Ethnopharmacology and Biodiversity of Herbal Medicine

3

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Abstract

Ethnopharmacology and herbal medicine remain a significant hope for human civilization. Many of the modern medicines have their origins in traditional medicine and ethnopharmacology. Traditional Indian Medicine: Ayurveda has a long history, and is one of the greatest living traditions. Several research studies have been done on the pharmacology, chemistry, pharmacology and clinical treatment of Ayurvedic medicinal plants. A number of preclinical and clinical studies have tested the cytoprotective, immunomodulatory and immune adjuvant potentials of Ayurvedic medicinal products. The relationship between society, nature and environmental health to human health has recently been widely recognized. The loss of biodiversity has an indirect impact on human well-being. By changing the function of the ecosystem, the loss of biodiversity reduces the elasticity of ecosystem, making it more susceptible to shocks and destruction, and even less able to provide services that people need. Traditional drug systems require more evidence-based research on plant extract and purified plant molecules. The use of natural products as pharmacological tools can produce many important new therapeutically effective metabolites. Identifying

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and evaluating the quality and safety of natural products is a basic requirement for industries and other organizations dealing with natural health products. This chapter analyzes some of the links between biodiversity and traditional medicine and discusses their impact on public health. Biodiversity and functional ecosystem have a positive effect on global and human health.

Keywords
Ayurveda, Biodiversity, Ethnopharmacology, Medicinal plants, IPR

1. Introduction

Ethnopharmacology studies natural remedies created from medicinal plants and other substances that have traditionally been used by an indigenous group of people to treat various human diseases. The observation, identification, description and experimental investigation of the ingredients and the effects of the ingredients and the effects of such indigenous drugs is a truly interdisciplinary field of research which is very important in the study of traditional medicine. Ethnopharmacology is here defined as the interdisciplinary scientific exploration of biologically active agents traditionally employed or observed by man (Bruhn and Holmstedt 1981). Ethnomedicine or ethnopharmacological drug development process usually starts with the collection and identification of plants of interest by botanists, ethnobotanists, ethnopharmacologists, or plant ecologists. The method of ethnopharmacology is based on botany, chemistry, and pharmacology (observation, identification, description, and experimental research); but other disciplines have also made important contributions. Based on these considerations, ethnopharmacology is defined as "interdisciplinary scientific research on biologically active ingredients traditionally used or observed by humans". Therefore, it plays an important role in the evaluation of natural products, especially medicinal materials of traditional and folk origin. Ethnopharmacology is not only the science of the past, it continues to form a scientific basis for the development of active therapies based on traditional medicines and outdated methods of different ethnic groups. Its main goal is to verify traditional medicines through isolation of bioactive ingredients or according to various pharmacological assays that further confirms their use

(Mukherjee 2005). The use of Ayurvedic medicines and formulations has always been an important part of the treatment of various diseases in different communities in India. The results of research on Ayurvedic drugs have led to the emergence of many drug candidates commonly found in the commercial market today. Many plants with potential therapeutic activity were first widely used in Ayurvedic medicine. Field observations and descriptions of the uses and effects of traditional therapies, botanical identification, phytochemistry and pharmacological research are all within the scope of ethnic pharmacology. Ethnopharmacology has developed into an innovative method of drug discovery. Most ethnopharmacological research has focused on plant compounds that provide a natural library of various chemical structures and scaffolds. Each plant contains hundreds of biologically active molecules and compounds. Each biologically active substance can regulate one or more targets. Each target can affect one or more genes and metabolic pathways that may be involved in one or more diseases. It becomes a highly complex biological system with an interactive network of biologically active substances, targets, genes and signal pathways. Natural products are the source of most of the effective ingredients in western medicine. This is widely recognized when applied to drug discovery. In the "old age", before the development of high-throughput screening and the post-genomic era, more than 80% of drugs were obtained from or based on natural substances (Sneader 1996). Currently, more than 100 compounds derived from natural products are being tested in clinical trials, and at least 100 such projects are in the preclinical development stage. Most of the drugs currently planned will come from lead from plants and microbial sources (Butler 2008). Previous publications and researchers from all over the world have found that a relatively small part of the world's plant biodiversity has been rigorously tested for biological activity (Baker et al. 2007). Therefore, a wider collection of plants based on further advances in ethnic medicine/ethnic practices or microbial culture can provide many new chemical substances for drug discovery. Natural products have stimulated many developments in organic chemistry and advanced synthetic methods to develop various analogs of lead compounds with therapeutic potential. *Cinchona* bark was introduced to treat malaria in the 17th century, followed by *Digitalis* and morphine. The structure is extremely diverse, and it is used to treat various diseases with drugs. India has an ancient heritage of

traditional medicine. The Indian system of medicine provides a lot of information about folklore traditions and the traditional aspects of natural products with therapeutic value. Traditional Indian Medicine is based on different systems such as Ayurveda, Siddha and Unani (Harvey 2005). The world is increasingly interested in accepting and studying traditional systems and using their potential from different health perspectives. The Indian government has repeatedly tried to investigate and evaluate the potential of these systems in practice and it helps in data collection for inclusion in national health plans. The AYUSH department (Ayurveda, Yoga, Siddha, Unani and Homeopathy) manages training and research on these systems. The National Medicinal Plant Board (NMPB), which is responsible for plant protection and research, is solving problems in these areas. The natural drugs were isolated from plants and used for various disorders (Figure 1). The new branch that attempts to study these complex multifunctional biologically active interactions is called polypharmacology or network pharmacology. Network pharmacology uses computing power and supercomputer-based virtual HTS to combine research to improve the efficiency of the discovery process. Network pharmacology is the integration of chemoinformatics and bioinformatics, which can help us develop a network view of drug action. It is a new paradigm that combines systems biology and computational biology to study multi-component and multi-directional drugs and preparations. It uses computing power and computer-based virtual HTS to connect research to improve the efficiency of the discovery process. With the help of network pharmacology, it is now possible to study the complex relationships between biologically active substances, targets, diseases and genes. Network pharmacology, established by a large amount of biological and pharmacological information available in the literature, is also a promising means of drug reuse pharmacology (Hopkins 2007; Ellingson et al. 2014). Nowadays, people are very concerned about the loss of the world's biodiversity and its ethnic habitats. The loss of traditional knowledge about medicinal plants not only due to the extinction of plant species due to climate change, urban expansion, and habitat destruction, but also due to the collapse of traditional social structures. This threat is particularly serious in a culture where information is communicated verbally rather than in writing, due to population migration to cities, especially young people, ignorance of local materials, acceptance of globalized western products and health structures, wars, hunger and other reasons intensified.

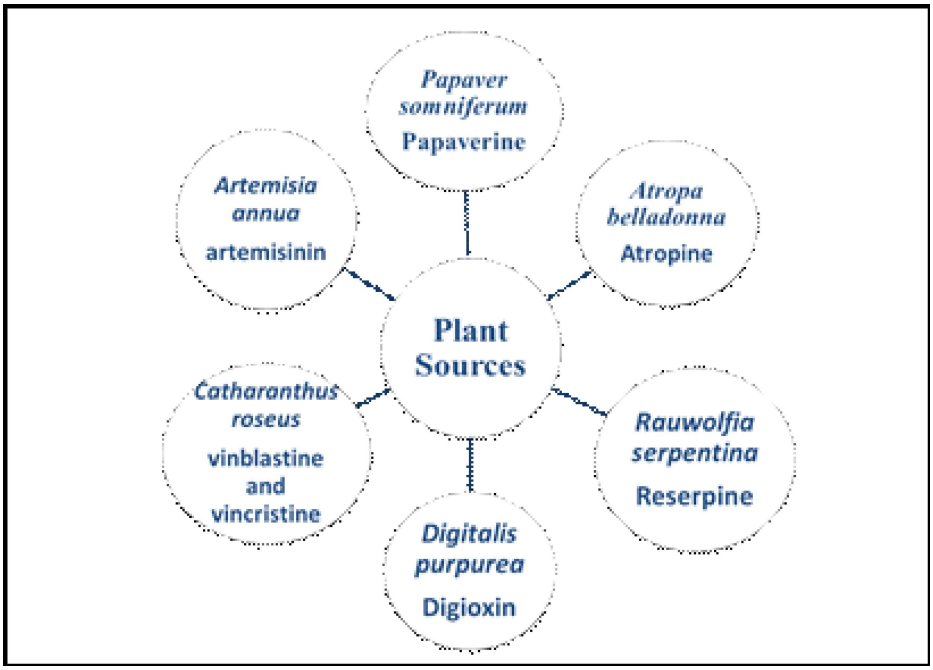

Figure 1: Drugs developed from plant source for various disorders

2. Bioactive Compounds and Ethnopharmacological Findings

Medicinal plants have diverse phytochemical constituents that are responsible for their versatile pharmaceutical properties (Table 1). Medicinal plants are a rich source of secondary metabolites. Secondary plant metabolites are phytochemical constituents that are categorised based on their metabolic processes. Secondary metabolites are the products of the shikimic acid pathway and played a very important role in alleviating several ailments. Secondary metabolites are classified into a diverse group of chemicals structures such as alkaloids, steroids, glycosides, amines, flavonoids, insecticides, and other metabolites. Secondary metabolites have antibiotic, antiviral and antifungal properties. Secondary metabolites can protect plants from pathogens. Traditional medicine and folk medicines are dependent on secondary metabolites which are present in medicinal plants. More than 100 chemical constituents have been isolated and identified from different medicinal plants including alkaloids, coumarins, volatile oils, fatty acids, polysaccharides, micro-elements, and other compounds. Most of the bioactive compounds are active

constituents, and the medicinal values and pharmacological effects are associated with these compounds.

Table 1: Ethnopharmacological uses reported for the medicinal plants with their chemical constituents

Plant Name	Ethnopharmacological Uses	Chemical Constituents
Acacia catechu (L.f.) Willd.	Anti-inflammatory and chemoprotective. Antihyperglycemic and antinociceptive activity	Catechin and epicatechin (Stohs and Bagchi 2015)
Aloe vera (L.) Burm.f.	Antimicrobial, anti-inflammatory, aphrodisiac and anti-helmenthic,	Vitamins, minerals, enzyme, amino acids (Sahu et al. 2013)
Asparagus racemosus Willd.	Diarrhoea and dysentery, immunostimulant, anti-dyspepsia and antitussive effects	Saponins, quercetin, rutin, diosgenin (Bopana and Saxena 2007)
Bambusa nutans Wall. ex Munro	Anti-inflammatory, anti-helmintic, anti-diabetic and anti-ulcer	Phenols, vitamin C and E and mineral elements (Nirmala et al. 2018)
Bauhinia vahlii Wight & Arn.	Diarrhoea and dysentery	Phenol (Sowndhararajan and Kang 2013)
Bauhinia variegate L. Fabaceae	Antitumour, antimicrobial, anti-inflammatory, antigoitrogenic, hepatoprotective and haemagglutination	Sterols, glycosides, flavanone (Mali et al. 2007)
Boehmeria virgata (G.Forst.) Guill.	Anticancer	Boehmeriasin A and B (Wardihan et al. 2013)
Boerhavia diffusa L	Jaundice and cancer	Rotenoids, flavonoids, xanthones, purine nucleoside, lignans, and steroids (Mishra et al. 2014)
Brugmansia suaveolens (Humb. & Bonpl. exWilld.) Bercht. & J. Presl	Hallucinatory, analgesic, aphrodisiac, nematicide, rheumatism, asthma and inflammation	Alkaloids, coumarins, flavonoids, steroids, and hydrocarbons (Petricevich et al. 2020)
Capsicum annuum L.	Anti-inflammatory, analgesic, stomachic and hypoglycemic	Thiamine, red carotenoids, capsanthin and capsorubin (Pandey et al. 2012)
Calotropis procera (Aiton) Dryand.	Asthma, leprosy, eczema, elephantiasis, vertigo, baldness, toothache, rheumatoid and paralysis	Cardenolide, proceragenin, calotropin, calotropagenin, calotropenyl acetate, uzarigenin, and terpenol ester (Meena et al. 2011)

Camellia sinensis (L.) Kuntze	Anticancer, cardiovascular and antiaging	Catechins, quercetin, myricetin and kaempferol (Mahmood et al. 2010)
Cannabis sativa L.	Inflammation, pain, colitis, sleep disorders, neurological, healing oils and psychoactive effects	Cannabinoids, cannabinoids, tetrahydrocannabinol (Bonini et al. 2018)
Cassia occidentalis L.	Antidiabetic, anti-inflammatory, anticancerous, antimutagenic and hepatoprotective activity	Anthraquinones, anthrones, apigenin, aurantiobtusin, campesterol, cassiollin, chryso-obtusin, chrysophanic acid, chrysarobin, chrysophanol, chrysoeriol (Yadav et al. 2010)
Cedrus deodara (Roxb. ex D. Don) G. Don	Anti-inflammatory, analgesic, anti-hyperglycemia, antispasmodic, insecticidal, anti-apoptotic, anti-cancer, immmunomodulatory, molluscidal, anxiolytic and anticonvulsant properties	Matairesinol, dibenzylbutyrolactol, berating, isopimpillin, lignans 1, 4 diaryl butane, benzofuranoid, isohemacholone (Chaudhary et al. 2011)
Celastrus paniculatus Willd.	Nervine tonic, rejuvenator, anti-depressant, rheumatism, gout and paralysis	Celastrine and paniculatin, palmitic, stearic, oleic, linoleic, and linolenic (Arora and Pandey-Rai 2012)
Curcuma longa L.	Antiinflammatory, anticarcinogenic, antimutagenic, anticoagulant, antifertility, antidiabetic, antifibrotic, antivenom, antiulcer, hypotensive and hypocholesteremic activities	Curcumin (diferuloylmethane), Anthocyanins (Verma et al. 2018)
Curcuma zedoaria (Christm.) Roscoe	Diarrhoea, cancer, flatulence, dyspepsia, rubefacient and diuretic	Curcumin, arabin, sesquiterpenes (Lobo et al. 2009)
Cymbopogon citratus (DC.) Stapf	Anti-amoebic, antidiarrheal, antifilarial, anti-inflammatory, antimalarial, antimutagenicity, hypoglycemic and neurobehaviorial	Terpenes, ketones, aldehyde, esters, Citral α, Citral β, Nerol geraniol, terpinolene, Geranyl acetate, myrecene and terpinol methylheptenone (Shah et al. 2011)
Dendrophthoe falcata (L.f.) Ettingsh.	Anticancer, aphrodisiac, astringent, narcotic, pulmonary tuberculosis, asthma and menstrual disorders	Flavonoids, phytosterols, tannins, phytosterols (Dashora et al. 2011)
Dioscorea bulbifera L.	Ulcers, sores, dysentery, diabetes and cancer	Diosbulbin, bafoudiosbulbin, diosbulbiside (Ghosh et al. 2015)

Eclipta prostrata (L.) L.	Haemorrhagic diseases, skin diseases, respiratory disorders, coronary heart disease, vitiligo and snake bite	Cardiac glycosides, coumestans, polyacetylene, steroids, saponins, phytosterol, triterpenes (Feng et al. 2019)
Euphorbia hirta L	Female disorders, respiratory ailments, dysentery, jaundice, pimples and gonorrhoea	Triterpenes, phytosterols, tannins, polyphenols, and flavonoids (Kumar et al. 2010)
Ficus auriculata Lour.	Diarrhoea and dysentery	Alkaloids, saponins, glycosides, phytosterols, resins, phenols, tannins, diterpenes (Gaire et al. 2011)
Ficus benghalensis L.	Dysentery, diarrhoea, diabetes, leucorrhoea, menorrhagia and nervous disorders	Sterols, flavonoids, phenol, tannins, and saponins triterpenoids, gums (Gopukumar 2015)
Ficus religiosa L.	Antidiabetic, antiviral, hypolipidemic, antiasthmatic, antitumor, antiulcer, antihelmintic, apoptosis and hypotensive	Phytosterols, amino acids, furanocoumarins (Singh et al. 2011)
Leucas cephalotes (Roth) Spreng.	Diaphoretic, fever and liver disorder	Flavonoids, phenol, phytosterol and tannins (Itoria et al. 2011)
Litchi chinensis Sonn.	Hypoglycemic, anticancer, anti-platelet, anti-tussive, analgesic, antipyretic and diuretic	Flavonoids, sterols, triterpenes, phenolics (Ibrahim and Mohamed 2015)
Mallotus philippinensis var. reticulatus (Dunn) F.P. Metcalf	Antiviral, cytotoxicity and immunoregulatory	Coumarins, isocoumarins, bergenin, mallotophilippinens, rottlerin, and isorottlerin (Gangwar et al. 2014)
Mentha arvensis L.	Antimicrobial, cytotoxic and analgesic activities	Quercetin, menthoside, and isorhoifolin, eugenol and thymol, monoterpenes, viridiflorol (Biswas et al. 2014)
Morus alba L.	Antidiabetic, antimutagenic, anticancer, anxiolytic, anthelmintic, antistress, immunomodulatory, nephroprotective and hepatoprotective	Carotene, vitamin B_1, folic acid, folinic acid, quercetin, tannins, flavonoids and saponins (Devi et al. 2013)
Mucuna pruriens (L.) DC.	Antidiabetic, aphrodisiac, antineoplastic, antiepileptic and antimicrobial activities	Mucunadine, mucunine, lecithin prurienidine, prurienine (Kavitha and Thangamani 2014)

Murraya koenigii (L.) Spreng.	Anti-diabetic and cholesterol reducing property, antimicrobial activity, antiulcer activity, antioxidative property, cytotoxic activity and anti-diarrhoea activity	carotene, nicotinic acid and vitamin C,glycosides, carbazole alkaloids, koenigin and resin (Singh et al. 2014)
Murraya paniculata (L.) Jacq.	Antinociceptive, antioxidant, anti-diabetic, antimicrobial and analgesic activities	Coumarins, alkaloids, phenols, terpenoids and flavonoids (Sayar et al. 2014)
Phyllanthus emblica L.	Anti-inflammatory, analgesic and antipyretic, adaptogenic, hepatoprotective, antitumor and antiulcerogenic activities	Phosphatides, essential oils, phosphatides, essential oils, tannins (Luo et al. 2011)
Phyllanthus niruri L.	Antimicrobial, anticancer, anti-inflammatory, antiplasmodial, antiviral, diuretic and hepatoprotective	Rutin, quercetin, quercitrin, astragalin (Kaur et al. 2017)
Plantago lanceolata L.	Anti-inflammatory and wound healing	Iridoid glucosides and phenylethanoid glycosides (Gonçalves and Romano 2016)
Plumbago zeylanica L.	Anti-fungal, anti-tumor, disease of heart, rheumatic pains, liver diseases, fever, diabetes and kidney disease	Plumbagin, zeylinone, isozeylinone, naphthoquinones, sitosterol, lupeol (Mandavkar and Jalalpure 2011)
Rhynchostylis retusa (L.) Blume	Antibacterial and antifungal potential and paralysis	Alkaloids, glycosides, flavonoids, saponins, tannins, terpenoids, steroids, quinine and coumarin (Rohani et al. 2018)
Solanum aculeatissimum Jacq. Solanaceae	Protease inhibitor (Meenu Krishnan and Murugan 2015)	Saponin (Ikenaga et al. 1995)
Solanum americanum Mill. L. Solanaceae	Hepatoprotective, anti-tumor, cytostatic, anti-convulsant, anti-ulcerogenic and anti-inflammatory effects	Nigrumins, solanine (Atanu et al. 2011)
Solanum virginianum L.	Antimicrobial, insecticidal and antiradical activity	Alkaloids, phenolics, flavonoids, sterols, saponins, glycosides, fatty acids, tannins, and amino acids (Tr et al. 2017)

Syzygium cumini L. skeels.	Antidiabetic	Anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol, alkaloid, jambosine, and glycoside jambolin or antimellin and myricetin (Ayyanar and Subash-Babu 2012)
Verbascum thapsus L.	Anticarcinogenic, antimicrobial and anthelmintic	Flavonoids, saponins, tannins, terpenoids, glycosides, carbohydrates, proteins, fats and fixed oils (Ali et al. 2012)
Withania somnifera (L.) Dunal	Anti-inflammatory, antitumor, antistress, immunomodulatory, hemopoietic, and rejuvenating properties	Steroidal lactones (withanolides, withaferins), saponins, alkaloids (Mishra et al. 2000)
Woodfordia fruticose (L.) Kurz	Anti-inflammatory and analgesic properties and hepatoprotective (Baravalia et al. 2012)	Tannins, flavonoids, anthraquinone glycosides, and polyphenols (Das et al. 2007)
Zingiber officinale Roscoe	Anticancer, anti-inflammatory, anti-apoptotic, anti-hyperglycaemic, anti-hyperlipidaemic and anti-emetic actions	Sesquiterpenoids, zingiberene (Rehman et al. 2011)

3. Ethnopharmacology and Drug Discovery

The discovery of drugs and ethnopharmacology using natural substances remains an important issue in the field of pharmaceutical industry. Many modern medicines have appeared in ethnopharmacology. Many recent studies related to medicinal plants shows that the barriers to entry of new drugs decrease over time. In addition, the protection of traditional knowledge in health, medicine and biodiversity has become a serious problem. To overcome this deadlock, pharmaceutical companies are looking for truly innovative drug discovery methods. The World Health Organization (WHO) recently established Intellectual Property, Innovation and Public Health Committee to examine these issues (Patwardhan et al. 2004). In research and practice around the world, there are positive trends in traditional and comprehensive health sciences. There are many general methods for drug discovery, including the use of chemical biology, intuition, chemical synthesis, combinatorial chemistry, and genomics.

3.1. Ayurveda

Ayurveda and the Chinese medical system are the great traditions of medicine, and they play an important role in the bioprospecting of new drugs. In the fields of

pharmacology, chemistry, pharmacology and clinical treatment, a large number of studies have been conducted on the Ayurvedic medicinal plant. Based on the experience of Ayurveda, many molecules have emerged, including the alkaloid Rauwolfia for hypertension, psoralen in the treatment of leukoplakia, holarrhena alkaloids for amoebiasis, guggulsterones as a lipid-lowering agent, *Mucuna pruriens* as a bioavailability enhancer for Parkinson's disease, bacosides for mental retardation, hemophilic liver protection, antiviral agent, turmeric, lactic acids and their glycosides as immunomodulators. In Sanskrit, Ayurveda means science of life which aims to comprehensively manage health. It is still one of the oldest medical systems which is practised in today world. It was cited in the Indian subcontinent by a strong philosophical and experimental background. Charak Samhita and Sushrut Samhita (500-100 BC) is the most important Ayurvedic classic, of which describes more than 700 plants and their classification according to their pharmacological and therapeutic properties. Rasayana therapy is one of the eight branches of Ayurveda one of the types, usually composed of nutrition and anti-aging drugs. These drugs have multiple uses of prolonging life, enhancing memory, kinds of immunomodulation and adaptogens. Many researchers have proposed the neuroendocrine-immune axis theory to explain rasayana's activities which is considered to be the innovative source of immune drugs.

4. Current issues in Ethnopharmacology

4.1. Traditional medicine knowledge acquisition

At least 80% of the world's population in developing countries use plant materials as a source of primary health care. The knowledge of these systems can be kept individually or by tribe, or recorded in a complete volume. As a result of cumulative global efforts, it is not supported or available anywhere in the world. Therefore, it is impossible to conduct detailed scientific analysis of global data. In the world national medical information database, there are huge opportunities to discover new drugs. The known and accumulated information about plant use in the world health system is invaluable. It needs to be tested, correlated, checked and expanded. One of the most important aspects of collecting ethnopharmacological information is accompany of qualified doctors (local or external) to independently confirm the stated health benefits. We envision that the results should focus on drug development with a single active ingredient or one form of plant extracts and materials, rather than the global medicinal ingredients.

4.2. Intellectual property rights (IPR)

Over the years, both formal and informal scientific groups and organizations have recognized that the state and individual groups have the right to control their biological characteristics at sea and on land (Cordell 1993). The focus of local knowledge is on the ethnobotany that can be protected and the practice of ethnic medicine. Since the adoption of the Convention on Biological Diversity (CBD), IPRs related to the acquisition of plants (and all biological organisms) and its related indigenous knowledge have also become very difficult to access. CBD also, plans to catalogue and protect their indigenous knowledge and biodiversity. Some of the countries have chosen to enact strict rules and extensive bureaucracies to control access to their biomes. Others decided to strongly encourage stakeholders to cooperate with the CBD. So, it is very important that academic institutions have an effective technology transfer team to negotiate academic, corporate, public, and private organizations.

4.3. Traditional medicine safety and standards

The most important aspect of all health care is to ensure that any material ingested by humans for medical purposes is safe. The efficiency of ingested material is a secondary factor. Many users of traditional medicines believe that they are safe to eat but some speculations are based on extensive field experience. In many parts of the world, medicinal materials are often consumed in over-the-counter and prescription products. The clinical interaction of these approved products with phytotherapy and traditional medicinal products has become a very serious problem. It requires close monitoring and reporting, followed by extensive scientific research and exchanges to increase public awareness and safety. The number of plant therapeutics from different traditional medical systems around the world has increased dramatically, opening up commercial markets in developed and developing countries. An important finding of the growing research on phytotherapeutics is that the relevant world scientific literature is expanding accordingly. The continuous evaluation of clinical research on analytical procedures, biological, chemical information, phytotherapy and traditional medicine has therefore become a very important aspect of safety and effectiveness. Traditional medicinal plants are sold as herbal medicines worldwide, but their quality control is usually poor or non-existent. Effectiveness is underestimated and ignored. Consumers are usually unaware of this uncertainty. The WHO has issued general guidelines for traditional medical research. The goal is to summarize the challenges of developing research

methods, and to improve the quality and value of traditional medical research. Our vision for the future of primary health care facilities must be much higher than these minimum standards. Consumers in most countries of the world need to develop a more comprehensive safety and effectiveness standard general plan for these herbal products. Plant materials or preparations must not contain contaminants, such as insects, herbicides and pesticides (illegal), solvent residues, heavy metals, aflatoxins and other toxic microbial metabolites and radioactivity. The operation of phytotherapeutic is the intentional addition of biologically active substances to herbal supplements, has become a major problem in the United States and other countries in the past. Several products are withdrawn due to the presence of aminopyrine, indomethacin, phenylbutazone and various corticosteroids. The plant, chemical, and biological standardization of products should be carried out in batches, as well as other studies to prove the safety of products. The microchip is becoming the standard method for certifying plant material. The multi-component analysis system will have a significant impact on the standardization of routine chemistry. The rapid, cheap, accurate and clinically significant biological system mainly based on the microchip proves (confirms) the biological activity level of each batch of commercial products. The impact of extensive microarray analysis illustrates the positive and negative characteristics. In addition, the difference in action between pure active ingredient and plant extracts has become more pronounced. Finally, plant materials or the materials that make up product must be available on a sustainable basis (Zhang et al. 2005).

5. Biodiversity of Medicinal Plants

There are 8,000 medicinal plant species utilized by indigenous communities of India. Out of them only 10% (880 species) plant species were traded actively. Among these, 42 species were imported and 48 species were exported in form of raw drugs and extract. Approximately, 100 wild plant species numbers are declined and considered as threatened species. India is among world's top 12 mega biodiversity countries having 10 bio geographic regions. India is known for having two biodiversity hotspots among eight biodiversity regions. The fluctuation of climate and altitude, coupled with the diversity of the country's ecological habitat, has contributed to the country's extremely rich vegetation and unique medicinal plant varieties which plays an important source of medicinal raw materials for traditional medicines. In India, about 2500 plants are used in the local medicinal system. The Red Book lists 427 endangered Indian medicinal plants, of which 28

are extinct, 124 are endangered, 81 are rare, and 34 are unknown. Another interesting element is the natural distribution of traded medicinal species. These species have been found to be distributed in different biogeographic regions, different habitats and landscape elements. About 18% of these species are found in the Himalayas and Trans-Himalayas, including north-eastern India. Approximately 4% live in the Western Ghats, 0.5% live only in desert areas, and the remaining species (approximately 77%) are widely distributed in other biogeographic regions of the country.

Table 2: Bio-geographical distribution of traded medicinal plants (Lakshman 2016)

Bio-geographic Zones	No. of Medicinal Plants Identified	Example of Species
Himalayan	2900	*Picrohiza kurroa, Pistacia chinensis, Nardostachys grandiflora, Polygonatum cirrhifolium, Swertia chirayata, Valeriana jatamansi, Aconitum heterophyllum, Arnebia benthamii, Dactylorhiza hatagirea, Podophyllum hexandrum, Rubia sikkimensis, Coptis teeta, Rhododendron anthopogon, Taxus wallichiana.*
Trans – Himalayan	700	*Ephedra gerardiana, Hippophae rhamnoides, Physochlaina praealta, Arnebia euchroma, Ferula jaeschkeana.*
Desert areas	500	*Tecomella undulata, Tribulus rajasthanensis, Citrullus colocynthis, Commiphora wightii, Acacia nilotica.*
Semi-arid areas	1000	*Balanites aegyptiaca, Withania coagulens, Tribulus alatus, Commiphora wightii, Boswellia serrata, Canscora, Acacia nilotica.*
Western ghats	2000	*Myristica malabarcia, Garcinia indica, Coscinium fenestratum, Hydnocarpus pentandra, Garcinia gummi gutta, Vateria indica, Nilgirianthus ciliates.*
North East India	2000	*Aquilaria malacensis, Smilax glabra, Ambroma augusta, Hydnocarpus kurzii, Vetivaria zizaniodes.*
Deccan peninsula	3000	*Embelia tsjeriam-cottam, Caesalpinia digyna, Schrebera sweitenoides, Decalepis hamiltonii, Pterocarpus santalinus.*
Gangetic plains	1000	*Holarrhena pubescens, Mallotus philippensis, Pluchea lanceolata, Peganum harmala.*
Andaman and Nicobar Islands	1000	*Claophyllum inophyllum, Adenanthera pavonina, Barringtonia asiatica, Aisandra butyrace.*
Coastal islands	500	*Rhizophora mucronata* Lam., *Acanthus ilicifolius, Avicennia marina, Sonneratia caseolaris.*

5.1. Biodiversity and human health

The impact of biodiversity loss on the global environment has aroused widespread controversy, but the direct and serious consequences for human health have not been noticed until recently. Health risks are not only associated with pollution, but other factors such as depletion, degradation of freshwater resources, global climate change and natural disasters ultimately affect the overall health. We cannot look at human health in isolation, because it depends to a large extent on the quality of people's living environment. If people want to stay healthy, they need a healthy environment. The traditional risk is that the destructive effects of the deterioration of ecosystem services disproportionately fall on the shoulders of the poor. The conference held in Brazil, clearly explained the close relationship between human health and the environment. The link between poverty and underdevelopment on the one hand, and the relationship between environmental protection and natural resource management on the other hand was also emphasized (Lebel 2003). The loss of biodiversity reduces the availability of raw materials for drug and pharmacological discovery, leading to the loss of medicinal plants, affecting the spread of human diseases, and threatening food production and water quality. Biodiversity reduction has a direct impact on the discovery of potential drugs. Biodiversity plays a important role in disease recovery, it also makes a significant contribution to disease prevention, because a well-functioning ecosystem. The well-functioning biodiversity can help in protection of human health from contaminated water, air and diseases related to disturbed ecosystems. The key role is played by the ecosystem in controlling the occurrence and spread of the infectious disease and maintaining the balance between the predator and the prey, the host and the vector, and the plant, animal and human parasites. Recently, this protective function of biodiversity was recognized. Human activities are critical to the spread of many diseases. Wetland drainage removes wetlands used by many species, but may provide open channels that other species like (for example, *Culex* mosquito vectors, major European malaria and St. Louis Encephalitis vectors).

5.2. Biodiversity and traditional medicine

Wild populations of many species are exploited worldwide, and the demand for traditional medicine is one of the reasons for exploitation. There are many environmental factors associated with such practices. Obviously, Traditional Medicine practice is not immune to the environmental crisis of our planet.

Significant changes in forests, savanna and other types of vegetation have affected the procurement, preparation and cost of herbal medicines. The desecration of spiritual sacred sites, sacred sites and ravines often weakens the dignity of this "landscape" and encourages their abuse. Over the past three decades, deforestation in the Brazilian Amazon has reduced the supply of some commonly used herb species (Gillingham 2001). The degradation of the Amazon Forest not only means the loss of important medicines in industrialized countries, but also the destruction of the only health care facilities of many rural and urban poor residents. Under the influence of industrialization and urbanization, western medicine has replaced the local medical system in many areas, resulting in the inaccessibility of medical services in many areas. Most villages in the world are no longer surrounded by natural habitats that were surrounded by natural vegetation. The folk knowledge has been accumulated over the 1000 years, is disappearing at an alarming rate. In these cases, this loss would actually affect the net health gain. But modern society will never know what effective medicine is lacking. For example, in Latin America, governments have made many efforts to protect biodiversity for future generations. The changes in the local ecosystem caused by human activities have severely restricted the availability and accessibility of certain animal and plant species for medicinal purposes. As forests turn into savannas, and savanna to scrublands and bushes, and scrublands to desert, they characterize the depletion of biodiversity in this world. This situation created problems for the future practice of local medicine. With a few exceptions, all medicines were made from a mixture of plants, plant organs, or their secretions. The acquisition of plant and animal species needed by indigenous doctors now requires long-distance travel, which not only affects the operating costs of traditional health services, but also affects the preparation of herbal medicines. In rural areas, herbal medicines are increasingly being replaced by various mixtures. Infusion and powder forms are frequently used so that they can be stored for longer periods of time without losing potency or deterioration. Although traditional medicine is important to the public health of many regions of the world, such is the current rate of extinction of plants and animal species, that ethnic medicine practitioners seem to be even more endangered. The knowledge about the use of medicinal plants is declining faster than the plants themselves. The destruction of tropical rain forests in many parts of the tropics has led to the extinction of indigenous peoples living in these areas and people

with collections of popular knowledge about the usefulness of plants to treat various diseases. Communities with extensive knowledge of the local environment can be used for conservation and joint management. Examples of such practices can be found in the document "Mamirahua Sustainable Development Reserve, Brazil" (Castello 2004).

5.3. Endangered medicinal plants

Parts of plants, such as leaves, bark, roots, fruits, seeds and even whole plants are randomly collected from wild sources, regardless of plant protection. Due to overexploitation and habitat destruction, many important beneficial plants insects are threatened with extinction. 95% of medicinal plants are collected from the wild; some of them are endangered in their natural habitat. The reproduction and cultivation of these plants should be encouraged. The collection of the following species from wild sources should be prohibited.

Aconitum sp. (Monk's Hood, Bachang), *Anchusa strigosa* (Gaozaban), *Aristolochia bracteate* (Kiramar), *Acorus* spp. (Sweet Flag, Vekhand), *Artemisia annua* (Worm wood), *Berberis aristate* (Indian Berberry, Daru Haridra), *Brunium persicum* (Kala Zeera), *Atropa acuminata* (Indian belladonna), *Chlorophytum* spp (Safed Musli), *Commiophora wightii* (Guggul), *Concinum fariestatum* (Jeevanti), *Colchicum luteum* (Tara-Tutiya, Suranjan-1-Talah, Golden Collyrium), *Coptis teeta* (Halad-Vachnag, Gold Thread, Mamira), *Dorsera* sp. (Sundew), *Ephedra gerardiana* (Somlata), *Eulophia campestris* (SalebMisri), *Ferula jaeskaena* (Indian Hing), *Curculigo orchioides* (Kali Musli), *Gentiana kurroa* (Indian Gentian Pashanbheda), *Gloriosa superba* (Glory Lily, Agnisikha), *Didymocarpus pedicellate* (Shila-Pushpa), *Gynocardia odorata* (KaduBonsha), *Holostemma annulare* (Peet-chandan, Kasturi Mazil*), Hydrocarpus* sp., *Inula racemosa* (PushkarMool*), Iphigenia indica* (Nirpani), *Lilium polyphyllum* (KshiraKankoli), *Hyoscyamus niger* (Henbane), *Microstylis nucifera* (Jeevaka), *Microstylis wallichii* (Rishvake), *Orchis latifolia* (Salam Panja), *Panax pseudo-ginseng* var. himalicus (Indian Ginseng), *Physochlaina praealta* (Scholar, Lalthang), *Picrorhiza kurroa* (Kutki), *Nardostachys grandiflora* (Jatamansi), *Onosma bracteatum* (Ratnajyot), *Piper cubeba* (Kababchini), *Rauwolfia serpentina* (sarpagandha), *Rheum astrata* (Rewadchini), *Podophyllum hexandrum* (Bankari), *Rheum emodi* (Indian Rhubarb, Gandhini), *Swertia chirayata* (Chirayata), *Saussurea sacra* (Yogispada), *Taxus baccata* (Talispatra), *Taxus wallichiana* (Indian Yew) (Lakshman 2016).

5.4. Loss of biodiversity of medicinal plants

5.4.1. Environmental factors

5.4.1.1. Rainfall: In recent years, annual rainfall has decreased, causing many herbs to not remain healthy during the months of summer.

5.4.1.2. Deforestation: There have been reports of deforestation in the past two decades. Agricultural expansion, logging, heavy logging, and intensive grazing are the main reasons for the decrease in the area of precious forests. Every year, deforestation activities destroy or reduce medicinal plants.

5.4.1.3. Siltation of water bodies: The siltation of water bodies in the forest reduces the water storage capacity which results into groundwater depletion.

5.4.1.4. Lack of pollinators: In the forest and other areas, the honeybee community has decreased by 50-60%. The death of pollinators has reduced the number of seeds and their spread.

5.4.2. Developmental activities

5.4.2.1. Submersion: Many medicinal plant species in the forest have been lost due to flooding, such as the Maradavally forest catchment area of the Linganamaki Dam, Karnataka. This dam is the main source of irrigation and power generation. Submersion leads to loss of nearly 10 square kilometres of forest area. It results into loss of valuable medicinal plant species.

5.4.2.2. Infrastructure: Road expansion, power line laying and building construction cause considerable damage to forests and medicinal plants

5.4.3. Agricultural and forestry practices

5.4.3.1. Monoculture: Monoculture gradually increases economically important plantations of native and exotic species. Monoculture in forests completely affects organic productivity and reduces natural stability and complexity, leading to loss of medicinal plants. For example: Monoculture of *Eucalyptus* and *Acacia* species in the forest.

5.4.3.2. Invasion: Encroachment of forestland has reached an alarming level. In addition to cutting trees and clearing vegetation, farming methods used on highlands and abandoned lands have resulted in soil erosion and reduced crop yields.

5.4.3.3. Overexploitation: The collection of medicinal plants in the forest is very common. The collection was carried out by unorganized wood collectors, who sold the products to the contractor at the price set by the contractor. However, due to the propaganda of members of the "Local Traditional Medicine Practitioners Association", the illegal collection of medicinal plants is now under control.

6. Conclusion

The research of ethnic pharmacology and herbal medicine has made great progress. However, in clinical practice, it has not conducted treatment follow-up research through laboratory methods, and there is no public health policy or procedure that allows it to be carried out under medical supervision during treatment. Ethnopharmacological knowledge and experience-based drug research from clinical to laboratory is a true reverse pharmacology method. "Safety" is still the most important starting point. In addition to these clinical parameter estimates, there are many important parameters for evaluating and promoting safety and drug-herbal and herbal-herbal interactions. As the number of refineries continues to increase, it is necessary to consider the possibility of advanced analysis and mechanical screening of their extraction and production. Therefore, there is a need to carry out international coordination for the promotion and development of natural health products, including their evaluation, prospects, pharmacovigilance, and possible coordination of supervision, quality control, and clinical applications. Efficiency has become the problem of the Golden Triangle. It is composed of traditional knowledge, modern medicine and modern system science. It will combine to create an innovation engine and discover new things, safer, affordable and effective treatment methods. In these areas, work is currently underway to create pharmacoepidemiological and experimental databases for new chemical/molecular active ingredients, and develop standardized herbal formulas. It is important to study the utilization of plant resources in developed countries. In this case, ethnopharmacology will provide important pieces of information about the role of plants in our society. It is well known that traditional medicine plays a vital role in the public health of the majority of the population in developing countries. The interaction between public health, ethnopharmacology and biodiversity conservation includes urgent and current issues that are becoming more and more obvious, as demonstrated by WHO's goals of medicine to save life of peoples. The rational use of traditional medicines and the promotion of equal and sustainable access to essential medicines, especially the provision for the poor and disadvantaged groups is most urgent need of the hour.

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