant samples used as medicinal substances. In earlier times some plants were venerated because they were known to have valuable properties. No one sought to discover how or why they had this power; it was an undisputed fact and seemed to border on magic. Presently one third of all pharmaceuticals are of plant origin. It is estimated that one in seven of all existing plant has medicinal or curative power, but only if carefully chosen and properly prepared. Scientific analysis of medicinal plants has led to the discovery of many important modern drugs and some experts believe that plants may well hold the secret to combat superiority diseases. Recently the constituents of medicinal plants have gained importance in the treatment of AIDS, malaria and tuberculosis. At present, use of plants are the inspirations for a new drug discovery, whichever by combination of novel compounds or substances for healing diseases. Innovative study is required for evaluating plants from the traditional system of medicine, endow with us with clues as to how these plants can be used in the treatment of diseases with suitable experiments. This review offers information's on use of plants based drugs in modern medicine. Additional it describes the significance of medicinal plants in infectious and superiority diseases.

Keywords: Medicinal plants, Traditional knowledge, Infectious diseases, Antibiotic resistance

INTRODUCTION

"GOD of his infinite goodness and bounty hath by the medium of plant, bestowed almost all food, clothing and medicine upon man".

"Thomas Johanson"

History:

Ever since the birth of mankind there has been a relation between life, disease and plants. One of the earliest human activities has been the study of plants and animals which were the most common things they could find in their vicinity and used them as a source of food and cure of various human ailments. He found that majority of plants were suitable as food, and few are poisonous or medicinally important. By his experience, thus knowledge of herbal remedies was transferred through generation as folk medicines. Thus plant derived drugs have serving through age as the mainstay in the treatment of human ailments and preservation of health.

The use of drugs can broadly be divided into five periods. The early period covers the Indian, Chinese, Sumerian, Egyptian and Assyrian civilization followed by the Greco-Roman, Arabian, Medieval and Modern periods. The earliest mention of the medicinal uses of plants in Indian medicine was derived from Rig Veda (4500-1600 B.C.) and Ayurveda (2500-1600 B.C.). Charak Samhita, written in the same period gives a comprehensive description of the "*Materia Medica*". Later, during the Buddhist period, considerable progress was made and medicinal plants were cultivated. Egyptian described the use of medicinal plants for the treatment of various human ailments as early as 1550 B.C. in the "*Ebers Papyrus*". Following this, Assyrian and Babylonian pharmacy emerged about 650 B.C. followed by Hellenic Greco-Roman periods. The history of medicine and pharmacy begins with Hippocrates, the Father of Medicine (450 B.C.) and Theophrastus (287-237 B.C.). However the most significant pharmacological compilation was the authoritative test of Dioscorides. In earlier times some plants were venerated because they were known to have valuable properties. No one sought to discover how or why they had this power; it was an undisputed fact and seemed to border on magic.

The history of chemotherapy can be conveniently divided into three periods. The first dates from 1619, when plants were the main source of therapeutic drugs, in 1632 the Peruvian Indians used *Cinchona* bark, containing quinine (an alkaloid) to treat malaria. The remedy was then introduced into European medicine by Spaniards[1]. Similarly the root bark of *Ipecacuanha* was introduced in Europe in 1657 for its medicinal qualities in curing diarrhoea. An alkaloid, emetine, isolated from this plant root was also found active in amoebic dysentery. The use of antiseptics and disinfectants arose from the observation that certain substances stopped putrefaction of meat and rotten wood. Mercuric chloride was used by Arabian physicians in the middle ages for preventing sepsis in open wounds. However, in nineteenth century, antiseptic came into general use in medicine. Chlorinated Soda, essentially hypochlorite was introduced in 1825 by Labarrque for the treatment of infected wounds. Holmes in 1835 used chloride of lime for disinfecting hands to

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reduce the incidence of fresh puerperal fever. Tincture of iodine, an antiseptic, was introduced in 1839. Lister in 1860's used phenol in surgery [1,2]. The second period of chemotherapy starts was Louis Pasteur and Robert Koch, who firmly established that microorganisms are responsible for infectious diseases. It was also known that the microorganisms are killed by various antiseptic and disinfectants. Therefore, Koch tried injections of mercuric chloride to cure anthrax infected animals but the animals died of mercury poisoning[3]. Another attempt was made by Lindgard in 1893 to cure horses from Sura by arsenious oxide. He found some improvement, but it appeared too toxic[1]. The germ theory of disease formed the basis of infectious diseases and change in the humoral equilibrium, the basis of physiological disorder[4]. The most dramatic development has taken place since the late 1930's by the discovery of Penicillin[5]. It was an accidental discovery when Alexander Fleming noted that the contaminating colony of *Pencillium* species lysed the adjacent colonies of *Staphylococci*, but the lytic agent appeared too unstable to be used. Chain *et al*.,[6], purified the active substance and found it effective against certain infections. With the advent of Penicillin, Waksman began intensive search for antibacterial antibiotics on mold and actinomycetes and succeeded in isolating several antibiotics including Streptomycin, Actinomycin, Neomycin etc [7]. Since 1940 several workers have isolated and identified thousands of antibiotics. Many of them were of no practical importance as yet, but a few like Chloramphenicol, Vancomycin, Gentamycin, Clindamycin, Cefazilin etc. have changed the entire concept of chemotherapy.

After the discovery of antibacterial antibiotics and associated increased incidence of fungal infection such as candidiasis, the need for control mycotic infections became imperative and stimulated a vigorous search for antifungal antibiotics. The discovery of Nystatin in 1951[8], opened up a new era for therapy of mycoses. Since then many antibiotics have been isolated and described. A number of antibiotics produced by actinomycetes were found active against different pathogenic fungi (*in vitro*) and only Amphotericin B is partially absorbed without toxic effect when administrated orally[9]. The Griseofulvin, an antifungal antibiotic from *Penicillium griceofulvum* is unique in being absorbed when taken orally and active against dermatophytic fungi[10]. The Imidazole structure has been exploited in a variety of ways to develop some useful therapeutic agents. Antifungal Imidazole has a broad spectrum of *in vitro* activity against a variety of Gram-positive bacteria, some protozoa and many pathogenic fungi. Four of them (Clotrimazole, Itaconazole, Ketoconazole and Miconazole) have been introduced as chemotherapeutic agents in fungal infections[11].

The study of natural drugs which had taken into comparative neglect as a result of phenomenal success with the development of chemotherapeutic drugs has been gradually gaining ground and is now occupying its earlier position of prominence. This recovery of interest in natural drug which was highlighted by classical studies in the field of vitamin and sex hormone has found its culmination in the development of antibiotics derived from microorganisms. Drugs derived from medicinal plants have served through the ages as the mainstay for the treatment of various diseases and human ailments. According to an estimate, presently one third of all pharmaceuticals are of plant origin. Throughout the world some 70% of the population relies on traditional herbal remedies to cure a wide variety of ailments from minor infection to asthma, dysentery and malaria. It is estimated that one in seven of all existing plant has medicinal or curative power, but only if carefully chosen and properly prepared. Scientific analysis of medicinal plants has led to the discovery of important modern drugs and some experts believe that plants may well hold the search to combat diabetes, cancer; AIDS etc. The advantages ascribed to these drugs are their comparatively low toxicity and their effective therapeutic properties experienced since ancient time.

In 1977 the World Health Organization encouraged the study of traditional medicines, which can be incorporated into national health care system. In the West, there is a growing demand for herbal remedies. It is now widely accepted that the cheap and readily available herbal remedies should replace some of the expensive Western drugs. Medicinal plants are used as major source of drugs for the treatment of various ailments all over the world. International organizations like WHO and UNIDO are putting more emphasis on the use of medicinal plants in the developing countries through the promotion of traditional system of medicine. Not only developing countries, but also developed countries depend to a large extent on medicinal plant resources in their health care system. The American consumer paid 3 billion US $ during 1959-74 for drugs derived from plants, which amounted to 25% of all new and refilled prescriptions dispended from community pharmaceutics in U.S.A. Similarly in Soviet Union, 30% of drugs prescribed each year are of vegetable origin. According to survey conducted in Italy during 1977, it was revealed that 28% of the medicinal specialist used product of vegetable origin [12].

The search for bioactive chemicals from the traditional part of the plant kingdom can be conducted essentially with three methods [13]. The random method involves the collection of all plants found in a given area, phylogenetic targeting means the collection of all members of those plant families which are known to be rich in bioactive compounds, and the ethnobotanical approach based on the traditional knowledge of the medicinal plant uses. Cox[14], suggested that the ethno-directed sampling is most likely to succeed in identifying drugs used in the

treatment of gastro-intestinal, inflammatory and dermatological complaints. Due to their specialized biochemical capabilities, plants are able to synthesize and accumulate a vast array of primary and secondary chemicals useful for the plant itself as protecting against environmental stress factors. These compounds have made many plants useful for humans for instance as spices, medicines etc. Plant still remains the predominant source of medicine for the majority of world population, particularly in developing countries. Even in the developed countries there has been a resurgence of interest in traditional medicines. Biologically active compounds from natural sources have always been of great interest to researchers. In the recent decades, there has been an increasing interest in investigation of plant extracts for their microbial and antioxidant potentials.

INFECTIOUS DISEASES

Infectious diseases are world's leading killers after cardiovascular diseases as they account for death of 13.3 million people globally [15]. Microorganism's viz. bacteria, fungi, viruses and protozoan's which have the capacity to cause diseases are referred to as pathogenic or infectious microorganisms. Pathogenic or infectious microorganisms can be killed or inhibited by agents of biological or non-biological origin commonly referred as antimicrobials. Antimicrobials are used therapeutically to treat infections. Drug-resistant infectious microorganisms are those, which are not killed or inhibited by antimicrobial compounds. The increasing incidences of drug resistance and emergence and reemergence of deadly microorganisms are posing a great threat to the society. Drug resistance and emergence of new infectious microorganisms is a set of complex problems driven by a variety of factors ranging from abuse of antimicrobials, interactions of prescriber's and patients, economic incentives, characteristics of a country's health system, and the regulatory environment. Patient's perception of a new drug in the market to be more effective than older drugs leads to self-medication. Prescriber's perceptions regarding patient expectations and demands substantially influences prescribing practice. Physicians can be pressured by patient expectations to prescribe antimicrobials even in the absence of appropriate indications. Patient compliance with recommended treatment is another major problem. Patients forget to take medication, interrupt their treatment when they begin to feel better, or may be unable to afford a full course, thereby creating an ideal environment for microbes to adapt rather than be killed. Hospitals, worldwide are major contributors of the problem of antimicrobial resistance. The combination of highly susceptible patients, intensive and prolonged antimicrobial use and cross-infection have resulted in nosocomial infections with highly resistant bacterial pathogens. Resistant hospital-acquired infections are expensive to control and extremely difficult to eradicate. Around the world, as much as 60% of hospital-acquired infections are caused by drug-resistant microorganisms [16]. In a nutshell development of drug resistance among pathogens can be attributable to (i) indiscriminate use of antibiotics and chemotherapeutic agent; (ii) prolonged use of a particular antibiotic; (iii) application of broad spectrum antibiotic without prior knowledge of the antibiogram patterns of the pathogens; (iv) failure of the complete course of antibiotic; (v) use of sub optional antibiotics. Further, application of chemotherapeutic agent in poultry and dairy deeds is another major cause of development of drug resistance among pathogens. Additionally, use of various chemicals in modern aging culture adds a physiological pressure for development of resistance to these compounds.

Developing countries especially, Africa and India suffer significant population losses each year from infectious and parasitic diseases. Approximately 2 million people in India die each year because of these diseases. Africa and India together account for 70% of deaths due to infectious diseases worldwide. Today, 20-50% of *Streptococcus pneumoniae* are resistant to widely available antibiotics such as Penicillin, Erythromycin and Sulfamethoxazole. In Vietnam, the majority of *Salmonella typhi* are resistant to all first line antibiotics e.g., Ampicillin, Chloroamphenicol and Sulfamethoxazole. Some microorganisms are showing resistance to second and third line antibiotics as well. In some countries up to 80% of hospital acquired *Staphylococcus aureus* infections are Methicillin resistant (MRSA) [17]. Once drug resistance is acquired by the pathogens, it can transmit or spread among other pathogens through horizontal gene transfer (Transformation, Transduction and Conjugation). Beside these pathogens more septically bacteria develop drug resistance through either of the routes (a) the organism may lack the structure of cell wall, some bacteria such as *Mycoplasma* lack a typical bacterial cell wall and are resistant to Penicillin; (b) the organism may be impermeable to antibiotics e.g. most Gram-negative bacteria are impermeable to Penicillin; (c) the organism may be able to alter the antibiotic to an inactive form such as *Staphylococci* contain β-lactamase that cleave the β-lactum ring of most of the Penicillin; (d) the organism may be able to pump out an antibiotic entering the wall; (e) the organism may modify the target of the antibiotic; (f) by genetic change alteration may occur in a metabolic pathway that the antimicrobial agents blocks beside the antibiotics and chemotheraptic agents produce a numbers of side effects inside human body. Of the hundreds of the antibiotics discovered only few are of wide application in medicine. Pronged use may weak the body's natural defense against invading germs and may have undesirable side effects. Few examples are given here. Excessive doses damage the kidney in case of Streptomycin, sometimes causing complete and permanent deafness, large doses of

Penicillin and Streptomycin has a neurotoxic action. Tetracycline affects the liver, Chloromycetin has toxic effects on a hematopoietic (blood cell forming) organs and Chlorotetracycline and Oxytetracycline upon intravenous injection may lead to collapse with lethal outcome. Many times allergic reaction arising during local application of antibiotics.

Treating resistant infections often requires the use of more expensive or more toxic drugs and can result in longer hospital stays for infected patients and thus impose higher healthcare costs. World Health Organization (WHO) [15], in its annual report on infectious diseases, "Overcoming antimicrobial resistance," quotes that people throughout the world "may only have a decade or two to make use of many of the medicines presently available to stop infectious diseases". Susceptible microorganisms can replace resistant microorganisms by removing selection pressure. Proposed solutions outlined by the Centre for Disease Control (CDC), USA and WHO as a multi-pronged approach includes: prevention, (such as vaccination); improved monitoring and the development of new treatments. It is this last solution that would encompass the development of new antimicrobials to combat the problems posed by increasing drug resistance as well as emergence and reemergence of deadly infectious diseases [18]. Therefore, the human race in a dice need of an alternate. This is because, plant products are nature based, biodegradable, don't accumulate in the ecosystem causing biomagnifications or do not cause any environmental pollution as compared to costly harmful antibiotics and chemotherapeutic agent. Most significantly plants have co-evolved in nature along with various pathogens, implies for synthesis of various chemical compounds namely secondary metabolites against these pathogens for self-defense.

It is estimated that plant materials are present in, or have provided the models for 50% Western drugs [19]. Many commercially proven drugs used in modern medicine were initially used in crude form in traditional or folk healing practices, or for other purposes that suggested potentially useful biological activity. The primary benefits of using plant derived medicines are that they are relatively safer than synthetic alternatives, offering profound therapeutic benefits and more affordable treatment. There are essentially two routes of drug discovery, the first one pertains to synthesizing entirely new chemicals and evaluating them for a particular pharmaceutical use and the other approach is identifying the chemical of biological origin (natural product chemistry) and evaluate it for direct or indirect use as a template for development of new drug. The ninth century was marked as the golden era for development of synthetic drugs. More and more people became interested in synthetic drugs because of their quick action as compared to traditional medicines and secondly because of their bulk production in industries. Since, 1970's almost 75% of all standard medicines are of synthetic origin or the product of fermentation. The emerging number of incidences of resistance of microbes towards synthetic drugs and antibiotics of microbial origin has turned the attention of scientists, towards traditional medicines especially herbal drugs or drugs of plant origin.

PRIORITY DISEASES: TUBERCULOSIS, HIV AND MALARIA

Traditional medicine has a central role to play in combating new and re-emerging diseases. Global priority is currently placed on combating tuberculosis, malaria and HIV. These diseases are addressed below with use of plants for curing these.

Plants against tuberculosis:

Tuberculosis has become a major health problem, in particular with the emergence of extremely drug resistant tuberculosis (XDRTB). Globally, there were an estimated 9.27 million incident cases of TB in 2007 in compared to 9.24 million cases in 2006, 8.3 million cases in 2000 and 6.6 million cases in 1990 [20]. Compared to industrialized nations, tuberculosis in the developing world, exacerbated by drug resistance, and possibly HIV, is extremely difficult to control. Expensive drug therapies are often financially inaccessible, geographically impractical and culturally irrelevant to the people of the developing world [21]. However, herbal treatment, presents the potential to provide an affordable, and culturally relevant method to manage tuberculosis. There have been various reviews showing antimycobacterial activity of plant species and natural products [22-23]. Cantrell et al. [22], also reviewed the antimycobacterial activities of plant with special references to terpenoids. Justifiably, there continues to be a renewed effort at isolating and assaying compounds from natural sources. Later, Okunade et al.[24], emphasizes the structural diversities of the naturally occurring compounds with antimycobacterial properties at minimal inhibitory concentrations (MICs) of <200 mg/ml. Another excellent review presented by Copp [25], with 352 compounds that have shown activity against *Mycobacteria.* Several plants viz. *Solidago canadensis, Erigeron philadelphicus, Micromelum hirsutum, Oplopanax horridus, Zingiber officinale, Buddleja cordata, Glycyrrhiza glabra, Erythrina indica, Galipea officinalis, Cananga odorata, Croton kongensis, Borrichia frutescens* and *Morinda citrifolia* have proved as potential antitubercular drugs.

Plants against HIV:

Since, 1990's clinical research has been started to screen antiviral effects of plants. Asres et al. [26], found that the highest selective inhibition of HIV-1 replication was found with *Combretum paniculatum* Vent. (acetone fraction), and *Dodonaea angustifolia* L.f. (methanol fraction) from Ethiopian region. They also found that the greatest degree of antiviral activity against HIV-2 was

achieved with the acetone extract of *C. paniculatum* (EC_{50}=32). The 50% cytotoxic concentration ranged from 0.5 mg/ml (hexane extract of *D. angustifolia*) to >250 mg/ml (methanol fraction of *Alcea rosea* L.). Traditional Chinese medicine is being used in HIV management, throughout the world. A study conducted by Zhan *et al.,* [27], Qian-kun-nin, a Chinese herbal formulation considered to have anti-infection, anti-tumor and antiretroviral and immunomodulatory properties, was evaluated for its anti-HIV effects. Eight HIV-positive subjects were given oral Qian-kun-nin capsules for 24 consecutive weeks in a single-blind design. Compared to baseline level, the plasma virus load decreased significantly in between the end of 12-24week ($p < 0.01$). Four weeks after cessation of Qian-kunnin treatment, plasma virus load was still significantly lower compared to baseline ($p < 0.01$). Blood CD4 cell counts were increased significantly at the end of the 12 week compared to the baseline level ($p < 0.01$). No adverse/side effects were observed in any subjects during the experiment [27].

Plants against malaria:

The emergence of multidrug-resistant strains of malaria has lead to finding new approach for prevention and treatment of malaria. The best solutions have been liable to focus on the development of new classes of drugs from plants. More recently, there has been an emphasis on promoting combination therapy of existing drugs as a means of preventing resistance. Two drugs such as quinine from cinchona bark and artemisinine from *Artemisia annua* has directly proved as antimilarial drugs. From India, Saxena et al., [28] published a review article in current science, providing a critical account of crude extracts, essential oils and antiplasmodial secondary metabolites with diverse chemical structures from higher plants, collected from the period 1993-2003. Similarly another review published by Frederich et al., [29] covers 31 indole alkaloids isolated from natural sources with high antiplasmodial activity (*in vitro* and *in vivo*), most of them displaying IC values under the micromolar range and with a good selectivity index. Kaur et al. [30], published a review focusing on antimalarial compounds discovered during 1998-2008 from all natural sources, including crude plant and marine extracts. Similarly, Batista et al.,[31] listed 266 antiplasmodial natural products pertaining to the classes of alkaloids, terpenes, quassinoids, flavonoids, limonoids, chalcones, peptides, xanthones, quinones, coumarins and miscellaneous compounds, as well as 37 promising semisynthetic antimalarials. Plants viz. *Cedrela odorata, Morinda lucida, Vernonia amygdalina, Ageratum conyzoides, Aloe humilis, Canna bidentata, Cestrum laevigatum, Premna angolensis, Pycnanthus angolensis, Struchium spargano-phorum* and *Tithonia diversifolia* has been reported as antimalerial plants [32-34]. Similarly a study conducted by Bagavan et al.,[35] from India, proved antiplasmodial activity with plants *Phyllanthus emblica* (leaf), *Syzygium aromaticum* (flower bud), *Abrus precatorius* (seed) and *Gloriosa superba* (leaf) extracts.

PLANTS AS POTENTIAL SOURCES OF NEW DRUGS

Since time immortal, plants and herbs have been used in virtually all cultures as a source of medicine. The widespread of herbal remedies and healthcare preparations, as those described in ancient texts such as the Vedas and the Bible, and obtained from traditional or folklore practices, has been traced to the occurrence of natural products with medicinal properties. Many of the homeopathic drugs are the crude extracts of plant or plant parts. Some of plant part and their extracts are directly used as medicine for curing some human diseases. Instinctive urge, intuition and the accumulated knowledge has guided man to discover remedies for common ailments from plants as natural sources. The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been widely observed and about 80% of the world population relies on herbal medicines [36]. Furthermore, an increasing reliance on the use of medicinal plants in the industrialized society has been traced for the extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used rural herbal remedies [37]. In these industrialized countries, plant derived prescription drugs constitutes an aliment in the maintenance of health. More ever, in these societies, herbal remedies have become more popular in the treatment of minor ailments, and also on account of the increasing costs of personal health maintenance. Indeed, the market and public demand has been so great that there is a great risk that many medicinal plants today may face either extinction or less of genetic diversity. Other than for the purposes of scientific enquiry, plants historically have served as models in drug development for three reasons:

a) Each plant is a unique chemical factory capable of synthesizing large number of highly complex and unusual chemical substances.
b) The biological active substances derived from the plants have served as templates for synthesis of pharmaceuticals. Such compounds may have poor pharmacological and toxicological profiles.
c) Many highly active secondary plant constitutes have been instrumented as a pharmacological tools to evaluate physiological processes.

INDIAN MEDICINE SYSTEMS

The Indian system of medicines itself is of great importance and is believed to be one of the most ancient. India has been identified as one of the top 12 mega diversity centers of the world with an immensely rich medicinal and aromatic plant population occurring in diverse ecosystems. These medicinal plants are used

both for primary health care and for treating chronic diseases such as AIDS, cancer, hepatitic disorders, heart disease, and age-related diseases such as memory loss, osteoporosis, and diabetic wounds etc. (Table.1). It is estimated that about 3.6 lakh plant species are spread over on earth and out of which 40% available in India. Recently the WHO compiled a list of 10,000 plants are used for phytotherapy in Indian system of medicine [38]. In the Indian coded system (Ayurveda, Unani, Siddha, Amchi), Ayurveda currently utilizes as many as 1000 single drugs and over 8000 compound formulations of recognized merit (Table.2). Similarly 600-700 plants are utilized by other systems such as Unani, Siddha, and Amchi. About 70% of Indian medicinal plants are found in tropical and subtropical forest and less than 30% are found in the temperate and high altitude forest [39]. These medicinal plants species belong to a wide range of plant types, including trees, herbs, lianes, woody climbers, and twiners (Fig. 1) [40]. Several crude drugs are manufactured from different parts of these plants viz. roots, rhizomes, stem, bark, seed, wood, leaves, flowers, fruits and whole plants etc. [38]. In India more than 90% of plant species used by industry are collected from the wild and over 70% of the collection involves destructive harvesting, using different parts of the plants (root, stem, bark, wood, whole plant) (Fig. 2) [41]. The domestic Indian System of Medicine (ISM) market, comprising Ayurveda, Unani, Siddha, and homeopathy, has been estimated to exceed Rs 42 billion (US$950 million) and India alone exports herbal medicines and materials to the tune of Rs 5.5 billion (US$124 million) (Fig. 3). The world trade in medicinal plants is estimated to be about US$ 62 billion, with the major players being the European Union at 45%, Asia 17%, and Japan 16% (Fig. 4).

Table.1: Health care areas in which there is an emerging need for medicinal plant preparations that can be used for common ailments

Emerging health care areas	Status	Medicinal plants suited for herbal medicine/formulations
Protozoan diseases (including malaria)	Widespread	*Artemisia annua*, *Cinchona* sp.
Amoebic diseases	More than 60 million suffer	*Cephalis ipecacuantha*, *Terminalia bellerica*, *Tylophora indica*
Ulcer diseases	General occurrence	*Glycyrrhiza glabra*, *Terminalia* sp., *Aloe barbadensis*
Cardiovascular diseases	Number one killer in the world	*Ammi visnaga*, *Cloeus forskohlii*, *Nardostachys jatamansi*, *Rauvolfia serpentina*, *Swertia chirta*, *Digitalis* sp.
Cancer	Threatening	*Catharanthus roseus*, *Podophyllum emodi*, *Taxus baccata*
Age-related diseases, rheumatism etc.	Occur widely in old age	*Commiphora wightii*, *Withania somnifera, Pluchea lanceolata*, *Berberis vulgaris*
Lifestyle disorders viz. diabetes, stress, piles and hypertension	17 million suffering in India	*Catharanthus roseus*, *Mimordica charantia*, *Salancia prinoides*, *Syzygium cumini*, *Gymnema silvestre*, *Curcuma longa*, *Zingiber officinale*, *Ocimum sanctum*
Constipation disorders	Common occurrence	*Plantago ovata*, *Cassia senna*
Autoimmune disorders	General occurrence	*Withania somnifera*, *Asparagus racemosus*, *Tinospora cordifolia*, *Picrorhiza kurroa*, *Acorus calamus*, *Sida cordifolia*, *Azadiracta indica*, *Crocus sativus*, *Glycyrrhiza glabra*

Table.2: Some plants based drugs used in modern medicine

Drug	Medicinal uses	Plant species	Family
Acetyldigoxin	Cardiotonic	*Digitalis lanata*	Plantaginaceae
Adoniside	Cardiotonic	*Adonis vernalis*	Ranunculaceae
Aescin	Anti-inflammatory	*Aesculus hippocastanum*	Sapindaceae
Ajmaciline*	Antihypertensive, tranquilizer	*Catharanthus roseus*	Apocynaceae
Ajmalin	Heart arrhythmia	*Rauvolfia serpentina*	Apocynaceae
Ajmaline	Antihypertensive, tranquilizer	*Rauvolfia serpentina*	Apocynaceae
Allantoin	Vulnerary	Several plants	
Allyl isothiocyanate	Rubefacient	*Brassica nigra*	Brassicaceae
Anabesine	Skeletal muscle relaxant	*Anabasis sphylla*	
Andrographolide	Baccillary dysentery	*Andrographis paniculata*	Acanthaceae
Anisodamine	Anticholinergic	*Anisodus tanguticus*	Solanaceae
Anisodine	Anticholinergic	*Anisodus tanguticus*	Solanaceae
Arecoline	Anthelmintic	*Areca catechu*	Arecaceae
Asiaticoside	Vulnerary	*Centella asiatica*	Apiaceae
Asprin	Analgesic, anti-inflammation	*Filipendula ulmaria*	Apocynaceae
Atropine	Anticholinergic	*Atropa belladonna*	Solanaceae
Artemisine	Antimalarial	*Artemisia annua*	Asteraceae
Atropine*	Ophthalmology	*Atropa belladonna*	Solanaceae
Benzoine	Oral disinfectant	*Styrax tonkinensis*	Styracaceae
Benzyl benzoate	Scabicide	Several plants	
Berberine	Bacillary dysentery	*Berberis vulgaris*	Berberidaceae
Bergenin	Antitussive	*Ardisia japonica*	Myrsinaceae
Betulinic acid	Anticancerous	*Betula alba*	Betulaceae
Borneol	Antipyretic, analgesic, antiinflammatory	Several plants	
Bromelain	Anti-inflammatory, proteolytic	*Ananas comosus*	Bromeliaceae

Caffeine*	Stimulant	*Camellia sinensis*	Theaceae
Camphor	Rheumatic pain	*Cinnamomum camphora*	Lauraceae
Camptothecin	Anticancerous	*Camptotheca acuminata*	Cornaceae
Cascara	Purgative	*Rhamnus purshiana*	Rhamnaceae
Cocaine	Ophthalmologic anaesthetic	*Erythroxylum coca*	Erythroxylaceae
Codeine*	Analgesic, antitussive	*Papaver somniferum*	Papaveraceae
Chymopapain	Proteolytic, mucolytic	*Carica papaya*	Bromeliaceae
Cissampeline	Skeletal muscle relaxant	*Cissampelos pareira*	Menispermaceae
Colchicine*	Antitumor agent, anti-gout	*Colchicum autumnale*	Liliaceae
Colchiceine amide	Antitumor agent	*Colchicum autumnale*	Colchicaceae
Convallatoxin	Cardiotonic	*Convallaria majalis*	Ruscaceae
Curcumin	Choleretic	*Curcuma longa*	Zingiberaceae
Cynarin	Choleretic	*Cynara scolymus*	Asteraceae
Danthron	Laxative	*Cassia species*	Fabaceae
Demecolcine	Leukemia	*Colchicum autumnale*	Liliaceae
Deserpidine*	Hypertension	*Rauvolfia canescens* *R. serpentina*	Apocynaceae
L-Dopa*	Antiparkinsonian	*Mucuna pruriens*	Papilionaceae
Dicoumarol	Thrombosis	*Mililotus officinale*	Fabaceae
Digitoxin*	Atrial fibrillation	*Digitalis purpurea*	Scrophulariaceae
Digoxin*	Atrial fibrillation	*Digitalis purpurea*	Scrophulariaceae
Digoxin*	Cardiotonic	*Digitalis lanata*	Scrophulariaceae
Diosgenin	Induces steralization	*Dioscorea deltoidea*	Dioscoreaceae
Emetine*	Antiamoebic	*Psychotria ipecacuanha*	Rubiaceae
Ephedrine*	Bronchodilator	*Ephedra sinica*	Ephedraceae
Etoposide	Antitumor agent	*Podophyllum peltatum*	Berberidaceae
Eugenol	Toothache	*Syzygium aromaticum*	Myrtaceae
Galanthamine	Cholinesterase inhibitor	*Lycoris squamigera*	Amaryllidaceae
Gallotanins	Hemorrhoid suppository	*Hamamelis virginiana*	Hamamelidaceae
Gitalin	Cardiotonic	*Digitalis purpurea*	Plantaginaceae
Glaucarubin	Amoebicide	*Simarouba glauca*	Simaroubaceae
Glaucine	Antitussive	*Glaucium flavum*	Papaveraceae
Glasiovine	Antidepressant	*Octea glaziovii*	Menispermaceae
Glycyrrhizin	Sweetener, Addison's disease	*Glycyrrhiza glabra*	Fabaceae
Gossypol	Male contraceptive	*Gossypium herbaceum*	Malvaceae
Hemsleyadin	Bacillary dysentery	*Hemsleya amabilis*	Cucurbitaceae
Hesperidin	Capillary fragility	*Citrus* species	Rutaceae
Hydrastine	Hemostatic, astringent	*Hydrastis canadensis*	Ranunculaceae
Hyoscyamine*	Anticholinergic	*Atropa belladonna;* *Datura stramonium;* *Hyoscyamus muticus*	Solanaceae
Hyoscyamine*	Anticholinergic	*Hyoscyamus niger*	Solanaceae
Ipecac	Emetic	*Cephaelis ipecacuanha*	Rubiaceae
Ipratropium	Bronchodilator	*Hyoscyamus niger*	Solanaceae
Irinotecan	Anticancer, antitumor agent	*Camptotheca acuminata*	Cornaceae
Kawain	Tranquillizer	*Piper methysticum*	Piperaceae
Kheltin*	Vascodilator	*Ammi visnaga*	Apiaceae
Lanatosides A, B, C	Cardiotonic	*Digitalis lanata*	Scrophulariaceae
Lapachol	Anticancer, antitumor	*Tabebuia* sp.	Bignoniaceae
a-Lobeline	Smoking deterrant, respiratory stimulant	*Lobelia inflate*	Campanulaceae
Marsilin	Sedative, anticonvulsant	*Marsilea minuta*	Marsileaceae
Menthol	Rubefacient	*Mentha* species	Lamiaceae
Methyl salicylate	Rubefacient	*Gaultheria procumbens*	Ericaceae
Monocrotaline	Antitumor agent (topical)	*Crotalaria sessiliflora*	Faboideae
Morphine*	Analgesic	*Papaver somniferum*	Papaveraceae
Neoandrographolide	Dysentery	*Andrographis paniculata*	Acanthaceae
Nicotine	Insecticide	*Nicotiana tabacum*	Solanaceae
Nordihydroguaiaretic acid	Antioxidant	*Larrea divaricata*	Zygophyllaceae
Noscapine	Antitussive	*Papaver somniferum*	Papaveraceae
Ouabain	Cardiotonic	*Strophanthus gratus*	Apocynaceae
Palmatine	Antipyretic, detoxicant	*Coptis japonica*	Ranunculaceae
Papain*	Attenuates mucus	*Carica papaya*	Caricaceae
Papaverine*	Antispasmodic	*Papaver somniferum*	Papaveraceae
Phyllodulcin	Sweetner	*Hydrangea macrophylla*	Hydrangeaceae
Physotigmine*	Glaucoma	*Physostigma venenosum*	Fabaceae
Picrotoxin*	Barbiturate antidote	*Anamirta cocculus*	Menispermaceae
Pilocarpine*	Glaucoma	*Pilocarpus jaborandi*	Rutaceae
Podophyllotoxin	Vermifuge, Cancer	*Podophyllum hexandrum* *Podophyllum peltatum*	Berberidaceae
Proscillaridin	Cardiac malfunction	*Drimia maritime*	Liliaceae
Protoveratrine*	Hypertension	*Veratrum album*	Liliaceae
Pseudoephedrine*	Central nervous system stimulant	*Ephedra sinica*	Ephedraceae

Pseudoephedrine	Rhinitis	*Ephedra sinica*	Ephedraceae
Psoralen	Vitiligo	*Psoralea corylifolia*	Fabaceae
Quinidine*	Cardiac arrhythmia	*Cinchona pubescens*	Rubiaceae
Quinine*	Malaria prophylaxis	*Cinchona pubescens*	Rubiaceae
Qulsqualic acid	Anthelmintic	*Quisqualis indica*	Combretaceae
Rescinnamine*	Hypertension	*Rauvolfia canescens* *R. serpentina*	Apocynaceae
Reserpine*	Hypertension	*Rauvolfia canescens* *R. serpentina*	Apocynaceae
Rhomitoxin	Antihypertensive, tranquillizer	*Rhododendron molle*	Ranunculaceae
Rorifone	Antitussive	*Rorippa indica*	Ericaceae
Rotenone	Piscicide, Insecticide	*Lonchocarpus nicou*	
Rotundine	Analagesic, sedative, traquillizer	*Stephania sinica*	Menispermaceae
Rutin	Decreases capillary fragility	*Ruta graveolens*	Rutaceae
Salicin	Analgesic	*Salix alba*	Salicaceae
Sanguinarine	Dental plaque inhibitor	*Sanguinaria canadensis*	Papaveraceae
Santonin	Ascaricide	*Artemisia maritima*	Asteraceae
Scillarin A	Cardiotonic	*Urginea maritima*	Hyacinthaceae
Sennoside-A* & B*	Laxative	*Cassia angustifolia*	Caesalpiniaceae
Scopolamine*	Motion sickness	*Datura stramonium*	Solanaceae
Silymarin	Antihepatotoxic	*Silybum marianum*	Fumariaceae
Sparteine	Oxytocic	*Cytisus scoparius*	Fabaceae
Stevioside	Sweetner	*Stevia rebaudiana*	Asteraceae
Stigmasterol	Steroidal precursor	*Physostigma venenosum*	Fabaceae
Strophanthin	Congestive heart failure	*Strophanthus gratus*	Apocynaceae
Strychnine	CNS stimulant	*Strychnos nux-vomica*	Loganiaceae
Taxol	Overian cancer, Breast cancer	*Taxus brevifolia* *T. wallichiana*	Taxaceae
Teniposide	Bladder neoplasms	*Podophyllum hexandrum* *P. peltatum*	Berberidaceae
a-Tetrahydrocanna-binol (THC)	Antiemetic, decrease occular tension	*Cannabis sativa*	Cannabinaceae
Tetrahydropalmatine	Analgesic, sedative, traquillizer	*Corydalis ambigua*	Menispermaceae
Tetrandrine	Antihypertensive	*Stephania tetrandra*	Fumariaceae
Theobromine*	Diuretic, myocardial stimulant, vasodilator	*Camellia sinensis*	Theaceae
Theophylline*	Cardiac stimulant, vasodilator, diuretic, asthma	*Camellia sinensis*	Theaceae
Thymol	Antifungal (topical)	*Thymus vulgaris*	Lamiaceae
Topotecan	Antitumor, anticancer agent	*Camptotheca acuminata*	Cornaceae
Toxiferine	Surgery, relaxant	*Strychnos guianensis*	Loganiaceae
Trichosanthin	Abortifacient	*Trichosanthes kirilowii*	Cucurbitaceae
Tubocurarine*	Muscle relaxant	*Chondrodendron tomentosum*	Menispermaceae
Valapotriates	Sedative	*Valeriana officinalis*	Valerianaceae
Vasicine	Cerebral stimulant	*Vinca minor*	Apocynaceae
Vinblastine	Hodgkin's disease	*Catharanthus roseus*	Apocynaceae
Vincristine	Pediatric leukemia	*Catharanthus roseus*	Apocynaceae
Xanthotoxin*	Vitiligo	*Ammi majus*	Apiaceae
Yohimbine	Aphrodisiac	*Pausinystalia yohimbe*	Rubiaceae
Yuanhuacine	Abortifacient	*Daphne genkwa*	Thymelaeaceae
Yuanhuadine	Abortifacient	*Daphne genkwa*	Thymelaeaceae

*Plant derived drugs widely employed in Western medicine

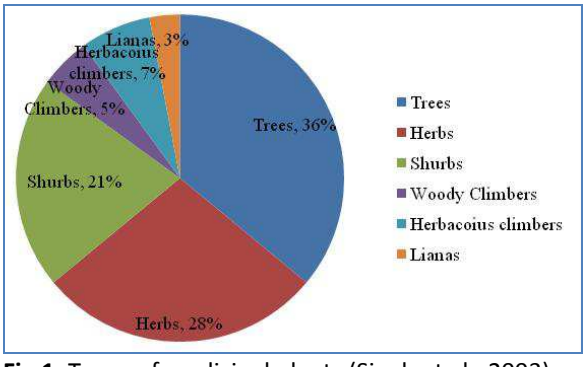

Fig.1: Types of medicinal plants (Singh et al., 2003)

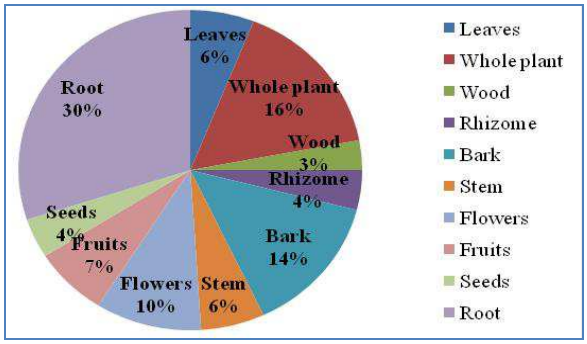

Fig. 2: Parts of medicinal plants used (Singh et al., 2003)

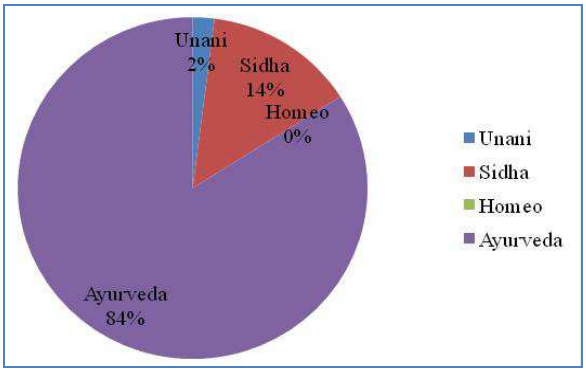

Fig. 3: The Indian System of Medicine and the divisions (Ved et al., 1998)

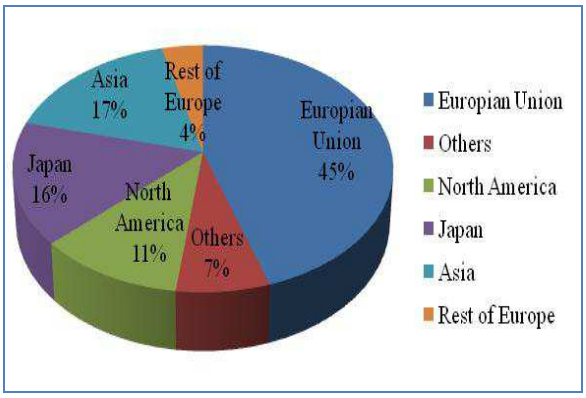

Fig. 4: Global markets for herbal medicine (Ved et al., 1998)

CONCLUSION

Conservative estimates suggest that there are more than 2, 50,000 species of higher plants existing in this planet, and only a very small percentage of plants have been exhaustively studied for its potential value as a source of drugs. Obviously natural products will continue to be extremely important as a source of medicinal agents. It has renewed the interest of researchers and academicians for the development plant based medicines, because plant products are without any side effects, do not add any physiological pressure on the pathogens for the development of drug resistance, easily degradable, non-accumulative in the environment, do not cause environmental pollution too. However, there are many new approaches are also available such as combinational chemistry and computer based molecular modeling design, which can replace the important role of natural products in drug discovery and development. Due to absent of sufficient modern health care system, particularly in the rural areas people prefer to visit traditional healer where few plants can cure certain infections, although they are not investigated scientifically. It can also be assumed that the major part of traditional therapy involves the use of plant extracts or their active principles. With proper investigations these may serve as a source of modern drugs.

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