Chemistry, Biochemistry and Ayurveda of Indian Medicinal Plants

भारतीय औषधीय पादपों का रसायन, जैवरसायन एवं आयुर्वेद

Edited by

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Mahatma Gandhi Chitrakoot Gramodaya University Chitrakoot

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प्रो. कृष्ण बिहारी पाण्डेय
कुलपति
महात्मा गांधी चित्रकूट ग्रामोदय
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ग्रामविद्या की राजधानी में आपका स्वागत है

चित्रकूट भारत की सांस्कृतिक राजधानी है। भगवान श्रीराम ने वनवास काल का अधिकतर समय इसी सुरम्य परिक्षेत्र में बिताया था। कालान्तर में इतिहास पुरुष राष्ट्रऋषि नानाजी देशमुख ने चित्रकूट में विविध प्रकल्पों के माध्यम से युगानुकूल सामाजिक पुनर्रचना का एक ऐसा मॉडल प्रस्तुत किया जिसकी सम्पूर्ण राष्ट्र में सराहना हुई। महात्मा गांधी चित्रकूट ग्रामोदय विश्वविद्यालय नानाजी देशमुख द्वारा संस्थापित देश का पहला ग्रामीण विश्वविद्यालय है। हमारे लिए यह **'ग्राम विद्या की राजधानी'** है। चित्रकूट में ग्राम विद्या की इस राजधानी में भारतीय औषधीय पादपों के रसायन, जैवरसायन एवं आयुर्वेद पर पंच–दिवसीय राष्ट्रीय कार्यशाला (1–5 सितम्बर 2012) में पधारे सभी लब्ध–प्रतिष्ठित वैज्ञानिकों, चिकित्सकों, आचार्यों एवं शोध छात्र–छात्राओं तथा स्थानीय वैद्यों व अतिथियों का मैं हृदय से स्वागत करता हूँ। मेरा विश्वास है कि चित्रकूट में आपका आगमन विश्वविद्यालय से आपके दीर्घकालीन आत्मीय संबंधों का आधार बनेगा और यह प्रेरणा भूमि आपको अपनी ऐतिहासिक धरोहर और सांस्कृतिक मूल्यों के प्रति उदात्त चेतना विकसित करने में उपयोगी सिद्ध होगी। मुझे विश्वास है कि चित्रकूट के परिक्षेत्र की वनौषधियों से परिचित हो तथा कार्यशाला में महत्त्वपूर्ण विषयों पर विचार–मंथन आपके व्यक्तित्त्व के उन्नयन में महत्त्वपूर्ण कारक सिद्ध होंगे। चित्रकूट में आपको रामभक्ति के साथ–साथ वनौषधियों से तादात्म्य होने का रस मिले, यही शुभकामना है।

(प्रो. कृष्ण बिहारी पाण्डेय)

PREFACE

India has over 3000 year old medicinal heritage whose main resource base was medicinal plants. We have perhaps one of the richest ethno botanical traditions in the world. Over 8000 species of plants of diverse habitats from orchids and ferns to trees, grasses, shrubs, climbers are used by local communities in different ecosystems from Ladakh to Kanyakumari and stretching to Northeast hills to Kutchh of Gujarat. Plants also became intricate part in various spheres of the human society. About 70% population of India inhabit in rural and remote areas of the forest and utilize a large number of flora for their routine requirements.

Ayurveda is the ancient (before 2500 BC) Indian system of health care and longevity. It involves a holistic view of man, his health, and illness. Ayurvedic treatment of a disease consists of salubrious use of drugs, diets, and certain practices. Medicinal preparations are invariably complex mixtures, based mostly on plant products. Around 1,250 plants are currently used in various Ayurvedic preparations. Many Indian medicinal plants have come under scientific scrutiny since the middle of the nineteenth century, although in a sporadic fashion. The first significant contribution from Ayurvedic materia medica came with the isolation of the hypersensitive alkaloid from the sarpgandha plant, valued in Ayurveda for the treatment of hypertension and insanity. This was the first important ancient-modem concordance in Ayurvedic plants. With the gradual coming of age of chemistry and biology, disciplines central to the study of biologic activities of natural products, many Ayurvedic plants have been reinvestigated.

In the early development of modern medicine, biologically active compounds from higher plants have played a vital role in providing medicines to combat pain and diseases. For example, in the British Pharmacopoeia of 1932, over 70% of organic monographs were on plant-derived products. However, with the advent of synthetic medicinal and subsequently of antibiotics, the role of plant derived therapeutic agents significantly declined in the economically developed nations.

In the last two decades, there has been a new trend in the preparation and marketing of drugs based on medicinal plants. These preparations, labeled herbal drugs or phytomedicines, are single plant extracts or fractions thereof and are distinct from the pure chemical entities of molecular drugs. These new plant-derived products are carefully standardized, and their efficacy and safety for a specific application have been

demonstrated. Thus, plant-based therapeutic agents continue to have scientific, social, and commercial significance and appear to be gathering a momentum in health-relevant areas.

Indian medicinal plants are the essence of Ayurveda and Ayurvedic treatments, when used judiciously. Their role cannot be confined to mere duration of disease but they also used being of human body. Hence, Ayurvedic drugs are rightly called the elixirs of life. Ayurvedic Herbs played important role in Ayurvedic treatment, from ancient time to this most modern time.

Indian Medicinal Plants/herbs shows good result on disease cure. Ayurveda is the medical/Health care system which uses this as treatment base with theoretical principles. We need to research many things to find out the pharmacological action of it.

The advent of development exploitation of mineral and metal resources, construction of minor and major dams for hydro-electric or thermal plants, development means of communication, reckless hacking and cutting of forests tracts for rehabilitation and agricultural purposes are having telling effect on the plant resources of Central India. The forest area are gradually shrinking due to population explosion and increasing demand on forest resources for sustenance of human at large. A large number of medicinal plants may then disappear prematurely before their inventorization, assessment and utilization of potentials for human welfare. Sustainable utilization and conservation of medicinal plants is the demand of the time.

This workshop aims to discuss and practices all the issues pertaining to medicinal plants research, documentation, utilization. conservation activities, standardization, quality control, tissue culture, biotechnology, biochemistry, phytochemistry and chemical characterization taking place in various Universities, Institutions, Colleges and their impact on medicinal plants.

Thirty five abstracts related to chemistry, bio-chemistry and Ayurveda were presented and discussed in the workshop. An excellent practice (tissue culture, identification of plant, instrumental techniques etc.), Harbal garden & pharmacy visit and marvelous field visit was also orgnised during the workshop.

I hope the proceeding will catalyze activities for further research and practices of all the issue pertaining to Indian medicinal plants.

Prof. I.P. Tripthi

ACKNOWLEDGEMENTS

We humbly present our gratitude to Honourable Vice-Chancellor Prof. K. B. Pandeya and Padamshri P. Puslpanghan for grateful inauguration of the National Workshop on Chemistry, Biochemistry and Ayurveda of Indian Medicinal plants amidst a September gathering.

We record our special thanks to right Honourable Vice-Chancellor Prof. K. B. Pandeya for his keen interest in the workshop and an encouraging foreword for the proceeding.

We are very thankful to Dr. R.R. Rao (FNA), Vaidya Jamuna Prasad, Dr. Bharatandu Prakash for her splendid address delivered in the inaugural ceremony. Our sincere thanks are also to Honourable Sant Chola Baba, Satianusuia Ashram Chitrakoot and Dr. K.V. Billore, Prof. T.R. Sahu & Dr. N.C. Shah for the valedictory address in the workshop.

The proceedings are outcome of cooperation of the authors, reviewers and many people at different stages in different capacities. We are obliged to Prof. Aroop Kumar Gupta, Presently Vice-Chancellor & Dean, Agriculture Faculty, Prof. S. S. Sengar, Dean, Art Faculty, Prof. R.C. Singh, Dean, Management Faculty, Er. K.P. Mishra, Dean, Eng. & Technology, Dr. Ajai Kumar, DSW and Prof. K.D. Mishra, Director, Research Directorate for encouragements. We wish to thankfully acknowledge the support and cooperation of Dr. Ravindra Singh, Dr. Vandana Pathak, Dr. Shudhakar Mishra, Dr. S.K. Chaturvedi, Dr. Sadhana Chaurasia, Dr. R.L.S. Sikarwar, Dr. Sachin Upadhyaya, Dr. Vijay Pratap Singh, Dr. S.P. Pathak, Dr. Rakesh Shrivastava, and Dr. Reetu Sharma. We also thank to our departmental colleagues and students for their active cooperation.

The conference was financial supported by various organizations and we again record our thanks to University Grant Commission-New Delhi, DRDO-New Delhi, M.P. Council of Science & Technology-Bhopal and Bundelkhand Extended Region Chaper (NASI) Chitrakoot.

Our thanks are also due to Academy Press Allahabad for excellent and timely printing and to Shri Bramhanand and Shri Vishnu Kumar for appreciable computer layout, and keen interest in the publication.

We deeply appreciate the sacrifices made by our family members who granted us the time we required to organize the conference and to complete the publication of this scale. We specially mention our researches & Post Graduate students Sarika Singh, Arvind Dwivedi, Sanjay Saxena, Neelesh Dwivedi, Priyanka Gupta, Noopa Dwivedi, Mahendra Mishra, Atul Dwivedi, Arti Kamal, Ruchita Tripathi, Chinmayee Mishra, Kailash, Anjnay etc. for their patience and cooperation.

Prof. I. P.Tripathi

भारतीय औषधीय पौधों के रसायन, जैव रसायन एवं आयुर्वेद पर आयोजित पंचदिवसीय कार्यषाला का प्रतिवेदन

लगभग 5000 हजार वर्ष पुरानी मानव सभ्यता में भारत वर्ष का पुराना चिकित्सीय ज्ञान है जो वनस्पतियों पर आधारित था और शायद उसी महत्व को ध्यान में रखते हुए भारतीय सभ्यता में पौधों की पूजा अर्चना की जाती थी जिससे उनका संरक्षण हो सके और उनका विस्तार व प्रवर्धन होता रहे जिससे यह विरासत हमारी आने वाली पीढ़ी को भी मिल सके।

आयुर्वेद पद्धति ही मनुष्य के सम्पूर्ण स्वास्थ्य एवं उसके दीर्घायु होने के लिए एक सम्पूर्ण ज्ञान है। विकास की दौड़ एवं पाश्चात्य सभ्यता के संक्रमण के कारण हमारे परम्परागत ज्ञान का धीरे–धीरे लोप होता जा रहा है और हम आधुनिक बनने के प्रयास में इस धरोहर को किनारे करते हुये बढ़ते जा रहे है।। इनमें मुख्यतः हमारे औषधीय पौंधों व खनिजों का निरंतर ह्रास हो रहा है। मानव सभ्यता के लिए प्राकृतिक रूप से उसके शारीरिक आवश्यक्ता एवं प्रकृति के साथ सामंजस्य बनाने वाली आयुर्वेदिक चिकित्सा पद्धति की ओर ध्यान आकर्षित करने हेतु यह पंच दिवसीय कार्यशाला आयोजित की गयी जिसमें निम्नलिखित पहलुओं पर विस्तृत विचार विमर्श किया गया।

1. औषधीय पौंधों की पहचान, उनके एकत्रीकरण, प्रोसेसिंग, सतत् उपभोग एवं संरक्षण।
2. औषधीय पौंधों की रसायनिक संरचना।
3. औषधीय पौंधों का आयुर्वेद, यूनानी एवं होम्योपैथी में उपयोग।
4. औषधीय पौंधों का मानकीकरण, गुणवत्ता नियंत्रण, औषधि निर्माण एवं उनकी सम्भावनायें।
5. टिशुकल्चर से औषधीय पौधों के विकास एवं संरक्षण की सम्भावनायें।

कार्यशाला के प्रथम उद्देश्य पर बोलते हुये प्रो0. टी.आर.शाहू, प्रो0 आर.आर.राव, प्रो0 के. व्ही. विल्लोरे एवं डा0 आर.एल. एस. सिकरवार ने बताया कि चित्रकूट में आयुर्वेदीय औषधि पौधों की लगभग 300 प्रजाजियाँ उपलब्ध है और उनके संरक्षण के लिए प्रयास करना आवश्यक है। डा0 भारतेन्दु जी ने बताया कि च्यवनप्राश में प्रयुक्त होने वाली सभी चालीस औषधियाँ चित्रकूट में उपस्थित हैं। चित्रकूट जैव विविधता के लिए एक स्वर्ग के समान है और इस प्राकृतिक वातावरण को संरक्षित करने की आवश्यकता है।

कार्यशाला के द्वितीय उद्देश्य पर प्रकाश डालते हुए विशेषज्ञों ने बताया कि औषधीय पौंधों की पहचान रासायनिक संरचना का अध्ययन कर उनकी वास्तविक पहचान करने से उनके सही उपयोग में सहायता मिल सकती है व इससे उनका उपयोग गुणकारक औषधियों के निर्माण में भी किया जा सकता है।

डा0 एन. सी. साह ने कार्यशाला के तीसरे उद्देश्य के अन्तर्गत अपने विचार व्यक्त करते हुये कहा कि भारतीय औषधीय पौंधों को जो स्थान मिलना चाहिए वह हमारी उपेक्षा के कारण नहीं मिल पा रहा है, और आधुनिक चिकित्सा पद्धति की ओर हमारा आकर्षण बढ़ गया है। कार्यशाला में औषधीय पौंधों के मानकीकरण एवं उनकी गुणवता पर विशेष ध्यान रखते हुये उन्हें विश्व स्तरीय दवाइयों के रूप में विकसित करने की आवश्यकता है।

जैसा कि आपको विदित है कि आज जंगलों की अधाधुन्ध कटाई एवं ब्सपउंजम बैंदहम और हिमखण्डों के नष्ट होने के कारण बहुत से औषधीय पौधे समाप्त होते जा रहे हैं। एक सर्वेक्षण के अनुसार प्रत्येक 1 मिनट पर जैव विविधता से एक प्रजाति विलुप्त होती जा रही है। यदि इस विनास को रोकना है तो उन प्रजातियों को जो विलुप्ती के कगार पर है उनके महत्व का प्रचार–प्रसार, खेती व ज्पेनम बनसजनतम द्वारा संरक्षण व संवर्द्धन कर उन्हें संरक्षित करने की अति आवश्यकता है। इस उद्देश्य पर विभिन्न दिशाओं में चल रहे प्रयासों को भी कार्यशाला में वैज्ञानिकों ने बताया। कार्यशाला के दौरान स्थानीय फार्मेसी, आयुर्वेद संस्थानों तथा वनस्पतिक उद्यानों का वैज्ञानिकों एवं छात्रों द्वारा भ्रमण किया गया तथा वहाँ की गतिविधियों को समझा गया। इसी दौरान चित्रकूट के जंगलों का भ्रमण कर औषधीय पौधों की पहचान को छात्रों ने जाना तथा उनके गुण व उपयोग के विषय में गहराई से विमर्श किया। उपरोक्त व्याख्यानों व क्षेत्र अध्ययन से विश्वविद्यालय में विषय सम्बन्धित लगभग 300 छात्रों को अपने भविष्य एवं अपने शोध विषयों को चुनने के लिए दिशा निर्देश भी प्राप्त हुये।

कार्यशाला की अनुषंसायेंः–

1. चित्रकूट जैवविविधता का स्वर्ग है, जिसके संरक्षण की अति आवश्यकता है। यहाँ औषधीय पौधों के एकत्रीकरण के लिए स्थानीय लोगों को प्रशिक्षण देने की आवश्यकता है, जिससे औषधीय पौंधों का विनाश रोका जा सके।
2. औषधीय पौंधों की खेती के लिए स्थानीय किसानों के समूह बनाकर उन्हें प्रेरित करना, जिससे उनके साामजिक–आर्थिक (Socio Economic) स्तर में सुधार आ सके।
3. औषधीय पौंधों की प्रोसेसिंग करने के बाद ही बाजार में भेजा जाय, जिससे किसानों को उनका पूर्ण व उचित मूल्य मिल सके और उसका सतत् उपयोग हो सके।
4. पादपों के पहचान में उनकी एवं रासायनिक संरचनाओं (Phyto-chemistry) की महत्वपूर्ण भूमिका है। इस तकनीकि का प्रयोग कर औषधि निर्माण में सही प्रजाति के उपयोग को सुनिश्चित करें जिसमें दवाओं की गुणवत्ता बढ़ेगी तथा जनसामान्य का कल्याण होगा।
5. औषधीय पौंधों के आयुर्वेद में उपयोग को बढ़ावा देने हेतु स्थानीय फार्मेसी विकसित की जाय जिससे दवाओं की गुणवत्ता बनी रहे और औषधीय पौंधों को उचित स्थान मिल सके।
6. विश्वविद्यालय में टिशुकल्चर प्रयोगशला का विकास कर उन औषधीय पौंधों को प्रवर्धित (Propagate) करना चाहिए जो विलुप्त प्रायः या विलुप्ती के कगार पर है।

इन्हीं अनुशंसाओं के साथ सौहार्द्रपूर्ण वातावरण में कार्यशाला के समस्त तकनीकी सत्र सम्पन्न हुये।

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राष्ट्रीय कार्यशाला

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PHYTOCHEMICAL CHARACTERIZATION OF MEDICINAL PLANT IN HERBAL DRUGS

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ABSTRACT

The prospects of exploring biodiversity for new medicines, foods, crops, insecticides, pesticides and other commercially valuable genetic and biological products and processes are booming, thanks to the rapid development in Biotechnology - particularly genomics, proteomics, enzymatic and transgenic technologies – Herbal Technology and Information Technology. And, this exploration of biodiversity for commercially valuable genetic and biochemical resources is termed as "bioprospecting". Bioprospecting involves investigation of genetic resources or biochemicals for new commercial leads and includes three major areas such as "chemical prospecting, gene prospecting and bionic prospecting". 20th Century witnessed a radical shift in the driving force of the world from the traditional military power to the industrial and financial powers. In 21st century we are witnessing yet another revolutionary driving force, '**the knowledge'**. According to Mashelkar (2001) 'The 21st century will be a 'Century of knowledge… and a nations' ability to convert knowledge into wealth and social good through the process of innovation will determine its future'. A new thinking centered on the concept of knowledge engineering for building up future '**knowledge societies'** and **'knowledge industries'** is gaining attention and acceptance both nationally and internationally. Four technologies namely, Biotechnology (BT), Information Technology, Herbal Technology and Nano-technology are going to be the most powerful instruments of the 21st century that would control the world trade and economics. Generating new knowledge and converting it into useful products, process and services using the latest advances made in S&T, and subsequent transfer of such products and technologies to industry and commerce with appropriate safeguards of IPR protection are some of the key strategies that countries like India should focus on to achieve economic prosperity and sustainable development.

Phytochemistry is the study of secondary metabolites in different plant parts. Secondary metabolism is an enigmatic process controlled and conditioned by a variety of factors. The finger print of secondary metabolites from the same speceis may vary depending on the stage of development and growth, edaphic and environmental factors. It is therefore essential to know the chemical constituents of therapeutically important medicinal plants before they are used in preparation of medicines. Marker compounds can play a useful role in characterization of medicinal plants and quality control of finished products.

Key words : Phytochemistry, bioprospecting, biotechnology, nanotechnology, metabolomism, phytonutrients, nutrigenomics, pharmacogenomics

INTRODUCTION

The history of human culture and civilization is all about the management and utilization of natural resources around him. Living close to nature, the traditional societies of the world have acquired unique knowledge about the use of wild flora and fauna, most of which are not known to the people who live away from the natural ecosystem (forests). This knowledge is so invaluable for developing new kinds of food, cosmetics, drug and pharmaceuticals and other chemicals of industrial importance. The year 2011 is declared as the International Year of Chemistry. Also the year 2011 is the 100th anniversary of Nobel Prize Awarded to Madam Curie, an opportunity for us to celebrate the contribution of women in science. The year 2011 is also the 100th anniversary of the founding of the International Association of Chemical Sciences.

Man first used his own legs powered by his own muscle power. After that he adopted animal power and later he discovered steam engine which he used to his best advantage. In 19th century he discovered electricity and automobile. In 19th century the prime driving force was the traditional military power which in 20th century shifted to industrial and financial powers. The 21st century is witnessing still another driving force – the knowledge. The 21st century will be the century of knowledge – a nation's ability to convert knowledge into wealth and social good through the process of innovation will determine its future. A new thinking centered on the concept of '**knowledge engineering'** for building up future **'knowledge societies'** and '**knowledge industries'** is now gaining attention and acceptance both nationally and internationally (Mashelkar, 1999). Generating new knowledge and converting it in to useful products, production processes and services using modern science and technology, and subsequent transfer of such products and technologies to industry and commerce with appropriate safeguard measures for intellectual property rights (IPR) protection are some of the key strategies that the Third World nations like India should focus on to achieve economic prosperity and sustainable development.

21st century is now acclaimed as the Century of Biology. The advancements made in physical sciences if applied appropriately can transform bioresources of nations to economic power. The centuries old traditional wisdom using plants for medicine for the prevention and treatment of diseases by ethnic communities is known as ethnomedicine. The ethnomedicine of India functions through two social steams. One is local folk stream which is prevalent in rural and tribal villages of India. The carriers of these traditions are millions of house wives, thousands of traditional birth attendants, bone setters, practitioners skilled in acupressure, treatment of eyes, snake bites etc. and the traditional village level herbal physicians "the vaidyas" or tribal physicians in the tribal areas. These local health traditions thus represent an autonomous, community supported system

of health delivery at the village level which run parallel to the state supported system. The potential of ethnomedicine is largely not noticed because of the dominant western medicine.

Biodiversity thus represents (1) a priceless resource with many actual uses and potential values to humanity and (2) a complex self-sustaining ecological system that helps, maintain the integrity and resilience of biosphere. These two complementary perceptions would lead to the surmise that biodiversity is an invaluable natural resource, which needs to be conserved and sustainably utilized for the benefit of the present as well as the future generations of humankind. Humankind has tapped only a fraction of this great nature's genetic library. Bioprospecting is the systematic search for genes, natural compounds, designs and whole organisms of forest/wildlife with potential for product development. Bioprospecting has three important facets like 'chemical prospecting, gene prospecting and bionic prospecting'

PLANT METABOLITES – PRIMAY AND SECONDARY

Plants synthesise the primary metabolites like carbohydrates, proteis and fats at all times wherever they are, but the secondary metabolites are synthesised only when they are required. The secondary metabolite production is controled and conditioned by a variety of factors such as edaphic, climatic, altitudinal and the association of other plants and microorganisms. The secondary metabolites are maily phenolics (Flavonoids, cumarins and tannins), alkaloids, saponins, terpenes, glycosides and steroids. It is found that most plant derived drugs belong to the classes such as steroids and terpenoids. The second major category belongs to the group of glycosides particularly saponins, flavonoid glycosides, digitalis glycosides etc. The third major category belongs to the class of alkaloids, some well known examples being quinine, atropine, morphine, berberine, camptothecine, vincristine, vinblastine etc and the other minor categories include the salicylates, vitamins etc.

HERBAL TECHNOLOGY

All technologies used for the manufacture of value added plant products can be called herbal technology. A multi-disciplinary team consisting of botanists, ethnobiologist, pharmacognosists, pharmacists, ethnopharmacologists, phytochemists, biochemists, and ayurvedic scientists are included in this programme. The R&D involved is essentially a blend of traditional knowledge/ wisdom and the latest S&T knowledge and tools with the objective of developing scientifically validated, standardized and IPR covered diverse herbal products such as health foods/ functional foods/ nutraceuticals, primary health care products and cosmaceuticals. Herbal drugs are best suited for primary health care, infectious diseases, Degenerative & Gerontological Conditions, Metabolic Disorders etc. Developments of products based on ethnic and indigenous knowledge are herbal drugs, herbal drinks, herbal beer, herbal dyes, herbal lipstick, nutraceuticals.

HERBAL PRODUCTS DEVELOPED BY NATIONAL BOTANIC RESEARCH INSTITUTE (NBRI)

NBRI has started developing a number of value addedd herbal drugs from 1999 onwards. Some of the most important among them are (1) NBIRA (Fermented herbal health drink) (2) A novel herbal brain tonic for improving memory and treatment of amnesia and cognition (3) Herbal formulation for anti pyretic, relapsing fever and dengue conditions (4)'NBIRASOF' - Health protective herbal soft drink (5) Herbal oro-dental care for halitosis and mouth ulcer (6) Antihyperlipidemic and slimming herbal composition(s) (7) A novel anti-diabetic herbal formulation (8) Antiulcer herbal composition (9) Development of an anticough, antitussive and throat soothing herbal formulation (10) Antidiarrhoeal herbal formulation (11) Herbal ointment for cuts burns and wounds (12) Herbal Gulal (13) Neem based products. They also developed a herbal functional lipstic with 17 shades (Luvstic-Figure 1).

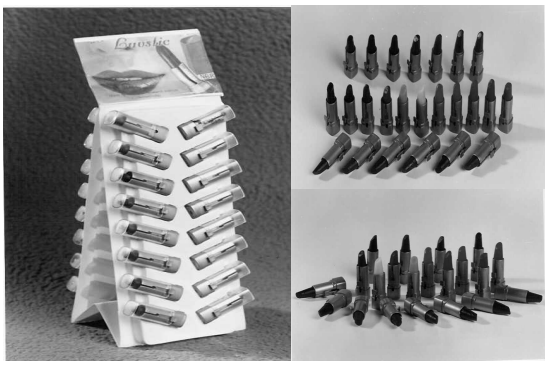


Figure 1: Luvstic Developed by NBRI

NBRI also developed a number of custom made nutraceuticals and functional foods giving specific attention for optimal growth and development of brain and general health. The most important among them are the nutraceutical for (1) pregnant and lactating mothers (2) infants and growing children (3) diabetics and old persons. Antioxidant functional foods were also developed in different value added herbal products. All these products have been patented and a good number of them have been transferred to industry.

NUTRACEUTICALS

A food or part of food that provides medical-health benefits including the prevention and/or treatment of disease is called a functional food. Such products may range from isolated nutrients, dietary supplements and diets to genetically engineered 'designer' foods, functional foods, herbal products and processed foods such as cereals, soups and beverages.

Some other nutraceuticals with antioxidant properties are soy isoflavones & soy health products, marine algae, spices, carotenoids, vitamin E etc. These antioxidant functional foods help to promote optimal defence against oxidative stress.

The promotive, preventive, corrective /restorative and curative approach in healthcare and medicinal plants possessing such properties are indeed the strength of Indian Systems of Medicine. The increasing evidence /realisation of the health hazards associated with the harmful side effects of many synthetic medicines and also the

hazards associated with indiscriminative use of modern medicine such as antibiotics, steroids and other synthetic drugs have given a new impetus to the study of medicinal plants with a view to develop novel herbal drugs. The increasing popularity in plant based drug is now felt all over the world leading to a fast growing market for plant based drugs, pharmaceuticals, nutraceuticals, functional foods and even cosmaceuticals. This has led to the rapid spurt in demand for health products like herbal tea, ginseng, Noni health care products and such novel products. The health promoting and disease preventing/curing properties of these products have been well established.

NUTRACEUTICALS AND FUNCTIONAL FOODS

The role of food and nutrition is now fairly well understood. With the advancement in science, molecular biology and genetic engineering, our ability to understand and manage health at molecular level is increased manifold. It is now scientifically demonstrated that it is possible for one to achieve a high level of health and well being if one takes right food and nutrition that suits one's genetic constitution. Molecular biologists are now busy in designing individualized food, customized food based on one's genetic makeup called 'nutrigenomics'. It has become very clear that traditional food and nutritional recipes, now called ethnic food are best suited for the people living in that particular locality or in similar agroclimatic conditions. Towards the end of the 20th century, this understanding led the health scientists and nutritional experts to scientifically investigate the traditional foods and that have led to the discovery that the traditional food and other traditional nutritional recipes can be best suited for maintaining a healthy life. It has also led to the development of designer food that suited different groups and also different categories of people suffering from what is now called life style diseases like diabetes, obesity, cancer, arthritis, hypertension etc. Functional foods or medicinal food or pharma food or nutraceuticals are the best treatment regime for curing or managing such diseases. In future, one may first go to genomic expert who will make a genomic profile and based on the genomic profile the dieticians will prescribe a new diet regime or a 'Rasayana' therapy of Ayurveda or advise for a proteomic therapy or a gene therapy.

TRADITIONAL DIETS AND NUTRACEUITCALS

The key to the development of health foods/pharma foods or nutraceuticals lies in the value addition in the traditional natural diets. India has over 5000 years of heritage of health science wherein food has been given an important role in maintaining healthy life. People living in different agroclimatic regions of the country had experimented and made a variety of food and diet and health care poducts, which is now termed as ethnic foods and ethnic nutritional diets. Ayurvedic medicine as explained earlier deals with an unique system of management called 'Rasayana Therapy' which is essentially a combination of food and medicinal herb recipes intended to

rejuvenate the whole body system and make it fully healthy and functional.

Phytonutrients/ phytochemicals have tremendous impact on the health care system and may provide health benefits including prevention and treatment of diseases and physiological disorders. Polyphenols are one of the most widely distributed groups of phytochemicals that are responsible for the health promoting effects of nutraceuticals. They range from simple phenols to highly polymerised tannins. They protect plants from oxidative damage and they also play the same role in humans protecting the tissues from oxidative decay there by acting as antioxidants. The outstanding feature of these phytonutrients is their ability to block specific enzymes that cause inflammation. They also modify prostaglandin pathways and thereby protect platelets from clumping.

NUTRACEUTICALS IN AYURVEDA

The Acharyas of ancient India who codified systems of medicine namely Ayurveda and Siddha seemed to have an indepth knowledge and understanding about the delicate relationship between food, nutrition and health. They also had a clear understanding of the delicate cellular mechanisms of the body and the deterioration of the functional capacity of human beings. These ancient medical masters had developed certain dietary and therapeutic regimes to arrest/delay ageing and rejuvenating whole functional dynamics of the body system. This revitalization and rejuvenation is known as the 'Rasayan Chikitsa' (Rejuvenation therapy) in Ayurveda. It is specifically adopted to increase the power of resistance to disease (enhance immunity) and improve the general vitiation and efficiency of the human being. 'Rasayana' therapy is done for a particular period of time with strict regimen on diet and conduct. Rasayana drugs are very rich in powerful antioxidants, hepatoprotective agents and immunomodulators. Rasayana is one of the eight clinical specialities of the Indian classical Ayurveda, aimed for the rejuvenation and geriatric care. Rasayana is not a drug therapy, but is a specialized procedure practised in the form of rejuvenation recipes, dietary regimen (Ahara Rasayana) and special health promoting conduct and behaviour ie. 'Achara rasayana'. Sushruta while defining rasayana therapy says that it arrests ageing ('Vayasthapam'), increase life span ('Ayushkaram'), intelligence ('Medha') and strength ('Bala') and thereby enable one to prevent disease. There are over 30-35 medicinal plants mentioned in different treatise of Ayurveda and Siddha having rasayana properties. The important among them are Sida cordifolia, S. cordata, Abutilon indicum, Tinospora cordifolia, Acorus calamus, Ocimum tenuifolium (syn. O. sanctum), Withania somnifera, Emblica officinalis, Asparagus racemosus, Piper longum, Commiphora mukul, Semicarpus anacardium, Centella asiatica, Curcuma longa, Chlorophytum borivilianum, Chlorophytum tuberosum, Dactylorhiza hatagirea, Morinda citrifolia etc.

In 'Ayurveda' the term 'Rasayana' therapy thus refers to the use of plants or

their extracts as rejuvenators or as an elixir to enhance longevity, to improve memory, intelligence, good health, promote youthfulness, improve the texture and luster of the skin/body, improve the complexion and voice, promote optimum strength of the body and sense organs. Rasayana materials can be special foods/nutritional items, medicinal herbs or a combination of all these three. Thus the use of the medicinal plants as a source of dietary supplement or as a nutraceutical is well documented for centuries.

The ancient Ayurvedic physicians treated every individual as unique. According to them, normally there cannot be two individuals with same constitutional nature. That they referred as 'Prakruti' and therefore, the treatment is prescribed only after diagnosing the constitutional nature of the individual. This constitutional nature of the individual is based on the 'Tridosha' philosophy. The various permutation-combination of the 'dosha' in conjunction with 'triguna'-the qualitative nature could offer countless variation in the constitutional nature of the individual and an experienced physician can very well diagnose it. Interestingly, the modern molecular geneticists also now speak a language similar to this i.e., genomic composition – i.e., DNA finger print is unique to an individual and we are now talking about gene profiling to understand the genetic predisposition and then suggest treatment to correct it, either by proteomic therapy or using other substances that can alleviate the defects or even the genomic therapy- proteomics, metabolomics and genomic methods for correcting disorders or treating diseases and nutrigenomics, genetically designed nutrition or food items. The ancient Ayurvedic masters had advised to consume specific food that suit to the constitutional nature of the individual whom they have categorized into7 major groups. They have insisted certain dos and don'ts with regard to food and nutrition according to the constitutional nature of the individual (Prakruti). Modern molecular biology and genetic engineering is offering genetically modified nutrition/food that suit to the constitutional/genomic background of the individual or designer drug suited to the individual – known as Nutri genomics and pharmacogenomics respectively. With the perfection of technology of mapping the human genome, it is now possible to get the DNA profile of individuals and then develop customized nutrition and treatment regimen.

STANDARDIZATION OF HERBALS

Standardization of herbal raw drugs includes preparation of passport data of raw plant drugs (Crude drugs), correct taxonomic identification & authentication, study on the medicinal part: root, stem, bark, leaves, flowers, fruits, nuts, gum, resins etc., collection details: location, stage & development/ growth of the plants, time, pre-processing, storage, etc., organoleptic examination of raw drug - evaluation by means of sensory organs: touch, odour taste, microscopic & molecular examination, chemical composition (TLC, GLC, HPLC, DNA fingerprinting), biological activity of the whole plant, and shelf life of raw drugs.

This is followed by well defined Good Manufacturing Practices (GMP) and scientific validation including toxicity evaluation, chemical profiling, pharmacodynamics – effect of drug in the body, pharmacokinetics – absorption, distribution, metabolism, mechanism of action and execution, proper dosage form, proper presentation and packing and proper claim of therapeutic merits – compared with other drugs. This should be followed by good survey of literature (Ancient & Modern), development and observation of norms of: Good Agricultural Practices (GAP), Good Collection/Harvesting and Post Harvest Handling Practices (GCP/ GHP & GPHP), Good Laboratory Practices (GLP), Good Clinical Practices (GCP), Good Manufacturing Practices (GMP) and Good Marketing Techniques (GMT).

The spin-offs and potential contributions of Ayurvedic Pharmacoepidemiology are expected to be sizeable: (1) Usage safety records for Ayurvedic drugs, (2) Data useful for herbal drugs registration, (3) Adverse drug reactions registry for rational therapeutic precautions, (4) Drug dosage adjustments in special age or disease groups of patients, (5) Pharmacoeconomics of Ayurveda vis-à-vis marketing and rational drug policy, (6) Discovery of novel beneficial effects as leads for further research, (7) 'quality of life' (QOL) studies with Rasayana Dravyas, (8) Patterns of drug usage across the systems of medicine, (9) Drug interactions likely due to concomitant administration of intersystem drugs and (10) Fulfilment of ethical and cultural obligations for the heritage of healing.

Revitalizing Ayurveda through integrated scientific research and development initiatives is very much important not only in terms of improving the healthcare standards and quality of life of our own people, but also in view of the enormous potentials and benefits this system could offer India to become a global leader in the global herbal drug/pharmaceuticals industry. The practitioners of both Ayurvedic and modern medicine need to accept and appreciate these as the real challenges and should work in a synergetic way so as to take Ayurveda and other traditional Indian systems of medicine to the pedestals of global medicine.

MODERN BIOTECHNOLOGY

Biotechnology is becoming increasingly transdisciplinary and one of the most powerful technologies of the 21st century which has revolutionalised the Life Sciences and has grown as a separate discipline encompassing a number of other disciplines like Cell Biology, Immunology, Molecular Biology, recombinant DNA technology and bioinformatics. The development of Biotechnology is making visible impacts in varied areas such as biology, medicine, agriculture, environment, human genome project, animal and plant genome projects etc.

Biological system is just not an assembly of tissues, cells, genes or proteins, but what is important is the traffic and cross talk between them – system

biology. The Ayurvedic Masters of ancient India had a clear understanding of the delicate cellular mechanism of the body and the deterioration of the functional capacity of human being. To arrest such deterioration of the functional efficiency and to revive and revitalize the body system, the Ayurvedic masters developed an elaborate rejuvenation therapy known as 'Rasayana' therapy. 'Rasa' in Sanskrit means the essence and 'ayana' means to circulate in the body without any obstruction. 'Rasayana' is one of the eight clinical specialties of Ayurveda that is aimed for the rejuvenation and geriatric care. Rasayana is not a drug therapy, but a specialized procedure practiced to cleanse the body from the toxic and other microbial substances. In Rasayana Therapy, with the help of special diet and nutritional agents comprising of highly powerful antioxidants, the body is rejuvenated by providing greater immunity, vitality, longevity and by improving all faculties to attain youthfulness of the whole body.

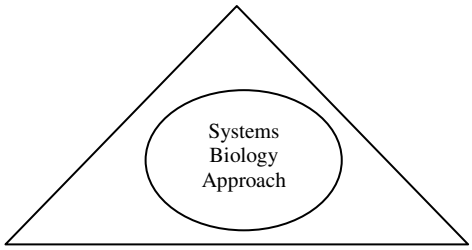
PHARMACOGENOMICS

Pharmacogenomics is the study of the hereditary basis for differences in response of populations to a drug (Patwardhan etal, 2004). The same view was expressed by the ancient Ayurvedic master Charaka, some 4000 years ago. Charaka observed that 'Every individual is different from another and hence should be considered as a different entity. As many variations are there in the universe, all are seen in human beings. Patwardhan (2003) referred it as the Ayugenomics and explained that it has quite clear similarities with the pharmacogenomics that is expected to become the basis of designer medicine.

An "in-depth study and analysis" of the constitutional concept of Ayurveda namely 'Prakruti' with that of the modern genotype will yield highly valuable insight in understanding the functional dynamics of the human health and can lead to the development of a customized treatment regimen. Less than 20% of the plant species have been evaluated chemically or biologically (Cordell, 2003). Approximately 21,200 alkaloids have been isolated and described out of which hardly 70% have been evaluated in a single bioassay. Out of about 5000 compounds which enter advanced pharmacological development only one will become a drug. (Cordell, 2005). It is also now a well established fact that drug discovery for a single entity drug is an inefficient and extremely expensive process and the best choice is to develop phytomedicine or pharmacomedicine which involve activity guided isolation of fractions of selected traditional polyherbal formulations and their various permutation combinations. This way one could develop effective therapeutic remedies gaining increasing acceptance and popularity. Such an approach could lead to the development of evidence based herbal formulations. Automation and application of nanotechnology, proteomics and metabolomics may further advance nutraceutical research and development.

'Golden Triangle' refers to the converging of Ayurveda, modern medicine and modern sciences to form a real discovery engine (Fig. 1) that can result in newer, safer, cheaper and effective therapies.

Ayurveda (Traditional wisdom)



Modern Sciences (Technological advances) (Golden Triangle, Mashelkar 2003)

Modern medicine (Evidence based clinical trials/practices)

New technologies are constantly being developed to isolate and identify the components responsible for the activity of plants. But these technologies should consider and possibly use the fact that the biological activity of plant extracts often results from additive or synergistic effects of its components. Another possibility is the qualitative and quantitative variations in the content of bioactive phytochemicals, which are currently considered major detriments in its use as a medicine. Different stresses, locations, climates, microenvironments and physical and chemical stimuli, often called elicitors, qualitatively and quantitatively alter the content of bioactive secondary metabolites. Enzymatic pathways leading to the synthesis of these phytochemicals are highly inducible (Ebel and Costa, 1994). This is particularly true for phytochemicals that are well documented for their pharmacological activity, such as alkaloids (Facchini, 2001), phenylpropanoids (Dixon and Palva, 1995) and terpenoids (Trapp and Croteau, 2001) whose levels often increase by two to three orders of magnitude following stress or elicitation (Darvill and Albershelm, 1984). Thus, elicitation-induced, reproducible increases in bioactive molecules, which might otherwise be undetected in screens, should significantly improve reliability and efficiency of plant extracts in drug discovery while at the same time preserving wild species and their habitats. Molecular biologists and genetic engineers are currently engaged in designing food and medicinal plants with desired genetic make up so as to make custom made nutritional composition food or therapeutically desirable agents in plants – known as nutrigenomics and pharmacogenomics or proteomic approach to healthcare. Another emerging research area in medicinal plants is the metabolomics and systems biology. Metabolomics is considered as a key technology in the systems biology approach to study the mode of action in the therapeutic activity of traditional medicine and medicinal plants (Roos et al, 2004; Rao etal, 2004 and Mei Wang et al 2005). By measuring the activity of living organisms (which can be anything from a cell culture, animals to patients) for extracts with different composition, possibly one may identify a compound or a combination of compounds that correlate

with the activity. Thus systems biology approach is a major challenge for the coming years in studying medicinal plants (Verpoorte et.al., 2005).

ADVANTAGES OF HERBAL DRUGS

Herbal drugs are comparatively safer and modern drugs can produce serious side effects. Drug induced or chemical induced (Iatrogenic) diseases fourth leading causes of death in USA and other developed nations (JAMA, 1998). Side effects of modern drugs kill more Americans annually than the world war 2nd and Vietnam War combined (Newyork Times, 2003). Around 2600 people died in the Twin tower tragedy on 11th September, 2001 causing global repercussions. It is however not recognized that the same number die in USA from the effects of modern prescription drugs every 10 days (JAMA, 1998). Health care policies largely market driven by the pharmaceuticl industry diverting attention from health preservation to illness cure. Prevention and iradicatio of diseases undermine the economic basis of this industry. There is no satisfactory modern drugs available for most of the degenerative disorders characteristic of graying population and for remerging resistant infections. Herbal drugs are best suited for primary healthcare, infectious diseases, degenerative gerontological conditions, metabolic disordes and other conditions of liver diseases, cancer and immunostimulant and microcirculatory disorders.

AIHBPD AND DRUG DEVELOPMENT

Amity Institute for Herbal and Biotech Products Development (AIHBPD) was established in 2006 with a view to develop scientifically validated and standardized herbal drugs. Keeping in view of the vision of the Founder President of Amity Group of Institutions Dr. Ashok K Chauhan, the Institute is focusing all its resources and energy to develop novel nutraceuticals, cosmaceuticals and phytomedicines. Under the leadership and guidance of the authors the Institute has developed 18 novel herbal products combining traditional wisdom with the knowledge and tools of modern science and technology. Patent applications on all the 18 novel products have been filed and steps are being taken for the mass production of nutraceuticals and cosmaceuticals so that the fruits of our research are made available to our fellow citizens.

CONCLUSION

21st century is witnessing still another driving force – the knowledge. The 21st century will be the century of knowledge – a nation's ability to convert knowledge into wealth and social good through the process of innovation will determine its future. A new thinking centered on the concept of **'knowledge engineering'** for building up future **'knowledge societies'** and **'knowledge industries'** is now gaining attention and acceptance both nationally and internationally. Plants synthesise the primary metabolites like carbohydrates, proteis and fats at all times wherever they are, but the secondary metabolites are synthesised only when they are required. The secondary metabolite production is controled and conditioned by a variety of factors such as edaphic, climatic, altitudinal and the association of other plants and

microorganisms. The third major category belongs to the class of alkaloids, some well known examples being quinine, atropine, morphine, berberine, camptothecine, vincristine, vinblastine etc and the other minor categories include the salicylates, phenolics, coumarins, vitamins etc. Modern biotechnology particularly the disciplines like Cell Biology, Immunology, Molecular Biology, recombinant DNA technology and bioinformatics. Phytonutrients/phyto-chemicals have tremendous impact on the health care system and may provide health benefits including prevention and treatment of diseases and physiological disorders. New technologies are constantly being developed to isolate and identify the components responsible for the activity of plants.

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MEDICINAL PLANTS OF INDIA: DIVERSITY, CONSERVATION AND BIOPROSPECTION- A PRIORITY AGENDA FOR 21st CENTURY

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ABSTRACT

The use of plants to alleviate human suffering is as old as the evolution of human civilization itself. Mention of medicinal virtues of hundreds of plants in India has been made in the ancient works like Charaka samhita, Susruta samhita, Rigveda and Astanga Hridaya. India also possesses a great heritage of other ancient systems of medicine such as Siddha, Unani and Homeopathy. More than these systems there also exist in India a vast knowledge of tribal and folk medicine among the numerous ethnic tribes and all these collectively add to the rich diversity of medicinal flora in India. Indian region encompassing a broad range of ecological habitats and innumerable adivasi tribes in all states, hosts for about 50% of the total higher plant species in India. A few important medicinal plant species occurring at various phytogeographic regions of the country including altitudinal zones, such as tropical, temperate and subalpine regions are listed. The numerous adivasi tribes occupying the different forested areas have depended on surrounding flora for all their ailments and consequently hundreds of medicinal plants are in usage for one or the other ailments. A few important medicinal plants reported through ethnobotanical surveys are also enumerated. Although considerable amount of literature have accumulated on the subject during recent years, the authors emphasize the urgent need for further exploration in the region for documenting all medicinal plants of the region for their effective utilization. Discussing the various threats for medicinal flora, the authors opine that cultivation of medicinal plant species appears to be the only solution to save the vanishing medicinal flora. The problems and benefits of cultivation of medicinal plants are also highlighted. Finally, the author stresses the need to intensify the inventorization of medicinal plants and develop a comprehensive database on the State-wise medicinal plants of India. Study of infraspecific and genetic diversity in medicinal plants, which is least attempted is advocated at least for those medicinal plants, which are in high demand and needing commercial cultivation. Discussing the utilization of the bio resources, the author outlines the immense opportunities for bioprospection of the medicinal plants. Recent developments in molecular biology and biotechnology have made it possible to scan the biodiversity for molecules with potential for commercial application. Problems and prospects associated with the bioprospection of medicinal plants in India are discussed.

INTRODUCTION

During the last few decades there has been a greater interest in scientific study and wider application of medicinal plants to alleviate human suffering. Although more than 7500 medicinal plant species are reported to occur in Indian region with tremendous amount of infra-specific biodiversity in them, the medicinal plants sector largely remains neglected. The use of plants to alleviate human suffering is as old as the human civilization itself. Mention of medicinal virtues of hundreds of plants in India has been made in the ancient works like *Charaka samhita, Susruta samhita, Rig-Veda and Astanga hridaya*. India also possesses a great heritage of other ancient systems of medicine such as Siddha, Unani and Homeopathy. Apart from these systems, there also exists in India a vast knowledge of tribal and folk medicine among the numerous ethnic tribes and all these collectively add to the rich diversity of medicinal flora in India. Although the diversity of medicinal plants in India is enormous with their heritage as old as 5000 years, the medicinal plants sector is still mostly unorganized. It is attempted to discuss the enormous diversity of medicinal plants in India.

During recent decades, the rich biodiversity of medicinal plants in India is under considerable threat from a variety of human generated factors and most of the high valued medicinal plants in trade are exclusively collected from wild, critically endangering them in their natural habitats. Several high value medicinal species like *Podphyllum hexandrum, Aconitum sp., Janakia arayalpathra, Trichopus zeylanicus, Garcinia gummiguta, Utleria salicifolia, Myristica malabarica*, *Aquilaria malaccensis, Dioscorea deltoidea, Pterocarpus santalinus, Rauvolfia serpentina, Saussurea lappa* and *Taxus wallichiana* etc, having high economic potential have already become critically endangered in the region. The paper also highlights the various attempts for conservation of medicinal plants. Utilization of medicinal plants through Bioprospection is also much neglected in India, which is discussed at some length in this paper.

MEDICINAL PLANTS DIVERSITY

The use of plants to alleviate human suffering is as old as the evolution of human civilization itself. Mention of the medicinal virtues of plants in India has been made even in the epics like the Ramayana and Mahabharatha. Around the world many billions of people still use plants as their primary source of medicine. Much of these uses are based on knowledge passed down through generations. In addition, nearly 40% of the modern medicines are derived from natural products. For example, aspirin is made from an organic molecule derived from Willow trees; Quinine a treatment for malaria is derived from bark of the *Cinchona* tree; Rosy periwinkle is the source of alkaloids used to treat childhood leukemia and Hodgkin's disease.

India also possesses a great heritage of other ancient systems of medicine such as Siddha, Unani and Homeopathy. Apart from these systems, there also exists in

India a vast knowledge of tribal and folk medicine among the numerous ethnic tribes and all these collectively add to the rich diversity of medicinal flora in India. Nearly 550 ethnic tribes dwelling in different forest regions have vast amount of traditional knowledge about plants, particularly medicinal plants. Again, a vast majority of these species are represented by numerous subtypes or populations depending upon the climatic and edaphic conditions. Indian region being one of the mega diversity regions of the world supports an enormous biodiversity of ancient lineage. It is estimated that over 50,000 species of plants are accounted for in this region, which represent roughly 11% of the known plant species of the world. Nearly 18,500 species of flowering plants belonging to 2,250 genera and 315 flowering plant families occur here. This includes nearly 8000 species which are used as herbal remedies for a variety of ailments under different systems of medicines. According to FRLHT's reports in Ayurveda-1689; Folk medical system-4775; Homeopathy-491; Modern medicine-200; Siddha-1563; Tibetan-343 and Unani-843 plants are mentioned. Medicinal plants diversity in India is very high. Although rough estimate of the total number of medicinal plant species in India is reported to be around 8000 species, the infra specific diversity of these species is least known. The medicinal plans diversity in different biogeographic regions in India is highlighted. It is roughly estimated that West Himalaya harbors 1500 species of medicinal plants, East Himalaya 3000, Western Ghats 3500, and Eastern Ghats 1500, Andaman & Nicobar Islands 750 species. Further, it is shown that Karnataka hosts for about 1495 medicinal species while Tamil Nadu, 1574; Kerala, 1500; Andhra Pradesh, 1100 species. While on one side we have not been able to evaluate the infra specific diversity in most of these medicinal plants for identifying the elite types (which is expected to be very high), many species and populations are facing the threat of extinction due to several anthropogenic reasons. Medicinal uses of a few important species like *Costus speciosus, Sassurea obvollata, Gymnema sylvestre, Aegle marmelos,* Phyllanthus amarus, Aloe vera, Abrus precatorius, Thymus vulgaris, Rhus semialata, Tinospora cordifolia, Rauvolfia serpentina, Celastrus paniculatus, Mucuna pruriens, etc., are very high. Himalaya and Western Ghats are the treasure houses of many reputed medicinal plants like Rauvolfia serpentina, Gloriosa superba, Cassia angustifolia, Withania somnifera, Chlorophytum sps., Catharanthus roseus, Andrographis paniculata, Pyllanthus amarus, Trichopus zeylanicus, Janakia arayalpathra, Utleria salicifolia, Aristolochia tagala, Piper barberi, Adenia hondala, Garcinia sps, Thotea siliquosa, Caryota urens, Adhatoda beddomei, Myristica malabarica, Coscinium fenestratum etc. (in Western Ghats) and Taxus wallichiana, Picrorhiza kurrooa, Aconitum spp, Saussurea obvallata, Berberis sp., Ephedra gerardiana, Podophyllum hexandrum and a few others

(in Himalayas) which offer immense prospects for bioprospection of medicinal flora.The most ancient and celebrated treatises on Hindu medicine are no doubt the Ayurveda. The authoritative works like **Charaka samhita**, **Susruta samhita**, **Rigveda** and **Astanga Hridaya** marks the early base of herbal science in India. As many as 4000 plants are collectively mentioned in these early works. Added to this, India also possesses a great heritage of other ancient systems of medicine such as Siddha, Unani and Homeopathy. Nearly 2500 species of plants are used in one way or other by some of these systems. In addition to these traditional systems, there also exists in India a vast knowledge of tribal and folk medicine, which utilize around 7500 species of plants as medicinal. Some of the ethnobotanically important species have also provided leads for production of modern drugs by pharmaceutical companies (table-1). In fact, it is estimated that in India 90% of the prescriptions contain plant products (Husain, 1983, Natesh,2001). The Ayurvedic and other traditional systems of Indian medicines fully depend on wild plants for preparation of drugs. In recent times, wild medicinal plants have also found their way even in allopathic medicines. Madagascar periwinkle (Catharanthus roseus), Sarpagandha (Rauvolfia serpentina), Acorus calamus, Gloriosa superba, Podophyllum spp. are only a few standing examples. The rhizomes of Acorus calamus with insecticidal and sedative properties are being used in as many as 51 different drug preparations (Ayensu, 1983).

There is an urgent need to intensify the inventiorization of medicinal plants for developing a comprehensive, State wise databases on medicinal plants of India with as many parameters like correct names, synonyms, vernacular names, names of ethnic communities using the plants, distribution in the region, threat status, conservation initiatives and ailments for which used and detailed mode of application, etc. Study of infra-specific and genetic diversity in medicinal plans, which is least attempted is also advocated for at least those medicinal plants, which are in high demand and needing commercial cultivation.

The Indian region supports almost all types of habitats for luxuriant growth of medicinal plants. Over 8000 species reported to be medicinal are found in different ecosystems in the country. While on one side we have not been able to evaluate a vast majority of these medicinal plants for identifying the elite types, many species are facing the threat of extinction due to several anthropogenic reasons. Already a number of reputed medicinal species such as Aquilaria malaccensis, Dioscorea deltoidea, Podophyllum hexandrum, Pterocarpus santalinus, Rauvolfia serpentina, Saussurea lappa and Taxus wallichiana have become endangered.

Although the diversity of medicinal plants in India is enormous with their heritage as old as 5000 years, the medicinal plants sector is still mostly

unorganized. In spite of the tremendous diversity in medicinal plants, India is still listed as a leading importer of medicinal plants (Table 12). The reasons for this are many. Unsystematic collection of the medicinal plants from the wild during different seasons and from different places is one such major reason. Immature harvest, unscientific production of the drugs and adulteration through some cheaper substitutes all add to this. Evaluation of the elite populations through scientific studies and their large-scale cultivation can only reverse this situation. The recent establishment of a "National Medicinal Plant Board" by the Government of India with the objective of co-ordination of all matters related to medicinal plants, including drawing up of policies and strategies for medicinal plants is a big boost for this industry in India. The diversity of medicinal plants in India is mainly discussed with reference to 3 major phytogeographic regions, which are also considered as 'hot-spots'of biodiversity (Myers, 1988).

DIVERSITY OF MEDICINAL PLANTS IN HIMALAYAN REGION

The Himalayan bio-geographic zone is the richest and unique botanical region in India and encompasses a broad range of ecological habitats varying from grassy meadows to dense humid evergreen forests; disturbed secondary formations to almost virgin and relict types as in `Sacred Forests'. A mixture of tropical, temperate and alpine forests each type depicting its own characteristic biodiversity is represented in this region. About 50% of the total number of flowering plant species of India occur in this region, which also include nearly 40% of endemic taxa. This region being the `Sanctuary of Primitive Angiosperms' is considered as the cradle of Flowering Plants where some groups of angiosperms have originated and diversified (Takhtajan, 1969; Rao, 1994). The Himalayan region has always been considered as a store house of many life saving drug plants. Based on several ethnobotanical and other publications, the medicinal plants in this region cover almost 50% of the total medicinal plants of India, i.e, ca 4000 species. Further, the varying habitats, from tropical to alpine flora support the growth of numerous medicinal plants, many of which have not been critically evaluated. Some of the important medicinal plants of the region are Coptis teeta, (Mishmiteeta) Paederia foetida (Gandhali), Podophyllum hexandrum (Papra) Nardostachys grandiflora (Jatamansi), Panax pseudo-ginseng (ginseng), *Picrorhiza kurroa* (Kutki) *Alpinia galanga* (Bara kulapjan), *Dactylorhiza hatagirea*, *Rheum emodi, Berberis* spp, *Aconitum heterophyllum, Elaeocarpus sphaericus, Acorus calamus*, *Atropa acuminata, Costus speciosus, Mucuna prurita, Rauwolfia serpentina, Swertia chirayata, S. hookeri, Valeriana hardwickii, Berginia ciliata, Mahonia nepalaensis, Saussurea obovallata, S. graminifolia, Solanum khasianum, Ephedra girardiana* and many others (Rao, 1994). With the increasing demand for medicinal plants, most of the raw

materials are being exploited from the wild source leading to the depletion of wild populations of important medicinal plants *like Aconitum ferox, A. heterophyllum, Acorus calamus, Panax pseudo-ginseng, Podophyllum hexandrum, Valeriana wallichii, Taxus baccata*, etc

DIVERSITY OF MEDICINAL PLANTS IN NORTHEAST INDIA

North-East India encompasses a broad range of ecological habitats varying from grassy meadows to dense humid evergreen forests; disturbed secondary formations to almost virgin and relict types as in sacred forests. About 50 % of total higher plant species of India occur in this region with maximum number of endemic taxa. The region being the 'Sanctuary of Primitive Angiosperm' is also the "Cradle of Flowering Plants." The rich species diversity is largely attributable to the diverse geographical area, varied topography, climate and soil variability and invasion of plant species from the surrounding countries. The region is the transitional zone between the Palaeo-artic, Indo-Malayan and Indo-Chinese biogeographical zones as well as the confluence of the Himalayan region with the peninsular India. It is therefore no surprise that the region acts as a storehouse of vast number of medicinal plants apart from the other groups of economically important species.

The medicinal plants diversity in Northeast India is quite enormous. Although no data is available on the exact number of medicinal plants occurring in Northeast India, a recent publication by the Indian Institute of Remote Sensing (Anonymous 2002) has listed 419 species of medicinal plants from Arunachal Pradesh, 228 species from Assam, 86 species from Manipur, 74 species from Meghalaya, 83 species from Mizoram, 86 species from Nagaland, 73 species from Tripura and 70 species from Sikkim. Listing of all medicinal plants of Northeast India is avoided here nor it is required too in this discussion. Only a few major ones confined to different forest types are listed. It may be noted from that Arunachal Pradesh tops the list with maximum number (419) of medicinal plants followed by Assam, Nagaland, Mizoram, Meghalaya, etc.

ETHNOBOTANICALLY IMPORTANT MEDICINAL PLANTS

The numerous adivasi tribes occupying the different forested areas in northeast region depend on the surrounding vegetation for all their ailments. Only a few seleced medicinal plants among different ethnic communities are enumerated in table 2. As evident from the table 2, the tribals have known the use of medicinal plants for all major diseases like malaria, leprosy, pneumonia, tuberculosis, Typhoid, night blindness, ulcers, cancer, skin diseases, hypertension, jaundice, eye diseases, lever disorder, kidney troubles, gynecological disorders etc. Scientific evaluation and authentication of these leads can certainly result in patentable drugs. Practically every ethnic tribe uses hundreds of medicinal plants for their day to day life. While some of these medicinal

plants have been documented by ethnobotanical surveys (Borthakur 1976; Dagar 1989; Dutta and Nath 1999; Gogoi and Borthakur 2001; Jain 1965; Jain et al. 1973; Jain and Tarafder 1970; Kotoky and Das 2000; Megoneitso and Rao 1983; Neogi et al. 1989; Pal and Jain 1989; Rao 1981a; Rao and Jamir 1982a, 1982b; Sarma et al. 2001; Siddique et al. 1989), there still remains vast treasure of medicinal plants wealth to be explored. Many of the medicinal plants like *Aconitum, Coptis, Swertia, Picrorhiza, Taxus, Valeriana* and a few others have high pharmaceutical importance offering immense scope for their commercial cultivation and trade in the region. Although it is not possible to list out all the medicinal plants of northeast India, it is estimated that about 1500 species of medicinal plants occur in the region. A few important medicinal plants occurring in tropical, temperate and sub-alpine regions of northeast India are enumerated below.

A. Medicinal plants occurring in Tropical & sub-tropical region

The tropical and subtropical region in northeast India is extremely rich in medicinal plant resources (Rao, 1994). A few important species are Abroma augusta, Abrus precatorius, Acorus calamus, Adhatoda zeylanica, Adiantum lunulatum, Allium chinense, Alpinia bracteata, Alpinia galanga, Alysicarpus monilifer, Amomum sublatum, Anaphalis adnata, Aristolochia tagala, Asparagus racemosus, Atropa acuminata, Begonia palmata, Boehmeria malabarica, Bonnaya reptans, Borreria articularis, Brassica campestris, Careya arborea, Centella asiatica, Centranthera grandiflora, Citrus medica, Cinnamomum tamala, Colocasia esculenta, Costus speciosus, Crassocephalum crepidioides, Curcuma angustifolium, Curcuma domestica, Curcuma Montana, Curcuma zeodaria, Cyclea bicristata, Dendrocalamus hamilonii, Dichrocephala bicolor, Dioscorea deltoidea, Dysoxylum procerum, Embelica officinalis, Entada purseatha, Garcinia cowa, Garcinia lancifolia, Gerbera macrophylla, Glochidion khasicum, Gloriosa superba, Habenaria acuifera, Hedyotis scandens, Hodgsonia heteroclita, Hydrocotyle javanica, Imperata cylindrica, Iphigenia indica, Ipomoea aquatica, Kaempferia rotunda, Leucosceptrum canum, Hydnocarpus kurzii, Hyoscyamus niger, Lycopodium clavatum, Mangifera indica, Mesua ferrea, Mimosa pudica, Mucuna prurita, Musa paradisiaca, Nerium indicum, Nepenthes khasiana, Ocimum sanctum, Oxalis corniculata, Paederia foetida, Panicum maximum, Piper brachystachyum, Piper griffithii, Piper betle, Plectranthus coetsa, Plumbago zeylanica, Polygonum capitatum, Polygonum perfoliatum, Pouzolzia hirta, Psidium guajava, Punica granatum, Rhus semialata, Rauvolfia serpentina, Rubia cordifolia, Sarcandra glabra, Schima wallichii, Spilanthes acmella, Vetiveria zizanioides.

B. Medicinal plant species in Temperate region

Although the medicinal plant resources in temperate region are much less, some of the high valued medicinal plants are encountered in this region. Some of the high valued medicinal

species are Artemisia nilagirica, Berberis asiatica, Berberis wallichiana, Bergenia ciliata, Brugmansia suaveolens, Daphne cannabina, Datura stramonium, Ephedra gerardiana, Habenaria commelinifolia, Hoya globulosa, Gaultheria fragrantissima, Gentiana kurroo, Illicium griffithii, Mahonia nepalensis, Mahonia pycnophylla, Myrica esculenta, Panax pseudo-ginseng, Plantago major, Sarcandra glabra, Saussurea lappa, Taxus wallichiana.

C. Medicinal plants confined to Sub-alpine and alpine zones

The alpine region in north east India is limited to some high altitudes in Sikkim and Arunachal Pradesh and contain many important drug plants like Aconitum chasmanthum, Aconitum deinorrhizum, Aconitum ferox, Aconitum heterophyllum, Coptis teeta, Swertia chirayita, Swertia hookeri, Swertia ciliata, Nardostachys grandiflora, Picrorhiza kurrooa, Podophyllum hexandrum, Rheum australe, Rheum nobile, Valeriana hardwickii, Valeriana jatamansi.

In spite of the rich diversity of medicinal plants in the northeast, a large number of medicinal plants such as Swertia chirayita, Nardostachys jatamansi, Valeriana wallichi, Gentiana kurrooa, Rubia cordifolia, Rheum sp. and Ephedra gerardiana which occur in North-East India are imported from various other countries. The reasons for this are many. Unsystematic collection of the medicinal plants from the wild during different seasons and from different places is one such major reason. Immature harvest, unscientific production of the drugs and adulteration through some cheaper substitutes all add to this. Evaluation of the elite populations through scientific studies and their large-scale cultivation can only reverse this situation. The recent establishment of a "National Medicinal Plant Board" by the Government of India with the objective of co-ordination of all matters related to medicinal plants, including drawing up of policies and strategies for medicinal plants is a big boost for this industry in India.

Table 1: Some Drugs from Himalayan Medicinal Plants:

Species	Product	Manufacturer
Saussurea costus	Koflet (Syrup)	Himalayan Drug Co.
Abies webbiana, Ephedra, Inula racemosa	Kuftone (Cap.)	Dharmani Drug Res. & Trg. Instt.
Podophyllum hexandrum	Liv.-10(Syrup)	Allens Labs (Pvt.) Ltd.
	Livosin (Syrup)	Allins India Marketing (P) Ltd.
Nardostachys jatamansi, Valeriana wallichii	Mentat (Syrup)	Himalayam Drug Co.
Nardostachys jatamansi, Viola, Abies spectabilis	Octin Expectorant (Syrup)	Myncil Pharmaceuticals
Berberis aristata	Orthoherb (Cap.)	Walter Bushoell Ltd.
	Pilex (Tab.)	Himalayan Drug Co.
Picrorhiza kurrooa	Pedzer (Tab.)	Lyovak Laboratories
	Tredeptone (Tab.)	Swastik Formulation (P) Ltd.

Eulophia dubia	Pee-Eee-Forte(Tab.)	Aimil Pharm. Pvt. Ltd.
Swertia chirayita	Trepeptone (Tab.)	Swastik Formulation (P) Ltd.
Aconitum spp.	Pyopil (Liquid)	Amulet Pharmaceutical

Table 2: Herbal Drugs used by adivasi tribes for certain ailments:

Diseases	Tribe	Species/plant parts
Scabies	Madahi (Assam)	Leaf paste of *Centella asiatica* and *Ageratum conyzoides, Alternanthera sessilis, Commelina benghalensis, Impatiens balsamina, Ricinus communis* and *Sida rhombifolia* (Sarma *et al*. 2002); rhizome paste of *Curcuma aromatica* (Tripathi & Goel 2001).
Diarrhoea and Dysentery	Chakma, Singpho & Tangsa (AP)	Powdered tuber of *Aristolochia saccata* mixed with water, roots of *Aristolochia tagala,* rhizomes of *Curcuma caesia* chewed raw, seeds of *Rhus semialata* in the form of paste (Nath & Bordoloi 1993).
	Ao (Nagaland)	Young shoots and leaves of *Acacia gageana* (Rao & Jamir 1990).
	Madahi (Assam)	Leaves of *Clerodendrum viscosum*, Leaves of *Oxalis corniculata*, Leaf juice
	Bodo (Assam)	of *Houttunia cordata* Fruit of *Spondias pinnata* boiled with *Channa punctatus* (Sarma *et al*. 2002).
		Leaf juice of *Clerodendron infortunatum* (Sarma *et al*. 2001)
Fever	Chakma, Singpho & Tangsa	Infusion of *Aquilaria agallocha* and *Croton caudatus* mixed together and given orally (Nath & Bordoloi 1993).
	Madahi (Assam)	Paste from tender leaf of *Ziziphus mauritiana* and flowers of *Tabernaemontana divaricata*.
		Stem tip of *Corchorus capsularis* (Sarma *et al*. 2002)
	Tribals of Sikkim	Leaf decoction of *Azadirachta indica* (Arvind & Jain 1996).
Pneumonia	Chakma, Singpho & Tangsa	Seeds of *Citrus limon* with a few *Piper nigrum* seeds are boiled and extract is given (Nath & Bordoloi 1993).
	Garo (Meghalaya)	Bruised leaves of *Chenopodium ambrosioides* are kept on forehead (Rao 1981b).
Malaria	Chakma, Singpho & Tangsa	Root bark of *Prunus communis* and the leaves of *Stereospermum chelonoides* (Nath & Bordoloi 1993).

Cholera	Bodo (Assam)	Bark paste of *Terminalia bellirica, Spondias pinnata* and *Psidium guajava* with fruit of *Terminalia chebula* and *Emblica officinalis* (Gogoi & Borthakur 2001).
Bone fracture	Chakma, Singpho & Tangsa (AP)	Leaves of *Pothos cathartii* and *webera corymbosa* mixed with coconut oil (Nath & Bordoloi 1993).
	Angamis (Nagaland)	Paste from leaves of *Alternanthera sessilis* with leaves of *Hibiscus rosa-sinensis* (Rao 1990)
Gynecological disorder	Chakma, Singpho & Tangsa	Stem bark of *Croton oblongifolius* for women as emmenagogue (Nath & Bordoloi 1993).
Arthritis	Bodo (Assam)	Roots of *Imperata cylindrica* and *Achyranthes aspera* and long pepper; rhizome of *Acorus calamus* and *Zingiber officinale* (Gogoi & Borthakur 2001)
Hypertension	Chakma, Singpho & Tangsa	Roasted tender leaves of *Clerodendrum colebrookianum* with *Allium sativum* and salt (Nath & Bordoloi 1993).
Colic disorders	Garo (Meghalaya)	Fresh and dried rhizomes of *Alpinia nigra* (Tripathi & Goel 2001).
Jaundice	Chakma, Singpho & Tangsa	Fresh root of *Zehneria umbellata* with *Luffa acutangula* seeds (Nath & Bordoloi 1993).
	Khasi & Garo (Meghalaya)	Rhizome of *Curcuma zedoaria* mixed with water (Rao 1981b).
	Bodo (Assam)	Fruit of *Averrhoa carambola* with roots of *Musa balbisiana* and *Lens esculentus*; juice of *Cuscuta reflexa*; powder of dry fruit of *Terminalia chebula* (Gogoi & Borthakur 2001).
	Nagas (Nagaland)	Rhizome paste of *Curcuma angustifolia* (Tripathi & Goel 2001).
Leprosy	Chakma, Singpho & Tangsa	Leaf paste of *Plumbago zeylanica* as plaster (Nath & Bordoloi 1993).
	Khasi & Garo (Meghalaya)	Juice of Rhizome of *Costus Speciosus* (Rao 1981b).
Small-pox	Garo (Meghalaya)	Fruits of *Amomum aromaticum*; rhizome paste of *Curcuma aromatica* (Tripathi & Goel 2001).
Tuberculosis	Chakma, Singpho & Tangsa	Decoction of seeds of *Myristica fragrans* together with few seeds of *Piper longum* (Nath & Bordoloi 1993).
		Rhizome of *Alpinia galanga* (Tripathi & Goel 2001).

Blood purifier	Bodo (Assam)	Bark juice of *Terminalia arjuna*; powder of dried fruit of *Terminalia chebula* and *Emblica officinalis*; bark juice of *Saraca asoca* (Gogoi & Borthakur 2001).
Cough	Chakma, Singpho & Tangsa	Decoction of aerial portion of *Artemisia nilagirica,* Meshed aerial part of *Elsholtzia eriostachiya* var. *pusilla* is rubbed on the chest (Nath & Bordoloi 1993).
	Mizo tribe	Rhizome paste of *Rhynchanthus longiflorous* (Tripathi & Goel 2001).
Eye diseases	Ao (Nagaland)	Leaves of *Maesa chisia* slightly warmed and kept on eyes; latex of *Ficus indica* mixed with *Ficus benghalensis* is dropped in eyes (Rao & Jamir 1990).
	Mikirs (Assam)	Leaf juice of *Boerhavia diffusa* (Arvind & Jain 1996).
	Garo (Meghalaya)	Rhizome of *Kaempferia rotunda* (Tripathi & Goel 2001).
Boil, Liver trouble	Madahi (Assam)	Rhizome juice of *Curcuma longa* (Sarma *et al*. 2002).
	Bodo (Assam)	Leaf juice of *Bryophyllum pinnatum* (Sarma *et al*. 2001).
Kidney trouble	Bodo (Assam)	Leaf juice of *Bryophyllum pinnatum* (Sarma *et al*. 2001).
	Garo (Meghalaya)	Bark decoction of *Cinnamomum obtusifolium* (Rao 1981b).
Itching	Madahi (Assam)	Bark paste of *Heteropanax fragrans* (Sarma *et al*. 2002).
	Tribes in Assam & Meghalaya	Paste of rhizome of *Curcuma amada* (Tripathi & Goel 2001).
Conjunctivitis	Madahi (Assam)	Leaf juice of *Tabernaemontana divaricata* (Sarma *et al*. 2002).
	Bodo (Assam)	Leaf juice of *Ocimum sanctum* mixed with honey (Gogoi & Borthakur 2001).
Worms	Madahi (Assam)	Leaf juice of *Nyctanthes arbortristis* (Sarma *et al*. 2001).
Gastric trouble	Madahi (Assam)	Juice of *Centella asiatica* (Sarma *et al*. 2001).
	Bodo (Assam)	Juice of *Hydrocotyle javanica*; rhizome juice of *Curcuma longa*; juice of *Tinospora cordifolia*; shoots of *Clerodendrum viscosum* (Gogoi & Borthakur 2001).
Night blindness	Garo (Meghalaya)	Juice of unopened Pitchers of *Nepenthes khasiana* (Rao 1981b).
Ulcers	Garo (Meghalaya)	Leaves of *Smilax macrophylla* (Rao 1981b).

Asthma	Adi tribe	Seeds of *Amomum sericeum*; rhizome of C*urcuma amada* (Tripathi & Goel 2001).
	Tribes in Mizoram	Juice of rhizomes of *Globba multifolia* (Tripathi & Goel 2001).
	Mikirs (Assam)	Seeds of *Hornstedtia costata* (Tripathi & Goel 2001)
Cancer	Khasi & Garo (Meghalaya)	Fruit juice of X*eromphis spinosa* (Rao 1981b).
Pyorrhea & Gum trouble	Meitei & Rongmei (Manipur)	Roots of *Achyranthes aspera* (Arvind & Jain 1996).
Typhoid	Folk of Manipur	*Centella asiatica* (Arvind & Jain 1996).
Skin diseases	Jaintia (Meghalaya)	Roots of *Cissampelos pareira* (Arvind & Jain 1996).
	Khasi (Meghalaya)	Leaves of *Cannabis sativa* (Arvind & Jain 1996).
	Khasi & Jaintia (Meghalaya)	Leaf paste of *Valeriana hardwickii* (Arvind & Jain 1996).

Diverssity of Medicinal plants in Western Ghats:

Western Ghats or 'Sahyadris'form a chain of mountains parallel to west coast almost stretching from Tapti River in the north to Kanyakumari in the south, covering a total area of about 160,000 km^2 and is considered as a storehouse of several promising economically important plants including medicinal plants. The medicinal plant diversity in Western Ghats is of a very high order. Apart from the well established medicinal plants like Rauvolfia serpentina, Gloriosa superba, Cassia angustifolia, Withania somnifera, Chlorophytum sps., Catharanthus roseus, Andrographis paniculata, Phyllanthus amarus, etc. the region particularly the Southern Western Ghats harbours many ethnobotanically important species like Trichopus zeylanicus, Janakia arayalpathra, Utleria salicifolia, Aristolochia tagala, Piper barberi, Adenia hondala, Garcinia sps., Thottea siliquosa, Caryota urens, Adhatoda beddomei, Myristica malabarica, Coscinium fenestratum, etc with many curative properties (table 3). The region is known as the 'Emporium of medicinal Plants. ' Due to varied physiographic and physiognomic factors, medicinal plant diversity is very high both in terms of species diversity as well as infra specific diversity. Roughly, 1800 species of medicinal plants from out of the total of 6000 species of Western Ghats are reported (Yoganarasimhan, 1996, 2000). A few important ones in this category are listed (Table- 4) The floristic diversity of wild aromatic plants in Western Ghats is also incompletely known. While medicinal plants have received some attention, other groups such as the essential oil yielding plants (which are also of medicinal valaue) of the region are least studied. There are more than 200 such aromatic species in different ecosystems of Western Ghats and are predominantly spread among Lamiaceae, Asteraceae, Rutaceae, Zingiberaceae, Lauraceae, Oleaceae and Poaceae (table–5 & 6). While species diversity is assessed to some extent, infra specific diversity in these aromatic species is

least known. Nevertheless, many species like Hyptis sauveolens, Blumea lacera, B. hieracifolia, B. membranacea, Cymbopogon flexuosus, Ocimum basilicum, Plectranthus mollis exhibit remarkable morphological variations in the region. Western Ghats with a wide variety of ecological habitats certainly provides for numerous ecotypes / chemotypes in some of these medicinal plants. Authentication and development of value added products from these drug plants after critical scientific evaluation and pharmacological trials can certainly boost the regional economy. Pharmaceutical companies must take a lead in R & D activities on these medicinal plants and establish scientifically sound pharmacopoeias for the drugs developed from these plants.

Table 3: Some Noteworthy Medicinal Plants of Western Ghats: (*-Endemic Plants)

Species Name	Family	Uses
Trichopus zeylanicus *	Trichopodaceae	Fruits are anti-stress, anti fatigue, energy boosting, Immuno-modulating properties.
Utleria salicifolia *	Periplocaceae	Tuber for treating asthma, debility due to tuberculosis, intestinal ailments and bleeding due to ulcers.
Vateria indica *	Dipterocarpaceae	Resin for leprosy, asthma, ulcers, gonorrhea, anemia, dysentery, cough, chronic bronchitis and skin eruptions.
Adenia hondala*	Passifloraceae	Tuber for hernia, hydrocele.
Artocarpus hirsutus *	Moraceae	Fruits, barks and leaves for treating diarrhoea, skin diseases, haemorrhage and poisons, hydrocele, pimples and cracks.
Cinnamomum travancoricum*	Lauraceae	Bronchitis asthma, mouth diseases, dental diseases, chronic cold, thirst, vomiting and carminative.
Cinnamomum wightii *	Lauraceae	Barks, leaves and oil for treating paralytic disorders, abdominal disorders, cough, gynecological disorders, stimulant and carminative.
Coscinium fenestratum	Menispermaceae	Stem is anti inflammatory and anti septic, to treat bleeding piles, cough, ulcers, janudice, liver disorders, diabetes, fever, snake bite and general debility.
Aristolochia tagala	Aristolochiaceae	Snake bite
Piper barberi *	Piperaceae	Post delivery complaints.
Pterocarpus santalinus *	Papilionaceae	Chronic fever, defects of vision, leprosy, scorpion, spider poisoning, ulcers, bleeding piles, general debility and mental aberrations.
Strophanthus wightianus *	Apocynaceae	Seeds for cardiac troubles and body pains.
Thottea siliquosa	Aristolochiaceae	Roots for treating dysentery, cholera, chronic sores and ulcers.
Ochreinauclea missionis *	Rubiaceae	Bark used for leprosy, skin diseases jaundice, rheumatism and constipation.

Myristica malabarica *	Myristicaceae	Aril of seeds used to cough, bronchitis, fever, burning sensation, sprains and sores.
Smilax zeylanica	Smilacaceae	Roots for veneral diseases, skin diseases, sores, swellings and abscess.
Syzygium travancoricum *	Myrtaceae	Diarrhorea, diabetes, haemorrhage, vomi-ting, maggots in ear.
Ventilago bombeiensis *	Rhamnaceae	Resin used as Anti fertility agent.
Eulophia cullenii *	Orchidaceae	Rhizomes as tonic and aphrodisiac and treating stomatitis and heart disorders and poisons.

Table 4: Medicinal Plant species diversity in Western Ghats

Species	Family
Trichopus zeylanicus	Trichopodaceae
Utleria salicifolia	Periplocaceae
Janakia arayalpathra	Periplocaceae
Myristica malabarica	Myristicaceae
Adenia hondala	Passifloraceae
Artocarpus hirsutus	Moraceae
Cinnamomum travancoricum	Lauraceae
Cinnamomum wightii	Lauraceae
Piper barberi	Piperaceae
Vateria indica	Dipterocarpaceae
Ochreinauclea missionis	Rubiaceae
Syzygium travancoricum	Myrtaceae
Hydnocarpus alpina	Dipterocarpaceae
Michelia nilagirica	Magnoliaceae
Mahonia leschenaultii	Berberidaceae
Gardenia obtusa	Rubiaceae
Cinnamomum wightii	Lauraceae
Atalantia wightii	Rutaceae
Garcinia cambogia	Clusiaceae
Ilex denticulata	Aquifoliaceae
Microtropis ramiflora	Leguminaceae
Gymnosporia montana	Celastraceae
Rhus mysorensis	Anacardiaceae
Scutia circumscissa	Rhamnaceae
Plecospermum spinosum	Ulmaceae
Pterolobium hexapetalum	Caesalpiniaceae
Xeromphis spinosa	Rubiaceae
Toddalia asiatica	Rutaceae
Ziziphus spp.	Rhamnaceae
Acacia spp.	Mimosaceae
Sagearaea dalzelli	Annonaceae
Dysoxylum malabaricum	Meliaceae
Holigarna arnottiana	Anacardiaceae
Syzygium mungudam	Myrtaceae
Memeylon malabaricum	Melastomaceae
Diospyros paniculata	Ebenaceae
Humboldtia vahliana	Leguminosae
Buchanania lanceolata	Anacardiaceae
Myrstica malabarica	Myristicaceae
Nothapodytes foetida	Icacinaceae
Maesua nagassarium	Clusiaceae
Aphanamyxis polystachya	Meliaceae
Semecarpus anacardium	Anacardiaceae
Butea monosperma	Papilionaceae
Hymenodictyon orixense	Rubiaceae
Phyllanthus amarus	Euphorbiaceae
Mucuna pruriens	Papilionaceae
Asclepias curassavica	Asclepiadaceae
Celastrus paniculatus	Celastraceae
Abrus precatorius	Papilionaceae
Cissus quadrangularis	Vitaceae
Plumbago zeylanica	Plumbaginaceae
Tylophora indica	Asclepiadaceae
Gymnema sylvestre	-do-
Withania somnifera	Solanaceae
Centella asiatica	Apiaceae
Ocimum sanctum	Lamiaceae
Boerhavia diffusa	Nyctaginaceae
Tinospora cordifolia	Menispermaceae
Bacopa monnieri	Scrophulariaceae
Wrightia tinctoria	Apocynaceae
Strychnos spp	Loganiaceae
Pterocarpus marsupium	Fabaceae
Mallotus philippensis	Euphorbiaceae
Knema attenuata	Myrsticaceae
Dioscorea spp.	Dioscoreaceae
Anamirta cocculus	Menispermaceae
Alagium salviifolium	Alangiaceae
Gmelina arborea	Verbenaceae
Ichnocarpus frutescens	Apocynaceae
Helicteres isora	Sterculiaceae
Entada purseatha	Mimosaceae

Aristolochia indica	Aristolochiaceae
Alstonia scholaris	Apocynaceae
Zanthoxylum rhetusa	Rutaceae
Acrocarpus fraxinifolius	Caesalpiniaceae
Gluta traancorica	Anaacardiaceae
Stephania japonica	Menispermaceae
Elaecarpus spp.	Elaeocarpaceae
Narenga alata	Rutaceae
Murrya paniculata	Rutaceae

Table 5: Diversity of aromatic and medicinal species in Western Ghats

Family	Genus	Species
Rutaceae	10	18
Asteraceae	7	10
Zingiberaceae	6	12
Lauraceae	2	5
Lamiaceae	17	47
Myrtaceae	1	3
Oleaceae	1	9
Geraniaceae	2	2
Verbeneaceae	1	1
Lamiaceae	1	2
Ericaceae	1	1
Flindersiaceae	1	1
Chenopodiaceae	1	1
Burseraceae	2	2
Euphorbiaceae	1	1
Apiaceae	1	1
Poaceae	1	3
Total	**56**	**120**

Table 6: Diversity of Wild Aromatic and medicinal species of Western Ghats

S.No.	Name of the species	Family
1	Acalypha fruticosa	Euphorbiaceae
2	Acronychia pedunculata	Rutaceae
3	Alpinia calcarata *	Zingiberaceae
4	Alpinia malaccensis *	Zingiberaceae
5	Amomum masticatorium *	Zingiberaceae
6	Anisochilus carnosus	Lamiaceae
7	Anisochilus paniculatus *	Lamiaceae
8	Anisochilus robustus *	Lamiaceae
9	Anisomeles heyneana *	Lamiaceae
10	Anisomeles indica *	Lamiaceae
11	Anisomeles malabarica *	Lamiaceae
12	Artemisia nilagirica var. nilagirica *	Asteraceae
13	Atalantia monophylla	Rutaceae
14	Atalantia racemosa	Rutaceae
15	Becium filamentosum	Lamiaceae
16	Blumea lacera *	Asteraceae
17	Blumea lanceolaria *	Asteraceae
18	Blumea mollis *	Asteraceae
19	Boswelia serrata*	Burseraceae
20	Calamintha umbrosa*	Lamiaceae
21	Centratherum punctatum*	Asteraceae
22	Chenopodium ambrosioides*	Chenopodiaceae
23	Chloroxylon swietenia *	Flindersiaceae
24	Cinnamomum gracile	Lauraceae
25	Cinnamomum iners	Lauraceae
26	Cinnamomum sulphuratum*	Lauraceae
27	Cinnamomum verum	Lauraceae
28	Clausena dentata *	Rutaceae
29	Clausena heptaphylla	Rutaceae
30	Clausena willdenovii*	Rutaceae
31	Commiphora caudata*	Burseraceae
32	Curcuma aeruginosa*	Zingiberaceae
33	Curcuma aromatica *	Zingiberaceae
34	Curcuma neilgherrensis*	Zingiberaceae
35	Cymbopogon coloratus*	Poaceae
36	Cymbopogon flexuosus*	Poaceae
37	Cymbopogon martinii*	Poaceae
38	Endostemon viscosus*	Lamiaceae
39	Eryngium foetidum*	Apiaceae
40	Gaultheria fragrantissima	Ericaceae
41	Geranium nepalense	Geraniaceae
42	Globba ophioglossa	Zingiberaceae
43	Glycosmis pentaphylla*	Rutaceae
44	Gomphostemma eriocarpon*	Lamiaceae
45	Hedychium coronarium *	Zingiberaceae
46	Hedychium flavescens *	Zingiberaceae
47	Hyptis suaveolens *	Lamiaceae
48	Isodon coetsa	Lamiaceae
49	Isodon wightii	Lamiaceae

50	Janakia arayalpathra	Asclepiadaceae
51	Jasminum auriculatum *	Oleaceae
52	Jasminum azoricum var. travancorense *	Oleaceae
53	Jasminum cordifolium	Oleaceae
54	Jasminum malabaricum*	Oleaceae
55	Jasminum rigidum	Oleaceae
56	Jasminum ritchiei	Oleaceae
57	Jasminum sambac	Oleaceae
58	Jasminum scandens	Oleaceae
59	Jasminum sessiliflorum	Oleaceae
60	Kaempferia galanga *	Zingiberaceae
61	Kaempferia rotunda *	Zingiberaceae
62	Laggera crispata *	Asteraceae
63	Lavandula Gibson	Lamiaceaea
64	Lavandula bipinnata	Lamiaceaea
65	Cyathocline purpurea	Asteraceae
66	Pimpinella adscendens	Asteraceae
67	Leonotis nepetiifolia*	Lamiaceae
68	Leucas ciliata*	Lamiaceae
69	Leucas lavandulifolia *	Lamiaceae
70	Leucas marrubioides	Lamiaceae
71	Leucas stelligera *	Lamiaceae
72	Leucas vestita var. vestita *	Lamiaceae
73	Limonia acidissima *	Rutaceae
74	Limonia crenulata	Rutaceae
75	Mentha arvensis*	Lamiaceae
76	Mentha spicata *	Lamiaceae
77	Murraya indica *	Rutaceae
78	Murraya koenigii *	Rutaceae
79	Murraya paniculata *	Rutaceae
80	Neolitsia zeylanica	Lauraceae
81	Ocimum americanum	Lamiaceae
82	Ocimum basilicum *	Lamiaceae
83	Ocimum gratissimum*	Lamiaceae
84	Ocimum kilimandscharicum*	Lamiaceae
85	Ocimum tenuiflorum *	Lamiaceae
86	Orthosiphon diffuses *	Lamiaceae
87	Orthosiphon thymiflorus *	Lamiaceae
88	Paramignya monophylla	Rutaceae
89	Pelargonium graveolens	Geraniaceae
90	Plectranthus amboinicus *	Lamiaceae
91	Plectranthus aromaticus	Lamiaceae
92	Plectranthus barbatus *	Lamiaceae
93	Plectranthus coleoides *	Lamiaceae
94	Plectranthus deccanicus	Lamiaceae
95	Plectranthus malabaricus *	Lamiaceae
96	Plectranthus mollis *	Lamiaceae
97	Plectranthus subincisus	Lamiaceae
98	Plectranthus zeylanicus *	Lamiaceae
99	Pleiospermum alatum	Rutaceae
100	Pluchea tomentosa *	Asteraceae
101	Pogostemon benghalensis *	Lamiaceae
102	Pogostemon heyneanus	Lamiaceae
103	Pogostemon mollis	Lamiaceae
104	Pogostemon paniculatus *	Lamiaceae
105	Salvia coccinea *	Lamiaceae
106	Salvia leucantha *	Lamiaceae
107	Salvia plebeian	Lamiaceae
108	Scutellaria violacea *	Lamiaceae
109	Scutellaria wightiana *	Lamiaceae
110	Sphaeranthus indicus	Asteraceae
111	Syzygium aromaticum *	Myrtaceae
112	Syzygium cumini	Myrtaceae
113	Syzygium lineare	Myrtaceae
114	Thymus vulgaris *	Lamiaceae
115	Toddalia asiatica var. floribunda *	Rutaceae
116	Toddalis asiatica var. gracile	Rutaceae
117	Vitex trifolia *	Verbenaceae
118	Zanthoxylum ovalifolium *	Rutaceae
119	Zanthoxylum tetraspermum	Rutaceae
120	Zingiber zerumbet *	Zingiberaceae

*Marked ones are introduced in the CIMAP Conservatory

CONSERVATION OF MEDICINAL PLANT WEALTH

The Indian biodiversity including the medicinal plants diversity is under considerable threat from a variety of human generated factors like (a) habitat loss, fragmentation and degradation, (b) spread of invasive aliens species, (c) over exploitation of species, (d) forest clearance

for agriculture expansion, township, (e)selective removal of specific groups of plants,(f) dependence of plant based industries soley on wild medicinal plants (g) shifting cultivation (h) spread of certain invasive alien weeds like Mikania, Parthenium, Eupatorium, Synedrella, Cassia etc.(i) Road construction on Hills creating accessibility of remote areas and (j) modernisation leading to change of life style and cultural values of local tribals. Based on current trend globally an estimated 3400 plants and 5200 animal species are facing the threat of extinction. Several highly valued medicinal plant species like Coptis teeta, Ephedra gerardiana, Gentiana kurroa, Picrorhiza kurroa, Swertia chirayita, Aconitum spp., Nardostachys jatamansi, Rheum emodi, Dioscorea spp., Rauvolfia serpentina etc. which were common and abundant in the recent past in the Himalayas have all become scarce in the region due to indiscriminate and excessive removal from their habitats (Table 7 & 9).

Habitat destruction during recent years has certainly brought about a perceptible decline in the medicinal plant diversity. Selective removal of medicinal plants from their wild is another major threat to the diversity. Due to substantial increase in demand for certain medicinal plants the local herbal drug dealers have been over exploiting the forest resources. Many a time, these herbal resources are exploited in unplanned manner leaving no room for regeneration of these species and thereby resulting in virtual extinction of certain vital species from the area. In a recent workshop on Conservation Assessment and Management Prioritization (CAMP) for medicinal plants of northeast India, 51 extremely rare medicinal plants were critically assessed using IUCN criteria (Ved et al. 2003). Of the 51 taxa assessed, 47 are shown to be threatened in one or more states of northeast region. Of these, 6 are threatened at global scale (Red listed). These are Amentotaxus assamica, Coptis teeta, Gymnocladus assamicus, Nepenthes khasiana, Piper pedicellatum and Piper peepuloides. Medicinal plants Trade is stated to be a potential threat for 42 taxa (about 32 are in national trade while 10 are traded globally). Therefore, cultivation of medicinal plant species appears to be the only solution to save the vanishing medicinal flora.

India, in spite of high population and mounting pressure on land and other natural resources has shown keen interest and concern for the conservation of nature and natural resources. Some of the earliest legislation to protect our biota are the Madras Elephant Preservation Act of 1873 and the fish preservation act of 1879. Soon after independence a Board for wild life was established in 1952, which was later came to be known as the Indian Board for Wildlife. India also happens to be a signatory for some of the major International Conventions on Biodiversity such as the CITES programme, UNESCO's Man and Biosphere (MAB) programme, the Water (prevention and control of pollution) act 1974, the Forests (conservation) act 1980, the Air (prevention and control of Pollution) act 1981 and the Environment (protection) act

1978. However, the major step towards conservation and utilization of bioresources shown by India is by taking an active part in the recent Convention on Biological Diversity (CBD) during the earth summit at Rio de Janeiro, Brazil in 1992. The CBD, which came in to force on 29 December 1993, has become almost an International law as regards the biodiversity and its conservation is concerned.

The establishment of the Ministry of Environment & Forests under the Government of India to deal with the issues of the biodiversity conservation and environment of the country itself speaks for the India's sincere concerns for protection of the biodiversity. The enactment of the Indian Wildlife Protection act of 1972 and the UNESCO's Man and Biosphere Programme have resulted in the declaration of large forest areas as protected for in situ conservation of Flora and Fauna. Today, there are 89 National Parks, 496 Wildlife Sanctuaries and 13 Biosphere Reserves representing the major ecosystems in different biogeographic zones of the country. These cover almost three fourth region of the country. Five of the existing protected areas in India have also been recognized as World Heritage Sites. These sites represent Moist Alpine, Montane forests, Inland and Coastal Wetlands. The recent establishment of a "National Medicinal Plant Board" by the Government of India with the objective of co-ordination of all matters related to medicinal plants, including drawing up of policies and strategies for medicinal plants is a big boost for this industry in India. Thirty-two medicinally important species, which are in high demand, have been identified for cultivation and development (table 8). But yet, there are many more such medicinal plants which are to be brought under commercial cultivation.

Conservation of biodiversity and the sustainable use of genetic resources have been the priority issues for a number of countries including India over the past decade. We have begun to realize that rapid rate of development at all costs has generated forces that are threatening to destroy the very substratum of life on earth. Inspite of the hectic efforts of taxonomists during the last 50 years or so even the correct assessment of the species biodiversity is not yet complete. On one side the interest in taxonomy is waning and on the other side diversity is being diminished due to developmental programmes. While we know substantially the species diversity, genetic diversity studies are least attempted. Considering the large flora and fauna of our country, it is necessary to select at least a few species and species of economic importance from different zones for studies on their genetic diversity. While our conservation efforts are confined to declaring certain areas as protected (in situ) or shifting a few endangered species to Botanic Gardens and Zoos (ex situ) no serious efforts are made to study the "reproductive bottlenecks" in endangered/rare species to overcome the problems and multiply them. . It is high time that we should not only study and catalogue the diversity but

also sustainably utilize them for human benefits. Fortunately, a number of advanced biotechnologies are also available with us. A wedding of biodiversity with biotechnology is urgently needed so that the Indian biodiversity of medicinal plants can be quickly scanned for Bioprospection and product development before we loose them forever.

Table 7: Some high value medicinal plants of Himalaya harvested from wild

Trade name	Botanical name
Kuth root	Saussurea costus
Poshkar root	Inula racemosa
Atees root	Aconitum heterophyllum
Kutaki root	Picrorhiza kurrooa
Salam panja root	Dactylorhiza hatagirea
Sugandhbala root	Valeriana jatamansi
Aasmani booti, Somlata stem	Ephedra gerardiana
Birmi leaf	Taxus wallichiana
Chora root	Angelica glauca
Hauber Hindi	Juniperus communis
Seski herb	Artemisia maritima
Harar fruit	Terminalia chebula
Bahera fruit	Terminalia bellirica
Amla fruit	Emblica officinalis
Chaksu seed	Cassia absus
Kaunch beej	Mucuna pruriens
Laltang leaf	Physochlaina praealta
Kalazira, Vilayatizira	Carum carvi
Shingoo zira	Bunium persicum
Tejpat leaf	Cinnamomum tamala
Reetha fruit	Sapindus mukorossi
Thuth root	Salvia moorcroftiana
Malkangani seeds	Celastrus paniculatus
Pakhanbhed rhizome	Bergenia ciliata
Revand hindi rhizome	Rheum emodi
Brahmi whole herb	Centella asiatica
Singli mingli tubers	Dioscorea deltoidea
Kakarsingi galls	Pistacia khinjuk
Bankakri rhizome	Podophyllum hexandrum
Meda/Mahameda(rhizome)	Polygonatum spp.
Daruhaldi root	Berberis spp.
Anardana seed	Punica granatum
Banfsha (whole herb)	Viola spp.
Dhava phool	Woodfordia fruiticosa
Cheeta mool	Plumbago zeylanica
Safed musli root	Asparagus adscendens
Kapur kachri rhizome	Hedychium spicatum
Patisan rooli root	Heracleum lanatum
Timroo fruit	Zanthoxylum armatum
Vacha rhizome	Acorus calamus

Table 8: Thirty two species prioritized by National Medicinal Plants Board

Species	Trade name	Species	Trade name
Emblica officinalis	Amala	Saraca asoca	Ashok
Withania somnifera	Ashwagandha	Aconitum heterophyllum	Atees
Aegle marmelos	Bael	Phyllanthus amarus	Bhumiamlaki
Bacopa monnieri	Brahmi	Santalum album	Chandan
Swertia chirayita	Chirayita	Tinospora cordifolia	Giloe
Gymnema sylvestre	Gudmar	Commiphora wightii	Guggal
Plantago ovata	Isabgol	Nardostachys jatamansi	Jatamansi
Gloriosa superba	Kalihari	Andrographis paniculata	Kalmegh
Garcinia indica	Kokum	Saussurea costus	Kuth
Picrorhiza kurrooa	Kutki	Solanum nigrum	Makoy
Glycyrrhiza glabra	Mulethi	Chlorophytum borivillianum	Musali safad
Coleus barbatus	Patharchur	Piper longum	Pippal
Berberis aristata	Rasaut	Crocus sativus	Saffron
Rauvolfia serpentina	Sarpgandha	Cassia angustifolia	Senna
Asparagus racemosus	Shatavari	Ocimum sanctum	Tulsi
Embelia ribes	Vai Vidang	Aconitum ferox	Vatsnabh

Table 9 : Some Endangered medicinal plants of Himalaya

Plant	Trade name	Part Used
Aconitum heterophyllum	Atees	Tuber
Angelica glauca	Choru	Root
Arnebia benthamii	Laljari	Root
Atropa acuminata	Atropa	Root, Leaf
Berberis aristata	Darhaldi	Root
Berberis lycium	Kilmor	Root
Coptis teeta	Mishmitita	Rhizome
Dactylorhiza hatagirea	Salampanji	Root

Delphinium denudatum	Jadwar	Root
Dioscorea deltoidea	Kins	Tuber
Eulophia dubia	Salam misri	Root
Hydnocarpus kurzii	Dalmurgi	Bark
Inula racemosa	Pushkarmool	Root
Nardostachys jatamansi	Jatamansi	Rhizome
Nephenthes khasiana	Tiew-rakot	Juice
Panax pseudo-ginseng	Ginseng	Plant
Picrorhiza kurrooa	Kutki	Rhizome
Polygonatum verticillatum	Mahameda	Root
Paeonia emodi	Chandrayan	Root
Rheum australe	Revanda-chini	Rhizome
Saussurea costus	Kuth	Root
Acorus calamus	Vach,Calamus, Ghorabach	Rhizome
Costus speciosus	Keu, Kust	Tubers
Swertia chirayita	Chirayatah	Plant
Podophyllum hexandrum	Indian Podophyllum, Ban Kakri, Papri	Rhizome
Taxus wallichiana	Himalayan yew, Primi leaves	Leaves, bark
Bergenia stracheyi	Ratanjot, Balchar	Plant
Aquilaria malaccensis	Agar	Resin

Table-10: Agro-technology Packages for Medicinal Plants developed in India

Species	Common Name	Species	Common Name
Anethum graveolens	Anise	Andrographis paniculata *	Kalmegh
Withania somnifera *	Ashwagandha	Saussurea lappa	Kuth
Psoralea corylifolia	Babchi	Picrorhiza kurrooa	Kutki
Atropa belladonna *	Belladona	Glycyrrhiza glabra	Liquorice
Bacopa monnieri *	Brahmi	Piper longum	Long pepper
Phyllanthus amarus *	Bhoomyamalaki	Centella asiatica	Mandukaparni
Chamomilla recutita	Camomile	Melissa officinalis	Melissa
Swertia chirayita	Chirayita	Mucuna pruriens	Mucuna
Costus speciosus *	Costus	Azadirachta indica	Neem
Duboisia myoporoides*	Duboisia	Papaver somniferum *	Opium poppy
Commiphora wightii	Guggul	Catharanthus roseus *	Periwinkle
Hyoscyamus muticus*	Henbane	Inula racemosa	Pushkar
Heracleum candicans	Heracleum	Artemisia annua *	Quinghao
Dioscorea deltoidea*	Indian medicinal yam	Ocimum sanctum *	Tulsi
Boswellia serrata	Salai guggul	Valeriana jatamansi	Valerian
Rauvolfia serpentina*	Sarpagandha	Solanum viarum	Solanum
Cassia angustifolia*	Senna	Plantagoovata *	Isabgol
Asparagus racemosus	Shatavari	Ammi majus *	
Chlorophytum borivillianum	Safed musali	Dioscorea floribunda	

*Agro-technologies developed by CIMAP

Cultivation of medicinal plants

Medicinal plants cultivation, particularly those which are in high demand has a great potential. Evaluation of the elite populations of the medicinal plants through scientific studies and their large-scale cultivation certainly can boos t the economy of the region. Also, Standardisation of the agro-technology and nursery technology for some of the selected medicinal plants must be initiated in the region. The climate of Indian region is suitable for cultivation of a wide variety of medicinal and aromatic plants on

commercial scale. Yet, there exists no medicinal plant centres, herb gardens in its true sense. Only recently, the Forest Department of Arunachal Pradesh has taken up cultivation of a few medicinal plants (Pandey, 1988; Hegde and Ingalhalli, 1988; Hegde, 1988; Deori and Haridasan, 1988). But for a large country like India, where diverse ecological habitats prevail, this attempt, though praiseworthy, is very inadequate. Such centers need to be established in all ecological zones such as tropical zones, sub-tropical zones, temperate zones and sub alpine and alpine zones in order to accommodate the unique medicinal plant species of these zones. This activity should be taken up closely with the help of local people. While this programme provides employment opportunities to the local people, at the same time ensures the safety of these dwindling plant resources.

Cultivation of medicinal plants has several benefits. Firstly, this would ease the stress on the natural populations. Cultivation of medicinal plants can assure a constant supply of the required medicinal plants to the user industries. Once the elite populations are identified, only such populations can be cultivated for production of the raw material for industries. However, this requires the cultivation protocols, which again for a vast majority of the medicinal plants is lacking. Development of agro-technologies of the high valued medicinal plants as has been done for a few plants (Table 10) and their adoption by the local farmers certainly can boost the regional economy. Some of the high altitude medicinal plants are very highly priced and therefore tempts the local people to gather these from the wild, which has already endangered several populations.

Selection of superior germplasm for cultivation is another extremely important issue, which requires extensive scientific investigations. The species has to be evaluated over its entire range morphologically, genetically and chemically so as to identify the superior variety and superior location for cultivation. Analysis of active ingredients from all wild populations for the selection of the elite variety is a prerequisite.

Medicinal plants can be cultivated as cash crops sometimes along with the food crops. Cultivation of medicinal plants in the high altitudes is a profitable business (Table 11). As per existing rate, per hectare return of Aconitum heterophyllum is Rs. 5,50,000, Rs. 3,52,800 for A. balfourii, Rs. 71,500 for Picrorhiza kurrooa and Rs. 3,52,800 for Podophyllum hexandrum (Nautiyal, 1995). However, it may be noted that maturation time for the harvest of the drug in case of alpine herbs extends from 3 to 6 years and the farmers therefore are to adopt the inter-cropping system in order to earn regular annual income. Inter-cropping is recognized as potential option for medicinal plants cultivation. Crops like Potato, Pulses in the hills can be inter-cropped. Pulses can also improve the soil fertility.

Table-11: Market value of Some Medicinal plants

Species	Plant Part	Rate (Rs./Kg.)
Acorus calamus	Rhizome	20.00
Aconitum atrox	Tuber	60.00
Aconitum balfourii	Tuber	60.00
Aconitum heterophyllum	Tuber	2000.00
Angelica glauca	Root	65.00
Arnebia benthamii	Root	120.00
Bergenia ligulata	Rhizome	15.00
Berberis aristata	Root	30.00
Chlorophytum spp.	Tuber	1000.00
Dactylorhiza hatagirea	Root	1000.00
Eulophia dubia	Root	700.00
Inula racemosa	Root	30.00
Lilium polyphyllum	Plant	24.00
Nardostachys jatamansi	Root/rhizome	100.00
Picrorhiza scrophulariflora	Root	60.00
Polygonatum verticillatum	Root	16.00
Podophyllum hexandrum	Tuber	60.00
Swertia chirayita	Plant	100.00
Thalictrum foliolosum	Root	50.00
Valeriana hardwickii	Root	90.00
Viola biflora	Plant	400.00
Withania somnifera	seed	300.00

The forest departments in each state must come forward to save some these medicinal plant species having high economic potential. Programmes on large-scale cultivation, development of agro-tecchnology, ban on their collection from wild and regular monitoring the populations are certain priority actions recommended.

INVENTORIZATION OF MEDICINAL PLANTS DIVERSITY VIS-À-VIS BIOPROSPECTION

Bioprospection and Sustainable utilization of medicinal plants is much neglected in India. Biodiversity prospecting, particularly on medicinal and aromatic plants, can certainly result in some lead/novel molecules of great economic significance. As ecological diversity in India is very high, a greater genetic diversity in the widely distributed taxa is also expected. Scanning of the entire biodiversity in some short listed species (through cross cultural ethnobotanical investigation) particularly at the population level making use of the modern biotechnological tools can be highly rewarding. Bioprospection of tree flora, particularly of Western Ghats, where important antitumor plants like Aphanamixis polystachya, Nothopodytes nimmoniana, Mesua nagassarium, Semecarpus anacardium etc exist, would be rewarding. Nothopodytes foetida is shown to contain 0.1% camptothecine, an antitumor/anticancer drug. While the opportunities are limitless, constraints are also too many. Lack of trained manpower

(field botanists and taxonomists), enormous diversity in vast number of species, lack of basic knowledge of medicinal plants, lack of much needed co-operation between field botanists and biotechnologists are some such major constraints. The author feels that serious and meaningful efforts should be initiated to overcome these constraints so that the medicinal plant wealth of the country is properly and profitably utilized at least in the 21st century.

Medicinal flora of India as stated above is quite diverse. However, what we know is far less than what we are yet to explore and evaluate. We need to intensify the ethnobotanical exploration and bring out a comprehensive list of medicinal plants of India. A comprehensive database on the state wise medicinal plants of India with as many parameters like correct names, synonyms, vernacular names, tribe names using the plant distribution in the region, threat status, conservation initiatives and ailments for which used and detailed mode of application, etc. is an urgent agenda for action. Another urgent task in this direction relates to the evaluation of infra specific diversity with in a given species. Indian region with a varied topography climate, rainfall and soil types offers scope for extreme variations within a species, particularly a wide spread species. Some of these habitat specific populations could be elite-types needing cultivation and commercialization. Investigations on infraspecific diversity and genetic diversity of at least a few commercially important medicinal plants like Berberis asiatica, Bergenia ciliata, Illicium griffithii, Myrica esculenta, Panax pseudo-ginseng, Plantago major, Saussurea lappa, Taxus wallichiana, Aconitum chasmanthum, Aconitum heterophyllum, Coptis teeta, Swertia chirayita, Swertia ciliata, Nardostachys grandiflora, Picrorhiza kurrooa, Podophyllum hexandrum, Rheum australe, Rheum nobile, Valeriana jatamansi are needed, so as to identify the 'elite' types for popularization and commercial cultivation. Bioprospection of some of the high valued medicinal plants and other unique ethnobotanical leads in the region is urgently called for. Some such important species could be Panax pseudo-ginseng, Coptis teeta, Dactylorrhiza sp., Swertia chirayita, Nepenthes khasiana, Aconitum spp., etc. Investigation of the tree flora as medicinal plants is much neglected .The Tropical trees are well known for their variability. Bioprospection/chemoprospection of such medicinal trees (Nothapodytes foetida, Mesua nagassarium, Aphanamixis polystachya, Semecarpus anacardium, Butea monosperma, Hymenodictyon orixense) for commercial isolation of biochemicals and novel molecules. Nothapodites foetida (Icacinaceae) – an evergreen tree in Western Ghats is found to contain camptothecine, an antileukaemia and antitumoral compound. Camptothecine (0.005%) was earlier found only in Camptotheca acuminata (Nyssaceae) occuring in China, whereas our species contains 0.1%, highly promising for treatment of cancer. The oppurtunities for Bioprospection of

medicinal flora in India is quite enormous because of the enormous diversity in medicinal plants, enormous habitat variation resulting in vast infra-specific diversity in medicinal and aromatic plants. Therefore Bioprospection of the diversity in high Himalayas, cold deserts and Western Ghats could be rewarding. Added to this, we have excellent biotechnologists, field taxonomists and well equipped laboratory facilities. The Field botanaists or ethnobotanists have a great role in Bioprospection at the species level. Ethnobotanists can scan the entire biodiversity and shortlist medicinal species for bioprospection at molecular level (anti-cancer, anti-diabetic, anti-malarial, neutraceutical). Field botanists can also help in correct identification and in collection of required plant material, Field botanists can suggest species for bioprospection based on field knowledge about species (some unique characters of plants like highly aromatic, edible, poisonous and other unique morphological traits. But the constraints for Bioprospection are also too many. Lack of much required cooperation between taxonomists and molecular biologists; (some of the excellent field botanists are poor in biotechnology and good biotechnologists are poor in field knowledge), shortage of required number of good taxonomists / field botanists, vast array of flora with enormous infra-specific variation in taxa spread over vast extension of the geographical boundaries of the country, incomplete knowledge of our medicinal flora, lack of comprehensive ethnobotanical databases among biodiversity rich developing nations for comparative ethnobotanical study and huge cost involved in bioprospection work are some of them.

Table-12: Raw Material Imported by Pharmaceutical Industries in India:

Name of the Species	Part used	Source
Rheum emodi	Root	N. Africa, Algeria, Arabia
Swertia chirayita	Whole plant	Nepal, Bhutan
Cinnamomum zeylanicum	Bark	Sri Lanka, Singapore
Commiphora myrrha	Exudate	Africa, Arabia
Commiphora mukul	Gum, resin	Pakistan
Myristica fragrans	Kernel, seed, aril	Sumatra, Singapore, Sri Lanka
Nardostachys jatamansi	Rhizome	Nepal
Valeriana wallichi	Root, rhizome	Nepal
Gentiana kurrooa	Rhizome	Nepal
Paeonia officinalis	Root, rhizome	Nepal
Carum carvi	Seed, fruit	Europe, W. Asia, Afghanistan
Crocus sativus	Style + stigma	Iran, Egypt, Spain
Syzygium aromaticum	Flower bud	Indonesia, Tanzania, Sri Lanka
Rubia cordifolia	Root	Nepal, Bhutan, Afghanistan
Ephedra gerardiana	Stem	Nepal

In India, only a few medicinal plants are cultivated. More than 90% of the medicinal plants are gathered directly from the wild. Agro-technology packages are developed for some medicinal plants mainly by Central Institute of Medicinal and Aromatic Plants and other CSIR institutes (table-10). Recently, with the establishment of a separate board for medicinal plants this activity has been strengthened.

PRODUCTION PROCEDURES OF DRUGS:

Just like selection of a superior variety of medicinal plants for cultivation is important for high content of active principles (alkaloids), adoption of proper production procedures of drugs is also crucial for production of quality drugs. Production procedures of medicinal plants includes all those steps like a) Harvesting the material during proper season, b) Proper handling of the harvest, c) Proper drying: either shade/sun drying to avoid infection of Aspergillus fungus, d) Proper grading of the material (based on size, quality, etc.), e) Proper storage conditions: under light or away from the light, dry or moist conditions, f) Destoning, g) Pulverizing / grinding, h) Labeling as organically grown or otherwise, i) Proper labeling and packing for export.

CONCLUDING REMARKS

During the last few decades there has been a greater interest in scientific study and wider application of medicinal plants to alleviate human suffering. Although more than 7500 medicinal plant species are reported to occur in Indian region with tremendous amount of biodiversity in them, the medicinal plants sector largely remains neglected. Several medicinal plants, though occur in Indian region, are imported from other countries including adjacent Nepal and China as shown in Table 12. On the other end of the spectrum, a number of reputed medicinal plants such as Aquilaria malaccensis, Aconitum spp. Dioscorea deltoidea, Podophyllum hexandrum, Pterocarpus santalinus, Rauvolfia serpentina, Saussurea lappa and Taxus wallichiana and many more as discussed above have already become critically endangered calling the attention of biologists for conservation. There is a great need for a thorough holistic study of medicinal plants involving botanists, agronomists, biotechnologists, medicinal plant traders, economists, etc. for developing medicinal plants trade in the country. Among many others (1) conservation of medicinal plants, (2) systematic evaluation and identification of elite populations of medicinal plants for large scale cultivation, (3) development of agrotechnologies, (4) production practices of the drugs and (5) co-operative farming of selected demand-oriented medicinal plants in different biogeographic regions, etc are some urgent issues. The author also recommends the development of standard pharmacopoeias for several of the drugs already developed from Himalayan plants. Cultivation practices of medicinal plants require the development of agrotechnologies as developed by

CIMAP for some of the important medicinal species like Artemisia annua, Catharanthus roseus, Andrographis paniculata, Glycerhiza glabra, Phyllanthus amarus, Coleus barbatus and a few others. Economics of cultivation of some medicinal plants such as Catharanthus roseus, Asparagus racemosus, Aconitum spp. Valeriana jatamansi, Rauvolfia serpentina, Artemisia annua, Plantago ovata, Picrorrhiza kurrooa, Glycerhiza glabra, Costus speciosus, Chamomilla recutita, Withania somnifera, Atropa belladonna, Phyllanthus amarus, Andrographis paniculata is profitable. The author hopes that the establishment of Indian Medicinal Plant Board certainly boosts the large scale cultivation of medicinal plants in the country in the coming years, elevating the status of Indian position in the international trade of medicinal plants. Some future studies on medicinal plants must focus on the Complete Inventorization and Documentation of Medicinal Plants State wise , Development of comprehensive Databases using parameters like Correct name, vernacular names, ethnic tribes, distribution, threat status, ailments for which used, tribal resource person, cross-cultural aspects, exploring the infraspecific diversity and generation of trained man power for shouldering this responsibility, development of agro-technology and commercial cultivation of all medicinal plants in high demand, imposing ban on collection of medicinal plants from wild, Safeguarding the interests of indigenous forest people and their associated cultures and acknowledging the tribal wisdom on medicinal plants for benefit sharing and lastly most importantly , the Bioprospection of high valued medicinal plants and product development.

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UTILIZATION AND CONSERVATION OF MEDICINAL PLANTS IN INDIA

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ABSTRACT

India is bestowed with unique diversity of ethnic culture, natural resources and bio-edaphic and topographical features. Owing to the rich plant biodiversity, particularly the medicinal plants and ancient cultural background, India ranks one of the few countries in the world which is utilizing the enormous indigenous medicinal wealth in a big way since Vedic era. The importance of herbals both as medicine, cosmetics, dyes etc. has been overlooked for quite some time. However, in the recent past, the medicinal plants are looked upon not only as a source of affordable health care but also as a source of income developing in to an industry itself. The extensive use of medicinal plants from wild has brought about its serious depletion in nature. Medicinal plant sector in India is vast and complex. Utilization and Conservation of medicinal plants are most important components of medicinal plants sector. Consumption of medicinal plants is more than its production. In the present communication various aspects of consumption & data related to utilization & conservation of medicinal plants in India have been discussed in detail. Conservation strategies & Conservation measures have also been given.

INTRODUCTION

The relationship between the 'Plants' and 'human beings' is as old as human civilization. The plants provide three vital basic needs of life i.e. 'Food', 'Cloth' and 'Shelter' to Man. The fourth most important basic need is medicine, which is provided by the plants and used by man since thousands of years. Regarding medicinal properties, it has been postulated in Ayurveda that "there is no substance (including plants) in the universe which cannot be used as drug when used rationally and with definite objective."

The use and cultivation of medicinal plants in the past was a part of our culture and therefore not much importance was given earlier. Now it is a new concept to use them variously and cultivate them on large scale. The enormous use of medicinal plants in the recent past from the wild source has brought about depletion and extinction of some of the medicinal plants species. It has become a

serious matter of concern for the Indian System of Medicine, which mainly rely on rich medicinal plant biodiversity and bio - resources. The unregulated harvesting, trade, fluctuating prices etc. has largely affected the medicinal plants sector in the country. This sector has direct impact on the manufacture of the life saving drugs, health care system and also economy of our country. Under the circumstances the natural resource is depleting day by day because of the excessive utilization of natural resources. Hence, it is necessary to conserve our medicinal wealth. In the present paper an attempt has been made to present an overview of the **Utilization** and **Conservation** strategies in the country. Let us know in brief the status of medicinal plant wealth at global and domestic level.

GLOBAL SCENARIO OF MEDICINAL PLANT

There are an estimated 30000 Spp. of Med. Plants Worldwide. Of these, 1/3rd are tree species with 5000 genera distributed in1000 families, while shrubs, climber and herbs constitute two third of the total species. Nearly 90 % of Med. Plants species obtained from wild are used by 'eco-system people' living in the forest areas. Only 10% of the World's known medicinal plants are in national and global trade. It is indicative of vast repository of knowledge of plant medicine available for Global use, before it is lost. About70% of World's known medicinal plants occur in Tropical forests while remaining 30% occur in temperate and Alpine areas. Out of world's estimated 30000 medicinal plants, information on propagation and seed storage is globally available for less than 10% species only.

The extent of threat to medicinal plants species is not so far known, however, estimations are there. According to IUCN- 'Threatened Plants Database' (Walter & Gillett 1998) approx. 32000 Spp. of plants are threatened with extinction i.e. 13% of estimated 2.5 lacs including higher plants & Bryophytes on the earth. Nearly 28 % of plants are estimated to be used in ethno-medicine (Farnsworth & Soejarto 1991). Putting together the above two estimates, out of the 2.5 lakhs species, roughly 9000 species of medicinal plants are threatened globally.

DOMESTIC SCENARIO OF MEDICINAL PLANTS

India is one of the Mega biodiversity Countries in the world with two biodiversity Hot Spots out of 18 Hot Spots in the world.. It is rich in all the three levels of Biodiversity i.e. Species, Genetic and Habitat diversities. All the known types of Ecosystems - Ranging from Area with - 57°C to temperate, evergreen forests with high rainfall, tropical forests, arid to dry deserts and coastal conditions. It is a Habitat paradise for the growth of varieties of Medicinal Plants distributed in ± 17000 flowering plants. Nearly 5000-8000 species are used in Local Health Tradition (LHT) and codified systems. About 25000 plant based formulations are used in rural folk medicine. India with such a unique biodiversity has great potential for medicinal plants as we have yet to explore and exploit medicinal

properties of unexplored species. Rich bio-resource of the country represents 7 % of world Bio-diversity.

The 16 forest types distributed in varied conditions is the main 'source' of Medicinal plants covering 23 % (76 million ha) of Geographical area.70% of Medicinal Plants are found in Tropical Areas in deciduous/ scrub areas, while 30% are found in high altitude areas with high medicinal value. Quality of Source material depends on origin, period, growth and maturity of the plant collection. 80 - 95 % of medicinal plants collected are from wild which is 61% of the total resource. Medicinal plants are collected mostly by unskilled Tribals / lcoal people unsustainably as destructive harvesting to earn more and more through various agencies. Other main source of Medicinal Plants is from Cultivation. Quality of Cultivated Material is usually better, though costly. Organic farming is preferred

UTILIZATION OF MEDICINAL PLANTS

The medicinal plants are utilized variously by different agencies/ stakeholders in various ways not only for manufacturing medicines or as drugs but also in various industries like Cosmetics, Toiletries, Dying & Tanning etc. There is a large sector of people almost everyone all over the world use medicinal plants or are associated with medicinal plants, directly or indirectly. Medicinal Plant Sector in the country has to address diverse issues to a large number of varied stakeholders comprising of GOs & NGOs. In Government sector the relevant Depts. & organizations of central / State Govt. are the stakeholders. Following are some of the stakeholders in NGOs:

1. Traders and Manufacturers.
   Consumers: Commercial and non-commercial.
2. Forest dwellers, Adivasis, Collectors / Middle men and Cultivators / Growers of Medicinal plants.
3. Relevant NGOs engaged in various activities of the sector.
4. Scientists / Researchers and Research Institutions and Laboratories.
5. Ecosystem dependent communities – Traditional / Folk healers.
6. National, International organizational networks related with Medicinal plant sector.

The manufacturing sector consumes the highest volume of medicinal plants, apart from the practitioners and other users of ISM&H.. There is also a large segment of non commercial users generally based on regional ecosystems. There is,' however, no reliable data available on the extent of consumption of specific raw materials. The estimation of actual or even fairly estimated demand of raw material is a difficult task because the basic data on source, consumption and the demand per annum of the raw drugs is usually not provided by the traders and manufacturers. If at all it is provided, it is far from realistic.

In order to assess the raw material requirement of medicinal plants by domestic commercial users three sources

can be referred namely: a) Report "Demand study for selected Medicinal Plants" prepared by Center for Research, Planning and Action (CERPA), New Delhi, (2001-2002) commissioned by Govt, of India (GOI), DoISM&H, with a view to generate baseline information, b) Report of the Task force "On conservation & sustainable use of Medicinal Plants" commissioned by Planning Commission, GOI (2001). c) Interpolations carried out by foundation for Revitalization of Local Health Traditions (FRLHT) based on the annual turnover of herbal industry. The data on domestic use of medicinal plants is given below:

ESTIMATED DEMAND FOR MEDICINAL PLANTS:

Source - Particular	Basis of Study (No. of Plants & year)	Domestic Demand (in tonnes)	Value (Rs. crore)
a) Study Commissioned by DoISM&H, GOI, Report "Demand study for selected Medicinal Plants" prepared by CERPA, New Delhi (2001-2002)	Total 1200 Plants (1999-2000)	198054-71	1099.18
	Plants not included in the study (1999-2000)	7723741	428.68
	162 Plants Studied (1999-2000)	120816.80-	670.50
b) Task Force on Conservation and Sustainable Use of Medicinal Plants- Planning Commission, GOI, March 2000		2,40,000	Not given
c) Estimates prepared by FRLHT (basedon National Draft Policy on ISM, 2001 and DGCIS data	Plant raw material for domestic/ industrial consumption + Exports excluding extracts	1,28,000	384 + 463 384 + 463 - Total 847

Source: Compiled from above sources.

DOMESTIC USER'S PROFILE

Manufacturing Units:

The major users of the medicinal plants are the manufacturing units and the practitioners. The exact data regarding number of licensed pharmacies and their structural break up in terms of large medium and small companies are not available at single place since it is available in the respective states. The information gathered through secondary sources is given in following the table:

Sr. No.	Source	User Category	Numbers
1	CERPA Report and ISM Policy of GOI2002	Manufacturing Units(ISM)	over 8343
2	CERPA Report and ISM Policy of GOI2002	Codified practitioners (licensed)	over 5,00,000
3	LSPSS Reports	Folk Practitioners	1,00,000

Source: Reports cited above

The number 8343 of ISM manufacturing units is dominated by Ayurveda (7149) manufacturing units followed by Homeopathy (615), Siddha (309) and Unani (270). Presently there are over 9000 mfg. units. According to an estimate there are 6965 small/ very small manufacturing units (turnover Rs. 1-5 crore); 25 under the category of medium manufacturing units (turnover Rs. 5-50 crore) and 10 large pharmacies with over Rs. 50 crore

turnover. The requirement of individual pharmacy varies depending upon the total number of quantity of high and low values of medicinal herbs used by them.

REGISTERED PRACTITIONERS:

Practitioners are another major category of users of medicinal herbs after the manufacturing units. The number of registered practitioners in the ISM&H is given below:

Registered ISM Practitioners In India

Indian System of Medicines	No. of Practitioners
Ayurveda	427504
Siddha	16599
Unani	42445
Naturopathy	429
Homeopathy	194147
Total	681124

Source : National Policy on ISM&H, 2002, Govt. of India

In the following table Medical System - wise usage of medicinal plant/ raw materials being used is given:

System-Wise Usage Of Medicinal Plants

System	Percentage
Ayurveda	81.70%
Folk	67.97%
Homoeopathy	14.90%
Modern	06.38%
Siddha	56.72%
Tibettan	23.77%
Unani	52.29%

Folk Practitioners: The folk practioners and other healers also constitute a bulk consumer of medicinal plants as follows:

Traditional Carrier	Subjects	No. of Practitioners
Housewives & Mothers	Home remedies; food and nutrition	Millions
Traditional birth attendants	Normal deliveries	700,000
Herbal healers	Common ailments	300,000
Bone setters	Orthopaedics	60,000
Visha Vaidhyas	Natural poisons	60,000
Other specialists	Skin, respiratory, mental illness arthritis, dental, wounds, liver fistula, piles	About 1 per 300 Herbal Healers

Source : Export of Indian Medicinal Plants Products, Dr. P.E. Rajasekharan, Division of Plant Genetic Resources, IIHR, Hessaraghatta, Bangalore

The above brief account and data on utilization of Medicinal Plants clearly indicate that the medicinal plants are being utilized in large quantities, enormously by a large section of stakeholders as compared to its production both in nature (in situ) & away from their natural habitat(ex situ). **Conservation** of natural resources is the need of the hour.

CONSERVATION

The World Conservation strategy (IUCN, UNEP & WWF 1980) defines conservation as "the Management of Human use of the biodiversity so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations".

Two important International Conventions to address biodiversity conservation and regulation of trade are: CITES – The Convention on International Trade of endangered Species (1975), which is the tool for monitoring or restricting the Trade of threatened species. CBD – The Convention on Biological Diversity (1993), the first international legal

instrument to address biological diversity conservation and the sustainable use.

The most accepted and scientific means of Conservation is by - In- situ and Ex- situ methods. According to a study (FRLHT, Trade database -2003) conducted in Peninsular India (Maharashtra, T.N., A.P., Kerala, Karnataka) and North India (J & K and H.P.) revealed that Fourteen (14) Species are endemic to India , which are threatened Globally and deserves higher conservation priority. About 100 Species of traded Medicinal Plants are under various levels of threat (IUCN - now WCU), out of which 16 are Critically Endangered (CR**), 30** are Endangered (EN) and 39 are Vulnerable (VU).

In situ Conservation:

Conservation in its Natural habitat. Forests are the Natural Gene Banks, Conserving Plants in natural Habitat (MoEF-GOI) in the following conservatories**:**

(1) Biosphere Reserves - 26 ; Established-20

(2) Wild life Sancturies - 448 (1,15,903 Sq.km.)

(3) National Parks -85 (34,819 Sq.km.)

For an effective in-situ conservation measure: i) It would be necessary to prevent poaching of medicinal plants by enforcing the available legislation, and regulation of harvesting from wild. ii) It would also be necessary to educate the farmers and community living adjacent to the forest areas on the importance and value of medicinal plants. iii) Special efforts will be needed to educate the farmers and tribals living in the vicinity of the forest areas regarding scientific methods of harvesting, storage and transport of the raw materials, through awareness camps, training pogrammes. Besides this, iv) it should be supplemented with regulatory measures to ensure quality control and also to stop illicit poaching**.**

The natural habitat of medicinal plants viz. the forests are under severe stress on account of exploitation, illicit cutting, destructive harvesting and growing demand of the medicinal plants. It is therefore depleting day by day unless more serious measures are taken for their conservation.

Ex Situ Conservation:

Conservation outside habitats. Such conservation of medicinal plants is done in Gardens, Arogya Van and through Cultivation, Gene banks, Cryo-preservation etc. Following are some of the important ex situ conservation measures, being implemented in the country:

- No. of Botanical Gardens in India - over 140 (incl. over 33 in Univ.)
- Five herbal gardens of CCRAS: Guggulu Herbal farm, Mangliawas (Rajasthan) , about 15000 plants of Guggulu are cultivated. Other 4 herbal gardens - at Tarikhet, Jhansi, Pune, Itanagar.
- Artificial tropical forest conservation along with medicinal and aromatic plants in TBGRI, garden Coimbatore, is a unique combination of ex situ and in situ conservation (under Field Gene Bank Programme, 1992-1999).

- Under G-15 countries programme, DBT established 3 National Gene Banks for Germ plasm Conservation (DNA Library, Tissue Culture / Cryopreservation etc.) at (i) CIMAP, Lucknow (ii) NBPGR, Delhi (iii) TBGRI, Trivendrum.

Cultivation of Medicinal Plants: Brief cultivation activities in India are as follows:

- Total Area Under Med. Plants Cultivation - ± 1,11,000 ha (nearly 34 %).
- Agro techniques of Medicinal Plants :

No. of species traded	Propagation methods of Med. plants known	Agrotechnics& Agro-Economics of Med. Plants
880 Species	313 Species	108 Species

- **Procurement - wild or cultivated :**

No. of species traded	Species occur in wild (cultivation not known)	Species from cultivation source (not known found wild)	Species both in wild & cultivated
880	538	88	212 (42-imported)

- **Export / Import :**

No. of spp. exported	Species cultivated only	Harvested from wild	Species both in wild & cultivated	Exotic spp. (imported)
48	5	14	24	**5**

Ban on Exports of Medicinal Plants:

The habitat loss by export of medicinal plants collected from wild sources may lead to severe and irreplaceable loss of genetic stock of many species. The Ministry of Environment and Forests has, therefore, notified 29 species, which are banned and can't be collected from wild source for export from India. Following are the Species:

Plants, Plant portions and their derivatives and extracts obtained from the wild prohibited for exports:

1. Cycus beddomei (Beddom's cycad)
2. Vanda coerulea (Blue vanda)
3. Saussurea costus
4. Paphiopedilium species (Ladies slipper orchid)
5. Nepenthes khasiana (Pitcher plant)
6. Renanthera imschootianu (Red vanda)
7. Rauvolifia serpentina (Sarpagandha)
8. Ceropegia species
9. Frerea indica (Shindal Mankundi).
10. Podophyllum hexandum ((emodi) Indian Podophyllum).
11. Cyatheaceae species (Tree ferns).
12. Cycadacea species (Tree ferns).
13. Dioscorea deltoidea (Elephants Foot)
14. Euphorbia species (Euphorbias)
15. Orchidaceae species (Orchids)
16. Pterocarpus santalinus (Redsanders).
17. Taxus wallichiana (Common Yew or Birmi leaves).
18. Aquilaria malaccensis (Agarwood).
19. Aconitum species
20. Coptis teeta
21. Coscinium fenestrum (Calumba wood).
22. Dactylorhiza hatagircu
23. Gentiana kuroo (Kuru, Kutki).
24. Gnetum species
25. Kampheria galenga
26. Nardostachys grandiflora

27. Panax pseudoginseng
28. Picrorhiza kurrooa.
29. Swertia chirata (Chirayata)

COSERVATOIN ACTIVITIES AT A GLANCE

The issues of Conservation are addressed by a Number of Govt. Depts. Including DoE&F and NGOs. However, National Medicinal Plants Board (NMPB), play an important role in supporting & promoting in situ & ex situ conservation activities including creating awareness. The schemes of NMPB cover all the areas of Medicinal Plants Sector incl. Nursery/ Cultivation/ R&D/ Marketing etc. for Forest, public, GOs / NGOs, Institutions etc.

The Conservation activities can be implemented in 3 major Areas i.e. i) Awareness Campaign, ii) In situ & iii) Ex situ conservation.

i) Awareness Campaign

It an important component of conservation for bringing awareness about the identity of surrounding Medicinal Plants (MP), their importance in our life and their role in cultivating and generating income (as a profession). It is necessary to sensitize general public, farmers/cultivators, forest personals and other stakeholders about MP. The campaign for awareness for conservation of MP is done: - by conducting, district-wise / village-wise, lectures, meetings, seminar, workshops for public & all stakeholders in all the states through audio-visual electronic and print media.

ii) IN- SITU Conservation:

Through the schemes of NMPB- the state forest dept. conserve the MP rich area as 'Medicinal Plants Conservation Area' (MPCA) and Herbal gardens.

- An outlay of Rs. 32.30 cr has been allocated for In situ conservation activities by NMPB (in the 5yr plan)
- Conservation of 39653.82 ha is done in Forest Areas all over the country which includes :
- 19,481.82 ha under resource augmentation
- 12,727 ha area under In- situ conservation and 7445 ha – under MPCA (38 nos.)

iii) Ex-Situ Conservation:

The Govt. under DoAYUSH through NMPB has constituted centrally sponsored schemes of National Mission on Medicinal Plants (NMPB), with a total outlay of 630.00 cr for 11th 5year plan. The above scheme primarily supports Market Driven cultivation of MP on private lands – with forward and backward linkages. The scheme Implemented in 26 states through National Horticulture Mission (NHM) and NMPB. NHM through Mission Directors in 19 states & NMPB through CEO in 7 States and NMPB supported cultivation of MP (up to 31Dec.) in 1 1, 33,902.72 ha. Which include: 83419.72 ha under National Mission on MP and 50,483 ha under Contractual Farming (2002-2008).

Ex-situ conservation include establishment of medicinal plants gardens

all over the country: i) Herbal Gardens-255, ii) School Herbal Garden – 1798, iii) Home Herbal Garden – 11,420. Besides, Conservation through Germ – plasm, Gene Banks, Cryo-preservation & projects on RET species etc.

CONCLUDING REMARKS

The utilization and harvesting of Medicinal plants (MP) from natural resources has to be sustainably managed. The Forest Department (MoEF) at the centre and State Forest Department together with National Medicinal Plants Board (NMPB) has to formulate a System and Regulations for harvesting of medicinal plants from wild and for Collection of MP, plant parts sustainably region wise. Cultivation of MP has to be increased all over the country, to meet the demand. The NMPB has to be strengthened and given more power. Conservation measures to be implemented strictly. For effective in-situ conservation, it would be necessary to prevent poaching of medicinal plants by enforcing the available legislation, and regulation of harvesting from wild. It would also be necessary to educate the farmers and community living adjacent to the forest areas on the importance and value of medicinal plants. Special efforts will be needed to educate the farmers and tribal. A separate agency under NMPB consisting of three major players i.e. Dept, of AYUSH, Ministry of Environment & Forests, and Ministry of Agriculture could be constituted for policy framing, implementation and regulations of M P sector.

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Why the Indian medicinal plants could not find their place in the modern medicine? : An Overview

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ABSTRACT

Indian medicinal plants could be well defined as the herbs used in Indigenous system of Medicine in India like; Ayurveda, Unani –Tibb, Tibetan Medicine, and in Cosmeceuticals, and nutraceuticals, etc. and also in the folk-medicine in the tribal areas. In this paper only the Ayurvedic and & Unani drug plants are taken for discussion.

THE AYURVEDIC & UNANI MEDICINAL PLANTS

At the Vedic times, the plants used in Rig-veda and Atharva veda were numbered only 168, Sharma (1969). However, there are no records of plants used in Mohanjodaro (Indus civilization) except, Peepal, Ficus religiosa, found as an emblem in the excavation.

Fly Agaric, Amanita muscaria?, stated to be used as Soma by the Aryans before coming and reaching India, Wasson (1971).

The number of plants used in Vedic age and by Caraka, Sushruta and Vagbhatta, etc and the plants used in Unani-Tibb system of medicine, in different period of time have been shown in the Table-1. However, the number of Indian Medicinal plants at present used in India in the indigenous system of medicine and in folk medicine are about 5000 above.

THE MIGRATION OF ARYANS AND THE HISTORY OF RIG-VEDA :

It is stated about 2500 B.C. the Aryans migrated from Central Asia towards South-West under two flanks, one went to Iran, known as Indo-Iranian Aryans and other came to Afghanistan (Aryan) about 2000BC and they reached (present) India about 1500 BC.

It is mentioned by Wasson (1982) that up to Hindukush and Afghanistan 'Fly Agaric' was available possibly, for some time and then it gradually depleted and was not available to Aryans to be used as Soma.

Later, due to its scarcity the Aryans used its surrogates or substitutes in their religious functions, rites and drink and also in their sacrificial-fire, "Homa'. They began to use Ephedra sp., Tamarix sp. and Peganum harmala, in their first home Iran (Damania (2004) and in their second home India, they used, a number of plants like Ephedra, Sarcostemma sp. Periploca aphylla etc. in different periods, and in different parts of the country. According to Wasson (1968, 1971), the following hymn clarifies this fact:

सोमं मन्यते पपिवान्यत्संपिंषन्त्योषधिम्।
सोमंयं ब्रह्माणो विदुर्न तस्याश्नाति कश्चन।।
(ऋ.वे.मं. 9 अ. 7 सू. 3)

The Soma, which the Brahmans (the priest) know, no other person knows and the people think that they have drunk 'Soma' actually, they are not drinking the true 'Soma". (Further, the present 'soma' is being ground and then prepared, however, earlier one was first squeezed with fingers by the ladies then processed. It means they had changed the plant, which was being ground and not being squeezed.)

The Findings of the Russian Archaeologists: According to Russian archeologist Sarianidi (2003), for the first time, the monumental temples of Aryans, were excavated and discovered, in which intoxicating beverages of the Soma-Haoma type were prepared for cult ceremonies. The Soviet archeologists further uncovered, a massive shrine of the migrating Aryans of about the size of a football field, in this a sacred-fire place, a 'Havan kunda' was also found, in which remains of 'Sacrificed' horses were also found (The Ashwamedhh Yaggya). And, for the first time, the chariot remains with horses were also recorded.

Big vessels were also uncovered, in which 'soma' drink were kept. A pounding-hole was found in which the ingredients of 'soma' drink were pounded. According to Prof Sarianidi, the ingredients were the poppy (possibly seeds), cannabis and ephedra for making the Soma-Haoma drinks, were used. (They abandoned the use Amanita muscaria as it was not readily available.) Further, thickets of these plants were also found in excess in the vicinity of the excavated temples of Margiana, Sarianidi (2003). And on basis of an interview by Victor Sarindini in Discovery Channel, (2010 November).

Possibly, when the Aryans left for the Hindu-Kush Mountains, access to cannabis and poppy became difficult and possibly later, when poppy and cannabis plants were not available, only ephedra were used as a surrogate or substitute. It also depicts, possibly, the use of Fly Agaric, was abandoned due to non availability of the material, when they had reached the site of excavation during their migration.

Eventually, when they reached Indian plains availability of Ephedra was also not possible then they continued to use other substitutes, just a formality, in different parts of the country and in different periods of times. The plants they used as Soma in their ritual consecrations as surrogates and substitutes are discussed in the text and also Tabulated, in chronological order.

The Sanskrit language: Before reaching India, the Aryans used to remember their poetic hymns of Rig-veda orally known as 'shruti' as they did not have any script to jot down their hymns. After reaching India, they brought a script from the Middle- East, where, many scripts were emerging, and coined one, as in its original language the roots and shoots of the languages of Greek and Latin, Kelt, Teuton and Slavonian, and thus developed the Vedic Sanskrit.

After Rigveda, the other Vedas such as Atharva veda, Yajur veda and Samveda, and other texts like Brahmanas, Puranas, Samihita, etc. were composed and written by the Aryans in their new home land. So, whenever, we read Rigveda, actually we read about the life of the people in Central Asia and seldom we find the references of geographic locations of present India or any present deities and if there is any, possibly these were incorporated afterwards. It is always questioned that why the Indians have not come forward to probe into the 'Soma' issue, Nene(2004) and others. Actually, it is the complete ignorance of the knowledge of Sanskrit available to the researcher. The westerners, who had written on 'soma' were Vedists themselves or person like Wasson took the help of such a Vedist to assist, while in India no botanist had ever taken any help from the Vedist, in tackling the matter.

The most recent theory is by Spess (2000)**,** who proposed that the Soma plant is Nymphaea and Nelumbo (water lilies and the lotus plant), which attracts only our attention but does not do any thing more. Now, Soma in India is only venerated in our religious rites and ceremonies being in the 'Mantras'.

The Modern system of Medicine: When the Britishers came to India they studied the Indian medicinal plants so that they could adopt these in their own medicines as such many were adopted in the early British Pharmacopeias.

The modern system of medicine, actually began with the work of William Withering with Foxglove, who very meticulously identified the drug from a complex folk-botanicals and clinically studied the plant on his patients. In 1869,Nativelle, a French chemist isolated a glycoside, Digitoxin from foxglove and in 1890,Killani studied all the glycosides of Digitalis in detail and from 1925, the digitoxin, was used and as such the modern medicine emerged. Then, the leading pharmaceutical companies started looking out for new drugs from the herbal plants throughout the world for a potential chemicals, which could pass the FDA norms and work out efficiently. The survey also began in India and all the Ayurvedic and Unani and other wild growing plants were screened. But, except Sarpagandha, (Rauvolfia serpentina), Kutki, (Picrorhiza kurroa), and Guggul, (Commiphora mukul) , no other plant could pass the test to be used in modern medicine. No doubt, Sarpagandha's alkaloids reserpine, for some years reigned the world as a cure for high blood pressure(hypertension) but due to short of material and discovery of other

synthetic chemical drugs, now Sarpagandha is very seldom used in modern medicine. However, it is used in manufacture of Ayurvedic and Unani medicine in a big way.

Later wards, the modern system of medicine emerged and in place of crude drugs, their active chemical constituents were used, after testing pharmacologically and clinically approved by the Food & Drug Authority of each country. Efforts were conducted to find out any plant from India which could be adopted in the modern system of medicine. But, except Rauwolfia no other plant could be adopted in the modern system of medicine. And, to understand why ? We have to study the working of the Ayurvedic , Unani and other oriental systems of medicine.

No doubt,there are many effective Indian Medicinal Plants, which are used in our indigenous system of medicine but they could not pass the norms of the modern drugs.

The Oriental systems of medicine, which includes Ayurvedic, Unani, Chinese, Tibetan etc., are actually based on the "Theory of Synergism & Antagonism" promulgated by Takagi et al (1965) and later Williamson (2001). It is known that in this system of medicine, seldom a single drug is used, these are used in combination of more than three and even many. This theory explains that how a single herbal drug or more, work collectively, with two types of chemical constituents, the synergistic and antagonistic . The synergistic ones, work for curing the diseases, while the antagonistic ones cause the side effects or toxic effects. While, in modern system a single synergistic chemical is separated and extracted and the antagonistic ones are discarded. So, it was or still difficult to find a single synergistic chemical constituent in any Ayurvedic or Unani herbal plant with potential of curing with least side effects.

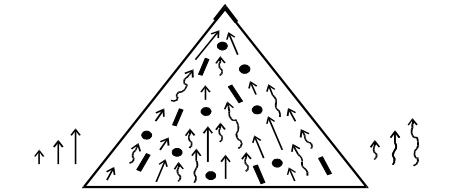
The Hypothesis of action of herbs or herbal medicine : How a herb or a mixture of herbs and mineral constituents or herbal or phytomedicine act in treatment in the traditional system of medicine ? A hypothesis was propounded by Takagi et al, (1965) according to them in oriental system of medicine (which includes, Chinese, Ayurveda, Unani, Tibetan or Amchi, etc), the herbs are used in combination with other herbs and minerals or zoological drugs. Each herb or constituent bears a number of individual active or inactive chemical ingredients and the active chemical ingredients of each herb, may have different pharmacological actions or activities such as : (i) The synergistic ingredients, which have similar pharmacological activity. (ii) The antagonistic ingredients, which have opposite pharmacological activity such as toxicity and side effects. (iii) The protecting ingredients, that protects the synergistic ingredients physically & chemically.

In traditional system of medicine, the use of a single herbal product is very rare and several units of plant products with various ingredient contained in one prescription exhibit, synergistic & antagonistic effect according to physiological condition of patients. The

same ingredient exhibit quite the opposite action, when the associates of the combination changed. The concept of synergistic interactions are regarded of vital importance in herbal or phyto-medicines, to explain difficulties in isolating a single active ingredient and explain the efficacy of apparently low doses of active constituents in a herbal product.

This concept, as a whole or partially purified extract of a plant offers advantages over a single isolated ingredient, also support the philosophy of action of herbal medicine. The whole philosophy of action is diagrammatically shown as under :

Thematic Diagram based On TAKAGI *et al,* (1965) Hypothesis and Modified into a diagrammatic re-presentation By N.C. Shah (2003)



Williamson (2001) has documented the synergistic interactions for constituents within a total extract of a single herb, as well as between different herbs in a formulations and has identified and measure of synergy. The Positive and negative aspects of interactions evidence is divided into experimental, in vitro instances, as well as clinical examples where available. Herbs discussed include Ginkgo biloba, Piper methysticum (Kava-Kava), Glycyrrhiza glabra, Hypericum perforatum, Valeriana officinalis, Cannabis sativa, Salix alba, etc., which are used now a days in the western countries as phytomedicine.

Synergistic component from two plants if combined then it is not certain that their action would be more synergistic after combination, it may act as an antagonistic which is evinced from the following example in which the combination of Bergenia ligulata and Dolichos biflorus extracts did not increased the synergistic effects but it slowed down the action in vitro antilithiatic / anticalcification activity by the homogenous precipitation method. Also a combination of the extracts of the two plants was tested while Bergenia ligulata showed less activity and the combination was not as active as the individual extracts, (Garimella et al, 2001).

The synergistic and antagonistic action could be explained from the example that when single alkaloid from Rauvolfia serpentina is used, it has 16 side effects but if crude drug is taken it has no side effect. It explains that in the crude drugs there are number of protective chemical constituents which protect from the antagonistic ones.

However, now a days, there are number of products in the market which are formulated by mixing different plants having same pharmacological action and these are sold under Ayurvedic brand. Though, it sound well but plants with similar action may not turn in synergistic way but may turn

into antagonistic way as a result side effects & toxic effects Such formulation require at least toxicological testing.

However, based on this concept, in India the synergistic constituents are separated from the antagnostic or the toxic ones, as an example the 'Gugul lipid'. In this case only the synergistic chemical compounds are used in a portion of extract and is called 'Allo-ayurvedic medicine'.

Guggul Extract

Guggul lipid' is the ethanolic extract isolates of the ketonic steroid compounds guggul sterones of the gum resin, effective to reduces the elevated serum blood cholesterol and triglycerides levels. Discovered by CDRI, in collaboration with Malti Chemicals. The CIPLA was licensed for the drug manufacturing known as 'Guggullip'. It is one of the example, where without any proper planning and assessing, the raw material and the annual availability, the production was started and then failed.

However, the raw material is already insufficient in the country to meet the demand of the indigenous medicines. However, 'Guggullip' was registered and patented in India as a new hypo-lipedaemic agent and was marketed under the brand name of 'Gugullip' tablets by CIPLA Ltd Bombay as an 'Allo-Ayurvedic drug"

Though, in India it was rarely available in the market, however, in foreign countries the drug was marketed by number of foreign and Indian companies. Further see Websites

ETYMOLOGY & PHILOLOGY OF SANSKRIT AND OTHER NAMES OF PLANTS

The Etymology & Philology of Sanskrit names of plants and their synonyms are very certain and perfect. We get many information in deciphering these synonyms. The book--Namalingaanusasana or Amarkosa a Sanskrit dictionary compiled by Amarasimha in the year 600-700 AD gives all proper & common noun Sanskrit names and the in uses of plants, animals, minerals etc. Amarsimha was among the 'Navaratnas' of Samrat Vikramaditya and a Sanskrit scholar. His work was compiled in 1600 A.D.

Sanskrit names of plants Etymology & Philology and their synonyms are very certain and perfect.

For example we take Turmeric, Curcuma longa in sanskrit known as 'Haridra' the etymology is two words, 'Hari' and 'Harit', the jaundice, or 'miraculous' and 'Dravya', the 'Jaundice article, or 'miraculous article. However, Amarismha mentioned only 5 synonyms but with a detailed etymology. Though, Dymock et al (1890-93) mentions 46 Sanskrit synonyms but no details, however, Shah (2007) could collect only 35 synonyms and tried to decipher these names or synonyms etymologically. A few important ones would only be discussed here.

The analyses of 35 names have shown that the names are based on the following characters. 1. Medicinal

properties; 2. Mode of preparation. and time of application; 3. As Dye & Cosmetic; 4. Abstractive properties; 5. Loved by the ladies. 6.After the Taboos; 7. After the Deities name; 8. The Habitat.

1. Medicinal properties

Under this those ailments and diseases are present, which said to be the curing properties of ailments & diseases, such as; 'Jwarantika', 'Jwar' means fever and "antika' is ending, which ends the fever; 'Krimighni', Kirmi' means worms and 'ghani' means the destroyer, which destroys the intestinal worms or other worms; Mihagni', 'Miha' means down-pouring and 'agni' means fire, i.e., the inflammation of the body is down poured, anti-inflammatory. Vishagni', 'Vish' means poison and 'agni' means the fire, which destroys the poison in the body or an anti-inflammatory.

2. On the mode of preparation

'Gharsini', 'Kasada', 'Kasapa'- All words denote that the rhizome is ground on stone to make a paste before application.

3. Used as a dye & cosmetic

'Varnagi' 'Var' means bride-groom and 'angi' means to put on. The bride-groom body was/is pasted with turmeric sent from the bridal house before leaving to the bridal house for marriage. This tradition still prevails. 'Varna-datri', 'Varna' means colour and "datri' means giving as it is used for dyeing and for body coluring & complexion, hence called, 'the one which imparts colour.

'Dirgha–ranga' 'Dirgha' means lasting , 'ranga' is colour, meaning the colour of which, lasts for long. 'Shobhna', 'Shobhna' means brilliant. When it was used by the ladies on the face and body as a cosmetic, the face and the body used to glow and shine. 'Nisha','Shyama' and 'Yamini'--All words denote 'night'. because it is applied in the night as a cosmetics so the words are used. 'Pinja','Pita','Pitika'--All meaning yellow colour. 'Ranjjini'--'Ranjini' means dyeing & coloring as it was also used to dye the colour of the body and face, therefore, and also the clothes hence called 'Ranjini'.

Hemragi','Hemragini' 'Kanchini'--All denotes golden colour. The colour obtained is 'Swarna-varna' golden colour or the rhizome.

4. The abstractive properties

'Bhadra'-- It means auspicious or fortune giving. Possibly, in the earlier days, it was used as an amulet or gem and regarded as fortune giving. In Kumaon a small piece of rhizome is still tied in the hands of bride and bridegroom as an amulet. 'Mangalprada' ,'Mangalia'--both the words mean 'welfare-bestower' ;'Pavitra' -- 'Pavitra' means holy. It is regarded as an holy article. 'Subhagya', It means 'good luck', which bestows good luck to the user, who uses it as an amulet.

5. Loved by the ladies

'Yoshit-priya', 'Yuvati' 'Yoshit' means young 'priya' is liked and loved. 'Yuvati' means young lady. It means, it is liked and loved by the young ladies.

"Hridya-vilasani'-- "Hridya' means heart, and 'vilasani' means that delights or charms. It charms the ladies.

6. The taboos

Anestha. means the thing which is not allowed to be offered in the sacrificial fire, "Yaggya'. Turmeric is never offered in Yaggya. **7. After the Deities name;** 'Shiva', 'Uma', 'Gauri','Laximi'.

7. The Habitat

Kaveri'–Possibly, 'Kaveri' the river in Tamilnadu and during those days turmeric was grown by the side of river Kaveri. Presently, the best turmeric is still produced from Tamilnadu.

THE 'RAJ' OF MADHYA PRADESH

In the state of Madhya Pradesh and its adjoining states a herb is found mostly its roots are used and these are known as Bhog raj. Kamraj, Tej raj Hans raj, etc. etc. So far 21 types of "Raj' are recorded to be found but these have been not collected systematically, identified and chemically analysed Only 7 species have been so far identified with Vernacular names & botanical names and according to Shah & Singh (1990) these are;

Tej raj	Bupleuram falcatum syn.	Peucedanam dhana (Umbelliferae)
Bhog raj	Peucedanum nagpurense	(Umbelliferae)
Jal raj	Oenoanthe stolonifera	(Umbelliferae)
Hans raj	Pimpinella bracteata	(Umbelliferae)
Kam raj	Cynoglossom lanceolatum	(Boraginaceae)
Patta Kam raj	Nelsonia campestris	(Acanthaceae)

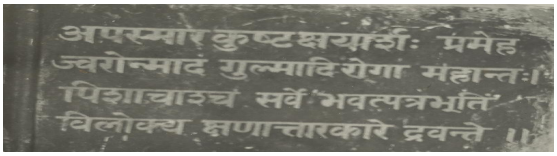
Kamraj (Nepal) Hemlinthostachys zeylanica, (Ophioglossaceae) Mitra et al (1973)

However, stil 14 plant species still remains to be found identified. These are;

Deoraj, Nag raj, Som raj, Agni-raj, etc . Even, 10 Raj, vernacular names & botanical names are still to be found out. Not only this these are required to be identified, and to work out the chemistry & pharmacology to find their potential in medicine. Please note in my recent visit during this workshop I had seen that Selagenella botryoptis was being sold as 'Kamraj', however, this drug is sold as 'Sanjivini' in Uttar Pradesh. When it is put is water the plant comes to its normal structure.

Psycho-somatic Treatment or Faith

We know certain diseases are psycho-somatic. In Amarkantak (MP), there exist a slab out side the Mahadev temple, near the source of river Narbada, in which, it is inscribed that just having a 'Darshan' of the deity, the 'Apasmar', 'Kushta' 'Kshaya','Prameh''Jwar-unmad' Gulmadi' diseases are ended. Not only this the demons also leave the patient immediately. What is this? An utter faith? Or a psycho- somatic treatment ?



The Crude drug selling tribals: Not only in Chitrakoot the crude drugs as medicine are sold but also in Amarkantak these are sold. Out side, the Amarkantak temples, the tribals are seen selling crude drugs as medicine. And, as such Dryopteris cochleata (a fern) is found to be sold .this is much used in various types of diseases.

Table 1.Showing the number of medicinal plants used in different period of time by different physicians

1.Pre-Vedic period or Indus Civilization		2600-1900 BCA -	'Peepal' Ficus religiosa "Soma'
2.Vedic period: Rigveda & Atharvaveda		1000 BCA	Amanita muscaria ?168
3 Post-Vedic period:			
Caraka Samhita	Caraka	125-150 A.D.	400-450
Bower's mss (Navanitakam)	?	350-375 A.D.	-
Amar Kosh	Amarsimha	600-700	?
Sushruta Samhita	Sushruta	800-900 A.D.	573
Ashtanga Hridiyam Samhita	Vagbhatta	Ca 700 A.D.	700-800
Ratnamala	Madhava	700 A.D.	-
Dravyaguna Sangrah	Chakrapani Dutt	1060 A.D	-
Dhanwantri Nighantu	Mahendra Bhogick	.?	373
Shodal Nighantu	Shodal	1200 A.D.	499
Madan Pal Nighantu	Madan Pal	1374 A.D.	-
Raj Nighantu	Narhari	1600 A.D.	750
Bhava Prakash Nighantu	Bhava Misra	1600 A.D.	-
Rajballabh Nighantu	Rajballabh	1760 A.D.	-
4. Unani & Unani Tibb. Medicine			
Period :	Ibn-sena (Avicena)	980-1033 A.D.	719
Al-Qanoon	Abdul Ariz-ibn-ark-Qaj	1252-1307 A.D.	212
Kitabu-umdafil-Jirahat Taj Kiratul Hind	Sayd	20th century	1500 herbs growing in
Makh-janul-adiva	Mohd.Husain	Late 20th century	South India
Muhete Azam'or	Azam Khan	1915	Above 1000 drug.
Qurabuddine-Azam	Najmul Ghani Khan	1957	2500
Khazan-etul- Adiva	Wahid & Aziz		88. Unani drugs included
Survey of Drugs			in Unani Tibb.
5. Modern Period:	Kirtikar and Basu	1935	1775
Indian Medicinal Plants			
Glossary of Indian Medicinal Plants	Chopra et al.	1956	Above 3500

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MEDICINAL PLANTS IDENTIFICATION AND IMPORTANCE OF HERBARIA IN MEDICO-BOTANY

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ABSTRACT

Identification and the quest to know the name of a Medicinal plants is a natural instinct. It is the basic requirement in general and for any study or research studies in particular. Herbarium provides identity of medicinal plants and authentic preserved voucher specimens for Medico -botanical Research. In the present communication the importance & methodology of Identifying Specimens of Medicinal plants and also the Importance of Herbarium in Medico-botany have been discussed.

INTRODUCTION

The use of plants for medicinal purpose is known since very early period. Plant collection and giving name to them is a natural instinct and is in practice since Vedic period. Medicine obtained from plants is one of the four basic needs i.e. food, cloth, shelter and medicine, full-filled to a large extent by the plants / plant products, since time immemorial. Medicinal Plants collections in India started since the publication by Garcia de orta (1565) (La Coloquios) even before the historic work 'Species Plantarum' by father of Botany Linnaeus (1753). Later, the medicinal plants were collected along with the botanical specimens, since ancient time and were preserved as herbarium for studies. The explorations conducted by earlier botanists including Sir Geo King, Roxb., J. D.Hooker, Dalzell & Gibs., T. Cooke etc., etc. are even now preserved. This study of plant identification and preservation forms the foundation of all researches involving plant material and its utility. In the present communication an attempt has been made to present in brief the methodology of identification and importance of Herbarium in Plant studies and identifying the specimens.

IDENTIFICATION (BOTANICAL)

In traditional sense herbarium methods are confined only to preservation of specimens only, but in broader sense it also includes identification, labeling, incorporation of the specimens both medicinal or other-wise. Once the herbarium specimens are prepared and labeled it is ready for identification. The specimens to be identified are arranged according to the broad groups/subgroups

based on the taxonomic characters and then placed in the suitable Families as per the accepted system of Classification for further taking up identification at generic and specific level. The plant specimen is then further studied based on generic characters to determine the **Genus** under the families.

The prerequisite for identification is the general knowledge of the geographic location, topography of the area and field observations and information of the regional floras. Observations in the field and notes with regards to habitat, altitude of area, habit, plant's association, local uses, if any, and record of such characters of the plant like aroma, color of flower, & other plant parts, which are likely to change or vanish on drying or poisoning of the plant specimen. Field observations and experience in the field and herbarium facilitates identification.

Identification of a plant specimen involves determination and giving correct scientific name to a plant as per International Code of Botanical Nomenclature (ICBN). Usually identification is considered to be the process through which a specimen whose name is not known is recognized by its characters, to be similar to some known plant, and accordingly given a name. Or in other words Identification is the determination of a taxon as being identical with or similar to another already known element. The determination may or may not be arrived at by the aid of literature or by comparison with plants of known identity. It involves keen and critical observation.

In some cases, when the plant specimen do not match with the existing specimens of the herbarium and do not fit in the keys & description in the floras / literature, in such cases it scrutinized at regional & national Herbaria, together with more national and international Floras / literatures and the opinion of the experts in the field. With such process of elimination it may turn out to be a new distributional record or may be determined to be a new species. The specimen is further studied in detail with reference to the characters of closely allied taxa and detailed notes & comparison is noted. For the final scrutiny of the specimen it is sent to Britain, the Royal Botanical Garden, and Kew Herbarium which has collections from all over the World or may be sent to any other international herbaria. The authorities of Kew herbarium give their opinion & determine the identity or declare as new species. Such species can be given a suitable name and published validly as per the guidelines of the ICBN.

Nomenclature is concerned with the determination of correct botanical name of a known plant as per a designated code / system i.e. International Code of Botanical Nomenclature. The code has certain Principles, Rules and recommendations. Six Principles broadly forms the basis of Systems of nomenclature. The rules provide detailed provisions of the system, and are laid out in 75 Articles. The aim of rules of Nomenclature is that one name can be rightly applied

For the purpose of identification the step by step scientific method is to**: i)** First study the characters of the plant, **ii)** Check them with flora(s) of the area (region) **iii)** Work through the family, genus and species keys and **iv)** Compare with full description and illustrations. **v)** It is then compared carefully with the earlier identified specimens of that species (taxon). **vi)** If specimen does not fit in the key or match in herbarium. vii) Efforts are made to consult floras of adjacent areas and other regional /national herbaria. The elimination process may lead to discovery of new Taxon as described in earlier para. **viii)** The next important task in the process of identification is the use of correct nomenclature as per International code (rules) of Botanical nomenclature (ICBN) as narrated above.

TRADITIONAL METHOD OF IDENTIFICATION

During Vedic period medicinal plants were identified and named based on their origin, morphological characters, smell, therapeutic action, properties etc. as follows:

i) **Origin** (Udhbhavbhodahak) – exp. Ashwattha, Sarpgandha, Varshabhu.

ii) **Properties** (Gunbhodhak) – exp. Ashwagandha.

iii) **Action** (Karmabhodahak) – exp. Apamarg.

iv) **Morphology or Appearance -** (Swarupbhodhak)- exp Ajashrungi.

Seven parameters were used. Based on these parameters The plants were described using adjectives during "Nighantu period", which resulted in great number of Synonyms. Due to this many medicinal plants were known by one name and vice versa. It was difficult to identify based on texts (Shastra). According to some Nighantus forest dwellers, shepherds living and wandering in forests are best source for identifying drugs. Even now we have and we are acquiring knowledge from them. In earlier days the identity of a plant drug was based on their 'names' & 'guna'. The names in 'Shashtra' (texts) and those derived and used by local people (Apabhransh) created difficulty is identification. There were confusion due to communication gap and geological barrier:

Not only names but their 'Guna' were over-lapping being similar to one another i.e. Sadaphal – This name is used for 1) Bilva 2) Narikal, Shankhapushpi, Rasana etc. Two different plants under the name Shankhapushpi are described, one from North India & other from South India. Likewise many Plants in different regions are known by the name 'Rasana' in Ayurveda.

Modern system adopted: In earlier period 18th or mid of 18th century, plants were named by using many words and thereby confusing their identity. This problem was solved when Binomial Nomenclature system was introduced by the scientist 'Rivinus' which was further developed and adopted by Linnaeus, who established this system in his monumental work "Species Plantarum" (1753). According to this system every plant name will have two names i.e. i) Generic name ii) species name, for example Ocimum sanctum Linn. etc.This System also brought clarity in

medicinal plants nomenclature and identity of the plant drugs.

IMPORTANCE OF HERBARIUM IN MEDICO-BOTANY

A herbarium which is store-house of plant materials including medicinal plants peserved according to certain standard methods, is in fact the main tool of taxonomy and forms the basis of all researches in different disciplines. Thus, Herbarium is of paramount importance. The rich medicinal flora in the forests were the laboratories and living herbarium during ancient period, the tradition of 'verbal teaching' as described in Ayurveda and practical knowledge in nature was in vogue. But it was disrupted by the British rule due to non-patronage and was neglected. As such Ayurveda suffered a great loss, as the whole chain of "Guru shishya- parampara" was almost completely destroyed.

This resulted in a great confusion as to the identity and nomenclature of the drugs. As such the controversy prevailed and most of the present day pharmacists have to depend on the crude drug suppliers or the 'pansaries' for procuring raw drugs. Under such a state of confusion in crude drugs, a need for the identification or the authenticity of genuine crude drugs is felt and importance of **Herbaria** was realized. The genuine raw drugs are the starting material or the basic tool in the field of medico-botany.Herbaria are of immense importance in Medico-botany mainly in the field of : (i) **Education, (ii) Research, and (iii) Pharmaceuticals**.

(i) Education

The herbaria have a prospective role in Medico-Botany as it houses preserved plant specimens of various areas and provides an up to-date information about the medicinal flora of our country in general and about local medicinal plants in particular. This information will be useful for the students & public at large,as follows:

Establishment of Herbaria in secondary schools / colleges for general knowledge & information. ii) Herbaria as an Aid in teaching about plants utility without going to the field in schools / colleges (Ayu. Colleges), iii) Educating public / rural people, and in iv) Govt. Institutions

(ii) Drug Research

Herbaria cater to the needs of drug research by way of providing authentic specimens and the voucher specimens. The Voucher specimens of the plants under study is mandatory. Herbarium acts as a tool in the following areas of medico botanical researches:

a) Medico botanical explorations and medico ethno-botanical Research.
b) Study of controversial drugs ;
c) Pharmacognosy & Phytochemistry
d) Pharmacological studies;
e) Clinical studies.

(iii) Pharmaceuticals

Herbarium study can provide authentic standard materials for the

following areas in the field of pharmaceuticals: (a) Pharmacognosy (b) Drug standardization (c) Study of identification of market samples to check adulteration.

Role Of The Herbarium In Medico- botany

In the foregoing account scope of herbaria in various disciplines have been discussed. Following are some of the **examples** on the role of Herbarium studies in medico-botanical research including pharmaceuticals:

A. M..R. Uniyal and R.K. Issar (1970) studied and identified some species of the well known group of Ayurvedic drug **Ashta varga** : a group of controversial drugs of Ayurveda based on field and Herbarium studies. **.** According to them probable "Ashta varga" identified are:

Jivak – Rishbbak Microstylis wallichii Lindl.

1) Kakoli- kshir - Kakoli Lillium polyphyllum D.Don.
2) Kakoli (i) Roscoea procera Wall. (ii) R. Alpina Royle
3) Meda Maha Meda : (i) Polygonartum verticillatum All. (ii) P.Cirricifolium Royle
4) Ridhi -Vridhi Habenaria intermedia D.Don.

* This group was further chemically studied by V. Shanker et al (1970) for Polygonatum verticillatum (Meda - Mahameda)
* Habenaria & Microstylis spp. (Ridhi-vridhi) V. Shanker et al (1972) .

B. Usman Ali (1972) – Based on herbarium and Laboratory studies identified two new source of 'Nagkesara' i.e. fruits of Dillinia pentagyna Roxb. and tender fruits of Cinna momum (C. Wightii & C. macrocarpum) in South Indian pharmacies. Accepted source is Mesua ferrea L.

C. K. V. Billore & M. R. Uniyal (1974), have identified the three "Mansis" or the Mansi-traya of Ayurveda-Jatamansi, Bhutkesi (Gandha Mansi) and Mura-mansi as Nardostachys jatamansi DC., Selinium vaginatum C.B.Cl. and S. tenuifolium Wall. ex DC., respectively based on field and herbarium studies and descriptions given in Ayurvedic texts.

D. V.V.S. Togunashi, B.S. Venkataram and S.N. Yoganarsimhan (1976) have studied the Ayurvedic drug Amlavetas and it was found that 3 species of Rumex, 2 species of Garcinia and one Citrus species are used as Amla-vetas.

E. M.Y. Ansari and R.S. Rao (1973) identified a new indigenous source of the drugs colchicine' in 6 species of Iphigenia based on field / herbarium and chemical studies. This biosystematic study indicated that out of 6 species, Iphigenia stellata has maximum percentage of active principle.

F. S. N. Yoganarsimhan, V.S. Togunashi, Z. mary and R.C. Nayar (1979) studied a crude market sample and found that Nymphoides macrospermum Vasu is used as "Tagara" in south Indian Pharmacies. However, actually Valeriana jatamansi is the Tagara in **Ayurveda.**

These examples indicate beyond doubt that Herbaria play an important role in the field of Medico-botany. Its scope is further enhanced as only small percentages out of a large number of plants are known to be medicinal. The Herbaria play a vital role in establishing the identity of controversial or imperfectly known Ayurvedic drugs.

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PROSPECTS OF CULTIVATION OF SOME IMPORTANT MEDICINAL PLANTS

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INTRODUCTION

Medicinal plants play an important role in human life to combat diseases since time immemorial. The rural folks and tribals in India even now depend largely on the surrounding plants/forests for their day-to-day needs. Majority of the medicinal and aromatic plants are still collected from wild for preparation of herbal drugs and perfumes/cosmetics. Rapid population growth and rising popularity of herbal drugs and natural essential oils have brought into focus the acute scarcity in availability of some of the plants due to indiscriminate and unregulated collection, habitat destruction through expanding agricultural lands, deforestation and urbanization. Fall in the supply of good quality, genuine raw material has resulted in price rise and deterioration in the quality of formulations. With growing demand and use of medicinal and aromatic plants, the important species have to be introduced into commercial agriculture.

The annual world trade in medicinal plants is around $ 60 billion (Rs. 240,000 crores) and is expected to touch $ 5 trillion by 2005.[3] The Indian annual turnover of herbal material has crossed Rs. 4000 crores mark, of which Rs. 300 to 400 crores worth is being the export market. The share of Indian trade in medicinal and aromatic plants is only 1.5 percent of the world market. India is one of the major exporters of crude drugs mainly to the developed countries like the USA, the UK, Germany, Japan, France, Switzerland etc. The main crude drugs having good export opportunities are Aconite, Aloe, Dioscorea, Ephedra, Digitalis, Bach, Belladona, Cincona, Ergot, Isabgol, Opium, Vinca, Senna, Sarpagandha, etc. Of these senna leaves, isabgol, husk/seed, and Cassia tora seeds are in maximum demand. China is the major producer of herbal plant material in the world. China earns US$ 5 billion per year from herbal trade besides meeting its domestic requirements. Though India has more potential of production of number of medicinal and aromatic plants than China, but because of the production of poor quality produce, the contribution of India in the world market is very low.

CURRENT SCENARIO OF AVAILABILITY OF RAW MATERIAL OF HERBAL DRUGS

About 90% of medicinal plants used by the industries are collected from the wild. While over 800 species are used in production by industry, less than 20 species of plants are under commercial cultivation. Over 70% of the plant collections involve destructive harvesting because of the use of parts like roots, bark, wood, stem and the whole plant in case of herbs. This poses a definite threat to the genetic stocks and to the diversity of medicinal plants if biodiversity is not sustainably used. Crude drugs are usually the dried parts of medicinal plants (roots, stem wood, bark, leaves, flowers seeds, fruits, and whole plants etc.) that form the essential raw materials for the production of traditional remedies of Ayurveda, Siddha, Unani, Homeopathy, Tibetan and other systems of medicine including the folk, ethno or tribal medicines. The crude drugs are also used to obtain therapeutically active chemical constituents by specialised methods of extraction, isolation, fractionation and purification and are used as phytochemicals for the production of modern allopathic medicines or herbal/phytomedicines. An approximate estimate of area under cultivation of medicinal plants in India is provided in Table 1.

Table 1. Area under major medicinal plants in India

S. No.	Common name	Botanical name	Producing states	Estimated area (ha)
1.	Psyllium	*Plantago ovata*	Rajasthan and Gujarat	55,000
2.	Opium poppy	*Papaver somniferum*	Madhya Prades, Uttar Pradesh and Rajasthan	20,000
3.	Senna	*Cassia senna*	Tamil Nadu, Rajasthan and Uttar Pradesh	20,000
4.	Coleus	*Coleus forskohlii*	Tamil Nadu, Karnataka and Andhra Paradesh	450
5.	Cinchona	*Cinchona* spp.	Darjeeling (West Bengal) and Tamil Nadu	8,000
6.	Ashwagandha	*Withania somnifera*	Madhya Pradesh, Rajasthan and Uttar Pradesh	5,000
7.	Safed musali	*Chlorophytum* sp.	Madhya Pradesh, Gujarat and Uttar Pradesh	5,000
8.	Periwinkle	*Catharanthus roseus*	Andhra Pradesh, Karnataka, Tamil Nadu and Maharastra	4,000
9.	*Khai katari*	*Solanum* spp.	Maharastra	4,000
10.	Sarpagandha	*Rauvolfia serpentina*	Madhya Pradesh	2,500
11.	Ipecac	*Cephaelis ipecacuanha*	Darjeeling (West Bengal)	100

INDIAN MEDICINAL PLANTS: POOR GLOBAL COMPETITIVENESS

Several medicinal plants have been assessed as endangered, vulnerable and threatened due to over harvesting or unskillful harvesting in the wild. Habitat destruction in the form of deforestation is an added danger. The other main source of medicinal plant is from cultivation. Cultivated material is infinitely more appropriate for use in the production of drugs. Indeed, standardisation whether for pure products, extracts or crude drugs are critical and while become increasingly so, as quality requirements continue to become more stringent. Given the higher cost of cultivated material, cultivation is often done under contract. In the majority of cases, companies would cultivate only those plant species which they use in large quantity or in the production of derivatives and isolates, for which standardisation is essential and quality is critical. More recently growers have set up cooperatives or collaborative ventures in an attempt to improve their negotiating power and achieve higher price. Some of the constraints associated with the processing of medicinal plants which may result in reducing their competitiveness in global markets and which have to be remedied are:-

- Lack of research on development of high-yielding varieties, domestication etc.
- Poor propagation methods
- Poor agricultural practices
- Poor harvesting and post-harvest processing
- Poor quality control procedures
- Lack of current good manufacturing practices
- Lack of R&D on product and process development
- Difficulties in marketing
- Lack of local market for primary processed products
- Lack of trained personnel and equipments
- Lack of extension service for latest technologies and market information

The World Health Organization (WHO) has released the guidelines for good agricultural and collection practices for medicinal plants-an industry. The guidelines are intended for national governments to ensure production of herbal medicines is of good quality, safe, sustainable and poses no threat to either people or the environment. The WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants are an important initial step to ensure good quality, safe herbal medicines and ecologically sound cultivation practices for future generations. In an easy-to-understand style, they cover the spectrum of cultivation and collection activities, including site selection, climate and soil considerations and identification of seeds and plants. Guidance is also given on the main post-harvest operations and includes legal components such as national and regional laws on quality standards, patent status and benefits sharing.

PROSPECTS OF CULTIVATION

Small farmers on marginal lands are generally cultivating medicinal and aromatic plants with low input in resources. Besides this, information on several aspects of their agricultural productivity is also not easily available to the farmers. Though we have been practicing the theory of organic farming for centuries, the modern science based chemicalized agriculture has pushed it in background. In this article, theory and practices of organic cultivation of medicinal and aromatic plants for stable production of good quality raw material without harmful effects on soil health and environment have been described.

SELECTION OF SITE

The selection of site for cultivation of medicinal and aromatic plants mainly depends upon the space available, physical and chemical properties of the soil, medicinal plant species and the micro-climatic conditions (availability of sunlight, shade etc.). The major area of the site selected should get sufficient sun light, especially in the mornings. The shady area may be used for growing shade-loving plants. The area should be safe from grazing by cattle.

SOIL

The majority of medicinal and aromatic plants prefer moderately well drained soil. The soil should preferably be neutral in reaction (pH between 6.5-7.5) and fertile with balanced water retention and drainage capacities. The soil should be rich in organic matter. During recent years, several recommendations have emerged for undertaking cultivation of medicinal and aromatic plants on marginal/problem soils like saline, alkaline soils or wastelands. The cultivation on these soils requires special agronomic management and amelioration before starting the cultivation. The plants have varying degree of tolerance to such soils and the cropping systems shall be adopted accordingly.

IMPROVED VARIETIES OF MEDICINAL PLANTS

Genetic improvement through selection, classical breeding and biotechnological tools is important for production of high quality raw material and herbal drugs. The plant genetic resources for medicinal plants represent the basis for health security through herbs. During past few decades, efforts have been made by various researchers for germplasm collection and characterization, describing the variations in growth and yield, content of the active constituents etc. Based on these efforts, several varieties have been released for some important medicinal plants. Recently, the National Medicinal Plants Board (NMPB) in the department of AYUSH has been supporting the cultivation of medicinal plants through several schemes. Considering the importance of quality of raw material as one of the important factors for quality of the herbal products, the Board (NMPB) has compiled details of improved/new varieties of medicinal plants, developed and released by various institutions (Table 2).

Table 2: Crop wise improved varieties and their characters (NMPB, 2009)

S. N.	Name of varieties	Main characters	Breeders seed production sites	Region suitable for cultivation
1.	**Aswagandha (*Withania somnifera*)**			
	Poshita	Tall green leaves & long roots. Average yield of roots.	CIMAP Lucknow	Northern Indian Plains
	Jawahar Asgandh – 20 (JA-20)	Dry root yield (6-8 q/ ha), Total alkaloid content (1.20-1.28%)	JNKVV Mandsaur	Northern-Central Plains, Madhya Pradesh and Chhattisgarh
	Jawahar Asgandh-134 (JA-134)	Dry root yield (8-10 q/ha) Total alkaloid yield (1.02-1.09%)	JNKVV Mandsaur	Central Indian Plains and Madhya Pradesh
	Ashwagandha	Dry root yield (8-10 q/ha) Quality parameters: Withaferin A, Withanolide A, Withnine	IIIM, Jammu	J&K
2.	**Senna (*Cassia angustifolia* syn. *Cassia senna)***			
	Sona	High leaf yield and high sennoside content	CIMAP Lucknow	Northern Indian plains, Rajasthan, Gujarat and south India.
	Anand Late Selection	Late flowering type, high foliage yield with 75% higher dry matter	AAU, Anand	Gujarat, Rajasthan, Maharashtra & M.P.
	AFLT-2	Late flowering, 2.3% sennoside content in leaves, leaf and pod yield 1.2–1.5 t/ha.	AAU Anand	Northern Indian plains, Rajasthan, Gujarat and south India.
	KKM-1	High leaf yielding variety suited for rainfed cultivation with higher dry leaf yield (918 kg/ha), sennoside content is 2.5%.	TNAU Killikulum unit, Tamilnadu	Trinnel valley & Ramnathpuram district, Tamilnadu, Karnataka, Gujarat, Rajasthan & Delhi
3.	**Isabgol (*Plantago ovata*)**			
	Niharika	Long panicle, 120 days maturity period, high seed yield.	CIMAP Lucknow	Northern Indian plains, Gujarat & Rajasthan
	Jawahar Isabgol-4 (JI -4)	High seed yield-1300-1500 kg/ha	JNKVV Mandsaur	Gujarat, Maharashtra, some parts of M.P. & Rajasthan
	Gujarat Isabgol-1 (GI-1)	Dwarf and erect plant, 1 ton/ ha seed yield and early maturing,	GAU Gujarat	Gujarat, Maharashtra, parts of M.P. & Rajasthan
	Gujarat Isabgol-2 (GI-2)	1 ton/ha seed yield, moderately resistant to downy mildew	GAU Gujarat	Gujarat
	Haryana Isabgol-5 (HI-5)	1-1.2 ton/ha seed yield, maturity period 140-145 days	CCS-HAU, Hissar	South western Haryana, some parts of M.P., Maharshtra, Gujarat & Rajasthan

4.	**Opium Poppy *(Papaver somniferum)***			
	Kirtiman (NOP-4)	Latex yield 45-50 kg/ha, Morphine content is 11.95%, moderately resistant to downy mildew.	NDUAT, Faizabad	Eastern Uttar Pradesh
	Jawahar Aphim - 539 (MOP-539)	Latex yield 65 kg/ha, Morphine content 14.85%).	JNKVV Mandsaur	Central western plains & M.P.
	Jawahar Aphim – 540 (MOP-540)	75 kg/ha latex yield, Morphine content 13%	JNKVV Mandsaur	Central Plains & M.P.
	BROP-1	Average opium yield 54 kg/ha, seed yield 10-12 q/ha, Morphine content 13% more than local check.	NBRI, Lucknow	Northern Indian Plains
	NBRI-1	Average opium yield 52 kg/ha, seed yield 10 q/ha, Morphine content is 12-13% more than parent plants.	NBRI, Lucknow	Northern Indian Plains
	NBRI-2	Average opium yield 52 kg/ha, seed yield 12 q/ha, Morphine content is up to 15% more than local check.	NBRI, Lucknow	Northern Indian Plains
	NBRI-3	High latex yield (47-58 kg/ ha)	NBRI, Lucknow	Central eastern U.P
	NBRI-6	Average opium yield 55 kg/ha, seed yield 12 q/ha.	NBRI, Lucknow	Northern Indian Plains
	NBRI-9	Larger capsules, seed yield 14 q/ha, average opium yield 52 kg/ha	NBRI, Lucknow	Northern Indian Plains
	Madakini	Multiple disease resistant, opium yield up to 64 kg/ha, high morphine content up to 15%.	NBRI, Lucknow	Northern Indian Plains
	Sweta Sampada Shyama Rakshit	Medium tall, dark green leaves and white flowers. The characters of these four varieties are different and give optimum yield of morphine content.	CIMAP, Lucknow	Northern Indian Plains
	JA-16 (Jawahar Aphim)	Early-maturing (150-110 days) Latex yield (60-70 kg/ ha); 10-12.5% morphine content.	JNKVV Mandsaur	Nothern Central India, M.P. & Chhattisgarh
	Trishna (IC-42)	Medium dwarf, Latex yield -65-70 kg/ha); 14.78% Morphine	NBPGR, New Delhi	Throughout India (Northern Central India)

	Chetak 17 (UO 285)	High latex yield- 65-70 kg/ha; High Morphine content (12-13%)	RAU, Udaipur	Central eastern U.P, Rajasthan
5.	**Tulsi (*Ocimum tenueflorum* syn. *O. sanctum*)**			
	CIM-Ayu	Tall with green leaves	CIMAP Lucknow	Northern Indian Plains M.P., Rajasthan, Gujarat, Haryana and Punjab
	CIM-Angana	Tall with purple leaves	CIMAP Lucknow	-do-
	CIM-Kanchan	Tall plants with light green leaves, high herbage yield	CIMAP Lucknow	Lower Himalayan Region
6.	**Mulhatti *(Glycyrrhiza glabra L.)***			
	Hariyana Mulhati No.1 (HM-1)	Root yield 60-75 q/ha after 2.5-3 years, Glycyrrhizin content 6-7% in rest at 30m age	HAU, Hissar	Northern Central Plains, Haryana & Punjab
7.	**Brahmi *(Bacopa monerii)***			
	CIM-Jagarti	Creeping/floating type plants with light green leaves & purple flowers.	CIMAP Lucknow	Northern Indian plains, Gujarat, Haryana, Karnataka, Rajsthan, MP, Punjab & Central-eastern India.
8.	**Mandukparni (*Centella asiatica* Syn. *Hydrocotyl asiatica*)**			
	Zandu Brahmi (Sel.)	Creeping herb, preferably cultivated as under crop in orchid produces 1.0 to 1.2 t/ha., leaf crop in 3 harvests in a year. Tri-terpinoid content (1.0%)	Zandu Foundation for Health Care, Vapi, Gujarat	Gujarat (Proper moist climate in high rainfed tracts)
9.	**Periwinkle *(Catharanthus roseus* syn. *Vinca rosea)***			
	Prabhat	Dry root yield- 15-18q/ha) Dry leaf yield- 20-25 q/ha after 2-3 cuts	CCS-HAU, Hissar	Northern Central Plains
	IC- 49581	High biomass yield & high alkaloid content; serpentine (0.41% more)	NBPGR, New Delhi	Central plains
	EC-120835	Total alkaloid content is 1.2% more in leaves.	NBPGR, New Delhi	Central plains
	EC-120837	Alkaloids are 2.49% more in root	NBPGR, New Delhi	Central plains
10.	**Kalmegh *(Andrographis paniculata)***			
	Anand Kalmegh-1 (AK-1)	High biomass yield- 3.5 t/ha, Andrographolide content- 1.20%	AAU Anand & ZFHC, Vapi	Middle Gujarat

	CIM-Megha	Medium height, bushy, light green leaves	CIMAP, Lucknow	All over India
	IC-111286 IC-111287 IC-111289	High biomass yield and 1-2% Andrographolide content	NBPGR, New Delhi	Northern plains
	KI-5	30-35q/ha dry herb yield, 2.15% Andrographolide content	College of Agriculture, Indore	Middle Gujarat, M.P. & Chhattisgarh
11.	**Safed Musli *(Chlorophytum borivilianum)***			
	Anand Safed Musli-1 (ASM-1)	Blunt end and whitish attractive colour, high root yield fresh (3-5 ton / ha), sapogenine content 0.62%	AAU, Gujarat	Northern Central Plains and middle Gujarat
	Jawahar (JSM-405)	Fresh root yield: 22-24 q/ha, tuber length- 5-7.5 cm, 2-8% Saponin	JNKVV, Mandsaur	Northern Central Plains, MP and Chhattisgarh.
12.	**Kewanch (*Mucuna pruriens*)**			
	CIM-AJAR	Fast growing, early maturing, lint less pod	CIMAP, Lucknow	Northern Plains, Rajasthan, M.P., Gujarat & south India
	IC-2533	High seed yield, high L-dopa content (3.82%)	NBPGR, New Delhi	Northern Plains, Rajasthan, M.P., Gujarat & south India
	Zandu Kewanch-1	High food yield, pods devoid of stinging hairs, high L –dopa (5-6% more)	ZFHC, Vapi, Gujarat	Northern plains, Rajasthan, M.P, Gujarat & south India
	IIHR MP 10 IIHR MP 11	Short trichomes, high seed yielding lines with high L-Dopa content (4.4-4.6%) with an average duration of 180 days.	IIHR, Banglore	Northern plains, Rajasthan, M.P, Gujarat & south India
13.	**Aloe/Ghritkumari (*Aloe barbadenis* L.)**			
	IC-111271	High aloin content (>20%)	NBPGR, New Delhi	Throughout India
	IC-111280	High gel yield (2.45 mg/ml)	NBPGR, New Delhi	Throughout India
	CIM-Sheetal	High aloin content (>20%) High gel yield (2.45 mg/ml)	CIMAP, Lucknow	Throughout India
	RLAV-18	Average leaf yield: 50t/ha Aloin 0.02%	IIIM, Jammu	Sub-tropical & arid areas.

14.	**Sarphgandha (*Rauvolfia serpentina)***			
	RS-1	Erect, evergreen, roots dull yellow with specific aroma.	NDUAT, Faizabad	Northern Indian plains
	CIM Sheel	Medium height plant, long roots and light green leaves	CIMAP, Lucknow	Northern Indian plains
	RI-1	75-90 cm height, seeding to flowering 115-145 days, 1.5% total alkaloid content	JNKVV, Indore	M.P. and Chhattisgarh
	Sarpgandha	75 cm height, dry root yield 800-1000 kg/ha	IIIM, Jammu	Tropical and sub-tropical regions of India
15.	**Shatavar (*Asparagus racemosus)***			
	Shatavar	Dry tuber yield 10 t/ha in 2 years, four types of saponins	IIIM, Jammu	Tropical and sub-tropical regions of India

The medicinal plants are valued for the content of secondary metabolites, and hence, their content and composition are often more important than the total yield of the economic part(s). In this context, cultivation of seeds/planting material of known genetic origin, with higher productivity and optimum quality in a particular edapho-climatic condition is very important.

PROPAGATION AND NURSERY MANAGEMENT

Medicinal and aromatic plants are propagated by a wide variety of methods. For propagation, the most suited method for the plant should be selected. For multiplication through seed, healthy and vigorous seeds may be sown either in containers or in prepared soil in open ground. Some seeds require special treatment for breaking their dormancy or improving germination. Propagation through cuttings is another popular method of propagation, suitable for woody perennial herbs. Some plants that form clump can be divided into smaller sections and replanted.

Some plants can be sown directly in the field, while others are first sown in nursery-beds where seedlings are raised and then transplanted. Proper nursery management for raising seedlings and transplanting them is important. It is advisable to have soil sterilization of the nursery bed before sowing. The soil can be sterilized through the process of solarization. When seeds are sown in extremely cold weather, rainy season or hot weather, a low tunnel of semi-circular shape may be erected over the seed beds to protect the seedlings from adverse weather conditions.

FIELD PREPARATION

The soil of the field should be prepared thoroughly before transplanting. The root crops and small seeded crops require fine tilth. The field should be leveled properly and beds of convenient size shall be prepared with ease in irrigation and drainage. Deep ploughing in summers and green manuring are beneficial before the final field preparation.

DIRECT SOWING/TRANSPLANTING

The seedlings should be transplanted as early as possible after carefully removing from the nursery beds without damaging their roots. For better establishment of the seedlings, it is advisable to transplant them in the evening so that they establish themselves within the night and may recover from the shock of transplanting before the sunrise. Transplanting should immediately be followed by irrigation. Seedlings that fail to establish or not doing well should be removed and replaced by new ones.

The direct sowing of crops should preferably be done in rows spaced at appropriate distance. The optimum depth of sowing may be decided on the basis of the seed size. For direct sowing, pre-sowing irrigation sowing is provided. When the field is at optimum moisture level, the rows are opened by cultivator or hand-hoe. These can be opened in the evening and left overnight to conserve the dew moisture. The seeds can be sown and covered with the soil in early morning. Widely spaced and large seeds can be dibbled into the soil. After the seed emergence, excess plants can be removed (thinning) to maintain the optimum plant population at the time of first weeding/hoeing after first irrigation.

NUTRIENT MANAGEMENT

While cultivating medicinal plants, one has to be very careful with application of chemical fertilizers, as this may reduce the quality of the herbs. Organic materials such as vermi-compost, farm yard manure, bio-gas slurry, compost, neem cake and other oilseed cakes, biofertilizers, green manure and cover crops can substitute the inorganic fertilizers. Nutrient management in integrated manner has beneficial effect on soil organic matter and available plant nutrients resulting in sustainable crop production. The application of organic manures including vermicompost and biofertilizers has been found beneficial in several medicinal plants. However, research work on nutrient requirements of medicinal and aromatic plants is quite meagre. Systematic studies need to be initiated to exploit full potential productivity by proper fertilization of crops.

IRRIGATION

Watering the plants is very critical as many plants produce medicinally active constituents in dry conditions. The object of irrigation is to keep adequate water available to the crops, or, if water is in short supply, to use it most effectively. The plants should be watered well after planting and later irrigations shall depend upon visual observation of the plant. These are based on early signs of dryness, slight temporary wilts, foliage colour and dryness of the soil. Stagnation of water due to over-irrigation or rains should be avoided and the general principle shall be ‘light and frequent irrigation’.

WEEDING

The plants growing out of the place compete with the medicinal and aromatic herbs for space, nutrients and water. The field should be kept free from weeds by hand weeding (removing them by *khurpi*)

and hoeing which increases aeration for the plant roots. Use of herbicides should be strictly avoided, using alternative weed management techniques leading to minimum loss in crop production and least disturbance to the ecosystem. Use of mulches smother perennial weeds and prevent the germination of annual weeds. Mulches also conserve moisture and lower the surface temperature.

INSECT- PEST AND DISEASE

Use of synthetic chemicals for the control of insects and diseases should be avoided due to their great hazard to humans, lower forms of the animal life and also to the active principle of the medicinal herb. Non-chemical, biological methods should be used to control insects-pests and diseases. These include conservation and augmentation of natural enemies of insect-pests and adoption of all cultural, physical, mechanical and biological methods. Oils and soaps and botanical pesticides are fast emerging tools for the control of insect pests.

HARVESTING AND PROCESSING

Harvesting of herbs requires careful planning so as to retain their active ingredients. To prevent the crushing and deterioration of the plant material, wooden tray or an open basket should be used for collecting herbs. The cuts should be made with a sharp knife or scissors to minimize damage. The material should be collected from healthy plants that are free from disease and insect damage. It is important to discard any damaged plants as they can lead to disease or decay in dried plant material. Only single herb should be collected at one time and the harvested plant material should not be mixed to avoid mistakes in identification. The herbs should be harvested in dry weather, preferably on a sunny morning after the dew has evaporated. Herbs can be preserved in a number of ways, the most common and simple being air or oven drying. A warm, dry place is ideal for storage and processing. Plain paper should be used for drying herbs and not the printed newspaper. Dried herbs can be stored for many months in a dark glass jar or a brown paper bag. The underground parts of the plant are usually collected in January when the plants become inactive. After removing the required amount, the remaining underground part should be replanted.

Medicinal plants should be harvested during the optimal season or time period to ensure the production of medicinal plant materials and finished herbal products of the best possible quality. The time of harvest depends on the plant part to be used. Detailed information concerning the appropriate timing of harvest is often available in national pharmacopoeias, published standards, official monographs and major reference books. However, it is well known that the concentration of biologically active constituents varies with the stage of plant growth and development. This also applies to non-targeted toxic or poisonous indigenous plant ingredients. The best time for harvest (quality peak season/time of day) should be determined according to the quality and quantity of biologically active constituents rather than the total vegetative yield of the targeted

medicinal plant parts. During harvest, care should be taken to ensure that no foreign matter, weeds or toxic plants are mixed with the harvested medicinal plant materials. Medicinal plants should be harvested under the best possible conditions, avoiding dew, rain or exceptionally high humidity. If harvesting occurs in wet conditions, the harvested material should be transported immediately to an indoor drying facility to expedite drying so as to prevent any possible deleterious effects due to increased moisture levels, which promote microbial fermentation and mould. Cutting devices, harvesters, and other machines should be kept clean and adjusted to reduce damage and contamination from soil and other materials. They should be stored in an uncontaminated, dry place or facility free from insects, rodents, birds and other pests, and inaccessible to livestock and domestic animals.

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PHYTO-PHARMACEUTICALS AND AYURVEDIC NORMS

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ABSTRACT

As the knowledge increases the quest for safe medication also increases. The era of scientific advancement and achievements will also be regarded as era of side effects of modern drugs. In fact this has brought the scientist and researchers to revisit traditional medicines, which are supposed to be safer. These drugs are having their roots in botanical source rather than the chemical moiety. Though primarily seems to be having tall and anecdotal claims, but are used since many centuries, either in the form of culinary or alone. These have been got place into the culture, many time also called as Hindu Medicine. Charaka quotes: "Nān aushdhibhutam jagat kinchit" there by meening – "Nothing in this world is devoid of medicinal properties"

Herbs and spices such as garlic, cloves, cinnamon and cardamom, ginger, garlic, pepper turmeric, and cumin are have been used for centuries for culinary purposes and are the foundation of many traditional medicinal practices. Great Indian sages noted the potential benefit of herbal remedies, Some of spices of current interest are curcumin (found in turmeric), capsaicin (found in red pepper), cinnamon, and ginger.

Ayurvedic norms for standard drug reveals that it should be efficacious in small quantity, great potency, kills various disorders, provides relief, easy to digest, tastes good, energizer, Disease killer, neither side effects and nor harmful, with soothing smell, colour – consistency and taste, given in proper dose is known as oushadham.

Ayurveda is the Knowledge that describes or indicates the four states of life, the appropriate and inappropriate, happy or sorrowful conditions along with what is good and bad for longevity as well as measurement of life itself. Charaka says: "Nān aushdhibhutam jagat kinchit" ie: "Nothing in this world is devoid of medicinal properties". In Charak Samhita - approx . 600 plants are described, where as in Shushrut Samhita –approx. 700 and in Bhav Prakash Nighantoo –approx. 350 plants are described. Herbal drugs in the form of formulation(s) have been used in India for more than 4000 years.

AIM OF FORMULATION

One must be very clear about aims of formulations, which are as follows:-

- Compatibility - To cures disease, and provides relief.
- Availability - in all season /region
- Palatability - for all Age groups
- Fixed dose per unit- including various convenient modes.
- To obtain more efficacious drug by synergistic properties (1+1=3)
- To remove various toxic or untoward effects

Table-1 Dosage forms described in various Ayurvedic texts

S. No.	Ayurvedic Text	Era	Number of dosage forms
1.	Charaka Samhita	12th BC	128 dosage forms
2.	Shushruta Samhita	10th BC	129 dosage forms
3.	Ashtanga Hridaya	6th AD	90 dosage forms
4.	Chakradutta	9th AD	90 dosage forms
5.	Sharangadhara Samhita	14th AD	75 dosage forms
6.	Bhaishajya Ratnavali	18th AD	98 dosage forms

DRUG

Derived from French– Drogue synonymous to *dravya* that is used for medicinal purpose or for *chikitsa* in *ayurveda.* WHO (1966) says – drug is any substance or product that is used to modify or explore physiological system or pathological states for the benefit of the recipient.

यत्राश्रिताः कर्मगुणाः कारणं समवायि यत्
तद्द्रव्यं समवायी तु निश्चेष्टः कारणं गुणः

Whereas Dravya in ayurveda means one among the shadpadartha (ie : Dravya ,guna, karma,samanya, vishesh, samavaya) and substratum of guna and karma (ie properties and action) and composed of five proto element (panchamahabhuta) and is used as diet (ahar) or drug (aushadha). The range of dravya -Nanaushadhi bhutam jagata kinchit …..means nothing in this world is devoid of medicinal properties. Charak revealed four components of medicine- Bhishak dravyani upasthata rogi padachatushtayam.

***Qualities of* dravya (drug) -** These are following four

1. *Bahuta (*should be in plenty*)*
2. *Yogatvam (*can be used as combination*)*
3. *Anekvidh kalpana* (usable with various type of combination)
4. *Sampad* (must have potency to combat the disease)

AYURVEDIC NORMS FOR STANDARD DRUG

As mentioned in Charak Samhita following are the norms for Standard Drug

अल्पमात्रं महावेगं बहुदोषहरं सुखम्
लघुपाकं सुखास्वादं प्रीणनं व्याधिनाशनम् १५

अविकारि च व्यापत्तौ नातिग्लानिकरं च यत्
गन्धवर्णरसोपेतं विद्यान्मात्रावदौषधम् १६

It should be efficacious in small quantity, must have great potency, kills various disorders, provides relief, easy to digest, tastes good, energizer, disease killer, neither side effects and nor harmful, with soothing smell, colour – consistency and taste, given in proper dose is known as oushadham.

Alpmatram (Efficacious in small quantity) Matra (dose) with prefix *alpa* – small quantityie amount of drug that is efficacious without any adverse or side effect represented in terms of Therapeutic index, which is

= maximum non-toxic dose/ minimum effective dose

= lethal dose/effective dose

= LD50/ED50

Aushadhi is veeryapradhan (have potency) so consumed in small quantity not like Ahara which is rasa pradhan consumed in large quantity. *Paracelsus (1493-1541)* says- *"All substances are poisons, there is non that is not a poison. The right dose differentiates a poison and a remedy"*.

Maha-vegam (with great intensity) it is better understood by stimulus verses reaction/response time. It depends upon pharmacokinetics therefore routes of administration, dose, latency of onset, tome of peak action, duration and frequency of administration should be considered.

It starts with absorption of drug and ends up in excretion, in between there are distribution, metabolism and storage. Absorption depends on routes of administration{- may be oral, topical, par-entral or rectal (?Basti)} for bioavailability and biotransformation (ie: metabolism). Where as Excretion ie: passage out of systemically absorbed drug through kidney, liver or lungs by means of urine, faeces, exhaled air, saliva, sweat and milk.

To alter the drug response Ayurveda consider certain substances as *yogavahi* (ie: carrier of drug or vehicle) and *anupan* to facilitate digestion of drug, may be considered as catalyst or bio-enhancer.

Bahudoshharam (cover wide range of disease) there exist three types of *dravya, based upon* the drug responds (pharmacodynamics= study of drug effect) in following three ways:- (1) Stimulant (2) Depressant and (3) Nutrient, thus covering wide range of diseases.

किंचिद्दोषप्रशमनं किंचिद्धातुप्रदूषणम्
स्वस्थवृत्तौ मतं किंचित्त्रिविधं द्रव्यमुच्यते

The principle of medicine is to make equilibrium as revealed below:-

सर्वदा सर्वभावानं सामान्यं वृद्धिकारणम्
ह्रासहेतुर्विशेषश्च प्रवृत्तिरुभयस्य तु ४४

सामान्यमेकत्वकरं विशेषस्तु पृथक्त्वकृत्
तुल्यार्थता हि सामान्यं विशेषस्तु विपर्ययः

Sukham *(Anukul vedaneeyam)* Feeling of goodness or pleasure since disease is dukham so disease free condition is sukham.

Laghu pakam easily digestible (should early metabolized).

Sukhaswadanam Palatable in quality (taste) and quantity (amount).

Preenanam Should provide pleasure

Vyadhi nashanam potency to cure disease

Avikari / avyapad must not have side effect/adverse effect.

Natiglanikara drug should not produce any guilty

Gandh- varna- rasotpetam should have pleasant smell, colour, and taste.

Matravad aushadham given in proper dose.

STANDARD NORMS OF SINGLE DRUG

Himalaya, the best among the mountains, is the habitat of medicinal plants. One should obtain their fruits/ produce grown in proper time, mature

with taste and potency, replenished with the sun, air, shade and water in respective seasons according to need, and which are uneaten, unpurified, uninjured and nontoxic. (I) Will explain further the excellent actions and use of these fruits. As mentioned in Charak Samhita:-

ओषधीनां परा भूमिर्हिमवान् शैलसत्तमः
तस्मात्फलानि तज्ञानि ग्राहयेत्कालजानि तु ३८

आपूर्णरसवीर्याणि काले काले यथाविधि
आदित्यपवनच्छायासलिलप्रीणितानि च ३९

यान्यजग्धान्यपूतीनि निर्व्रणान्यगदानि च
तेषां प्रयोगं वक्ष्यामि फलानां कर्म चोत्तमम् ४०

RELEVENCE OF *SHARANGDHAR SAMHITA*

For the first time in the history of hindu medicine certain norms or guidelines has been laid for the preparation of Ayurvedic drugs. Codified by grand son of Royal Physician to Hammir Deo, the king of Ranathambore (Now located in Rajasthan) in 13-14 century AD. This master piece of work got place among the three subsets (Laghutrayei). It is regarded as basic book for Ayurvedic Pharmaceutics. It is composed in three subdivisions with total 32 chapters and 2600 verses in Sanskrit. Its speciality lies in the basic preparations and their derived forms with examples. It has brought the turning point in the history of hindu medicine as proper preparation of drug is mentioned for the first time specifically. It is simple and easy to understand and gives further insight for regulatory norms for drug manufacturing. Norms are basically of two types viz: Generalised norms & Specified norms. The generalised and specified norms for basic and derived forms of drugs have been practiced long back.

Specialties of the *Sharangdhar samhita*

1. It is devoted to Lord Shiva, Though Buddhism was at the peak.
2. It has given a new thought regarding ayurvedic drug manufacturing ie : Pharmaceutics.
3. Got place in *Laghutrayie,* amongst others predominant in Nidan (Etiopathogenesis) & Dravyaguna (Pharmacognosy).
4. The disease is caused by 4 factors :-

- Natural- Like Hunger,Thirst, Old age, Sleep etc.
- External(Environmental &Accidental)
- Internal (Bodily Disturbances)
- and Mental (Psychological)

Pharmaceutical ABC of the *Sharangdhar samhita*

Amongst 7 chapters of the first section following are the Pharmaceutics related topics:-

A. 1st chapt - About Definitions and measurements.

B. 2nd chapt - Basic principles of Pharmacy.

C. 4rth Chapt - Classification of drugs according to their specific action, eg; Deepan,Pachan, etc.

Rule of generalization

These are general instructions to be followed, if nothing is specified eg:-

- Collection of the medicine - to be done in early morning
- Where parts are not mentioned -roots to be collected
- Where ratio is not mentioned - means equal ratio
- Where pot is not mentioned - Earthen pot
- Where liquid is not specified - Use water
- Where oil is not mentioned -use Til Tail
- Where mentioned in two places - double the quantity
- For Churna, Sneh, Asav, Lehyam - use Swet Chandan
- For Kashaya, Lep -use Rakta Chandan

Table-2 Classification of drugs as per their action *Sharangdhar samhita*- It is given in below table:-

Group(s)	Example(s)
Deepan (Appetizer)	Mishi (Saunf)
Pachan (Digestive)	Nag Keshar
Deepan Pachan (Appetizer & Digestive)	Chitrak
Samshaman(Palliative)	Guduchi
Anuloman (Carminative)	Haritaki
Samshran (Laxative)	Amaltash
Bhedan(Purgative)	Kutaki
Rechan (Cathartics)	Trivritt
vamak (Emetics)	Madanphal
Samshodhan (Purifiers)	Devdaali phal
Cchedan (Scarificant)	Kshar, pippli & marich
Lekhan(Dehydrant)	Honey,hot water,vach & yava
Grahi (Absorbant)	Sunthi, Jeerak, Gaja Pippli
Stambhan (Constipating)	Kutaj,Shyonak
Rasayana (Rejuvinators)	Guruch, Rudanti, Guggulu & Haritaki
Bajikar (Aphrodasiacs)	Nagbala beej, Kapikacchu
Shukral (Semenogouge)	Aswagandha,Moosali,Sugar, & Shatavari
Shukrajanak (Spermatogenetic)	Milk, Udad, Bhallatak
Sukshma (Subtle)	Saindhav, Honey, Nimbtail
Vayvayi (Absorb before digestion)	Bhang, Afeem
Vikashi (Reluctant of joints)	Supari, Kaudo
Madkari (Intoxicant)	Madhya, Sura
Pramathi (Decongestant)	Marich & Vacha
Abhishyandi (Obstructant)	Dadhi

Pancha Kashaya Kalpana

Derived from Sanskrit root 'kash himsayam' with meaning of - "by destroying original form" of substance, either by cutting, crushing, or cooking; to make it in a palatable form. It is the basic form of preparation (with alterations rest can be prepared). They are five in number.

1. ***Swaras*:** fresh juice of plant material is used as such

2. ***Kalka:*** paste of fresh plant material **– *Churna*** (ie- powder) may be dry**.**
3. ***Kwath*****:** decoction Boil with water and reduce to 1/4, 1/8 or 1/16 of the original.
4. ***Sheet*****:** (cold infusion) Material soaked in water over night.
5. ***Phant*****:** (hot infusion) boil the material.

The potency of drug decreases in following order :- *Swaras >Kalka> Kwath> Sheet> Phant*

Other forms

- Ksheer pak-(1:15:15) material is boiled with milk and water in equal amount,It can be taken when reduced to half. *e.g. Arjun twak Ksheer pak,Rason Ksheer pak*
- Usnodak & Aushadh siddha paneeya- eg;Sadang Paneeya for low grade pyrexia, which contains *Nagermotha, Pittpapada, Khash, Shoonthi, RaktaChandan, Sugandhbala.*

Kwthadinam punah pakat ghanatvam sa rasakriya soavalehasch lehasch tat matra karsa sammita

- *Ghana*-Boil the decoction till it becomes solid eg; Guduchi ghana vati alias Samshamani vati for peripheral neuritis & Pittaj jawar
- *Avaleh- 'Lih Aswadane'* the form of medicine which can be tasted with help of tongue.

Examination of *avaleh*- Following test has been mentioned

Supakwe tantumattavam syadlehoapsumajjanam sthirattavam peedite mudragandhvarnarasodbhav

Increasing order of solidity The consistency increases as below:- Kwath<Rasakriya<Avaleha<Ghana

Sandhan

- Fermented, Self generated alcoholic extract with long lasting shelf life.
- If coarse powder (*yavakoot)* is directly used it is K/a- *Asava.*
- If decoction is used it is termed as *Arista.*
- Dhataki provides *spores of yeast*, as well as specific color & enhances other biological activity.
- A match stick can tell whether the process is over or not.
- Distorted one becomes sour, bitter &acidic *chukra*
- In earlier period earthen pots /*Sagoan* drum are used but nowadays fermentors are in use
- Yeast has replaced the *Dkataki puspa.*
- Jaggary can be replaced by Sugar.
- Sp.gr., ph, suger%, Alcohal% are the modern parameters to ensure batch to batch consistancy.

Asavas and Arishtas Siddha Lakshanas & Precautions

- Cessation of sounds inside the vessel
- Light a matchstick and hold it over the mouth of vessel. If it continuous burning, the fermentation is complete If the match is extinguished (because during the process of fermentation carbon -di- oxide is produced) the fermentation process is said to be incomplete.
- If air passage of the fermentor, is kept in a water filled jar and the bubbles

comes out, than process is incomplete. Do not powder the Dhataki pushpa

- Sun dry the flowers before use.
- The prakshepa dravyas should not be fine powdered, since the sediments will increase if done so.
- The alcohol % should be within permissible limit.

Churnas – These are the fine powder(s) of herb or herbs, with following descriptions

Table-3 Practical size and their descriptive term

Descriptive Term	Practical size
Coarse (2000/355)	All the particles will pass through a no.2000 sieve, and not more than 40%through a No.355 sieve
Moderately coarse (710/250)	All the particles will pass through seive No 710 sieve and not more than 40% through a No 250 sieve.
Moderately fine (355/180)	All the particles will pass through a No 355 sieve and not more than 40%through a No 180 sieve.
Fine (180)	All the particles will pass through a No 180 sieve,
Very fine (125)	All the particles will pass through a No 125 sieve

MARKERS

There are phytochemicals developed through commercially viable processes for the optimum extraction of herb. These may or may not be the active constituents. The plant extracts generated thereof are standardized to contain known amount(s) of biologically active constituent(s). For plants where markers are not known, bioactivity guided fractionations are undertaken and markers are isolated for the purpose of standardization. Chromatographic techniques like column, flash, HPTLC, Preparative HPLC are employed for isolating constituents. The isolated single chemical entities are thoroughly characterized using the conventional spectroscopic (UV, IR, NMR & Mass spectroscopy) and chromatographic techniques.

Identification of crude drugs using pharmacognostic techniques:

- Isolation of markers for standardization of herbal products.
- Bioactivity guided fractionations of herbs to isolate their bio-active compounds.
- Development of extraction procedures for medicinal plants.
- Isolation of phytochemicals of high purity for use as chromatographic reference standards.
- Process optimization for supercritical CO_2 extraction of selected natural products.

Table 4: List of few medicinal plants with their marker compound

Botanical Name	Common Name	Marker compound isolation
Adhatoda vasica	Vasa	Vasicine by HPLC
Andrographis paniculata	Kalmegh	Andrographolide by HPLC
Albizzia	Sirisha	Total Polyphenols

lebbeck		by Spectrophotometer
Asparagus racemosus	Shatavari	Shatavarin by HPTLC
Azadirachta indica	Neem	Total bitters by Gravimetry
Bacopa monnieri	Nir Brahmi	Total Bacosides by HPLC/HPTLC.
Berberis aristata	Berberis	Berberine by HPLC
Boswellia serrata	Salai guggul	Boswellic acids by HPLC
Cassia angustifolia	Senna	Sennosides by Spectrophotometry
Camellia sinensis	Green Tea	Total Polyphenols by UV, Catechins by HPLC
Centella asiatica	Mandook parni	Total Asiaticosides by HPLC
Cinnamomum cassia	Cinnamon	Polyphenols & Coumarin by HPLC
Coleus forskohlii	Coleus	Forskolin by HPLC
Commiphora mukul	Guggul	Total Guggulsterones by HPLC
Curcuma longa	Turmeric	Curcuminoids by Spectrophotometer
Emblica officinalis	Amla	Gallic acid by HPLC & Total Tannins by Spectrophotometer
Eclipta alba	Bhringaraja	Total Wedelolactone by HPLC

Books Referred:

1. Charaka Samhita
2. Shushruta Samhita
3. Ashtanga Hridaya
4. Chakradutta
5. Sharangadhara Samhita
6. Bhaishajya Ratnavali
7. The Ayurvedic Pharmacopoeia of India
8. WHO GMP Guidelines for herbal drug
9. Drug and Cosmetics act

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Chemistry, Biochemistry and Ayurveda of Indian Medicinal Plants, 2013, pp. 87-93
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Publisher : M.G.C.G.V.,Chitrakoot, Satna (M.P.) 485780

CHITRAKOOT-AN EMPORIUM OF BIOLOGICAL AND CULTURAL DIVERSITY

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ABSTRACT

Chitrakoot (The Hill of many wonders) is a most holy place for the pilgrimage of Hindus and has been very rich cultural and biological diversity since ancient times. The richness of biodiversity is described in various ancient literatures. There are several tribal communities like Kol, Gond, Mawasi and Khairwar inhabit in Chitrakoot region and utilize wide variety of plant resources for food, fodder, fibre, medicine etc. The biodiversity of Chitrakoot is reduced to a great extent due to unsustainable human activities. A detailed study on plant biodiversity, threat assessment, conservation and ethno botanical study on tribal communities has been carried during 2003-2011. In the present paper the work carried out during the aforesaid period is illustrated.

INTRODUCTION

Chitrakoot means the 'Hill of many wonders is indeed a gift of nature and the gods and located on the banks of river Paisuni (Mandikini and falls in the northern vindhyan range of mountains spread over the states of Uttar Pradesh and Madhya Pradesh. The Chitrakoot region is included in the District Chitrakoot of Uttar Pradesh and the District Satna of Madhya Pradesh. Chitrakoot Parvat Mala includes Kamad Giri, Hanumaan Dhara, Lakshman Pahari,and Devangana are famous Religious Mountains. It is a town of religious, cultural, historical and archaeological importance, situated in the Bundelkhand region. The major part of Chitrakoot is situated in the northern region of Satna district of Madhya Pradesh and surrounded on north, northwest and northeast by Karwi (Chitrakoot) district of Uttar Pradesh and west by Panna District of Madhya Pradesh. It is lies between 80^0 52' to 80^0 73'N latitude and 25^0 10' to 25^0 52' E longitude, covering an area of 1584 sq km. The general topography is hilly, precipitation and undulating cut off by numerous reveres and rivulets. Mandakini, Chakara and Jhuri rivers drain the region.

The Mandakini (a offshoots of the Ganga) is Holy River that is also known as Payasuni. The forest of the Chitrakoot predominantly consists of tropical dry mixed deciduous type. The climate of the Chitrakoot is dry and the maximum temperature goes up to 49.5^0c in the month of May and minimum up to $5\ ^0$c in the month of January. Chitrakoot is a one of the famous place of pilgrimage of Hindus in India and surrounded by lush green hills of legendary Vindhyachal range. Since times immemorial, it is famous for its religious importance, elegant environment and spiritual peace. Chitrakoot is also well known for its beautiful hill ranges, historical caves, perennial streams and varied flora and fauna. Therefore, the Chitrakoot has been sacred place of worship for sages and hermits since antiquity. Chitrakoot's spiritual legacy stretches back to legendary ages: It was in these deep forests that Rama, Sita and his brother Lakshmana spent eleven and half years of their fourteen years of exile. The great sage Atri, Sati Anusuya, Dattatreya, Maharshi Markandeya, Sarbhanga, Sutikshna and various other sages, seers, devotees and thinkers meditated; and here the principal trinity of the Hindu pantheon, Brahma, Vishnu and Shiva, took their incarnations.

It has been the centre of devotion, dedication and faith of devout persons of Lord Rama. Lord Rama, the most dignified and the best among the men, excels as an ideal role model in every respect and remains a timeless source of inspiration for mankind since an eon.

The first known mention of the place is in the *Valmiki Ramayana*, which is believed to be the first ever Mahakavya (epic) composed by the first ever poet. As Valmiki is said to be contemporaneous with (or even earlier than) Rama and is believed to have composed the *Ramayana* before the birth of Rama, the antiquity of its fame can well be gauged.

Valmiki speaks of Chitrakoot as an eminently holy place inhabited by the great sages, abounding in monkeys, bears and various other kinds of fauna and flora. Both the sages Bharadwaja and Valmiki speak of Chitrakoot in glowing terms and advise Rama to make it his abode during the period of his exile. Lord Rama himself admits this bewitching impact of this place. In the 'Ramopakhyana' and descriptions of holy places at various places in the *Mahabharata*, Chitrakoot finds a favoured place. In '*Adhyatma Ramaya*na' and '*Brihat Ramayana'* testify to the throbbing spiritually and natural beauty of Chitrakoot. Various Sanskrit and Hindi poets also have paid similar tributes to Chitrakoot. Mahakavi Kalidas has described this place beautifully in his epic *'Raghuvansha*'. He was so much impressed with its charms that he made Chitrakoot (which he calls Ramgiri because of its time-honoured associations with lord Rama) the place of exile of his yaksha in Meghdoot.

Tulsidas, the saint-poet of Hindi has spoken very reverently of this place in all his major works- *Ramcharit Manas, Kavitawali, Dohawali* and *Vinaya Patrika*. The last-mentioned work contains many verses

which show a deep personal bond between Tulsidas and Chitrakoot. He spent quite some part of his life here worshipping Rama and craving his darshan. It was here that he had what he must have considered the crowning moment of his achievements—i.e. the darshan of his beloved deity Lord Ram at the intercession of Hanumanji. His eminent friend, the noted Hindi poet Rahim (i.e. Abdur Rahim Khankhana, the soldier-statesmen-saint-scholar-poet who was among the Nav-Ratnas of Akbar) also spent some time here, when he had fallen from favour with Akbar's son Emperor Jahangir.

Kamadgiri, the original Chitrakoot, is a place of prime religious significance. A forested hill, it is skirted all along its base by a chain of temples and is venerated today as the holy embodiment of Rama. Lord Rama is also known as Kamadnathji which literally means fulfiller of all wishes. The Kamadgiri (Chitrakoot hill) is a sacred grove, it is clearly mentioned in *Ramcharit Manas* as "all the forests of Gods existing in the universe were filled with envy at the sight of Rama's hill forest".

This holy place has provided spiritual inspiration and energy to many sages and dignitaries and changed their attitude of life like Maharishi Valmiki, Goswami Tulsidas, Abdul Raheem Khankhana, Tansen and even Aurangajeb etc.

BIODIVERSITY IN ANCIENT LITERATURE

In ancient time, Chitrakoot was very rich in biodiversity. Maharishi Valmiki and Goswami Tulsidas illustrated a comprehensive account of biodiversity in their epics *Ramayana* and *Ramcharit Manas* respectively. According to Valmiki Ramayana, Chitrakoot is a beautiful and sacred place where different types of herbs, shrubs, trees and climbers bearing variety of fruits, flowers and roots are available. The richness of biodiversity of Chitrakoot is described four chapters of Ramayana. Names of several trees found on Kamadgiri are also mentioned. He has also described varied fauna of Chitrakoot. He has mentioned the names of different variety of birds, animals and movements of elephants and deers in the forests.

Goswami Tulsidas has also described similarly the beauty and diversity of flora and fauna of Chitrakoot in *Ramcharit Manas* "Chitrakoot hill has luxuriant vegetation of herbs, shrubs, trees and climbers. He has also mentioned the names of different variety of birds like blue jays, koels, parrots, cuckoos, kakavas, partridges, and animals like elephants, lions, monkeys, boars and deer's etc".

Chitrakoot was very rich in respect of medicinal plants too. It is mentioned in *Valmiki Ramayana* that "there are thousand kinds of medicinal plants are available in Chitrakoot region that express them at night like flame of the lamp".

MATERIAL AND METHOD

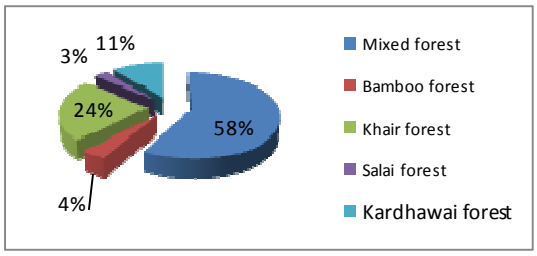
A comprehensive study on floristic diversity was carried out in Chitrakoot forest area of Madhya Pradesh region during the year 2003-2011 and covered almost all seasons. Detailed data of each plant was recorded with the help of prescribed field book. The data includes

date of collection, name of locality, local name, botanical name, family, altitude, habit and habitat, type of leaves, colour of flowers, type of fruits, flowering and fruiting, distribution, population status, threats etc. The voucher specimens were collected, pressed, dried, mounted and identified with the help of flora and herbarium specimens and preserved in the herbarium of Arogyadham, Deendayal Research Institute, Chitrakoot. The flora of Madhya Pradesh has been published in three volumes and one supplement ((Verma *et al*., 1993; Mudgal *et al.,* 1997; Singh *et al.,* 2001 and Khanna *et al.,* 2001) and no work on floristic diversity of Chitrakoot has so far been carried out. Sharma and Mamgain (1982) published a paper on flora of Satna district and listed 392 species of Satna district in which Chitrakoot was very poorly represented.

Similarly an ethno botanical survey was conducted in tribal areas of Chitrakoot region and the first hand information on medicinal uses of plants viz. local name of the plant, part used, mode of preparation, mode of administration/application, dose, duration etc. was collected from old and experienced tribal medicine man and women with the help of a standard questionnaire. The voucher specimens of the plants collected during the survey were properly identified with the help of floras and preserved in the herbarium of Arogyadham, Deendayal Research Institute, Chitrakoot.

FORESTS OF CHITRAKOOT

Forests are Tropical dry deciduous mixed type, 41% area is covered by the forests out of total area 1584 sq.km. The major forest types are Mixed forest, Bamboo forest, Khair (*Acacia catechu*) forest, Salai (*Boswellia serrata*) forest and Kardhawai (*Anogeissus pendula*) forest. The percentage of these forests is given below.



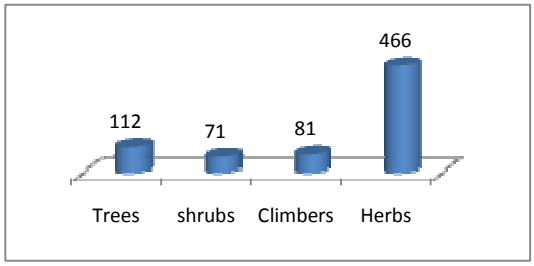
RESULT

A detailed floristic study of Chitrakoot region has been carried out by the author during the year 2003-2011 and found that there are over 730 species of flowering plants excluding cultivated and ornamental plants are found in Chitrakoot. These 730 species belongs to 445 genera and 111 families.

Table-1

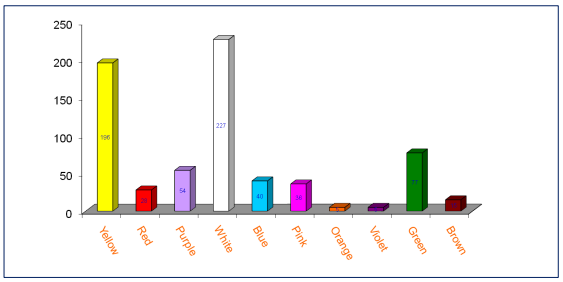
Taxa	Monocots	Dicots	Total
Families	89	22	111
Genera	344	101	445
Species	558	172	730

The life analysis shows that out of 730 species, trees are 112, shrubs are 71, climbers are 81 and herbs are 466.

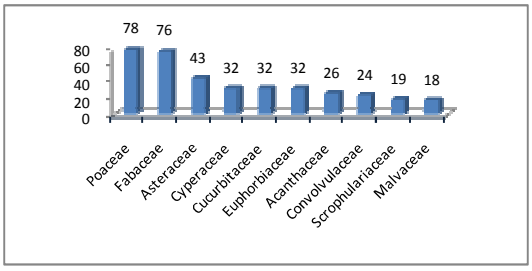


The flower colour spectrum reveals that out of 730 species, 196 plants bear yellow flowers, 28 red, 54 purple, 227 white,40 blue,36 pink,5 orange, 5violet, 77 green and 15 purple.

The flower colour spectrum reveals that



The 10 dominant families of Chitrakoot area are as follow:



The *Cyperus* is the largest genus having 20 species, followed *by Indigofera* and

Ipomoea-11 species each, *Ficus* has 10, *Cassia* 9, *Euphorbia* & *Fimbristylis* 8 each, *Grewia, Crotalaria,* & *Blumea*-7 each, *Alysicarpus, Justicia, Phyllanthus*, and *Eragrostis* 6 each, *Sida, Corchorus, Desmodium, Tephrosia, Acacia, Dioscorea* & *Commelina*-5each. Besides 6 Genera have 4 species, 27 have 3 species each, 68 have 2 species each and remaining 323 genus representing single species.

LOSS OF MEDICINAL PLANTS DIVERSITY

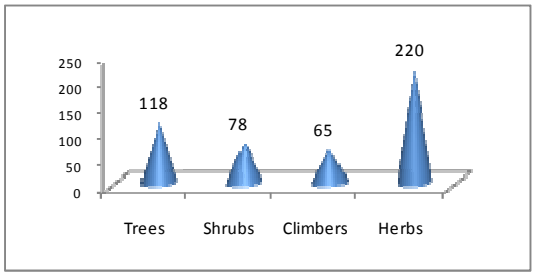
Chitrakoot was very rich in diversity of medicinal plants. It is mentioned in Valmiki *Ramayana* that "there are thousand kinds of medicinal plants are available in Chitrakoot region that express them at night like flame of the lamp". But at present, the Plant diversity of Chitrakoot is declining fast due to the degradation of habitats by heckles and indiscriminate cutting of forests for timber, fuel wood, expansion of agriculture, construction of roads, querying of stones, grazing, invasion of alien weeds, overexploitation of plants for medicines etc., the rich biodiversity of Chitrakoot region has reduced to a great extent. There are certain high value medicinal plants like *Chlorophytum tuberosum, Curcuma amada, Operculina petaloidea, Oroxylum indicum, Alectra chitrakutensis, Litsea glutinosa, Asparagus racemosus, Gloriosa superba, Andographis paniculata, Aristolochia indica, Celastrus paniculatus, Embelia basaal, Plumbago zeylanica, Uraria picta, Gymnema sylvestre Baliospermum montanum, Curculigo orchioides, Pterocarpus marsupium, Crataeva magna, Acorus calamus, Eulophia herbacea, Actiniopteris radiata, Costus speciosus, Butea monosperma* var. *lutea, Abrus precatorius, Habenaria plantaginea, Citrullus colosynthis, Trichosanthes tricuspidata, Plumbago zeylanica, Arisaema tortuosum, Plesmonium margaretiferum, Gymnema sylvestre, Cochlospermum religiosum, Terminalia chebula, Dioscorea bulbifera, D. hispida, D. pentaphylla, Dioscorea pubera, Tacca*

leontopetaloides, Clerodendrum serratum Nervillia prainiana, Bacopa monnieri, Centella asiatica, Smilax zeylanica, Luffa echinata, Cordia macleodii, Pueraria tuberosa, Piper longum, Zingiber zerumbet, Z. capitatum, Momordica dioica etc. These plants are assessed as threatened plants under IUCN Red List categories (2000) not only for Chitrakoot but also for Madhya Pradesh and Chhatisgarh. (Ved *et.al.* 2003). Therefore it is an urgent need to save the natural habitats and conserve the in valuable medicinal plants diversity of Chitrakoot region. Yet certain areas like Ansuiya forest, Guptagodawari forest, Mohkamgarh forest, Bagdaraghati forest and Kamadgiri hill have rich collection of plants and animals. These areas can be proposed for *in situ* conservation.

CONSERVATION OF PLANT DIVERSITY

The Deendayal Research Institute, Chitrakoot trying to conserve the medicinal plants diversity of Chitrakoot in their herbal garden, situated in Arogyadham campus. There are about 500 medicinal plants collected from different forest areas of Chitrakoot are conserved through ex situ method. Out of which about 70 plants are of threatened categories. The plants are divided in different groups like herbs, shrubs, trees, climbers, and tuberous plants.

Some doubtful plants in Ayurvedic point of view are planted in adjacent beds for easy identification. The life form analysis indicates that out of 500 species, 118 species are trees, 78 shrubs, 65 climbers and 220 herbs. The herbal garden is known for conservation of endemic and critically endangered plant Alectra chitrakutensis.



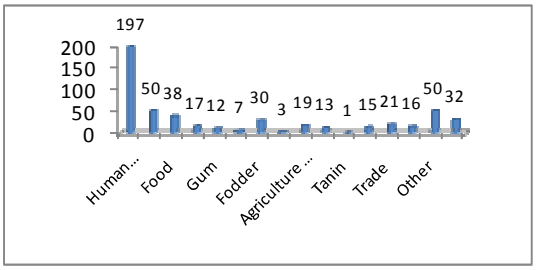
TRIBAL COMMUNITIES OF CHITRAKOOT

There are several tribal communities like Kol, Gond, Mawasi, and Khairwar etc. as mentioned in *Ramcharitmanas* still reside in Chitrakoot forest area. These tribal communities have their own culture, traditions, beliefs, customs etc. They are very poor and illiterate. They inhabit in and around forest area and utilize a wide variety of plants for food, fodder, fuel, medicine, dye, gum, tannin, thatching, household and farming implements etc. Their total population is about 0.16 million as per 2001 census which constitute 19.14% of the total population. They have small patches of land which are insufficient food requirements therefore; forest and its product play an important role in their daily life fulfilling a large number of their routine requirements. This area is largely excluded from urban culture and the people of this region still retain many originalities of their culture.

This region is unique in having some interesting ways of life and beliefs such as taboos, tattoos, magico-religious-beliefs etc. related to plants. The surrounding

plants are an important part of tribal culture and information about the plants get passed on from one generation to another generation only through oral folklore and many kept secret. It is also seen that the age-old cultural heritage of tribal is fast changing due to rapid urbanization, interference of outsiders in the tribal areas and changes in economic patterns. The habitats and environment where these primitive people experienced and learnt useful plant lore through generations are also disappearing day by day due to reckless deforestation and overexploitation of natural resources. Therefore, it is necessary that before this knowledge is lost forever it must be documented properly.

The collection of minor forest produces from the forest and selling these produces in nearby local markets is the main source of their economy. The tribal people inhabit in remote and far distant areas of the forests where no organized modern medical facilities are available. Besides they are very poor and of course unable to by expensive modern medicines. Therefore, they utilize locally available plant species for the treatment of human as well as livestock ailments and diseases. They are familiar about the medicinal uses of plants found their village surroundings and forest areas. But during the investigation it is observed that the young generation is not interested to hold this invaluable traditional knowledge transmitted orally from generation to generation. Therefore, before this traditional knowledge is lost forever it must be documented properly. For keeping these view in mind we have carried out an extensive ethnobotanical study on various tribal communities of Chitrakoot and found that they have utilize a wide variety of plant species for the various purposes such as human medicine, veterinary medicine, food, dye, gum, fibre, fodder, fish poison, agriculture implements, house hold implements and megico-religious beliefs etc.



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PART II

TISSUE CULTURE AND BIOTECHNOLOGY OF MEDICINAL PLANTS

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ROLE OF PLANT TISSUE CULTURE IN CLONING AND CONSERVATION OF PHYTODIVERSITY OF SOME ECONOMIC MEDICINAL PLANTS OF INDIA

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ABSTRACT

Biodiversity, particularly phytodiversity is the fundamental basis of human survival and economic development as it provides food, clothing, shelter, medicine, biomass, energy and industrial raw materials.

The medicinal plants constitute a large group of plants providing raw materials to be used in drug formulation and related industries. Because of the availability of all types of agroclimates, India is one of the richest centres in the world for plant genetic resources. Amongst the twelve megabiodiversity centres, India rank 10th in the world and 4th amongst the Asian countries in plant wealth. Out of 17000 flowering plant species in the country, 2000 have been found medicinally important. Due to high demand, medicinal plants have been indiscriminately extracted for short-term gain without putting any effort towards their conservation. In addition, during recent years, revival of traditional/herbal medicine has also led to over-exploitation of medicinal plants causing great depletion and even extincition of many medicinally important rare, endangered and threatened (RET) plant species worldwide. Under existing circumstances, it is warranted to explore conservation strategie4s in case of medicinal plants throughout the world to achieve the ultimate goal of their sustainable utilization for the welfare of mankind.

Conservation of phytodiversity is a holistic approach and involves both, in situ and ex situ methods. Amongst ex situ methods, plant Tissue Culture, as a foremost and extremely useful facet of Biotechnology, may play a pivotal role. Development of reproducible regeneration protocols not only forms the basis for successful micropropagation/clonal propagation, but also for a equally important aspect of germplasm preservation through in vitro strategies, which will lead to achieve the ultimate goal of conservation of phytodiversity by establishing 'Germplasm Repositories' or 'Gene Banks'. In this context, efficient in vitro processes for rapid micropropagation/cloning and germplasm preservation in case of four important show-propagating RET plants of the Indo-Gengetic plains, namely, Clerodendrum serratum L.Moon (a rare and threatened shrub), Uraria picta Jacq. DC (a rare endemic leguminous herb), Operculina petaloidea (Choisy) Oost. (a rare perennial vine) and Embelia tsjeriam-cottam Roem. & Schult. DC. (a vulnerable shrub) were developed for rehabilitation in their natural habitats for conservation and sustainable utilization.

Introduction

Biological diversity, particularly phytodiversity is the fundamental basis of human survival and economic development as it provides food, clothing, shelter, biomass, energy and industrial raw materials. According to Article 2 of the UN Convention on Biodiversity (CBD, 1993), biological diversity is defined as "the variety and variability among living organisms from all sources, including *inter alia*, the terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part, this includes diversity within species, between species and ecosystems". Thus, the three different levels of biodiversity are: (i) Diversity of ecosystem, (ii) Diversity of species and (iii) Diversity of genetic pool within species. The rich biodiversity of the planet is under threat due to various factors. The human population has witnessed a three-fold increase in the last century and the rate of fossil fuel consumption has increased by 12-fold during the period. It is estimated that, the carrying capacity of earth would saturate by the middle of the current 21st Century (Myers, 1990).

India is one of the 17 mega biodiversity countries, and has 26 recognized endemic centres that accounts for nearly one third of the flowering plants, though it constitutes 2.4% of land mass. According to State of Forest Report 1999 (2000), the forest cover in India is losing at an alarming rate coupled with various factors, which poses great threat to the rich biodiversity of the country. The main causes of habitat loss are agricultural activities, extraction (including mining, logging and harvesting) and unplanned developmental work. According to Wood *et al*. (2000) the underlying causes of biodiversity loss are poverty, macroeconomic policies, international trade factors, policy failures, poor environmental law/weak enforcement, unsustainable development projects and local control over resources. This has resulted in a situation where species are vanishing at an alarming rate. As per an estimate about 100 species of plants and animals are globally vanishing every day. The tragedy is still worse because many of the species will be getting extinct without being utilized or even known. It is calculated that half of the estimated 13.6 million species on the earth may become extinct if we do not take appropriate right measures to save them. Hence, conservation of biodiversity, particularly phytodiversity on global scale is the need of hour.

AN OVERVIEW OF CONSERVATION STRATEGIES

In India out of 47,500 species of plants one third are endemic to one or the other part of the subcontinent (BSI, 2000). Areas rich in endemism are north-eastern India, the southern parts of peninsular India, the Western Ghats and the North-Western and Eastern Himalaya. Two of India's great mountain ranges, the Eastern Himalayas and the Western Ghats have been designated among the world's eighteen 'hotspots' of biodiversity. But most of India's natural vegetation has been greatly modified by agriculture, forestry

and urbanization. Over 50% of the land area is cultivated and all forests, particularly moist forest types are rapidly being degraded due to population pressure and shifting cultivation resulting in loss of some important wild genetic resources. Today's requirement is sustainable utilization of biological diversity and its conservation for future, so that our coming generation should not be deprived of services and benefits provided by biodiversity on which they have full right.

Conservation of biological diversity leads to conservation of essential ecological diversity to preserve the continuity of food chains; therefore, it is important to conserve the whole ecosystem. This is important to understand that services provided by ecosystem, naturally free of cost, can never be replaced by mankind. The Convention on Biological Diversity (CBD) was the first legally binding international treaty to address the conservation, sustainable use and equitable sharing of benefits derived from the utilization of biological diversity in general. In April 2002, the Parties to the Convention committed themselves to achieve by 2010 (year proclaimed as the International Year of Biodiversity) "a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth".

Initiatives by India

A number of initiatives have been taken by our government, research Institutions and scientists in the country. India is a member of many international conventions working for conservation, like, CBD, Convention on International Trade and Endangered Species (CITES), etc. A list of about 1500 flowering and non flowering plants, have been compiled that are either very rare or are endangered and the information is being published in the form of "The Red Data Books of Indian Plants". Amongst 28 centres, National Botanical Research Institute (NBRI), Lucknow, Tropical Botanical Garden and Research Institute (TBGRI), Trivandrum and Forest Research Institute (FRI), Dehra Dun are the prominent organizations which are the members of Botanic Gardens Conservation International (BGCI) in India and actively involved in conservation programmes.

Conservation strategies

The effects of human activities on biodiversity have increased so greatly that the rate of species extinction is rising to hundreds or thousands of times the background level. These losses are driven by increasing demands on species and their habitats. The world conservation strategy (IUCN/UNEP/WWF, 1980) defines conservation as "the management of human use of the biodiversity so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations". The above definition invokes two complementary components "conservation" and "sustainability". The primary goals of biodiversity conservation as envisaged in the World Conservation Strategy can be summarized as: (i)

Maintenance of essential ecological processes and life support systems on which human survival and economic activities depend, (ii) Preservation of species and genetic diversity and (iii) Sustainable use of species and ecosystems which support millions of rural communities as well as major industries.

Conservation and sustainable utilization of plants must involve a long-term, integrated and scientifically oriented action programme. This should involve the pertinent aspects of protection, preservation, maintenance, exploitation, conservation and sustainable utilization. Conservation of biodiversity (phytodiversity) is a holistic approach and involves both *in situ* and *ex situ* methods of conservation.

In situ conservation:

In situ conservation means "on-site conservation", i.e., it is the process of conservation of species in its natural habitats and ecosystems. Establishment of biosphere reserves, national parks, wildlife sanctuaries, sacred groves and other protected areas are some of the examples of *in situ* methods of conservation. This strategy ensures the processes of evolution and adaptation within their environments. There are many practical problems exist in the development of such protected areas, like, cost, maintenance aspects, political and communal issues and the risk of complete wipe out of crops protected due to risks arising from biotic and abiotic stress as pests, insects, floods, cyclone, etc. Wild genetic resources, trees and forest species are appropriate candidates for this method where success rates of *ex situ* methods of conservation are very low.

Ex situ conservation:

Ex situ conservation means "off-site conservation", i.e., process of protection of species by removal of either the whole plant or their reproductive parts for conservation in an alien/foreign environment. This includes growing the plants in botanical gardens/arboreta, herbal gardens and biotechnological approaches such as *in vitro*, cryo and DNA banks.

Botanical garden and arboreta:

Botanical gardens and arboreta are the best centres for *ex situ* conservation of rare, endangered and endemic plant species. International Union for Conservation of Nature and Natural Resources (IUCN) strongly advocated that botanic gardens of world should be developed into major global centres for *ex situ* conservation of plant genetic resources. There are eight major botanical gardens in India and in addition there are more than 71 small gardens which vary in size and cater to the local needs. The Botanical Garden of NBRI, Lucknow and Indian Botanic Garden, Kolkata today act as *ex situ* centres for many endangered plants. Botanic Gardens Conservation International (BGCI) is a plant conservation organization based in England. It has 800 botanic gardens in 118 countries as members, whose combined work forms the world's largest plant conservation network.

Seed banks:

These are artificial seed repositories; where seeds can be stored under appropriate conditions as a source of planting material with the purpose of conservation of plant genetic resources. The method is suitable for orthodox seeds, which can be stored for a long time under low-temperature and low-humidity environment without losing viability and are easily stored in seed banks. Examples are small-seeded grain crops and vegetables. Whereas, recalcitrant seeds get damaged under low-temperature and low-humidity. However, seeds may be stored in low temperature ranges (0-10° C) for short periods such as 1-5 years. Examples are the seeds of cocoa, lychee, large and fleshy seeds, rubber, etc. Seed banks take up little space, but can be expensive to run, because of the need to maintain low temperatures and the necessity for germination tests, growth trials and regeneration. They are not suitable for heterozygous species or having recalcitrant seeds. National Bureau of Plant Genetic Resources (NBPGR), India has a large collection of long-term storage of seeds of orthodox species.

Pollen banks:

Pollens can also be stored at low temperature for longer period of time. It has advantages not only for conservation, but also tide over the time difference in flowering time of two species to be crossed whose flowering time is in different seasons.

DNA banks:

Isolated DNA can be stored *in vitro* at low temperature of -20°C for short- and mid-term storage (up to 2 years), and at -70°C or in liquid nitrogen for longer periods. Actually this is not a practical method of conservation, but at present is viewed as a substitute for existing techniques for the conservation of genetic resources. However, DNA banks can complement conservation strategies that make use of *ex situ* and *in situ* conservation, and they can help to ensure the optimal use of plant and animal populations. Still constraints are there in developing effective conservation strategies for some highly threatened species in wild, in such cases, DNA storage may be used as a resort to conserve the genetic diversity of these species and their populations in the short term, until effective methods can be developed.

In vitro tissue banks:

For homozygous plant species, seeds are ideal material for germplasm preservation, but certain other species, particularly heterozygous hybrids must be propagated vegetatively as also the case where seeds are recalcitrant or not produced or the plant is diseased. At the same time, maintenance of germplasm in field or glasshouse poses problems, such as vulnerability to diseases, occurrence of natural calamities, etc., besides genotypes requiring diverse agroclimates cannot be grown only at some selected places. Furthermore, the old genotypes which

have either lost the regeneration capacity or get systemically infected can be rejuvenated and made disease-free by *in vitro* methods, cloned to produce sufficient plant material and preserved. Thus, in this context plant tissue culture is the only hope for germplasm preservation. There can be five approaches to preserve germplasm through Tissue Culture for *ex situ* conservation.

i. Cryopreservation

Cryopreservation is the storage of biological material such as buds, shoot tips, zygotic and somatic embryos, and cell cultures under aseptic conditions at ultra-low temperature of -196°C in liquid nitrogen. At cryogenic temperature, cell division, metabolic and biochemical processes are arrested and cell retain their properties unchanged for a longer period of time (Niino *et al*., 1995). Though it has been found very successful for animal cells and organs (Wõlstenholme and O'Connor, 1970) is still in an experimental stage in the case of plant tissue and organs, as it has certain technical shortfalls (Withers, 1985). Further, this has yielded quite poor results and even after 30 years of efforts, we have few reports of successful regeneration of plant species after long-term preservation through cryopreservation.

In case of potato apices, recovery has been made after several years of their storage (Mix-Wagner *et al*., 2003). Recent reports have shown regeneration to complete plants from cryopreserved meristem after 28 years in case of pea and strawberry has been obtained (Caswell and Kartha, 2009). In India, NBPGR, New Delhi has a large cryopreservation bank with holding capacity of quarter million samples of small seeded crops. A total of over 6,000 accessions can be stored in the *in vitro* repository. Freezing and thawing injuries to membrane structure and function is a potential reason behind low survival rates in cryopreservation (Ashmore, 1997) and also low regrowth percentages. Besides, it requires very sophisticated and costly facilities, which sometimes even difficult to have in the under-developed and developing countries where conservation appears to be most essential.

ii. Limited growth cultures of shoots

Limited growth cultures of multiplying/ proliferating shoots of several important plants, as in case of medicinal plants, *Rauwolfia serpentina*, *Atropa belladonna*, *Dioscorea deltoidea*, *D. floribunda*, *Solanum khasianum*, *S. torvum*, *Rosmarinus officinalis*, *Chrysanthemum cinerariaefolium* (Chaturvedi et al., 2003), including rare, endangered and threatened plants of Indo-gangetic plains, like, *Clerodendrum serratum* (an endangered shrub; Sharma et al., 2009), *Uraria picta* (a rare endemic leguminous herb), *Operculina petaloidea* (a rare perennial climber) and *Embelia tsjeriam* – cottam (a vulnerable straggling shrub; Sharma et al., 2008) etc.; fruit trees, *Citrus grandis*, *C. aurantifolia*, *C. sinensis*, *C. karna, C. jambhiri and C. limonia* (Chaturvedi et al., 2001) and woody trees, *Mitragyna parvifolia* (Sharma et al., 2007), *Populus deltoides* (Chaturvedi et al., 2004a)

and *Azadirachta indica* (Arora et al., 2010) kept regenerative in long-term culture under culture room conditions, produced normal plants, even after 5 to 20 years of periodic subculture in the Tissue Culture Laboratory of NBRI, Lucknow. A high rate of multiplication can be achieved through this method, as from single nodal stem segment or shoot tip one can have thousands of plantlets within a shorter period of time. A large number of plants produced through this method can be replanted in their natural habitat providing a moderately good method of germplasm preservation. A complete cycle of plants produced through limited growth shoot culture raised from nodal stem segment of a 40-year old tree in case of *A. indica* is shown in Fig. 1 (a-g). However, some disadvantages are also associated with it, as it requires skilled workers to maintain cultures, subculturing has to be done within a particular optimum period of time generally 25-30 days (varies from species to species). Every time transfer of shoot/s to new nutrient medium involves cost of nutrients, growth hormones and agar (costliest ingredient of the medium) besides regular maintenance of temperature, light and humidity in the culture rooms. Most importantly one has to be cautious enough to maintain infection-free cultures as frequent subculturing could multiply the risk of infection in cultures.

iii. Slow growth/ restricted growth shoot cultures

In this approach the shoot apices are cultured on nutrient media with restricted growth. The growth rate of the *in vitro* cultures can be restricted by various methods including incubation at reduced temperature and/ or low light intensity (Withers, 1991), manipulation of nutrient elements in the culture medium and use of osmotic agents (Westcott, 1981; Tahtamouni et al., 2001; Moges et al., 2003) and sub-lethal levels of growth retardants (Gupta, 2001). Some commonly used growth retardants are tributyl-2,4-dihlorbenzylphosphonium chloride (Phosphon D), malic hydrazide, n-dimethyl succinamic acid (B-9), triidobenzoic acid (TIBA), 2-chloroethyl trimethylammonium chloride (CCC) and ancymidol. Sucrose, mannitol and sorbitol are the osmotic agents. Sucrose and sorbitol along with incubation at low temperature and dark have been used in *Allium sativum* to store the bulblets for more than one year which was accompanied with 100% survival and recoveries thereafter (Hassan et al., 2007). While, there are some examples from herbaceous plants of successful germplasm preservation by this method, the earliest being of grape (Galzy, 1969) followed by that of potato (Westcott et al., 1977). This method, since long, is in practice at the International Potato Centre, Lima, Peru, for germplasm preservation of potato. The technique has been successfully used in plant spp., like, apple (Hao and Deng, 2003), *Cedrus* spp. (Renau-Morata et al., 2006), *Musa* spp. (Cha-um et al., 2007), *Eucalyptus grandis* (Watt et al., 2000), etc. In this context, process of slow growth culture of *Glycyrrhiza glabra* developed at NBRI, Lucknow deserves special mention, where spectacular success was achieved in preserving its shoot apices under slow growth conditions for more than 7 years

without subculture. Normal true-to-type plants were retrieved from such preserved shoots (Jain et al., 2006). However, the minimal growth storage method is generally meant for short-term to medium-term storage and it also has certain limitations, such as, imposition of stress conditions on explant, vulnerability due to temperature fluctuations and above all light requirement, which becomes a major disadvantage during international exchange of germplasm leading to death of shoot cultures in transit for want of light.

iv. Synthetic seeds

Synthetic seeds produced by encapsulating somatic embryos or other regenerants may prove to be of great practical value both in propagation and storage of germplasm (Redenbaugh et al., 1986). Synthetic seeds have been produced with intention of short-term preservation of genetic resources, as in *Coffea arabica* (Nassar, 2003), mulberry (Pattnaik and Chand, 2000), pineapple (Soneji et al., 2002), etc. The technology has widely been used in orchids, e.g. *Geodorum densiflorum* (Datta et al., 1999), *Cymbidium* spp. (Nhut et al., 2005). Quantity, quality and efficiency of somatic embryos to convert into plantlets, lack of developmental synchrony in embryogenic systems, limited production of viable micropropagules are some considerable factors which limit the scope of synthetic seed technology. The choice of coating material for making synthetic seeds is also an important aspect for synthetic seed production (Ara et al., 2000).

v. Innovative method of germplasm preservation through excised root culture

Innovative and practicable approach of germplasm preservation through long-term excised root culture has an edge over other aforesaid methods. In nature, a number of plants have the propensity to produce shoot buds from their roots (Peterson, 1975). However, regenerants can also be induced to produce shoot buds with the aging of root cultures (Thomas and Street, 1972) or by the addition of growth hormones (Chaturvedi and Sinha, 1979) in plant species, which do not otherwise produce shoot buds *in vivo*. Excised root culture as a system for germplasm preservation has several outstanding features, like: simple incubation conditions with moderate temperature (25^{o}-35^{o}C), unaffected by temperature fluctuations, no light requirement, low maintenance cost, long intervals between subcultures, which can be extended to even 4 to 6 months, economy of space as several metres long roots can be accommodated in small containers and potential for producing enormous propagules (clonal plants) per culture of roots. Such attributes make this system also very useful to promote safe exchange of germplasm over long distances across the international boundaries unaffected by lack of light and temperature fluctuations during transit, which has been found very damaging for shoot cultures used for exchange of germplasm. In this way, plants requiring different agro climates can be conserved in terms of their root system as excised

root cultures at a place where they would otherwise not grow, safe from pathogenic infections, grown under aseptic conditions and can easily be managed in small space with no elaborate arrangements of air-conditioning. Thus, excised root cultures may constitute 'Gene Repositories' for posterity. However, it is to be evaluated as to how many plant species, with the existing knowledge of morphogenesis and the morphogenetic stimuli available, can be preserved as their excised root cultures, how many of them can be induced to regenerate plantlets and how long the regenerative potentiality of such excised root cultures can be retained in long-term cultures *in vitro*.

The fundamental principle underlying this method of germplasm preservation is: more the organization level of explant with minimum physical and chemical stress during incubation the less are the chances of genetic variability.

In *Brassica oleracea* shoot regeneration has been obtained from segments of excised roots and potentiality of culture has been retained for five months (Lazzeri and Dunwell, 1984a). However, possibility of developing regenerative excised root cultures appears to exist in a number of plant species, at least in those plant species, the root segments of which have been demonstrated to produce regenerants *in vitro*, viz., *Convolvulus arvensis* (Bonnett and Torrey, 1966), *Elaeis guineensis* (Barrett and Jones, 1974), *Actinidia chinensis* (Harada, 1975), *Phalaenopsis amabilis* (Tanaka et al., 1976), *C. sinensis* (Sauton et al., 1982; Burger and Hackett, 1986), *Cicorium intybus* (Vasseur and Roger, 1983), *B. napus* (Lazzeri and Dunwell, 1984b), *S. tuberosum* (Espinoza and Dodds, 1985), *Dendrobium* sp. (Sagawa, 1990), *P. tremula* (Nadel et al., 1992; Tzfira et al., 1996; Vinocur et al., 2000), *C. aurantifolia* (Bhat et al., 1992), tomato (João and Brown, 1994), *Cephaelis inecacuanha* (Yoshimatsu and Shimomura, 1994), *Acacia albida* (Ahée and Duhoux, 1994), *Lotus corniculatus* (Akashi et al., 1998), *Eleuherococcus koreanum* (Park et al., 2005), etc.

With this background, an innovative method of germplasm preservation through long-term regenerative excised root culture has been propounded in the Tissue Culture Laboratory, NBRI, Lucknow and successfully demonstrated for a number of plant species including herbaceous annuals to woody perennials as well as trees. The innovative method was developed originally for *S. khasianum* (Normal and its Spineless strain), in which case the true-to-mother type plants were later on regenerated from even more than 20-year-old cultures, tested so far, and also given successful field trials, was further extended to a number of other economic plants, including trees, namely, *S. torvum, S. surattense*, *A. belladonna, Kalanchoe fedtschenkoi*, *R. serpentina, P. deltoides and Dalbergia latifolia* (Chaturvedi et al., 1991, 2004b; Sharma et al., 2004). Recently, success has been achieved in inducing multiple shoot bud differentiation in segments of roots taken from 5-year-old excised root cultures of a multipurpose tree

– *A. indica*, established by employing explants from a 40-year-old tree (Fig. 2a). The root-regenerated shoot buds developed into vigorously growing normal green shoots leading to complete plants (Fig. 2b, d and e). The root-regenerated plants have been transferred to field with 100% survival (Fig. 2f). The clonal fidelity of plants has been ascertained by histological studies and molecular analysis using RAPD technique. Histological analysis showed that the regenerants have developed from pericycle cells of root, which are known to be genetically stable cells (Fig. 2c). Also, RAPD analysis of mother tree and progenies, showed monomorphic banding pattern of bands in RAPD profiles (Fig. 2g).

This complete the cycle of selection of elite plants, their cloning and preservation of germplasm in terms of their excised roots and production of cloned plants of such preserved genotypes through regeneration from their root explants, which will ultimately be useful and rewarding in developing "Repositories" of their genotypes as they will not only be preserved in a pathogen-free state, but will also be saved from being infected with new pathogens or destroyed by other natural calamities. During the process of multilocational trials, even if the genotypes do not survive at certain places, their stocks will be safe in such "Repositories" from which the cloned plants of such genotypes can be produced at a fast rate. The process is invaluable to conserve different genotypes of this tree of immense medicinal value and for developing a "Gene Bank" of its various genotypes growing world over.

CONCLUSION

We need to wake up before it is too late and preserve the boon of nature for present and future. If we still not take concrete steps to conserve biodiversity, particularly phytodiversity then for our mistakes a heavy penalty would be paid by our successors. Hence, for the survival of human race on this planet, there is an urgent need to develop strategies for conservation of biodiversity, particularly of genetic resources of our plant wealth. The integrated approach involving both *in situ* and *ex situ* methods developed for different plant species will go a long way to achieve the ultimate goal of conservation of phytodiversity as they are complementary to each other.

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Figure Legends:

Fig. 1 (a-g) Germplasm preservation of a 40-year-old tree of *Azadirachta indica* through limited growth shoot culture.

a. Axillary bud-break in the nodal stem segment explant leading to regeneration of healthy shoot.
b. Proliferation of shoots as seen after one year of subculturing.
c. Rooting of isolated shoots.
d. Acclimatization of *in vitro*-rooted shoots - plantlets - in inorganic salt solution in a pro-tray.
e. A group of *in vitro*-regenerated plants grown in potted soil.
f. Field cultivation of nodal stem segment-regenerated plants after two years of transplantation.
g. RAPD profile of 1-year-old field-grown plants of neem regenerated from nodal stem segments. Lanes from left are marker containing Low Range DNA ruler (lane 1) followed by lanes with DNA of the mother plant (lane 2) and nodal stem segment-regenerated plants (lanes 3-9), respectively.

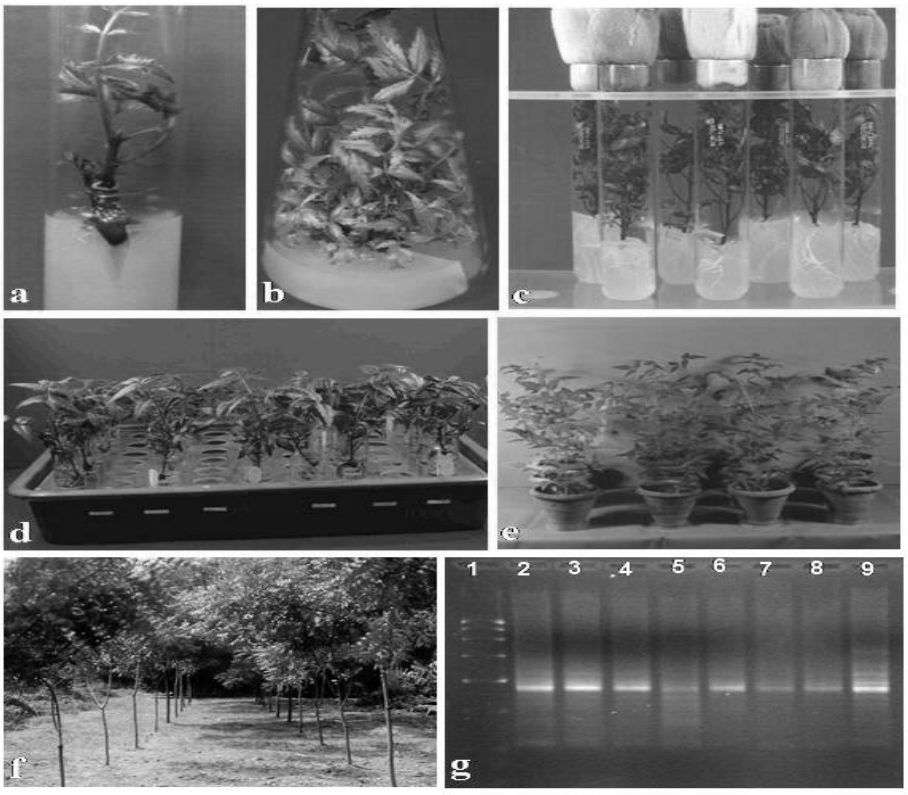


Fig. 2 (a-g) Germplasm preservation of *Azadirachta indica* A. Juss. through excised root culture.

a. Sustained growth of excised roots in prolonged culture (2 years).

b. Direct differentiation of shoot buds/ shoots in root segment taken from 2-year-old excised root culture.

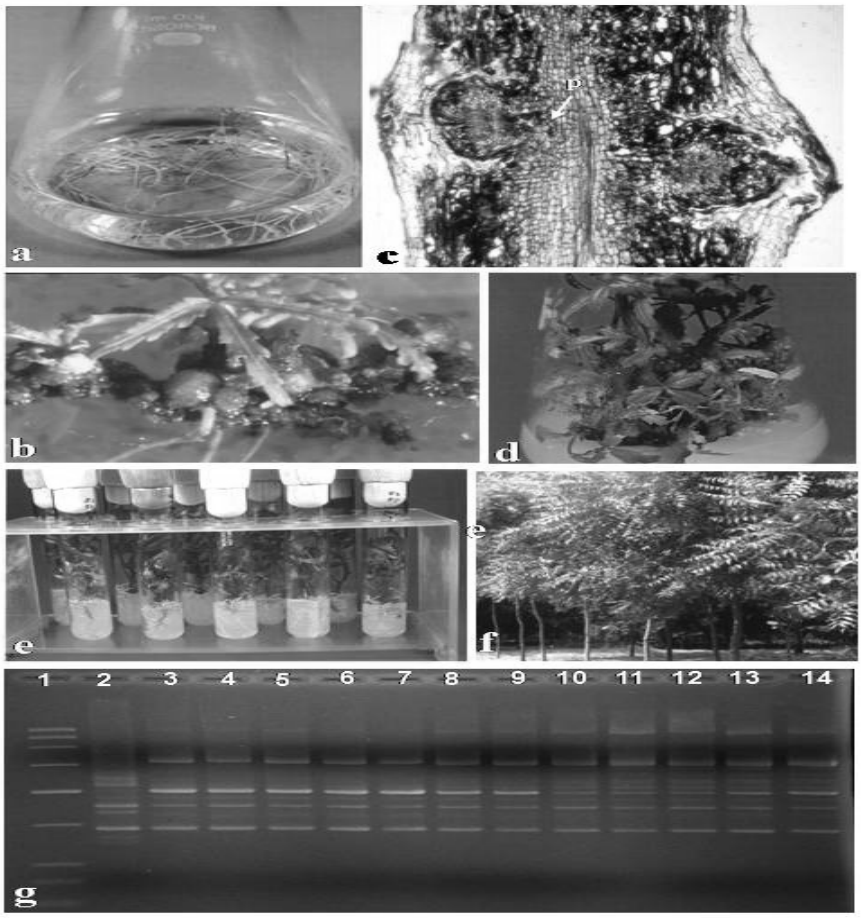
c. A magnified view of longitudinal section (L.S.) of responded root explant showing endogenous differentiation of meristemoids from the pericycle (p) juxtaposed to the vascular tissue of explant beneath the cortical tissue.

d. Proliferation of shoots regenerated from segments of roots taken from 2-year-old excised root culture.

e. Rooting of isolated shoots obtained from cultures of proliferating shoots raised from segments of roots of 2-year-old excised root culture.

f. *In vitro*-raised plants, regenerated from root segments of 2-year-old excised root cultures, as seen after 2 years of transplantation under field conditions.

g. RAPD profile of field-grown plants of neem regenerated from root segments taken from 2-year-old excised root culture. Lanes from left are marker containing Low Range DNA ruler (lane 1) followed by lanes with DNA of the mother plant (lane 2) and 12 root-regenerated plants (lanes 3-14), respectively.



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IN VITRO APPROACHES FOR MASS PRODUCTION OF MEDICINAL PLANTS

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Introduction :

Plants were the first medicines, and even as modern humans have developed sophisticated pharmaceutical chemicals to treat illness, medicinal plants remain an important tool for treating illness in most cultures.

Human beings have been utilizing plants for basic preventive and curative health care. According to a survey carried out by WHO, 80% population of developing countries still rely on traditional medicines, mostly plant-based drugs (Anonymous, 1998). Consumer demand for high quality medicinal herbs is increasing at a slow, but steady, rate. Many of these herbs are harvested exclusively from stagnant to declining wild populations. The rate of extinction of medicinally important plant species is further accelerated by habitat degradation, illelegal trade practices, loss of regeneration potential of degraded forests, policies and regulations. This factor poses a serious threat to the genetic stock and the biodiversity of medicinal plants. The IUCN Red list of threatened plants published by World Conservation Union includes 33,798 species, of which 380 are extinct in the wild, 371 may be extinct, 6,522 are endangered and the remainders are vulnerable or rare. Species of medicinal herbs are added to the federal and state threatened or endangered plant lists every year. Herb farming can change this but learning how to grow herbs is difficult on a large scale as farm crops.

Growing medicinal plants through micropropagation could be the answer to the problems that farmers face. Micropropagation or plant tissue culture is a method of propagating plants in mass under sterile, controlled conditions. Plant tissue culture can be broadly defined as a collection of methods used to grow large numbers of plants, *in vitro* (in test tubes), in an aseptic and closely controlled environment. Plant tissue culture is one area of biotechnology that had a dramatic impact on agriculture. Plant tissue culture is the only way to increase the number of plant within a short time period. Theoretically, a single cell or piece of plant tissue can produce an infinite number of new plants. The main industrial

goal of plant tissue culture is to produce a large number of plants in a month instead of years.

The production of a large number of plants from very small plant parts (explants) under aseptic conditions is referred to as micropropagation or clonal propagation, and it is one of the best and most successful examples of commercial application of plant tissue culture technology. The potential for this work was realized by Morel (1960) for rapid propagation of orchids. In most cases, clonal propagation is achieved by placing sterilized shoot tips or axillary buds onto culture medium that is sufficient to induce formation of multiple buds. Skoog and Miller (1957) proposed a concept which stated that organ differentiation in plants is regulated by an interplay of auxin and cytokinin. The technique of micropropagation involves 4 steps *viz.*, establishment of somatic embryos or shoots cultures, multiplication of shoot cultures through periodic sub culturing, induction of rooting and hardening of plantlets and transfer to soil.

Micropropagation ensures around 10 times multiplication per cycle of 2 weeks each and 26 cycles can be completed in a year.

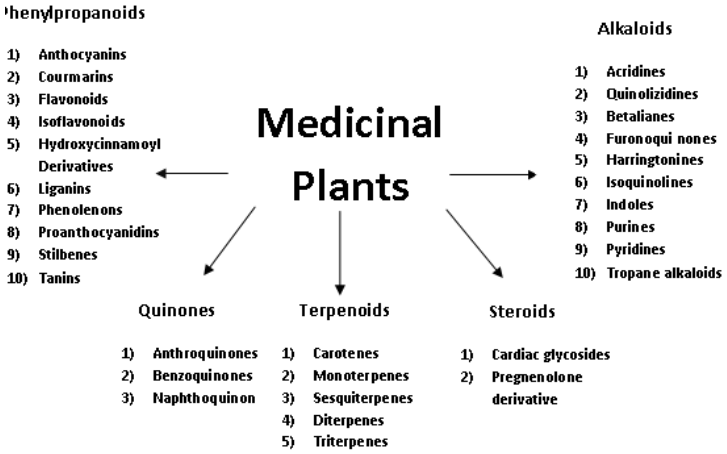

Figure: Adapted schematic showing the classification of plant derived compounds (Ramachandra and Ravishankar, 2002)

SCOPE AND IMPORTANCE OF MICROPROPAGATION

- It is independent of seasonal constraints and ensures year round, true to type, rapid mass multiplication for quick bulking of super elite material for commercial seed production.
- Micropropagated field-grown plants give higher yield and exhibit better quality.
- Micropropagation can be used for quick spread of genetically improved materials and rejuvenation of old varieties or clones of vegetatively

propagated crops for improving their yield and quality.

- Rapid spread of new varieties of vegetatively propagated crops like sugarcane, potato, poplar, medicinal/aromatic plants for crop diversification. In the vegetatively propagated species, multiplication through vegetative means is very slow. Moreover, pathogens keep on accumulating generation after generation, which cause huge losses in the quantity and quality ultimately causing decline of the clone or variety.
- Mass production of ornamental plants, which are otherwise difficult to multiply through conventional methods for domestic and international markets.
- Mass cloning of cross pollinated and seed propagated trees.
- Multiplication of male sterile lines for hybrid seed production or the multiplication of F_1 hybrids in field, vegetable and floricultural crops.
- It possesses tremendous potential in making our environment clean and green.
- Production of disease-free planting material for obtaining higher yields with better quality for export market.
- Interstate/International exchange of germplasm avoiding the risk of pathogens and insects.
- Biotechnology can provide help in popularization of some non-traditional medicinal and other crops like White musli, *Aloe vera*, *Geranium, Mentha, Banana, Paulownia, Burma dek* and *Jojoba etc.*

Explant source

Explant is material used as initial source of tissue culture. Tissue culture success mainly depends on the age, types and position of explants [38] because not all plant cells have the same ability to express totipotency [10]. The most commonly used explants are shoot tips, nodal buds and root tips. Large explants can increase chances of contamination and small explants like meristems can sometimes show less growth.

STERILISATION

Microbial contamination of plant tissue culture is a common problem. Common bacterial contaminants are *Bacillus, Pseudomonas, Staphylococcus and Lactobacillus*. In the practice of plant tissue culture, microorganisms are called "contaminants" because of their harmful effects on plant growth *in vitro*.

Six potential sources of contamination in the plant tissue culture lab are:

- Air
- Water
- Growth Media
- People
- Equipment
- Plant Material

Microbes multiply and compete with growing explant for nutrients, while

releasing chemicals which can alter culture environments e.g. pH and inhibit explants growth or cause death. Explants are cleaned by distilled water and sterilized using mercuric chloride, ethyl alcohol, and liquid bleach. Sterilization of laboratory instruments is carried out by autoclaving, alcohol washing, baking, radiations, flaming and fumigation.

TISSUE CULTURE MEDIA

Culture media contains vital nutrients and elements for *in vitro* growth of plant tissues. Choosing the right media composition is important for successful tissue culturing.

Functions of medium:

- Provide water
- Provide mineral nutritional needs
- Provide vitamins
- Provide growth regulators
- Access to atmosphere for gas exchange
- Removal of plant metabolite waste

Medium contains a carbon source (sucrose), macro and micro nutrients, vitamins, hormones and other organic substances. A wide range of media are available for plant tissue culture, but MS (Murashige & Skoog, 1962) medium is commonly used Other media used are Linsmaier-Skoog (LS) [Linsmier & Skoog, 1965], Schenk and Hilderbrandt (SH) [Schenk and Hilderbrandt, 1972], WPM (Woody plant medium) [Lloyd and McCown, 1980], and the Nitsch and Nitsch (NN) [Nitsch, and Nitsch, 1969]. Agar is not essential media component but is used as gelling agent. It prevents death of cultured cells due to submerging and lack of oxygen in liquid medium. The *pH* of culture media is normally between 5.0-6.0, and is also very important as it affects uptake of ions.

CULTURE BROWNING

Explants in cultures release phenol compounds, which are oxidised by enzymes known as polyphenol oxidase, and cause the media to turn brown. Browning can be minimized by adding antioxidants or phenol absorbents for e.g. ascorbic acid, glutathione, activated charcoal and polyvinylpyrrolidone or by transferring explants into new culture media on regular intervals.

PLANT GROWTH HORMONES

Growth hormones regulate various physiological and morphological processes in plants and are also known as plant growth regulators (PGRs) or phytohormone. PGRs are synthesized by plants; therefore many plant species can grow successfully without external medium supplements. Hormones can also be added into cultures to improve plant growth and to enhance metabolite synthesis. I*n vitro* growth and shoot formation was not achieved without adequate concentrations exogenous hormones. However, inadequate or excessive amount of growth hormones can cause morphological and physioloical abnormalities .

ROLE OF PHYTOHORMONES IN PLANT TISSUE CULTURE

Hormone	Product Name	Function in Plant Tissue Culture
Auxins	Indole-3-Acetic Acid Indole-3-Butyric Acid Indole-3-Butyric Acid, Potassium Salt α-Naphthaleneacetic Acid 2,4-Dichlorophenoxyacetic Acid p-Chlorophenoxyacetic acid Picloram Dicamba	Adventitious root formation (high concen) Adventitious shoot formation (low concen) Induction of somatic embryos Cell Division Callus formation and growth Inhibition of axillary buds Inhibition of root elongation
Cytokinins	6-Benzylaminopurine 6-γ,γ-Dimethylallylaminopurine (2iP) Kinetin Thidiazuron (TDZ) N-(2-chloro-4-pyridyl)-N'Phenylurea Zeatin Zeatin Riboside	Adventitious shoot formation Inhibition of root formation Promotes cell division Modulates callus initiation and growth Stimulation of axillary's bud breaking and growth Inhibition of shoot elongation Inhibition of leaf senescence
Gibberellins	Gibberellic Acid	Stimulates shoot elongation Release seeds, embryos, and apical buds from dormancy Inhibits adventitious root formation Paclobutrazol and ancymidol inhibit gibberellin synthesis thus resulting in shorter shoots, and promoting tuber, corn, and bulb formation.
Abscisic Acid	Abscisic Acid	Stimulates bulb and tuber formation Stimulates the maturation of embryos Promotes the start of dormancy
Polyamines	Putrescine Spermidine	Promotes adventitious root formation Promotes somatic embryogenesis Promotes shoot formation

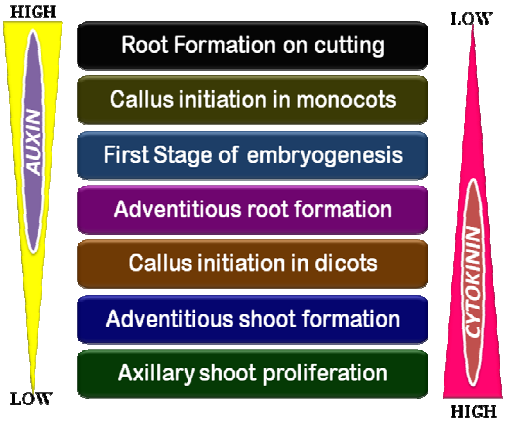

Figure: Relative concentrations of auxin and cytokinin required for plant growth and development

Asexual multiplication using tissue culture techniques can be achieved by three approaches:

1. Enhancing axillary bud break
2. Production of adventitious buds or Organogenesis
3. Somatic embryogenesis

The first two approaches lead to plantlets formation via organogenesis through production of unipolar shoots, which must then be further multiplied, followed by rooting in a multistage process. In contrast, somatic embryogenesis leads to the formation of a bipolar embryo through steps that are often similar to zygotic embryogenesis. Shoot multiplication is widely used for the clonal propagation using the above approaches; it has been possible to produce plantlets of over 70 angiosperms and 30 gymnosperms. Tissue culture techniques have been applied for the propagation of approximately 20% of 7000 known Ayurvedic plant species (Rajendra and D'Souza, 1999).

MICROPROPAGATED PLANTS ARE GROWN IN 4 STAGES.

Stage 1 is the initiation stage. A piece of plant tissue (called an explant) is cut from the plant, disinfected, and placed on a medium. The medium contains vitamins, mineral salts, sucrose, and a solidifying agent such as agar. The objective of this stage is to achieve an aseptic culture. An aseptic culture is one showing no signs of contamination of bacteria or fungi. Stage 2 is the multiplication stage. A growing explant can be induced to produce multiple shoots by including a cytokinin in the medium. A cytokinin is a plant growth regulator that promotes shoot formation from growing plant cells. Stage 3 is the rooting stage. Multiple shoots can be cut into singular shoots and placed in a medium that includes an auxin to produce adventitious roots. Auxins are plant growth regulators that promote root formation. Adding auxins to the medium are not necessary with plants that easily

root. Stage 4 is acclimatization The growing, rooted plants are removed from tissue culture and planted in soil. The humidity must be slowly reduced over a period of time to allow the plants stomata to adjust to an open air environment. Stomata's are like little mouths on the cells of the leaf surface that open and close according to environmental conditions.

Micropropagation of medicinal plants is mainly carried with following objectives: -

- In some plants, seed production is difficult and many a times seeds do not show proper germination and seedling growth.
- Micropropagation is mainly used in individual plants having elite characters and protect them against segregation or mutation.
- In many medicinal pants, planting material is becoming endangered so necessary to develop micro propagation protocols to preserve germplasm and for distribution during cultivation in new areas.
- Production of medicinal plant seedlings can be carried continuously without seasonal variation and environmental factors.

A clear distinction should be made against the medicinal plants which have been micropropagated on one's own choice and the plants which are actually in demand by the pharmaceutical Industry, Ayurvedic & Unani system of medicine and those which are in demand by the industry, but cannot easily be multiplied by commercial methods of propagation. It is the last category of plants, which has to be given priority for propagation by tissue culture strategy. There are many important medicinal plants required by the Drug India, but are not cultivated in the real sense of the term. Some important one's are *Angelica officinalis*, *A. sinensis*, *Gymnema sylvestre*, *Picrorhiza kurroa* and *Garcinia indica*.

Micropropagtaion in Stevia: *Stevia rebaudiana* Bertoni (Bertoni) is a perennial herbaceous plant and is part of the Asteraceae family. It's the only zero calorie sugar substitute with a fresh, clean, green image. It comes from the leaves of the bushy stevia plant, a native of Paraguay. Stevia is currently considered as the "green gold", as natural sweetener used to reduce sugar and synthetic sweetener as aspartame or sucralose. Besides, Stevia is considered to be hypoglycemic, hypertensive, diuretic, cardiotonic. Heavy exploitation, low propagation response and meagre systematic cultivation resulted in the important medicinal plants becoming extinct and endangered. Very limited scientific studies have been carried out on *in vitro* conservation of the medicinal plants Handa and Kaul (1996).

Micropropagtaion in Chlorophytum: Fasciculated roots of *Chlorophytum Borrivillianum* is used as tonic and constitute important ingredient of 20 ayuervedic and unani preparation. The productionof high quality planting material

propagated from vegetative parts has created global trading area, benefited growers, farmers, nursery owners and improved rural employment. However, there are still major opportunities to produce and distribute high quality medicinal plant *Chlorophytum borivilianum*. The main advantage of tissue culture technology lies in the production of high quality planting material that can be multiplied round the season basis under disease-free conditions.

Fig.: *In vitro* cultured mass of Chlorophytum

Micropropagtaion in *Rouwolfia*

Rouwolfia is a wonder drug plant of India is now endangered. It yields around 50 alkaloids, of which its characteristic medicinal property is due to Reserpine Its seeds have poor viability and poor germination

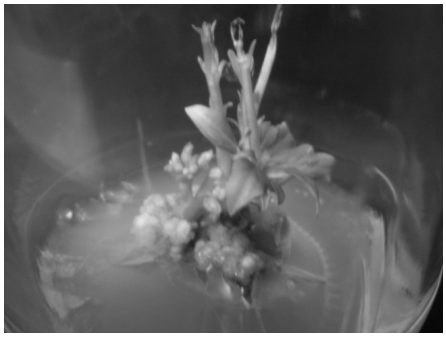

Figure: In vitro culture of Rouwolfia Micropropagtaion in Plantago

The genus Plantago comprises 200 species, ten of which occur in India (Anonymous, 1969). Isabgol, the common name in India for *P.ovata*, comes from the Persian words "isap" and "ghol" that means horse ear, which is descriptive of shape of the seed. India dominates the world market in the production and export of psyllum.

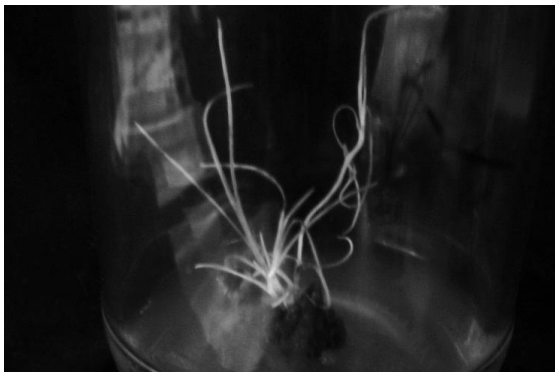

Figure: *In vitro* culture of Plantago

Micropropagtaion in Bacopa

Bacopa monnieri L. Penn. commonly known as "Brahmi" is an important medicinal herb of the family Scrophulariaceae. It is the foremost brain tonic herb of the Indian System of Medicine and other traditional systems, used primarily as a nerve tonic, to treat insomnia and nervous tension. Microropagation is rapid, *in vitro* clonal multiplication method of elite clones and also helps in dissemination and *ex situ* conservation of this endangered medicinal plant.

With the release of new drugs like Memory Plus in the market, there is going to be over exploitation of the natural populations of *B.monneri* that must meet the present requirement of 0.1 million quintal/year of the herb. (Ahmad, 1993).

There is thus an immediate need for assessing the natural populations, developing protocols for micro propagation, regeneration and agronomical practices. The characteristics of rapid vegetative growth, available morphological variation and short sexual life cycle raise the possibility of using Bacopa monnieri in the developmental studies related to bioprospection, morphogenesis and secondary metabolism.

Bacopa monnieri L. Penn., commonly known as Brahmi, has been used in Indian System of Medicine for centuries for everything from snakebite to headache. It is used most often as a brain tonic and a memory enhancer. The demand of Bacopa is met from natural population, which leads to put heavy strain on existing natural population and hence slow depletion of this important herb. Tissue culture techniques can be used to attain rapid multiplication of the elite clones and germplasm conservation of *Bacopa* monnieri

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IN VITRO CONSERVATION OF BIODIVERSITY OF MEDICINAL PLANTS IN INDIA

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ABSTRACT

Medicinal plants continue to be an important therapeutic aid for alleviating ailments of humankind. Advancements made in synthetic chemistry along with the discovery of antibiotics and cortico-steroids and their artificial synthetics caused rapid decline of plant based medicines particularly in the developed nations during the century. The developing nations depend on the other hand mostly on plants for their medicine. In recent times, however, due to the increasing realization of the health hazards and toxicity associated with the indiscriminate use of synthetic drugs and antibiotics, there has been a renewal of interest in the use of plants and plants based drugs throughout the world. The preventive and promotive aspects of the Eastern traditional systems of medicine particularly that of India and China are finding increased popularity and acceptance through out the world and scope for developing plant based drugs assumes greater significance at a time when modern medicine has failed to provide cure for a number of dreadful diseases. Considering the rapid loss of medicinal plants various measures has been initiated in India for conserving and sustainably utilizing the medicinal plant genetic resources. According to the Red List of threatened species 44 plant species are critically endangered, 113 endangered and 87 vulnerable (IUCN, 2000). Many medicinal plants are also in trouble from over harvesting and destruction of habitat. Population growth, urbanization and the unrestricted collection of medicinal plants from the wild is resulting in an over-exploitation of natural resources. Therefore, the management of traditional medicinal plant resources has become a matter of urgency. An ever increasing demand of uniform medicinal plants based medicines warrants their mass propagation through plant tissue culture strategy. Tissue culture technology is potent and has opened extensive areas of research for biodiversity conservation. Tissue culture protocols have been developed for a wide range of medicinal plants, which includes endangered, rare and threatened plant species.

Key words : Red list, Endangered, Medicinal Plants, Plant Tissue Culture

INTRODUCTION

In view of the tremendously growing world population, increasing anthropogenic activities, rapidly eroding natural ecosystem, etc the natural habitat for a great number of herbs and trees are dwindling. Many of them are facing extinction. To

cope up with alarming situation, the recent exciting developments in biotechnology have come as a boon. One of them is the use of plant tissue culture technique. Most of the plant raised through seeds are highly heterozygous and show great variations in growth, habit and yield and may have to be discarded because of poor quality of products for their commercial release. Likewise, majority of the plants are not amenable to vegetative propagation through cutting and grafting, thus limiting multiplication of desired cultivars. Moreover many plants propagated by vegetative means contain systemic bacteria, fungi and viruses which may affect the quality and appearance of selected items. In recent years, tissue culture has emerged as a promising technique to obtain genetically pure elite populations under *in vitro* conditions rather than have indifferent populations. Tissue culture has now become a well established technique for culturing and studying the physiological behavior of isolated plant organs, tissues, cells, protoplasts and even cell organelles under precisely controlled physical and chemical conditions. Most of the medicinal plants either do not produce seeds or seeds are too small and do not germinate in soils. Thus mass multiplication of disease free planting material is a general problem. In this regard the micropropagation holds significant promise for true to type, rapid and mass multiplication under disease free conditions. Besides, the callus derived plants exhibit huge genetic variation that could be exploited for developing superior clones/varieties particularly in vegetatively propagated plant species. In terms of the number of species individually targeted, the use of plants as medicines represents by far the biggest human use of the natural world. Plants provide the predominant ingredients of medicines in most medical traditions. There is no reliable figure for the total number of medicinal plants on Earth, and numbers and percentages for countries and regions vary greatly (Schippmann et al., 2002). Estimates for the numbers of species used medicinally include: 35,000-70,000 or 53,000 worldwide (Schippmann et al., 2002); 10,000- 11,250 in China (He and Gu, 1997; Pei, 2002; Xiao and Yong, 1998); 7500 in India (Shiva, 1996); 2237 in Mexico (Toledo, 1995); and 2572 traditionally by North American Indians (Moerman, 1998).

The United Nations Conference on Environment and Development (UNCED), held recently at Rio de Janeiro, Brazil helped to place the loss of biodiversity and its conservation on the global agenda. Resulting in biodiversity becoming a household wood. Biodiversity is a new term for species-richness (plants, animals, microorganisms) occurring as an interacting biotic component of an ecosystem in a given area.

CURRENT STATUS OF BIODIVERSITY OF IMPORTANT MEDICINAL PLANTS IN INDIA

Medicinal plants as a group comprise approximately 8000 species and account for about 50% of all the higher flowering

plant species of India. Millions of rural mass use medicinal plants. In recent years the growing demand for herbal products has led to a quantum jump in volume of plant material traded within and outside the country. Very small proportions of the medicinal plants are lichens, ferns, algae etc; the majority of the medicinal plants are higher plants. Though India has rich biodiversity and one among the twelve mega diversity centers, the growing demand is putting a heavy strain on the existing resources causing a number of species to be either threatened or endangered category. About 90% of medicinal plants used by industries are collected from the wild. While over 800 species are used in production by industry, less than 20 species of plants are under commercial cultivation. Over 70% of the plant collections involve destructive harvesting because of the use of parts like roots, bark, wood, stem and the whole plant in case of herbs. This poses a definite threat to the genetic stocks and to the diversity of medicinal plants. Recently some rapid assessment of the threat status of medicinal plants using IUCN designed CAMP methodology revealed that about 112 species in southern India, 74 species in Northern and Central India and 42 species in the high altitude of Himalayas are threatened in the wild.

IN VITRO CONSERVATION STRATEGIES USED FOR THE PROPAGATION OF MEDICINAL PLANTS

Micropropagation/Clonal propagation techniques using shoot tip and nodal segments are must for mass-scale multiplication and conservation of endangered or threatened medicinally important species within short period and limited space. The plants produced from this method are true to type. Propagation through tissue culture provides solution for mass propagation of plants in general and threatened plants in particular. There is a need to conserve plants with medicinal values. Due to ever growing demand, the availability of medicinal plants to the pharmaceutical companies is not enough to manufacture herbal medicines. The powerful techniques of plant cell and tissue culture, recombinant DNA and bioprocessing technologies have offered mankind a great opportunity to exploit the medicinal plants under *in vitro* conditions.

Micropropagation: In clonal propagation, plants are multiplied using nodal segments and shoot meristems as explants. For rapid *in vitro* clonal propagation of plants, normally dormant axillary buds are induced to grow into multiple shoots by judicious use of growth regulators cytokinins and or auxin and cytokinin combinations. Shoot number increases logarithmically with each subculture to give greatly enhanced multiplication rates. As this method involves only organized meristems, hence it allows recovery of genetically stable and true to type progenies (Murashige, 1974; Hu and Wang, 1983).

Organogenesis: For the regeneration of a whole plant from a cell or from a callus mass cytodiffrentiation is not enough and there should be differentiation

leading to organogenesis. This may occur through shoot bud differentiation (organogenesis) or through somatic embryogenesis. In the former, shoot buds (monopolar structures) are formed while in the later, somatic embryos (bipolar structures) are formed both leading to regeneration of whole plant. Callus mediated organogenesis depends on various factors. The type of callus, growth regulators used for induction of callus and also callus developed from the type of explant. The cells, although undifferentiated, contain all the genetic information present in parent plant. By suitable manipulation of growth regulators and contents of the medium, it is possible to initiate the development of roots, shoots and complete plant from callus cultures.

Somatic Embryogenesis: Somatic embryogenesis is the process of formation of embryo like structure from somatic tissue. The somatic embryo may be produced either directly on the explant or indirectly from callus or cell suspension culture. For the first time, Haccius (1978) defined somatic embryogenesis as a non-sexual developmental process, which produces a bipolar embryo from somatic tissue. The first report of plantlet regeneration via *in vitro* somatic embryogenesis was in Daucus carota (Reinert, 1958; Steward et al., 1958). This pathway has offered a great potential for the production of plantlets and its biotechnological manipulation. In addition to the development of somatic embryos from sporophytic cells, embryos have been induced from generative cells such as in the classic work of Guha and Maheshwari (1964) with Datura innoxia microspores. Tissue culture technique has been used successfully for *in vitro* mass propagation of various medicinal plants.

Table-: In vitro cultured important medicinal plants.

Plant species	Explants	Nature of Response	Reference
Bacopa monnieri	Leaf explants & Nodal Segments	Mass propagation	Mohapatra and Rath (2005)
Calastrus paniculatus	Nodal segments	Shoot culture	Sood & Chouhan (2009)
Clitoria ternatea Linn	Nodal segments	Shoot culture	G.R. Rout (2005)
Ginkgo biloba	Apical & Nodal segments	Shoot culture	Tommasi & Scaramuzzi (2004)
Glycyrrhiza glabra	Nodal segments	Axillary bud culture	Vadodaria *et al* (2007)
Gymnema sylvestre	Seeds	Seed culture	Komalavalli & Rao (2000)
Holostemma ada-kodien	Nodal segments	Bud culture	Martin (2002)
Oroxylum indicum	Nodal segments	Shoot culture	Dalal & Rai (2004)
Picrorhiza kurroa	Nodal segments	Mass propagation	Martin *et al* (2006)

Saussurea lappa	Shoot tip	Shoot culture	Johnson *et al* (2007)
Swertia chirata	Shoot tip	Shoot culture	Balaraju *et al* (2009)
Tylophora indica	Nodal segments	Mass propagation	Faisal *et al* (2007), Sharma & Chandel (1992)
Tinospora cordifolia	Nodal segments	Mass propagation	Gururaj *et al* (2007)

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THE WONDER PLANT AMARANTHUS PHARMACOGNOSTIC PROPERTIES AND APPLICATIONS

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ABSTRACT

Amaranthus, a dietary plant, rich in natural polyphenols specially anthocyanins, has been the focus of interest of scientific investigators for its antioxidant and chemopreventive properties. However. its applicability in various forms for clinical use is an area which is still unexplored. Here we present a review of literature along with our work on two Amaranthus sps .for possible clinical use.

Introduction

Recent decades have witnessed a resurgence of interest in traditional plant based treatments. The World Health Organization has recommended that indigenous plants be used as alternative medicine in the management of various diseases, particularly in developing countries where safe modern drugs, health centers and resources are limited or lacking (WHO, 2002). Dietary plants and products such as grains, nuts, cereals, soy, spices, flaxseed oil, fruits, vegetables, and herbs contain various phytochemical constituents, such as phenolics, carotenoids, alkaloids, nitrogen and organosulfur compounds, and vitamins and many of them have already been studied extensively for their potential chemopreventive efficacy (Park *et al*., 2010). Some of these free radical-scavenging molecules, such as phenolic compounds, nitrogen compounds, vitamins, terpenoids and some other endogenous metabolites, are rich in antioxidant activity (Cai *et al*., 2003; Cotelle *et al*., 1996; Larson, 1988; Shahidi & Naczk, 1995; Velioglu *et al*., 1998; Zheng & Wang, 2001). Among them phenolic compounds or polyphenols are the most numerous with more than 8,000 phenolic structures currently identified (Tsao, 2010) and constitute one of the major groups of compounds acting as primary antioxidant free-radical terminators (Agrawal, 1989). Plant polyphenols are important components of human diet and are considered to possess chemopreventive and therapeutic properties (Azmi *et al*., 2006). A strong relationship between total phenolic

content and antioxidant activity in fruits, vegetables and grain products has been reported by various groups (Dorman *et al*., 2003; Velioglu *et al*., 1998; Samarth *et al*., 2008). Flavonoids, as one of the most diverse and widespread groups of natural compounds, are probably the most natural phenolics (Shimoi *et al*., 1996). These compounds possess a wide spectrum of chemical and biological activities including radical-scavenging properties. Recently, anthocyanins along with other phenolics have attracted much interest since they are major antioxidants in our diet and may impart health benefits linked to their antimicrobial, anti-inflammatory and anticarcinogenic activities, insulin secretion ability and neuroprotective effects (Han *et al*., 2007). Anthocyanins belong to the parent class of molecule -flavonoids. They are a group of reddish-blue, water-soluble pigments common in many flowers, fruits and vegetables and they can be included in the category of natural additives (Roobha *et al*., 2011).They are widely spread throughout the plant kingdom and they can occur in almost all tissues of higher plants, including roots, stems, leaves, flowers, and fruits and are considered to be a group of major natural pigments in plants. Among different plants or even cultivars in the same plant, the total anthocyanin content varies considerably, affected by genetic make-up, light, temperature and agronomic factors (Routray and Orsat, 2011). One such herbaceous plant with abundance of anthocyanins is *Amaranthus.*

The wonder plant

Amaranthus sps. (Tambdi Bhaji/Lal Saag) is native to a large part of India and forms an integral part of the Goan diet. Grain amaranth belongs to the order *Caryophyllales*, family *Amaranthaceae*, sub-family *Amaranthoideae*, genus *Amaranthus*. The scientific plant name – *Amaranth* signifies in Greek “immortal”, “everlasting” or “non-wilting”. The name could be poetically connected with a story of renaissance or “rediscovering” of amaranth crop. Its mild spinach like flavor, high nutritive value, ability to grow in hot weather at low cost, have made it a very popular vegetable (Jerz *et al*., 2007). A classic 19th-century work of herbal/eclectic medicine, King's American Dispensory, lists *Amaranthus hypochondriacus* as an astringent, which is a substance that constricts animal tissues, thus tending to close pores or blood vessels (Buskirk and Winfred, 2005). According to the practitioners of Ayurveda, the root is used to treat uterine diseases (Marx, 2007).

POTENTIAL OF VEGETATIVE PARTS

An antiviral protein that imparts high resistance to sunnhemp rosette virus has been purified from the dried leaves of *A. tricolor* (Roy *et al*., 2006). Three galactosyl diacylglycerols (1-3) with potent cyclooxygenase and human tumor cell growth inhibitory activities have also been isolated from the leaves and stems of *A. tricolor* (Jayaprakasam *et al.,* 2004). Goan folklore suggests that the plant is a good liver tonic and therefore is recommended as

a staple diet for diabetic and anemic patients. The plant is well known for its purple betalain pigments, such as amaranthine and isoamaranthine. Clemente and Desai (2011), evaluated the antidiabetic, hypolipidemic, hematological and antioxidant effects of aqueous extract of *Amaranthus tricolor* on alloxan-mediated diabetes in rats and showed *A. tricolor* to be a potential natural source of ingredients for the management of antioxidants, hyperglycemia, associated lipidemia and overall health status of diabetic patients and that the plant may be used as a prospective food supplement. Al-Dosari (2010), tested the ethanolic extract of *Amaranthus tricolor* for its efficacy against CCl□-induced liver toxicity in rats and evaluated its hepatoprotective activity via measurement of various liver toxicity parameters, lipid profile and histopathological evaluation. He suggested that *A. tricolor* has hepatoprotective effect which appears to be due to its antioxidant properties. According to Baig and Saleem (2009), its aqueous extract and ethanolic plant extracts possess hepatoprotective activity which is comparable to silymarin. *A. tricolor* has significant antioxidant activity *in vitro* (Rao *et al*., 2010) which is compareable to other well characterized, standard antioxidants such as ascorbic acid and may be due to the presence of phytochemicals such as, steroids, flavanoids, alkaloids, terpenoids, tannins and phenols (Bharti *et al*., 2011). Leaves of *A. tricolor* and a protein isolate from the seeds of *A. mantegazzianus* exhibit potential antitumor properties (Jayaprakasam *et al*., 2004; Barrio and An˜o´n, 2010).

Potential of Seeds:

The seeds of *Amaranthus* are nutritious and are an important source of proteins and vitamins, especially, provitamin A (β-carotene). *Amaranthus* contains proteins, vitamins (C and E), provitamin A and minerals, such as Ca and Fe (Gopalan *et al*., 1989). *A. caudatus* and *A. paniculatus* seeds are antioxidant (Gandhi and Maudar, 2010). This is the reason that *Amaranthus* sps. is receiving special attention in developing countries as an alternative to tackle protein deficiencies in diet. The observed diverse pharmacological properties appear to be due to the antioxidant activities of *A. tricolor*, which may pave the way for development of a new drug to be used for fighting various diseases. Two varieties of *Amaranthus caudatus* seeds were investigated by Conforti *et al.,* (2005) for characterization of antioxidant and antidiabetic properties along with their phenolic content while Pasko *et al*., (2009) did similar work with seeds of *Amaranthus cruentus.*

Evaluation by *in vivo* assays:

The extracts of *Amaranthus* have been found to have protective effects in animal model system. The essential oil of *Amaranthus* spp. lowers cholesterol in hamsters and the seed of *A. esculantus* lowers cholesterol in rats (Berger 2003). *Amaranthus* pretreated irradiated animals exhibited a significant increase in GSH content and decrease in LPO level in liver tissue of Swiss albino mice (Maharwal *et al*., 2003). This could be due to enhanced utilization of the antioxidant system as an

attempt to detoxify the free radicals generated. The less depletion of liver GSH in *Amaranthus* pretreated, irradiated animals could be due to the higher availability of GSH, which increases the ability to cope up with free radicals produced by radiation. The increased GSH level suggests that protection by *Amaranthus* may be mediated through the modulation of cellular antioxidant levels (Maharwal *et al*., 2005). *Amaranthus* leaf extract acts as a potent antioxidant which is indicated by the fact that it helped to maintain a higher level of GSH and reduced the LPO content in the experimental animals as compared to controls. Samarth et al., (2008) have reported *A. paniculatus* extracts to moderate radical scavenging activity (IC50= 548 micrograms). The protective effect of *Amaranthus* can be attributed to its antioxidant property which is bestowed by the presence of provitamin A (β-carotene), vitamin C and riboflavin (Vietmeyer, 1983) that remove the free radicals from the body by the scavenging mechanism.

Escudero *et al*., (2011) investigated bioactive compounds and antioxidant activity in flour and protein concentrate from *A. cruentus* seeds and studied their effect on lipid content and liver histoarchitecture of Wistar rats. They concluded that the presence of phenols provoked an increase in the antioxidant defenses and thus played a protective role in liver. Several mechanisms, including a potent antioxidant activity, immune response and enhanced recovery of bone marrow have been suggested with *Amaranthus* extracts (Malick *et al*., 1978). Sangameswaran and Jayakar (2008) observed anti-diabetic and anti-hyperlipidemic effect with methanol extract of *Amaranthus spinosus* L. stem in streptozotocin-induced diabetic rats.

Evaluation by *in vitro* assays

The extract from *Amaranthus sp*. used in Mediterranean diet efficiently inhibits activation of both NF-kB and AP-1 thus showing some anti-inflammatory properties in HUVEC culture (Staliñska *et al*., 2005). In a study by Kumar *et al*., (2011), the α-amylase inhibition assay by CNPG3 revealed that the methanol extract of *A. caudatus* showed significant inhibition of α-amylase enzyme activity in all the *in vitro* antioxidant models. MeAc at 10, 50, 100µg/ml concentration showed 44.01±0.12, 65.56±0.18 and 74.98±0.11 percentage inhibition of α-amylase activity respectively and IC_{50} value was found to be 19.233µg/ml. This study indicates that the whole plant of *A. caudatus* possess antioxidant properties, can inhibit the activity of α-amylase at low concentrations and can serve as a free radical inhibitor or scavenger. Gandhi *et al*., (2011) tested the antiproliferative activity of *A. cruentus* aqueous extract on human peripheral lymphocytes and have suggested that it can be used as an inexpensive, biocompatible and alternate to other commercially available anti-proliferative therapeutics.

Clinical Applications

Whole amaranth (*Amaranthus cruentus*) seed flour, its air-classified fractions and extruded blends of these with wheat and oats were studied with the purpose of

evaluating their potential as components in the development in infant formulas (Sanchez-Marroquin *et al*., 1986). The 50:50 and 60:40 blends of whole amaranth, as well as of the protein-rich air-classified fraction, were found to be highly suitable for utilization in infant formulas. Mburu *et al*., (2011) determined the nutritional and functional properties of *Amaranthus cruentus* grain grown in Kenya for preparation of a ready-to-eat product that can be recommended for nutritional interventions as infant complementary food. Such studies are useful for developing a complementary product of adequate nutritive value that can be prepared using locally available resources and technology. Steeping and steam pre gelatinization of amaranth grain produced a ready nutritious product with improved solubility during reconstitution, suitable for infant feeding. Chávez-Jáuregui *et al*., (2010) evaluated the effects of defatted amaranth snacks (*Amaranthus caudatus* L.) on plasma lipids in moderate hypercholesterolemic patients. The intake of 50 g of extruded amaranth daily during 60 days did not significantly reduce LDL-c in moderate hypercholesterolemic subjects; furthermore there was a significant reduction in HDL-c. Studies with greater number of subjects and greater quantity of this food are necessary to test the effects of amaranth on lipid metabolism in humans.

A word of caution

Although *Amaranthus* has been documented for its various medicinal uses, a recent project undertaken by Singh and Sahi (2008), identifies *Amaranthus* to be an aeroallergen. Also the first case report from the country on *A. paniculatus* seed flour causing anaphylaxis has been recently presented (Kasera *et al.,* 2013). Although food allergy is reported only in 3-4%, individual immune response should be checked out before including any dietary plant as staple food.

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PART III

MEDICINAL PLANTS IN INDIAN SYSTEM OF MEDICINE- AYURVEDA, UNANI AND HOMEOPATHY

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ANTI-DIABETIC PLANTS

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"Jagatyevamanoushadham…"
Acharya Charaka has clearly said that there is no plant which is not medicinal in this universe which opens a door for research. Because till now approximately 7500 plants only are used for medicine out of more than 50,000 plants in India. Medicinal plants were mentioned first in the Vedas. Rigveda which is considered as the oldest Veda has reference of more than 67 plants. Plants like Apamarga, Soma etc are mentioned.

The medicinal plants which were initially used for rituals were later utilised for medicinal purpose gradually and their uses were documented after observing their efficacy. The next important documentation is found in Atharvaveda. Ayurveda which is regarded as Upaveda of Atharvaveda mainly has its roots in Atharvaveda. In Charaka Samhita the first samhita, we get references about approximately 500 medicinal plants and many are classified under 50 mahakashaya varga based on their important pharmacological actions. Charakacharya clearly said that Ayurveda has not been developed in a day or two but which were gradually documented by the observations made by Cow herds or shepherds and they are used clinically. Ayurveda speaks about both single drug therapy and compound formulations, which are administered to the patients that are suitable in the given condition. But at present, the complete scenario has changed and Ayurveda is becoming very popular among the western world and catering the large population. Lots of research works are being carried out at present to get a lead in this regard.

These medicinal plants have played an important role in Indian culture and festivals since Rigveda**.** It is estimated that out of 250,000 higher plants all over the world, more than 80,000 have medicinal value. India occupies unique position among world's 12 biodiversity centres as it has rich heritage of medicinal plants. In India about 20,000 plants have been identified as having good medicinal value & 7500 species are used by traditional communities.

LIST OF MEDICINAL PLANTS

Sl No	Book Name	No of Plants Mentioned(Appr)
1	Rigveda	67

2	Charaka	500
3	Sushruta Samhita	700
4	Ashtanga Sangraha	600
5	Bhavaprakasha Nighantu	550
6	Dhanvantari Nighantu	500
7	Sodhalanighantu	490
8	Madanapala Nighantu	450
9	Kaiyyadeva Nighantu	455
10	Raja Nighantu	698
11	Priya Nighantu	500

Anti-diabetic Drugs: Whenever anti-diabetic drugs are mentioned there is a doubt whether it is a Pramehahara dravya or Madhumehahara dravya.

Pramehahara Dravya: In Sushruta Samhita – Chi . 11/9 Acharya Sushruta has enlisted drugs for 20 types of Prameha:

Kaphaja Prameha:

Sl No	Name	Drugs / preparation
1	Udakameha (D. insipidus)	Parijata Kashaya
2	Ikshumeha (Alimentary glycosuria)	Agnimantha
3	Sura Meha (Acetonuria)	Nimba
4	Sikata Meha (Lithuria)	Chitraka
5	Shanairmeha (Obstruction)	Khadira
6	Lavanameha	Patha, Agaru, Haridra
7	Pishtameha (Chyluria)	Haridra, Daruharidra
8	Sandrameha (Phosphoturia)	Saptaparna
9	Shukrameha (Spermaturia)	Durva, Karanja, Kakubha
10	Phenameha	Haritaki, Aragwadha

Pitta Prameha

Sl No	Name	Drugs/ Preparation
1	Neelameha (Indicanuria)	Ashwattha
2	Haridrameha (Biluria)	Aragwadha
3	Amlamehina	Nyagrodha
4	Ksharameha (Alkalinuria)	Triphala
5	Manjishtameha (Haemoglobinuria)	Manjishta, Chandana
6	Shonitameha (Haematuria)	Guduchi

Vataja Prameha

Sl No	Name	Drugs/Preparation
1	Sarpirmeha	Chitraka
2	Vasameha (Lipuria)	Agnimantha
3	Kshoudrameha (D. mellitus)	Khadira, Kramukha
4	Hastimeha (Polyuria)	Shirisha

MADHUMEHA CIKITSA:

In Sushruta Samhita Chikitsasthana 13th Chapter, Acharya Sushruta has emphasized the usage of Bhallataka (Semecarpus anacardium) and Tuvaraka (Hydnocarpus laurifolia).

Mode of Action: The drugs used in Madhumeha (Diabetes mellitus) are mainly Tikta (Bitter) and Kashaya (Astringent) Rasa. Here Tikta (Bitter) is light and dry in nature which reduces heaviness and unctuousness of Madhura (Sweet) rasa and Kashaya (Astringent) gives strength to Urinary bladder so that it can accommodate more quantity of urine, which reduces frequent micturition.

Most of the drugs used in treatment of Madhumeha (Diabetes mellitus) are having chemical constituents like Terpenoids, Alkaloids, Bitter glycosides, Flavonoids and Phenolics.

Commonly Used Drugs in Madhumeha(Diabetes mellitus) :

JAMBU (*Eugenia jambolana*): Most reputed anti diabetic drug in Ayurveda.

- Useful Parts: Seed, Fruit & Bark which are having Kashaya Rasa (Astringent taste)
- Therapeutic administration:
- Seed Powder – 10 g twice a day before food. Fruit – Edible, Bark – Decoction 40 ml

BIMBI (*Coccinia grandis*):

- Useful Part: Root which has Kashaya Rasa (Astringent)
- Therapeutic administration:
- Root Powder – 10g /twice a day before food.

KARAVELLAKA(*Momordica charantia*):

- Useful Part: Fruit having bitter taste.
- Therapeutic Administration:
- Fruit Juice – 10 ml/twice / before food or fruit powder 5 gm before food twice a day.

ASANA (*Pterocarpus marsupium*): Most commonly used drug now a days and many preparation are prepared from this plant.

- Useful Part: Heart wood having Kashaya Rasa (Astringent)
- Therapeutic administration: Decoction – 50 ml twice a day before food.

HARIDRA (*Curcuma longa*): Reputed drug from the classical texts. Regarded as efficacious drug in all kinds of Diabetes.

- Useful Part - Rhizome which has bitter taste.
- Therapeutic Administration: Powder of Rhizome – 5 gm twice a day with water before food.
- Nishamalaki :Haridra (Termeric) and Amalaki (Indian gooseberry) mixed in equal quantity and taken 10 g twice a day.

AMALAKI (*Phyllanthes emblica*)

- Useful Part: Fruits
- Therapeutic administration: Juice – 5 ml twice a day

MESHA SHRINGI (*Gymnema sylvestrae*):

- Useful part - Leaves having bitter taste.
- Therapeutic Administration: Powder of dried leaves – 10gm twice a day.

NIMBA (*Azadirachta indica*): A classical medicine for Madhumeha which is very bitter in taste.

- Useful parts are Leaves & Stem.
- Therapeutic Administration: Juice of leaves – 10 ml twice a day or Powder of leaves and Bitter gourd Powder – 5g each may be taken

GUDUCHI (*Tinospora cordifolia*): Regarded as immune booster which really effective in Diabetes.

- Useful part: Leaf, Stem & Whole plant

- Therapeutic administration: Guduchi may be used in the form of Decoction – 40 ml, Juice – 10 ml or Powder – 10g

CONCLUSION

- Many research works are taking place in finding out effective and safe herbal medicine for Diabetes and still plenty of opportunities are there to reach an increasing demand to use the natural anti diabetic agents
- The literature pertaining to anti diabetic herbs are scattered in different classical texts and efforts are to be made to bring all those under one roof.
- Constitutions of individuals are different, so probably this would be the reason for mentioning many plants in one context like Madhumeha (Diabetes mellitus).

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THERAPEUTIC USES OF COMMON MEDICINAL PLANTS

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INTRODUCTION

The antiquity of medicinal plants goes back to the period of Vedas where certain Vedic Samhitas mention the use of many herbs. Rigveda, the oldest literary document presents the knowledge about medicinal plants in AushadhiSukta. (RV.10:47.1-23) According to Rigveda the Vedic physician was one whom the medicinal plants themselves offered their services. There is description of four herbs viz. ***Somvati, Ashwavati, Urjayanti &Udojasa*** inRigveda. Apart from this more elaborate description is available in Atharvaveda. After vedic period these plants were further regarded as the seats of specific divine powers in Upanishadas which reflects their importance. Upanishadas elaborates that ***Aswattha (Pipal)***is the seat of Lord Vishnu(Krishna),***Vata (Vargad)*** of Brahma,***Bilva (Bel)*** of Shiva, ***Kadamba***of Krishna, ***Tulsi&Amala*** of Lakshmi and ***Neem***of Shitala respectively. Moreover the properties and therapeutic utility of these plants have discussed in thorough detail in Classical period in different AyurvedicSamhitas and subsequent writings.

Until 19th century men was solely dependent on medicinal plants for opposing his agony. In spite of tremendous advancement in the field of western medicine, the scope of herbal medicine still remains because of its safety index and easy availability. Ayurveda elaborates the nature as a whole as the tool of its treatment. It is further verified by Charaka in the following statement.

"*NanaushadhibhutamJagatiKinchit*"- C. S. 1:69

Charak proclaims that there is nothing on the earth which is not a medicine. Apart from this, it is equally famous saying of our ancient Maharshisthat :

"***AmantramAksharamNasti,***
NastiDravyamanaushadham

AyogyahPurushamNasti,
YojakastatraDurlabhah"

Which reflects that there is no matter in the universe which is not having medicinal property.These inferences hint towards the fact that the nature has rich treasure of valuable remedies in the form of plants, animals & minerals. Therefore, these are considered as the three resources

of Ayurvedic therapeutics. It is not only sufficient to know the power of healing hidden in these resources but it is equally important to know about the form of use, its doses & time of administration to achieve maximum benefit of these medicaments.

More than 70% population of our country resides in the villages and is dependent on these plants for their day to day ailments. Not only this, there are certain diseases where western medicines give only a symptomatic relief and have a limited scope, these herbal drugs prove to be beneficial on current scientific parameters. The most common examples of the same are Liver diseases, Diabetes, Hypertension, Arthritis and Asthma. Apart from this, these herbs are having a magic healing power in geriatric health care too. Therefore, most of the popular MNCs are attracting towards this field and are producing herbal remedies for several diseases.

Present paper deals with the name of such drugs recommended for various health problems on one hand & common kitchen remedies on the other.

ROLE OF SPICES IN HEALTH CARE:

Turmeric, coriander, ginger, cumin, garlic & cinnamon are few of the common herbs used in our routine kitchen recipes and have a significant therapeutic utility. Scientific studies have shown that these kitchen remedies are protecting us from various common disorders.

Turmeric (*Curcuma longa*) has anti cancer properties as it protects DNA and stimulates detoxifying enzymes. Apart from this, it has anti inflammatory, hepatoprotective, anti bacterial, anti fungal, and wound healing properties. It protects us from heart disease as it decreases LDL and Triglyceride levels**.**

Coriander (*Coriandrumsativum)* protects against heart disease as it decrease levels of lipid peroxide and increases the activity of anti oxidant enzymes thereby decreases total cholesterol, LDL and TG on one hand and increases HDL on the other. It is traditionally used in the treatment of diabetes.

Cumin (*Cuminumcymimum*)is also an anti diabeticremedy, it reduces blood sugar, glycosylated haemoglobin, plasma cholesterol, phospholipids, free fatty acids and triglycerides.

Ginger (*Zingiberofficinale)* has various beneficial effects such as anti hyperlipidaemic, anti atherosclerotic. It has anti cancer, anti fungal, anti emetic, anti inflammatory and anxiolytic properties. It protects cells from amyloid injury hence it protects against Alzheimer's disease.

Garlic (*Allium sativum*) has been found beneficial in heart disease, hypertension, cancer, arthritis, infections and alzheimer's diseases. In clinical trials, garlic halted progression of arteriosclerotic plaque volume, reduced total serum cholesterol and triglycerides, increased HDL and had anti platelet activity.

Tejapatra (*Cinnamomumtamala*) reduces serum glucose, triglycerides and total cholesterol in patients with type 2 diabetes. It increases quantity of insulin and also enhances its effectivity. It is

traditionally used for the management of diabetes.

Dalchini (*Cinnamomumzeylanicum*) containscinnamaldehyde which lowers plasma glucose, glycosylated haemoglobin, total cholesterol and triglycerides and increases plasma insulin and HDL. It is an anti oxidant, anti microbial and enhances wound healing.

ROLE OF REJUVENATION THERAPY (*RASAYANAS*) IN PREVENTIVE HEALTH CARE :

Rasayana (Rejuvenation therapy) is a branch of Ashtanga Ayurveda which deals with promotion of health, longevity and prevention of decay and aging process.These drugs are basically meant to regulate the process of metabolism resulting in nutrition dynamics. Hence, they are recommended by Shargadhara to fulfil the bioloss in different age groups.

Table showing Age Specific Biolosses and suggested Rasayana Remedies

S. No	Age in years	Age specific Biolosses	Suggested Rasayanas
1.	0-10	Corpulence	Vacha, Kashmari, Gold
2.	11-20	Growth	Bala, Ashwagandha
3.	21-30	Lusture	Amalki, Haridra, Chandan
4.	31-40	Intellect	Brahmi, Shankhpushpi
5.	41-50	Skin glow	Bhringaraja, Jyotishmati
6.	51-60	Vision	Jyotishmati, Triphala
7.	61-70	Virility	Kapikachchhu, Musali
8.	71-80	Strength	Bala, Amalaki
9.	81-90	Memory & Cognition	Shankhpushpi, Brahmi
10.	91-100	Locomotion	Sahachara& other devine remedies.

REJUVENATING REMEDIES FOR VARIOUS SYSTEMS

Alimentary canal:

Haritaki (Terminaliachebula)
Kutaja (Holarrhenaantidysentrica)
Bilva (Aeglemarmelos)
Mustak (Cyperusrotundus)
Shunthi (Zingiberofficinale)

Liver:

Kalmegha (Andrographispaniculata)
Kutaki (Picrorhizakurroa)
Bhumyamalaki (Phyllanthusamarus)
Daruharidra (Berberisaristata)
Bhringraja (Ecliptaalba)
Pittapapara (Fumariapurviflora)
Makoya (Solanamumnigrum)
Guduchi (Tenosporacordifolia)

Stomach:

Shatavari (Asparagus racemosus)
Bhringaraja (Ecliptaalba)
Amalaki (Emblicaofficinalis)
Ela (Eletariacardemon)

Pancreas:

Jambu (Eugenia Jambolana)
Tejapatra (Cinnamomumtamala)

Vijayasar (Pterocarpusmarsupium)

Karela (Momordicacharantia)

Kiratatikta (Swertiachirayita)

Sadabahara (Vincarosea)

Tulsi (Ocimum sanctum)

Lungs (Respiratory tract):

Haridra (Curcuma longa)

Vasa (Adhatodavasica)

Shirisha (Albizialebbeck)

Tulsi (Ocimum sanctum)

Yashtimadhu (Glycyrrhizaglabra)

Pippali (Piper longum)

Heart:

Arjun (Terminaliaarjuna)

Pushkarmula (Inularacemosa)

Guggulu (Commiphorawightii)

Brahmi (Bacopamonnieri)

Rasona (Allium sativum)

Kidney:

Punarnava (Boerhaviadiffusa)

Gokshura (Tribulusterrestris)

Varuna (CrataevaNurvala)

Brain:

Shankhapushpi (Convolvulus pleuricaulis)

Mandukaparni (Centellaasiatica)

Brahmi (Bacopamonnieri)

Vacha (Acoruscalamus)

Guduchi (Tinosporacordifolia)

Madhuyashti (Glycyrrhizaglabra)

Jyotishmati (Celeastruspaniculatus)

Eyes:

Jyotishmati (Celeastruspaniculatus)

Haritaki (Terminaliachebula)

Vibhitaki (Terminaliabalerica)

Amlaki (Emblicaofficinalis)

Male Genitals:

Kapikachchhu (Mucunapruriens)

Ashwagandha (Withaniasomnifera)

Female Genitals:

Shatavari (Asparagus racemosus)

Ashoka (Saracaasoca)

Joints :

Rasna (Pluchialanciolata)

Nirgundi (Vitexnigundo)

Eranda (Reciniscommunis)

HERBAL REMEDIES FOR GERIATRIC CARE:

Some of the most common diseases of old age include constipation, arthritis, cataract, diabetes, dementia, depression, asthma, hypertension, liver & kidney diseases and cancer. Moreover impaired body functions, delayed wound healing and susceptibility to infection are frequently observed in old age. Common medicinal plants used for theseailments are as hereunder –

Constipation :

Harad – Baheda –Amla(Triphala), Munakka, Anjeer and Isabgol.

Colitis :

Kutaj, Bel, Nagarmotha.

Hypertension :

Arjun, Sarpgandha, Pushkarmool, Guggulu, Shankhpushpi, Ashwagandha and Punarnava.

Heart Disease :

Arjun, Karbir, Lasun and Guggulu.

Bronchial Asthma :

Kantkari, Vasa, Mulaithi, Tulsi, Bharangi, Duddhi and Shirish.

Allergy :

Shirish, Haldi and Tulsi.

Acidity :

Parval, Shatavari, Amla, Narial, Bhangara, Saunf and Badiilaichi.

Osteoarthritis :

Ashwagandha, Guduchi, Saunth, Shatavar, Hadjod and Kuchala (Shuddha)

Prostate Enlargement :

Sahijan, Varun, Gokhru and TrinPanchmool.

U.T.I. :

Chandan, Gokhru, Punarnava, Varun, Sahijan and Guduchi.

Depression :

Konchbeej and Brahmi.

Sexual Dysfunction :

Ashwagandha, Bala, Konchbeej, Mushli, Akarkara, Jaiphal, Laung, Bidarikand and Gokhru.

Parkinsonism :

Kaunch, Brahmi, Jatamansi, Vacha and Ashwagandha.

Forgetfulness :

Shankhpushpi, Mandukparni, Guduchi and Mulaithi.

Anaemia :

Anar, Palak, Chukandar, Khajur, Papita and Kela.

Eye Diseases :

Jyotishmati, Triphala, Mulaithi, Shatavar.

Skin Diseases :

Tuvarak, Bakuchi, Bhilava and Vidang (All after purification)

Arthritis :

Bhilava, Kuchala, Rasna, Lasun, Erand and Nirgundi.

Diabetes :

Vijaysar, Gudmar, Jamun, Maithi, Sadabahar, Haldi, Tejpatra,Belpatra and Mamjak.

Obesity :

Vidang, Guggulu, Harad,Arjun and Pushkarmool.

CONCLUSION

Ayurvedic literature contains the description of a huge number of medicinal plants along with their therapeutic utility and properties. Ayurveda advocates the prevention from diseases as its prime objective. Therefore, a vast number of drugs are recommended for prevention of diseases and promotion of health. These drugs are very much effective in the management of various life style related disorders too. Hence, the utility of these plant based medicines is increasing day by day. Moreover, these drugs are free from

any untoward effects because they are having similar biomorphic constitution, so these are accepted in our body very easily.

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MORINGA OLIFERA OR SAHIJAN – A MIRACLE PLANT OF MEDICINAL VALUE

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INTRODUCTION

Moringa olifera is a beautiful plant of sub-Himalayan tract of Indian subcontinent. Etymologically the name moringa is derived from the Tamil word murunggai or the Malayalam word muringa. Moringa is known with various names in different parts of India ie.- Sahajan or saijhan (Hindi), Shobhanjan or Shigru (Sanskrit), Drumstick tree, Horseradish tree, Benzolive tree, and Ben oil tree (English), Sajna (Bangla), Murunggai (Tamil), Muringa (Malayalayi), Shevaga (Marathi), Moonga (Telagoo). Moringa olifera belongs to order Brassicales and family Moringaceae of Angiosperms. Over the past few decades, many reports have appeared in mainstream scientific journals elaborating its nutritional and medicinal properties and its utility as a non-food product too, surprisingly the outcome of reports are merely verifying the therapeutic indications mentioned in the Ayurvedic literature as ancient as 4000 BC.

Since the ages Sahijan or Shigru has been a well known for its medicinal, nutritive economical and ornamental values. Its rapid growth and versatile uses turned it into a popular and eco friendly plant among medical professionals and farmers. In Indian subcontinent Moringa is consumed as roasted (seed) nuts, pods curry, and expressed juice of leaves. Now India is the largest producer of Moringa olifera with the annual production of 1.1 to 1.3 million tones of tender fruits of Sahajan at approx 380 km² of cultivation area. Andhra Pradesh leads in both area and production (156.65 km²) followed by Karnataka (102.8 km²) and Tamil Nadu (74.08 km²). While in other states, it occupies an area of 46.13 km². Tamil Nadu is the pioneering state for diversified genetic species.

Ayurvedic literature is very much enriched with the medicinal properties of Sahajan. Carak have placed it in to the Swedopag, Krimighna, Shirovirechanopag, Katuk Skandha and Haritak Varga according to pharmacological property, Acharya Sushruta has grouped it with Varunadi Gana and Shirovirechan dravya. In the Samhita period the properties of Shigru have been explored to a great extent. Caraka, Sushruta, Bhav Prakash and Dhanvatari Ninghantu all of these have

described the basic properties and therapeutic indications of Shigru. Shigru Leaves, seed and seed oil were used for the management various disorders. According to Sushruta Samhita the pharmacological properties of Shigru are as follow-

Rasa - Katu - Tikta

Guna (Properties) - Laghu, Ruksha & Teekshna

Vipak - Katu

Veerya - Ushna

Karma (Action) - Krimighna (Anti helminthic), Kushthaghna (Curing skin lesion), Pramehaghna (Anti diabetic / Anti dieresis) and Shirorogaha (Relieving the Headache)

"Shrigrutailani Teekshnani Laghuni Ushnaviryani Katuni Katuvipakani Saranyanilkapha Krimi Kushtha Prameha Shirorogapaharani cheti……"

(Sushruta Samhita Sutra Sthan Chapter 45)

Bhav Prakash has added it as the Chakshushya meaning there by improving, restoring or maintaining the vision.The medicated oils containing the seeds of Shigru are very frequently used for the purpose of Shirovirechan along with other drugs. Leaves were very frequently used as decoction for the treatment of Ashmari Bhedan, Udar shool, Nasal Disorders, Shirovirechan, Sandhigat Rogas, Krimi Rogas and Kushtha Roga.

Shigru: Sar: Katu: Pake Teekshno Madhuro Laghu: ।

Deepan: Rochano Ruksha: Ksharastikto Vidahakrit ॥

Medoapachi Vishapleeha Gulma Kandu Vranan Haret ।(CaraK Samhita)

Chakshushyam Shigrujam Vijam Teekshnoshnam Vishanashanam

Avrashyam Kaphavataghnam Tannasyen Shiroartihat ॥ (Bhav Prakash)

Now a day Ayurvedic physicians are using the Shigru preparations for the treatment of Renal Calculus, Arthritis, Antihelminthic and Shirovirechan procedures very successfully. The powder of leaves is also effective in the management of Udar Shool (Peptic Ulcer) and avitaminosis A.

Many bioactive chemical compounds have been extracted from the root, leaves, pods and seeds of Moringa olifera. These are reported to contain alkaloids, flavanoids, anthocynins, proanthocynidins and cinnamates. Few important active biochemical compounds which are the speciality of Moringaceae family are listed below –

- Simple sugar "Rhamnose"
- Glucosinolates and Isothiocyanates
- Benzyl isothiocyanate
- 4-(4'-O-acetyl-α-L-rhamnopyranosyloxy) benzyl isothiocyanate
- 4-(α-L-rhamnopyranosyloxy)benzyl isothiocyanate
- Niazirinin & Niazirin
- Pterygospermin
- 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate
- Moriginine

The Moringa plant contains the alkaloid called "Moringine" which exerts ephedrine like effect. Two isomers of 4-Benzyle isothiocynnate [4-(4'-O-acetyl-α-L-rhamnopyranosyloxy) benzyl isothiocyanate & 4-(α-L-rhamnopyranosyloxy) benzyl isothiocyanate] have been extracted from all the parts of Moringa plant. 4-Benzyle isothiocynnate has been proved to contain antimicrobial (bacteriostatic & bacteriocidal, antifungal and anti-helminthic activity) and anti-inflammatory activity. Pterygospermin & 4-glucosinolate have antibiotic activity against Helicobacter pylori. Pterygospermin was discovered early 1950's by a team from the University of Bombay (BR Das), Travancore University (PA Kurup), and the Department of Biochemistry at the Indian Institute of Science in Bangalore (PLN Rao). Helicobacter pylori are the main culprit in the occurrence of Peptic ulcer. The importance of this research could be understood by the fact that discoverer of Helicobacter pylori get Nobel Prize of medicine in year 2005. The presence of nitrile glucosides like niazirin and niazirinine produces dose dependent positive and negative ionotropic effect on heart.

Shigru or Moringa is a highly nutritive plant. Leaves pods and seeds are edible and consumed at very large scale in tribal community. Shigru is very rich in a number of vitamins and minerals as well as other phytochemicals such as the carotenoids (including β-carotene or pro-vitamin A). The leaves of moringa alone are sufficient enough to fulfill the recommended daily requirement of Vitamin A, B_1, B_2, B_6, C, Calcium, & Magnesium (Table 1).

Table -1, Showing the concentration of Nutrients (source FDA data base for nutrition USA)

Perticular	100 Gms of Leaves & % of RDA	100 Gms of Pauds & % of RDA
Energy	64 kcal (270 kJ)	37 kcal (150 kJ)
Carbohydrates	8.28 gm	8.53 g
Dietary fiber	2.0 g	3.2 g
Fat	1.40 g	0.20 g
Protein	9.40 g	2.10 g
Water	78.66 g	88.20 g
Vitamin A	Equiv 0.378 µg (47%)	4 µg (1%)
Thiamine (vit. B_1)	0.257 mg (22%)	0.0530 mg (5%)
Riboflavin (vit. B_2)	0.660 mg (55%)	0.074 mg (6%)
Niacin (vit. B_3)	2.220 mg (15%)	0.620 mg (4%)
Pantothenic acid (B_5)	0.125 mg (3%)	0.794 mg (16%)
Vitamin B_6	1.200 mg (92%)	0.120 mg (9%)
Foliate (vit. B_9)	40 µg (10%)	44 µg (11%)
Vitamin C	51.7 mg (62%)	141.0 mg (170%)
Calcium	185 mg (19%)	30 mg (3%)
Iron	4.00 mg (31%)	.36 mg (3%)
Magnesium	147 mg (41%)	45 mg (13%)
Manganese	0.36 mg (17%)	0.259 mg (12%)
Phosphorus	112 mg (16%)	50 mg (7%)
Potassium	337 mg (7%)	461 mg (10%)
Sodium	9 mg (1%)	42 mg (3%)
Zinc	0.6 mg (6%)	0.45 mg (5%)

A clinical study was conducted in year 2004 by department of Shalakya Tantra , Govt Aurvedic college Handia, Allahabad to evaluate the efficacy of "Shigru Patra siddha Grita" in the children suffering with the malnutrition and specially Vitamin A deficiency disorders ie conjunctival xerosis, night blindness, keratomalacia and non healing ulcers. The obtained results were very promising with the very high success rate of 83.5%. Very high nutritional value of moringa can be understood by the fact that 100 gms of moringa leaves are equivalent to vitamin C provided by 7 oranges, three times more Iron than spinach, three times more Potassium than bananas and four times more calcium than milk.

There are also a lot of non-medicinal or non-food uses of moringa. Leaves are used to produce the organic manure and bio mass for fields. In some areas bio gas is also produced and used as alternative fuel. Crushed leaves and seed powder are used to remove the impurities of water by flocculating the impurities. Seed powder as bio-insecticides is very effective and popular for organic farming. Ben oil is extracted from seeds which are used as lubricant in machines, in the manufacture of perfumes and hair care products. Logs for fencing can also be obtained from the plants. Ropes are manufactured from the fibers of moringa. Moringa plants are also planted on the either side of roads for shadow and ornamental purpose.

Moringa is a nature's gift to us. It has a good impact on the health, economy, environment and society. Especially in respect to the developing and undeveloped countries Shihru or Moringa plant can change the health scenario of society at the minimum or no cost. Every part of this plant is useful to mankind. With help of Shigru or Moringa or "Miracle tree" we can keep the individual healthy thus society healthy and finally building the healthy nation.

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IDENTIFICATION OF MEDICINAL PLANTS : HOW & WHY

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In the way of identification of Indian medicinal plants manyfold hurdles were created mainly due to gradual loss of contact with plants in their natural abode . The absence of a workable morphological description of plants, use of only a few multivocal descriptive terms both old and newly coined, and their indiscriminate use by the Nighantu writers during the last few centuries went on making confusion more confounded.

In the literary sphere the lexicons and the Nighantus sprang up which, while referring to a plant refer to more than one or rather many which were used as substitutes at different times and in different areas due to unavailability or ignorance of the originals. It is felt that with gradual obliteration of identities the practice of substitution continued unabated and the treatment of both the substituted and substitutes under the same name or names was the result. This practice ultimately resulted in complete merger of some important unidentified items with partially similar but different well-known plant. An insatance of this nature was detected in the merger of Tilaka and Tilvaka with Lodhara and cases of similar nature were found to exist in case of Murva and Asvakhuraka. Other similar cases of merger are suspected in Nighantu description of Aragvadha,Tagara, Balaka etc. where some of the so called synonyms may have originally been the names of altogether different drug items. We find the same practice in many modern books on the subject. The authors give big lists of regional or vernacular names of differents languages under a particular item, which are copied from previous publications without actual verification and some of which are found on enquires to be the names of substitutes and adulaterants rather than of those being actually described. All these misguided practices have produced a large numbsr of multivocal drug names which are the greatest hurdles.

Each and every plant has got medicinal property but it is a very important to identify these plants for utilizing their hidden potential for therapeutic purpose. One cannot be a good physician without this knowledge. Keeping this fact in the mind Narhari Pandit auther of Raj –Nighantu has mentioned that the physician depried knowledge of the drugs, Literarian without the knowledge of grammar & an Archier without constant

practice became a subject of laughing.Hence it is quit important to identify this treasure of medical values.

In Ancient and medieval times, there was no system of Morphological descriptionof plants as done now a days , this object, however was fulfilled by carring names & synonyms. which indicated the the salient features of the plants. Name denoted basonyms (mukhya naam) as well as synonyms (paryaya s) Roop is a specific character (svarup or prakriti) which includes morphology (akritis) as well as properties & actions (guna- dharma).

Study of name & rupa together of medicinal plants constitute the branch known as

pharmacognosy, which deals without idenetification of medicinal plants.

Name & synonyms are asigned to plants on the following seven besis according to Raj –Nighantu as follows –

1. Rudhi (traditional wage)
2. Prabhava (effect)
3. Desyokti (habitat)
4. Lanchana (morphological characters)
5. Upama (simile)
6. Virya (potency)
7. Itarvahvaya (name prevalent in other regions or due to other factors)

Ancients were keen observed of nature & coined exact synonyms to designate specific character of plants. For instanes the name karbudara for kachnar coined by Caraka suggested the varigated character one of the petal, on which the latin name Bauhinia varigata.is based .In short there are following ways of identification of medicinal plants in Ayurveda

1. Simile with animals:-

Musakarni (Ipomea reniforms)-> its leaves look like the ear of rats.

Matasysakala (Picrorhiza kurroa)-> The part and rhizome has fishy scales.

2. On the basis of organoleptic examination

(a). odour-Vidarigandha- Root having aroma of Vidari (Desmodium gangeticum)

Gandha prasarini- It spreds foetid smell arround

(b). Taste-kautvi & Tikta (Picrorhiza kurroa)- The part and rizome are unpalltable and

bitter in taste.Amlika (Temarindus indica) is a sourfruit.

(c). Touch- (solanum surettense) duhsparsa because of thorn plant is difficult to touch kharpatrk - (parijatak) Nyctanthes arbortristis- the leaves are rough in texture

(d) color peet-daru (barberis aristata) plant have yellow wood and flowers. Raktpusp- (Butea monosperma) flower are red in color

3. On the basis of morphology –

4. Root - Satpudi (aspargus racemosus) it has numerous succulent-tubers on root Suklakanda (Aconitum heterophyllum) -

the part used tuber are white in color Satparvika sadgrantha (vacha) its rhizome has many nodes . Tanutak - its bark is very thin Stem Trivrit(Operculina turpethum) -trivrit is a climber triangular and three winged Raktangi and tamramula -root is red in fresh stage Kalmulika when half dried coppery when half dried and black when dried completely

5. Leaf – Saptparn (Alstonia-scholaris) its tree is generally with seven leave . Petiole (dhirghvrint) its tree having leave with long petiole . Narikale - Skandhaphala, sadaphala , mahaphala fruit - apperars on trunk and seen round the year big and full of water having brush like structure at the top and three eyes .

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THE NEED OF THE ERA : CULTIVATION AND PROPAGATION OF COMMON MEDICINAL PLANTS

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Preservation of health and prevention from diseases (C.S.U-5.13) has been the instinctive necessity of mankind from the very beginning of the creation. From the dawn of the living beings or even much before the creation, plants came into existence as has been mentioned in Aushadhi Sukta of R.V.

This indicates the importance of plants for creator. Knowers of their utility always try for the better and rational knowledge resultantly, the knowledge of plants and their numbers increased accordingly.

Its evidence is 'ATHARVAVEDA' in which comparatively more number of plants (289) have been mentioned than in 'Rigveda'(67.)

In India medicinal plants are widely used by all sections of population whether directly as folk remedies or the medicaments or the different indigenous systems of medicine or indirectly in the pharmaceutical preparations of modern medicine. The country is richly endowed with a wide variety of plants of medicinal value which represents a great national resource.

Traditionally, practitioners of the Indian system of medicine- Ayurveda, Unani, Siddha have made up their own prescription for their patients, now a days most of their remedies are manufactured products. The increasing demand of the pharmaceutical industries have created problems of supply and one of the major difficulties being experienced by Indian system of medicine is that of obtaining sufficient quantities of medicinal plants for the manufacturing of genuine remedies. In absence of standards for crude drugs, adulteration and substitution have been common. To correct this situation, measures are needed to promote the cultivation of medicinal plants, to improve methods of collection, to ensure effective quality control and to regulate commerce so as to protect both the producer and the consumer.

There is also a need to create greater general awareness amongst the population as a whole, government officials (particularly those in agriculture and forestry), farmers and scientists of the medicinal and economic value of these plants. So that this heritage may be wisely

used and not be exploited, and at the same time, conserved for the future generation.

RESOURCES OR MEDICINAL PLANTS

Medicinal plants commonly used or found in various regions, making out the rough estimates of their availability are generally classified as- Abundant, Common or Scares. However even it is of value in focusing attention on species which were or might soon become endangered and on the need for their cultivation, conservation or substitution in this regard a regional list of medicinal plants duly completed and a number of exotic drug's species suitable for local cultivation be prepared and distributed among farmers to grow them under proper guidance making useful for both the sides.

CULTIVATION

Considerable expansion is required in the cultivation of medicinal plants, not only to meet the requirements of the health sector and commerce but also to counteract the harmful effects of over exploitation of species in short supply.

At state level cultivation at large scale should be undertaken of a variety of the most commonly used medicinal plants, both for demonstration purposes and as a source of supply as a genuine drug. Similarly, medicinal plant gardens should be setup as district level to serve as demonstration-Cum-Training Centre and also as nurseries. Even at village level small medicinal plant gardens would be of practical and educational value and could be developed simultaneously with social forestry programme.

Agricultural universities and other Research Organisations have a major role to play in establishing and maintaining model medicinal plant gardens, in carrying out researches, in serving as the reference centres, in providing technical guidance, in laying down agronomic practices for farmers and in studying the economics of medicinal plants productions. For plants in short supply they may use Tissue Culture techniques to large numbers of plants for supply to cultivators while at the same time accessing the contents of active principle of the plants obtained by such means for their proper efficacy.

The cultivation of medicinal plants may also be encouraged under the social forestry schemes by using abandoned land in shifting cultivation areas and also by road sides planting of suitable trees.

In this concern many medicinal plants are being used traditionally since very beginning as various preparations and including products from more than one plant in proper proportion of different ingredients and processings in treatment of ailments by local people. To maintain this heritage and availability of such plants need to be planted for future generation. Some of the such plants being mentioned in short regarding their utility in various disorders –

1. AMALATASA – Cassia fistula. Linn.- Caesalpinaceae. It is a small or medium sized tree with compound leaves and large, shining, dark green leaflets, Flowers bright yellow, in very large, hanging bunches. Fruits 50-60 cm. long,

black or shining dark brown and almost cylindrical. The tree is a conspicuous sight in flowers as well as in fruits and can be spotted in a forest from long distance. It sheds it leaves during early summer (March-May) with full blooming.

The medicinal properties have been attributed to nearly all parts of the plant, the fruits are the most important. The pulp from the fruits, called Cassia pulp, is a well known laxative. In larger quantities it causes purging, nausea and gripping.

The timber of the tree is strong and tough and is suitable for house and bridge posts and agricultural equipments. Apart from these it is much favoured for planting in road-side avenues and in gardens.

2. ASHWAGANDHA – Withania somnifera Dunal. – Solanaceae.

A small or middle-sized under shrub upto 1.5m. high, stem and branches covered with minute star shaped hairs. Leaves upto 10cm. long, ovate, hairy like branches. Flowers pale-green, small about 1cm. long, few flowers borne together in short axillary clusters. Fruits 6mm. diametre, globose, smooth red, enclosed in the inflated and membranous calyx, In drier regions it can be successfully cultivated.

The dried roots of the plant is used medicinally as in consumption, sexual and general weakness and rheumatism. It is diuretic-promotes urination, acts as narcotic and removes functional obstructions of body. The root powder is applied locally on ulcers and inflammations. Experimentally antibiotic and antibacterial properties have been found in roots and leaves as well.

It is known as Indian Ginseng.

3. ANTAMULA– Tylophora indica – Burm f.

Syn. T. asthmatica Wt.Arn. – Asclepiadaceae

A twining plant with many long, fleshy roots, leaves in opposite pairs, 5 – 10 cm. long, ovate, usually pointed at the tips. Flowers large, dull yellow, purple within, in short clusters. Fruits 5-10 cm. long in pairs, pointed at tip, ridged with many fine ridges.

The dried roots of the plant is used medicinally as in treatment of dysentery. An infusion of the drug is given in asthma and bronchitis. It is good for bringing about vomiting and thus causes relief in asthma. It is considered as a best substitute for Ipecac. So it should be cultivated profusely for the alleviation of disorders of respiratory system. The specific name asthamatica indicates its use in asthma.

4. KOLAKANDA – Urginea indica Roxb. – Alliaceae

Traditionally known as Jangali Piaz – is a bulbous plant, bulb 5-10 cm., dull white or pale, avoid. Lower basal leaves almost flat, very long, narrow and pointed. Flowering stem erect, about 45 cm. high. Flowers light brown, in slender long bunches. Fruit 1.5 – 2 cm. long, narrowed on both ends, seeds – black.

The dried outer coats of the bulbs are removed. The bulbs are sliced and dried

which is used as drug. It is used in ailments of heart and in cough and bronchitis. It promotes urination. It has some what properties like Digitalis but its action is very slow, so its larger doses are needed. Its use is recommended in those cases which need to be treated with Digitalis but are sensitive to the drug.

This drug is efficacious as that of European Urginea maritima Linn. Its clinical trials have confirmed the efficacy in chronic bronchitis and bronchial catarrh. It should be widely cultivated for the benefit of the society.

5. KALMEGHA - (Desi Chirayata) Andrographis paniculata Burm f. -Acanthaceae

An erect branched annual herb, branches sharply four-angled, leaves lance-shaped. Flowers small, in large, spreading and sparse bunches. Flowers rose – coloured, about 1 cm. long. Fruit capsular 1.5 – 2 cm. long.

The whole plant excluding roots is used medicinally. It is a bitter tonic and is useful in curing fevers, worms, dysentery, general weakness and excessive gas formation in stomach. It is also useful for children suffering from liver and digestive complaints. Traditionally villagers use its leaves for stomach complaints and itching. Recent experiments have shown its anti typhoid and antibiotic properties.

6. VACHA – (Ghoda Vacha) Acorus calamus Linn. - Araceae

A herbaceous plant with long, creeping and much branched aromatic rhizomes. Flowers shoots supported by a large leaf like structure called spathe. Flowers small pale-green in 5-10 cm. long cylindric spikes called spadix. Fruits yellowish in colour.

It can be easily and widely cultivated with enough economic value.

The dried rhizome is used as medicine. Due to presence of a volatile oil it acts as a carminative, it causes relief in flatulence and feeling of overfulness of stomach and increases appetite as well. It is considered as a best household remedy for colics with flatulence. Its essential oil contents act as an expectorant that promote the bronchial secretions so useful in asthma. On account of its tannins it is useful in diarrhoea and dysentery. It also acts as emetic while its larger dose causes violent vomiting. Its leaves and rhizomes are used in flavouring drinks, in perfumery and in making insecticides. Powdered roots are used as vermifuge.

The oil obtained from rhizomes acts as a good nerve-stimulent and the essential-oil free alcoholic extract shows marked sedative and analgesic properties that's why it is very much useful in mental diseases. In recent days it has been proved that the rhizome contains (shows) the antibacterial activity.

7. VASA - (ADUSA) - Adhatoda vasica Medik

Syn. A. justicea Linn., A. zeylanica Medik - Acanthaceae

A tall, much branched, dense, evergreen shrub, with large, lance shaped leave. Flowers in dense, short spikes,

stalks of the spikes are shorter than the leaves. Leaf like structures called bracts, present on the spikes are copiously veined. Corolla (the whole of Petals) of the flowers are white with few yellowish and few purplish markings. Fruits capsular, 4 seeded.

The fresh and dried leaves of the plant are used for medicinal purposes. The leaves contain vasicine as an alkaloid and some essential oil. Traditionally, it is used as an expectorant. It is given in form of juice, syrup or decoction. It softens the thick, stichy sputum and facilitates it coming out so brings about the quick relief in bronchitis. The expectorant activity is due to stimulation of bronchial glands. It's larger dose can however cause irritation and vomiting.

In agricultural point of view the leaves of the plant are utilized as green manure and for yielding a yellow dye. Due to presence of certain alkaloids, the leaves are not easily attacked by fungi and insects. Therefore, it is used in packaging and storing of fruits. Leaves emit an unpleasant smell and are spared from browsing so, it is suitable for planting in soul reclamation programmes.

8. SAPTAPARNA (Chhatima)– Alstonia scholaris R.Br. -Apocynaceae

A large evergreen tree reaching upto 25 mtr. High, having bitter milky juice, bark rough, dark grey, branches whorled, base of the tree often fluited or buttressed. Leaves leathery, 10-20 cm. long 5-7 in a whorl. Flowers small, greenish white, spice-scented in many flowered clusters. Fruits 30 – 60 cm. long narrow and slender, hanging in pairs and forming dense clusters.

Its dried bark is of ;medicinal importance. The drug is considered very efficacious in chronic diarrhea and dysentery. It is useful in malarial fever and brings down the temperature gradually without causing perspiration and exhaustion which usually follow other medicines for malaria. It is also very much useful in skin diseases.

In high doses it causes paralysing effect on motor nerves and consequently there is fall in blood pressure.

In olden days the timber of the tree was used in making of wooden slates for school children hence, the specific name scholaris was originated.

9. KUTAJA – Holarrhena antidysenterica Roth – Apocynaceae.

A tall shrub or small tree, sometimes upto 10 mtr. high leaves 10-30 cm. long, ovate, thin, nerves on the leaves are very conspicuous. Leaf stalks very small. Flowers white fragrant, 1 – 1.5 cm. diameter, in large terminal bunches. Fruits slender, cylindric, 20 – 45 cm. long, 6 – 8 mm. thick, very dark grey with white specks all lover, seeds about 1 cm. long, having a tuft of long (2 – 2.5 cm.), brown hairs at the top. All parts of the plant on incision give out milky juice.

The dried bark of the plant constitute the drug "Kurchi" which is chiefly used in Amoebic dysentery. Either an extract of the bark is used singly or several other

preparations in combination with chemical compounds are used. The bark of plant also has tonic and febrifuge properties. The alkaloid conessine present in the bark has been found to retard the growth of tubercular bacillii.

Seeds also possess the alkaloids which are effective in dysentery. Among leaves certain medicinal properties have also been attributed.

Apart from medicinal value this plant is good for a forestation of poor soils as a pioneer in newly cleared forest areas.

10. BAKUCHI – Psoralea corylifolia Linn. –Papilionaceae.

It is an erect herb, with densely gland-dotted branches. Leaves round, dotted with black glands on both the surfaces. Flowers small, bluish-purple, 10-30 in a bunch, arising in axils of leaves. Fruits black, roundish or oblong, closely pitted, seed – one & smooth.

The seeds of the plant is of medicinal value, which contains an essential oil – very effective in certain bacteria causing skin diseases. Thus the drug is very much useful in Leucoderma and Leprosy as an external application in the form of ointment as well as taking internally. The seeds are also useful for promoting urination and as anthelmintic. The anthelmintic and antibacterial activities of seeds are useful for local application on leucoderma of non-syphlitic origin. Due to its use in Leprosy, the drug has been called in our indigenous system of medicine as KUSTHANASINI. Roots of the plant is reported to be useful in carries of teeth and the leaves in diarrhoea.

Thus, in this concern there should be general awareness among people for cultivation and propagation of such plants which are of great value regarding their use in various disorders and other social applications. Now the time has come to pay much attention to maintain the balance between stipulated bio-diversities.

With thanks,

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ROLE OF BRIHATYADI TAILA GANDUSHA IN THE MANAGEMENT OF KRIMIDANTA (Dental Caries)

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INTRODUCTION

Krimi Danta is chronic degenerative disease of teeth. It is common disease found in population, involving any age group and is mainly caused due to bad oral hygiene and bad habits like chewing tobacco, smoking etc.

For the present study Brihatyadi Taila is selected for Gandusha as it has been described to be useful in the management of Krimidanta (Ashtanga Hridaya 22/22) and other later texts.

Ayurvedic Review

कृष्णश्छिद्री चलः स्रावी ससंरम्भो महारुजः
अनिमित्तरुजो वाताद्विज्ञेयः कृमिदन्तकः २९
su.ni 16/29

- Blackish cavity, mobility in teeth
- Discharge
- Severe inconsistant pain associated with inflammation.

MODERN REVIEW

Dental Caries is a disease of calcified tissues of teeth caused by action of micro - organisms on fermentable carbohydrates.

Materials & Methods

In the present clinical study patients are divided into 2 groups with 20 patients in each group.

Group BT – Gandusha with Brihatyadi Taila twice a day for 7 days.

Group TT – Gandusha with Tila Taila twice a day for 7 days.

Objectives

- To evaluate the effect of "Brihatyadi Taila Gandusha"
- To evaluate the effect of "Tila Taila Gandusha"(control drug).
- To compare the effect of Brihatyadi Taila Gandusha with Tila Taila Gandusha.

Inclusion Criteria:

- Patients belonged to the age of 5 to 50 years.

Exclusion criteria:

- Age below 5 years and up to 50 years.
- Patients with complications like fractured tooth, periodontal abscess.
- Patients with other diseases of oral cavity.

Drug Review

Pharmacodynamic Properties of Brihatyadi Taila						
Drug	**Rasa**	**Guna**	**Virya**	**Vipaka**	**Prabhava**	**Dosakarma**
Brahati	Katu, Tikta	Laghu, rukshaTikshana	Usna	Katu	Sothahara, shoolahara, krimighana	Kaphavathara
Eranda	Madhura	**S**nigdha, tikshana, sukshma	Usna	Madhura	Sothahara, shoolahara, krimighana	Kaphavathara
Kantakari	Katu, Tikta	Laghu, ruksha Tikshana	Usna	Katu	Sothahara, shoolahara, krimighana	Kaphavathara
Bhumi kadamba	Katu, Tikta Kashaya	Laghu, ruksha	Usna	Katu	Sothahara, shoolahara, krimighana	Tridoshsamaka
Tila Taila	Madhura, katu,tikta, kashaya	Vyavai,Guru, Snigdha, Sukshma	Usna	Madhura	Vishaghna,	Vataghna

ASSESSMENT CRITERIA

Subjective Parameters

- Dantashula (Toothache)
- Daurghandhya (Halitosis)
- Dantaharsha (Odontitis)
- Srava (Discharge)
- Paka (Pus formation)
- AniyamitaRuja (Pain without reason)

Objective Parameter

- Sotha (Inflammation)
- Chhidrata (Cavity Formation)
- Krishnata (Discoloration)
- Chalatva (Mobility)

OVERALL ASSESSMENT OF THERAPY

Overall effect of the therapy was assessed in terms of complete remission, marked improvement, moderate improvement, and mild improvement and unchanged is observed by adopting the following criteria.

Cured: 100% relief in the complaints

Marked Improvement: 76% to 99% relief in the complaints

Moderate Improvement: 51% to 75% relief in the complaints

Mild Improvement: 26% to 50% relief in the complaints

Unchanged: up to 25% relief in the complaint

RESULTS

Effects of Brihatyadi Taila Gandusha in patients of Krimidanta

Result	No of patients
Cured	0
Marked improvement	1
Moderate improvement	6
Mild improvement	12
Unchanged	0

Effect of Tila Taila Gamdusha in patients of Krimidanta

Result	No of patients
Cured	0
Marked improvement	0
Moderate improvement	1
Mild improvement	8
Unchanged	8

CONCLUSION

On the basis of the present study, following conclusions can be drawn.

- Krimidanta can be correlated with disease Dental caries.
- From the results and observation which were received from this study it can be concluded that Brihatyadi Taila Gandusha was provided better results in Dantasula, Durgandhya, Dantaharsa, Aniyamitruja, Sotha and Paka in Krimidanta.
- Further it can be concluded that there is no improvement in Chidrata (Cavity formation), Krishnata (Discoloration), IOPAR with Brihatyadi Taila and insignificant in Chaladanta (Mobility)
- The present clinical study has established that Brihatyadi Taila Gandusha gives better results than Tila Taila Gandusha.
- The present clinical study suggests that maintaining proper oral hygiene prevents the danta.
- Earlier management of dental caries helps in saving the teeth and improve a productive hours.

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BASIC PRINCIPLES OF AYURVEDIC DRUG STANDARDISATION

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INTRODUCTION

Ayurveda which is an prestigious boon to the mankind. Global awareness of ayurveda is striking at summit in recent time.

But now a days ayurvedic therapy gets disrepute due to substandard drugs. Therefore standardization of drugs is the most important challenge in the field of ayurveda. The term "MANA" means standardization. The separate section for standardization has been written in charak samhita viman sthan" . the term "Viman" conveys specific parameter.

Knowledge of names, forms, properties and action of drugs and their proper interpretation with each other to make unique identity is known as "Mankikarn"

Ayurvedic drugs are place as a second most imp in tetrapad of chikitsa. Standardization of ayurvedic drugs are based on their morphological characters properties, formulation, action, indication, effect on body.

Standardization is essential for a physician because without knowledge of specific feature, measure for drugs, he will not able to cure the disease properly. The scope of standaridasation has been described broadly in Viman Sthan. Summarising the scope for medical science Acharya Charak, has listed ten field.

Karan (Physician), Karan (Drug), Karyayoni (Pathogenesis) Karya (Action for normalization), Karyaphala (Presuet of Action) Anubandha (Assessment of Longevity), Desa (Place site location), Kala (Time), Pravritti (Therapeutic action) and upaya (means of action).

Bheshaja Priksha (Method of Drug Examination) :

Durg standardization is one of among ten factors. The drug is examined by.

तस्याषीयं परीक्षां

इदमेवंप्रकृत्यैंवगुणमेवप्रभावमस्मिन् देषे

जातमस्मिनृवातवेंक गृहीतमेवं

निहितमेवमुपस्कृतमनया च मात्रया युक्तिस्मिन्

व्याध्यवेवविधस्य पुरुषस्यैवतावन्तं

दोजपकर्जत्युपशयति वा।

—(च.वि. 8/87)

प्रकृति (Nature of Drug)	:	The inherent properties of the individual drug classified depending upon the superiority of Panchabhauta composition.
गुण (Quality)	:	Apart from Guna, it also represent rasa, virya, vipaka, prabhav and Karma.
प्रभाव (Specific Action)	:	Effect of drug in the body.
देश (Place of Growth)	:	Medicinal plant growing in particular geographical region.
ऋतु (Season)	:	Suitable time for abundance to principles described in Samhitas.
गृहीतम (Mode of collection)	:	Collection of drug according to principles described in samhitas.
निहितम् (Storage)	:	Method of storage and preservation.
उपस्कृतम् (Processing)	:	Preparation of drug accoding to pharmaceutics.
मात्रा (Doses)	:	Doses according to condition of patient and diseases.
व्याध्यवेवविधस्य (Idication)	:	Pacefication of dosa in particular disease in specific type of person.

Before advancement of this scientific era, Ayurvedic drugs were used to be prepared by vaidya (Ayurvedic physician) himself for the use of ailing community. The earlier vaidya well qualified for trained under Guru-Shishya parampara system and were well qualified for identification of drugs and preparing various formulations.

PROPERTIES OF STANDARD DRUGS

1. It should be small in quantity but quick in action.
2. It should be able to eliminate morbid dosas in large amount but easily.
3. It should be light for digestion, palatable, pleasing and cuvative of concerned disease.
4. It should not cause serious complication.
5. It should not cause depression.
6. It should possess agreeable smell, colour, taste.

The dosage of the drug should be decided according is disease, strength of the patient and Anni etc. Patency of the drug should be increase of decrease according to need by similarity, dissimilarity, time, processing and rationale.

All Ayurvedic drug's action depend on five factors-

Rasa : (Taste though chemical components)

Guna : (Property through quality)

Virya : (Potency of Dyanamic property)

Vipaka : (Metabolic properties though its qualities)

Prabhava: (Specific properties dominating the rest factors)

Acharya charak gives the importance of drug as described the beginning upto fourth chapter as Bheshaja Chatuska (Quadrulepts on drug)

For the correct knowledge of drugs. Acharya Charak opinion his view as no body can comprehend fully about the plants only by knowing their names and forms one is the real knower of medicinal plants who has got rationable knowledge of their administration after knowing the name and form. That who knows yoga (Administration and formulations) of plants according to place, time, individual constitution is said as Best physician.

For the purpose of Ayurvedic drug standardization as Acharya charak says-

''योग्यमपि चौक्षघमेव परीक्षेत''।

RESEARCH METHDOLOGY IN AYURVEDA :

As per Ayurvedi concept, Research methodology of drugs standardization should be following steps-

इदम्**1. PHARMACOGNOSTIC STUDY**

(a) एवन्नाम्	: Name of drug
(b) एवंरूपम्	: Botanical characters
(c) एकख्णम्	: General properties
(d) अस्मिनदेशेजातम्	: Habitate to which belong.
(e) अस्मिन्नृतगृहीतम्	: Season in which Gathered
(f) एवंगुहीतम्	: Species and parts selected
(g) एवन्निहितम्	: Way in which preserved.

2. PHARMACEUTICAL STUDY

(a) एवंविहितम्	: Form in which prepared
(b) एवंसंयुक्तम्	: Mode in which combined
(c) एवमुपसंस्कृतम्	: Way in which modified

3. CHEMO-BIODYNAMIC STUDY

(a) एवन्द्रव्यम्	: Composition
(b) एवंरसम्	: Patent & Latent tasters
(c) एवंख्णम्	: Medicinal properties
(d) एवंवीर्यम्	: Potential qualities or Active principles
(e) एवंविपाकम्	: Transformed characters in Digestion and metabolism
(f) एवन्निणिध्यम्	: Contra-indication if any

4. PHARMACOLOGICAL STUDY

(a) एवंयुक्तम्	: Mode of Administration
(b) एवङ्कर्म	: Different pharmacological action
(c) एवम्प्रभावम्	: Effect, unexplainable of any law yet known

6. CLINICAL STUDY

(a) अनयामात्रया	: Dosage in which prescribed

(b) एवंविधस्यपुरुणस्य	:	Personality to which administered
(c) एवंविधे काले	:	Time and condition which given
(d) एतावन्तदोमुपकर्ण त्युपशमयति वा	:	Quality in which it eliminates or normalize the dosas.
(e) एवंसमुदायप्रभावम्	:	Specified total effect.
(f) अन्यदपिचैवविधं– भेणजम् तन्मानेनवाविशेषेणप्रयु तमिदमकरोत्	:	Significance, if any in compositon

(वृ0वा0सू0 23/8) च0सू0 1/125, वि08/87

As per Ayurvedic classics, every thing is Panchbhautic and constitution of Dravya is also Panchbhautic. The Bhautic classification of Dravya and their pharmacological response can play important role in the drug standardization. Bhautic classification of Dravya and their properties as mentioned in Ayurvedic seers, the quality of drug standardization definitely may be improved.

पार्थिवादिभेदेन द्रव्याणाम् कर्मलक्षणानि

Bhautic Classification of Dravyas and their pharmacological respones :

क्र.सं.	पार्थिवम्	आप्यम्	तैजरनम्	वायव्यम्	आकाशीय
1	उपन्वय (Growta)	उपक्लेद (Moisture)	दाह (Burning)	रौक्ष्यम (Roughness)	मार्दवम् (Softness)
2	संघात (Compactnes)	स्नेहबन्ध (Viscosity)	पाक (Digestion of Suppuration)	ग्त्लानि (Exhaustion)	शौणिर्यम् (Porosity hollowness)
3	गौरवम् (Heaviness)	विषयन्द (Lequification)	प्रभाप्रकाशौ (Lustre)	विचार (Movement)	लाघवम (Lightness)
4	स्थैर्यम् (Steadyness)	मार्यवम् (Softness)	वर्ण (Complexion)	वैशद्यम (Ungresiness)	अवकाशदानम (Widening or Dilation)
5	धारणम् (Retention)	सङ्धननम् (Cohesion)	दारणम् (Burning)	व्यूहनम्	परिणाम (Transformation)
6	बलम् (Strength or Resistnace)	प्रहलाद (Refreshness)	तपनम् (Burning)	लाधवम् (Lightness)	

Keeping the above fact in view the Ayurvedic drug and formulation should be standardised with necessary quality control and acceptable dosages.

he Ayurvedic drugs are Less harmful and more hemogenous to human body than chemically produced drug. Anyrvedic treatment much depend upon herbal medicine, biological product and mineral preparation, so that 85% of the world population rely on herbal traditional medicine for primary health care, A considerable percentage of people of developing countres are using herbal medicine

PART IV

PHYTOCHEMISTRY AND CHEMICAL CHARACTERIZATION OF MEDICINAL PLANTS

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IODINE CATALYZED DIRECT ACCESS TO A LIBRARY OF 2-ARYL-3-HYDROXYALKYLQUINOLINES

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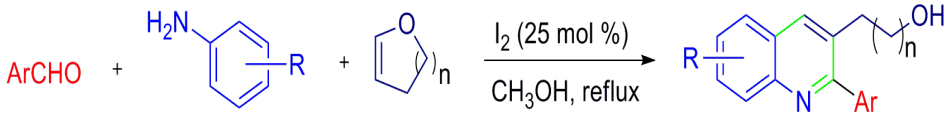
ABSTRACT

A practical, one step and atom economic synthesis of 2-aryl-3-hydroxyalkyl quinolines is disclosed during reinvestigation of Imino Diels-Alder (IDA) reaction, also called Povarov reaction (inverse electron demanding [4 + 2]-cycloaddition) with anilines, aldehydes and 2,3-dihydrofuran/3,4-dihydro-2H-pyran using excess of iodine (mild Lewis acid) as catalyst in methanol under reflux. Out of all catalysts screened, molecular iodine was found best in efficiency. The mechanistic study revealed that reaction took place by [4 + 2]-cycloaddition between initially formed Schiff base (acts as electron deficient-diene) formed from aldehyde and aniline and electron-rich dienophile, 2,3-dihydrofuran/3,4-dihydro-2H-pyran. In one of the examples (Table 3, Entry 5), tetrahydroquinoline intermediate was isolated from reaction mixture before the completion of reaction and characterized. Tetrahydroquinoline intermediate underwent oxidative aromatization (dehydrogenation) through cleavage of ether linkage to afford 2-aryl-3-hydroxyalkyl quinolines (4a-s) in good yields (36-59 %).



3a, n = 2
3b, n = 1

4a-s

Key words : Quinolines, Povarov reaction, [4 + 2]-cycloaddition, Anilines, Aldehydes Iodine.

INTRODUCTION

The Hetero Diels-Alder (HDA) reaction (Povarov reaction), with an enhanced synthetic diversity, is one of the most powerful reactions in organic synthesis of natural and unnatural polycarbocycles and polyheterocycles [1-3]. Quinoline, a privileged fragment is a ubiquitous subunit in many natural products with remarkable biological activities [4]. Apart from their use as synthons in organic synthesis of nano- and mesostructures with enhanced electronic and photonic properties [5], quinolines possess a wide spectrum of biological

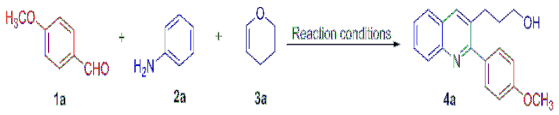
activities in medicinal chemistry such as antimalarial [6], antiinflammatory [7], antiasthmatic [8], antibacterial [9], antitubercular [10], antihypertensive[11], and tyrosine kinase inhibiting activities [12]. Among several variants of HDA the Povarov reaction (an inverse electron demanding [4 + 2]-cycloaddition), in which tetrahydroquinolines13 are formed by the coupling of electron-deficient N-arylimines (2-azadienes) and electron-rich alkenes has been studied extensively to access quinolines [14-17]. The reaction is promoted either by a protic or Lewis acid catalyst [18] and has been successfully performed by the coupling of alkenes, aldehydes, and anilines via in situ imine formation and subsequent formal [4 + 2]-cycloaddition. A wide variety of anilines, aldehydes and electron-rich alkenes such as cyclic and acyclic enamines, enamides and enol ethers, cyclic conjugated dienes or strained alkenes [19] have been used to get tetrahydroquinolines [20] which could be oxidized to respective quinolines.

Tetrahydroquinilones have recently been prepared by reaction of anilines, aromatic aldehydes and enol ethers or 2,3-dihydrofuran or 3,4-dihydro-2*H*-pyran using a number of Lewis acid catalysts such as $InCl_3$ [21], $BF_3.OEt_2$ [22], $GdCl_3$ [23], $LiBF_4$ [24], $Yb(OTf)_3$ [25] etc. Molecular iodine has also been used as mild Lewis acid catalyst in several organic reactions including in one of the Povarov reaction variants where 2,3-dihydrofuran and 3,4-dihydro-2*H*-pyran were used as electron-rich dienophile to afford tetrahydroquinolines [26]. In a three component reaction of 2,3-dihydrofuran or its equivalents, anilines and aldehydes there are several reports on the isolation of isomeric tetrahydroquinolines[27]. However, to the best of our knowledge there is no report on the direct assess of aromatized products, the quinolines except one by Takaki *et al* [28] where they isolated the aromatized product, only as side product but not as major product. Very recently during this study Wang *et. al.* [29] reported the reaction of naphthalen-2-amine, tetrahydrofuran and different aldehydes to get 2-(3-arylbenzo[*f*]quinolin-2-yl) ethanol derivatives. However, their method is limited to naphthyl amine only and the attempts with other aromatic amines were unsuccessful. Keeping in view the above facts and guided by the isolation of the quinoline as side product by Takaki *et. al.*, we were interested to reinvestigate the reaction of anilines, aldehydes and 2,3-dihydrofuran/3,4-dihydro-2*H*-pyran.We were successful in our mission and finally isolated the desired quinolines as the sole product. In this communication, we report a direct access of 2-aryl-3-hydroxyalkyl quinolines by reaction of anilines, aldehydes and 2,3-dihydrofuran/3,4-dihydro-2*H*-pyran catalysed by molecular iodine. The one pot reaction, generality of the method, and highly atom economic nature of this synthetic strategy constitute the most important feature of the method. The compounds synthesized herein have great potential to be exploited in medicinal chemistry.

RESULTS AND DISCUSSION

To standardize the most optimum reaction condition, reaction of 4-

methoxybenzaldehyde (**1a**, 1.0 mmol), aniline (**2a**, 1.0 mmol) and 3,4-dihydro-2*H*-pyran (**3a,** 1.5 mmol) was carried out (Scheme 1) under the influence of different catalysts, temperatures and solvents for 24 h to get the desired quinoline derivative **4a**. The results are shown in Table 1.



Scheme 1. Reaction of 4-methoxybenzaldehyde **1a**, aniline **2a** and 3, 4-dihydro-2*H*-pyran **3a**

Table 1. Synthetic Results of **4a** under different reaction conditions

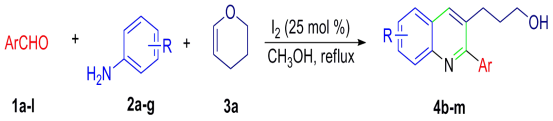
Entry	Temp. (°C)	Catalyst (mol %)	Solvent	Yields (%)[a]
1	r.t.	no catalyst	CH_3OH	0
2	reflux	no catalyst	CH_3OH	0
3	r.t.	I_2(5)	CH_3OH	5
4	50	I_2(5)	CH_3OH	10
5	reflux	I_2(5)	CH_3OH	28
6	reflux	I_2(10)	CH_3OH	30
7	reflux	I_2(15)	CH_3OH	45
8	reflux	I_2(25)	CH_3OH	57
9	reflux	I_2(40)	CH_3OH	59
10	reflux	CuCl(10)	CH_3OH	15
11	reflux	$CuCl_2.2H_2O$(10)	CH_3OH	30
12	reflux	$FeCl_3$(10)	CH_3OH	28
13	reflux	$ZnCl_2$(10)	CH_3OH	35
14	reflux	K_{10}	CH_3OH	20
15	reflux	I_2(25)	CH_2Cl_2	45
16	reflux	I_2(25)	CH_3CN	50
17	reflux	I_2(25)	C_2H_5OH	< 5
18	reflux	I_2(25)	DMF	-
19	reflux	I_2(25)	Benzene	< 5
20	reflux	I_2(25)	H_2O	-

[a] Refers to isolated yields by column chromatography.

Apart from molecular iodine as catalyst in the above reaction we have screened, $CuCl_2.2H_2O$, $FeCl_3$, $ZnCl_2$ and montmolnonitrile (K10) as Lewis acid catalyst which gave the desired quinoline in varying yields 15-35 % only. Iodine was successful catalyst as it gave good yields of the desired quinoline from 28-59 % depending upon the amount used in the reaction. It was observed that the yield improved from 28 to 57 % as the catalytic amount of iodine was increased from 5 mol % to 25 mol % respectively. However, increasing the amount of iodine from 25 to 40 mol % resulted only in a little increase of yield (59 %). It was also observed that at ambient temperature reaction afforded only 5 % of the desired product along with isomeric mixture of tetrahydroquinolines (Table 1, Entry 3) as major product. However, with increase in reaction temperature the yield of desired product also increased (Table 1, Entry 3-5). The screening of different solvents in 25 mol % iodine catalysed reaction proved methanol as the best solvent for our reaction while dichloromethane and acetonitrile resulted in moderate yields. Other solvents afforded either only 2-5 % (as observed on TLC) or no desired products. Since increasing the amount of iodine from 25 to 40 mol % resulted only little (2 %) increase in the yield of the desired product, it was decided that 25 mol % of iodine was sufficient to drive the reaction forward. Furthermore,

refluxing the reaction after 17 h resulted in no significant change on TLC. Thus refluxing the reaction in methanol as solvent, using 25 mol % of iodine as catalyst for 17 h was chosen as the most optimum reaction condition. However in later cases different optimum reaction time was observed depending upon the electronic affects of substituents present in aryl amine used. The structure of the quinoline derivative **4a** was established on the basis of its spectroscopic data and microanalysis. Furthermore, to confirm the structure of **4a** COSY and NOESY data were recorded.

With the optimised reaction conditions in hand, we then extended the scope of reaction with other aldehydes, anilines and 3, 4-dihydro-2*H*-pyran (Scheme 2) and the results are depicted in Table 2. As evident from Table 2, we did not observe any significant change on the course of reaction by varying substituents in aldehydes. Both the electron-releasing (like isopropyl) and electron-withdrawing (methoxy, chloro, fluoro, bromo etc.) substituents offer almost similar yields of the hydroxy propyl quinolines. However, anilines with electron-withdrawing groups required longer reaction times and afforded low yields of required products (Table 2, Entry 7, 12, 13). Another important observation was made with 3-chloroaniline **1d**, which on reaction with 4-chlorobenzaldehyde **2d** and 3,4-dihydro-2*H*-pyran **3a** resulted in two positional isomeric quinolines **4g** in 36 % and **(4g)**□ in 17 % (Table 2, Entry 7).



Scheme 2. Reaction of aldehyde **1a-l**, aniline **2a-g** and 3,4-dihydro-2*H*-pyran **3a**

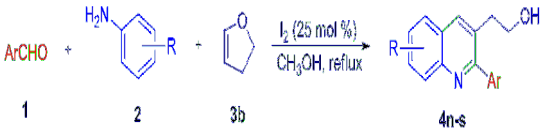
Table 2. Synthetic results of 4a-m

Entry	Ar	R	Products	Time (h)	Yield (%)[a]
1	**1a**, 4-$MeOC_6H_4$	**2a**, H	**4a**	17	57
2	**1b**, 4-(1-*H*-imidazol-1-yl)phenyl	**2b**, 4-MeO	**4b**	20	44
3	**1c**, 3, 4-$OCH_2OC_6H_3$	**2b**, 4-MeO	**4c**	16	52
4	**1d**, 4-ClC_6H_4	**2b**, 4-MeO	**4d**	17	56
5	**1a**, 4-$MeOC_6H_4$	**2c**, 4-Me	**4e**	18	56
6	**1e**, C_6H_5	**2b**, 4-MeO	**4f**	17	61
7	**1d**, 4-ClC_6H_4	**2d**, 3-Cl	**4g (4g)**□	23	36
8	**1f**, 4, 5-$(MeO)_2C_6H_3$	**2b**, 4-MeO	**4h**	20	56
9	**1g**, 4-$(Me)_2CHC_6H_4$	**2a**, H	**4i**	16	66
10	**1h**, 4-$C_6H_5CH_2OC_6H_4$	**2a**, H	**4j**	17	54
11	**1e**, C_6H_5	**2a**, H	**4k**	18	42

12	**1i**, 4-BrC_6H_4	**2e**, 4-CF_3O	**4l**	23	48
13	**1a**, 4-$MeOC_6H_4$	**2e**, 4-CF_3O	**4m**	24	46

[a]Refers to isolated yields by column chromatography.

The scope of 2,3-dihydrofuran (**3a**) as substarte in the above reaction was also investigated. Thus reaction of different aromatic aldehydes, anilines and 2,3-dihydrofuran led to the formation of respective 2-aryl-3-(2-hydroxyethyl) quinolines in good yields (Scheme 3), and the results are shown in Table 3. Here also the substitutents aromatic aldehydes did not alter the reaction yields significantly.



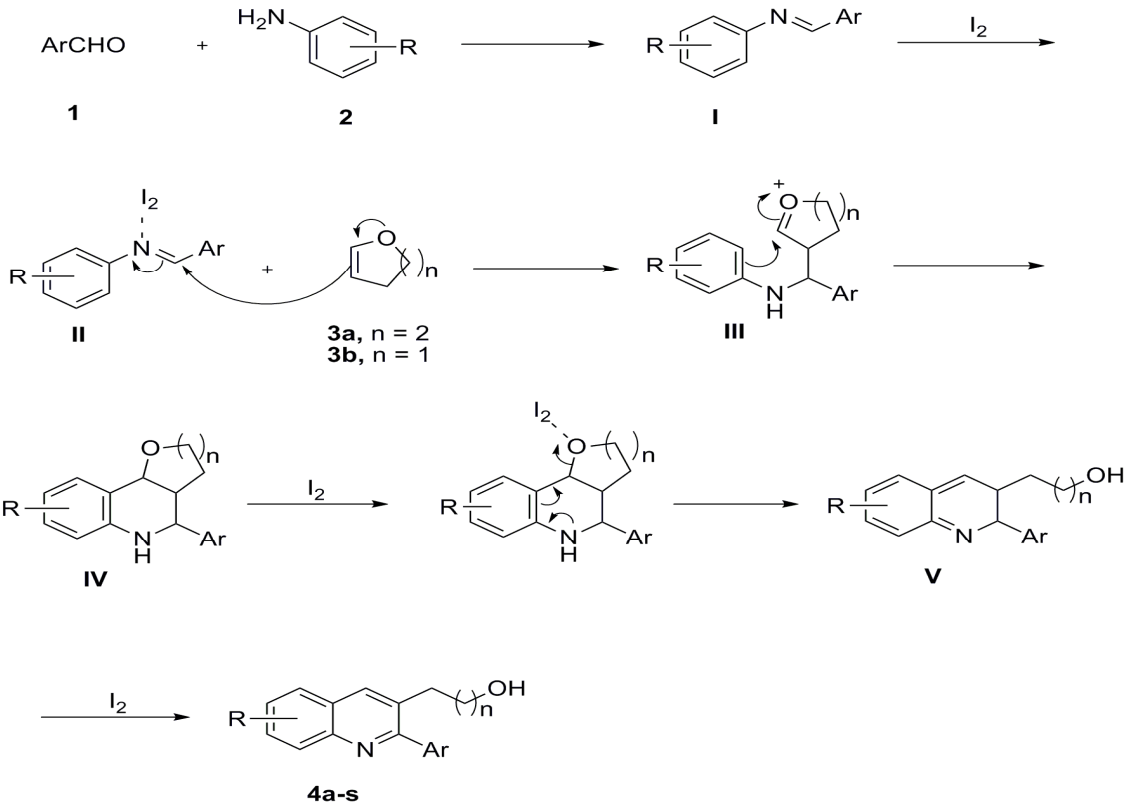
Scheme 3. Reaction of aldehyde **1**, aniline **2** and 2,3-dihydrofuran **3b**

Table 3. Synthetic results of 4n-s

Entry	Ar	R	Products	Time (h)	Yield (%)[a]
1	**1a**, 4-$MeOC_6H_4$	**2b**, 4-MeO	**4n**	21	56
2	**1c,** 3, 4-$OCH_2OC_6H_3$	**2a**, H	**4o**	17	59
3	**1d**, 4-ClC_6H_4	**2g**, 4-Cl	**4p**	24	53
4	**1j**, 4-$NO_2C_6H_4$	**2b**, 4-MeO	**4q**	20	41
5	**1k**, 4-pyridyl	**2f**, 2-Me	**4r**	19	47
6	**1l**, 4-FC_6H_4	**2b**, 4-MeO	**4s**	21	58

[a] Refers to isolated yields by column chromatography.

On the basis of literature precedents [30] it was thought that molecular iodine mediate the reaction as mild Lewis acid. The tentatively proposed mechanism is shown in Scheme 4. The Schiff base initially formed by the reaction of aniline and aldehyde and reaction is activated by iodine. The iodine-activated Schiff base is attacked by electron-rich dienophile (2,3-dihydrofuran/3,4-dihydro-2*H*-pyran) to give an intermediate II**.** The latter undergoes intramolecular Friedel-Crafts cyclization to afford tetrahydroquinoline intermediate III. The unexpected cleavage of C-O bond by iodine results in dihydroquinoline V, which is further aromatised probably by I_2/MeOH to give 2-aryl, 3-alkyl-quinoline. Such aromatization has earlier also been observed by us [31]. To support the mechanism an isomeric mixture of tetrahydroquinoline formed during reaction of pyridine-4-carboxaldehyde **1k**, 2-methylaniline **2f** and 2,3-dihydrofuran **3b** (Table 3, Entry 5) was isolated and characterised.



Scheme 4. Generalised possible mechanism for formation of products **4a-s**

CONCLUSION

Summarily, we have developed a facile one-pot, atom economic practical strategy to access a library of substituted quinolines through molecular iodine catalysed three component coupling/ dehydrogenation of aldehydes, anilines, and 2,3-dihydrofuran/3,4-dihydro-2*H*-pyran in good yields. Our findings constitute an advanced complement to conventional Povarov reaction. We are focused on biological applications of synthesized molecules and further studies on reaction mechanism and synthetic applications are currently underway in our group.

Experimental

General

Commercially available reagent grade chemicals were used as received. All reactions were followed by TLC on E. Merck Kieselgel 60 F_{254}, with detection by UV light, /and or spraying a 20 % $KMnO_4$ aq solution. Column chromatography was performed on silica gel (100-200 mesh E. Merck). IR spectra were recorded as thin films or on KBr pellets with a Perkin Elmer Spectrum RX-1 (4000-450 cm^{-1}) spectrophotometer. ^{1}H and ^{13}C NMR spectra were recorded on a Brucker DRX-300 in $CDCl_3$, CD_3OD or

DMSO-d_6 at 300 MHz and 50 MHz respectively. Chemical shift values are reported in ppm relative to TMS (tetramethylsilane) as internal reference, unless otherwise stated; s (singlet), d (doublet), t (triplet), m (multiplet), bs (broad singlet); *J* in Hertz. ESI mass spectra were performed using Quattro II (Micromass). Elemental analyses were performed on a Perkin-Elmer 2400 II elemental analyzer. Melting points were taken in open capillaries and are uncorrected.

General procedure for iodine mediated synthesis of 2-aryl, 3-(3-hydroxypropyl) quinolines (4a-m)

A mixture of aldehyde **1a-l** (1 mmol) and anilines **2a-g** (1 mmol) in methanol (20 ml) was stirred at 25-35 °C till the formation of Schiff base, as indicated by TLC. To the stirring reaction mixture, 3,4-dihydro-2*H*-pyran **3a** (1.5 equv) and 25 mol % of iodine were sequentially added. The stirring reaction mixture was heated under reflux for different times to complete the reaction time. After completion of reaction (TLC), the mixture was evaporated under vacuum to give a residual mass. The latter was extracted with ethyl acetate (2×40 mL), washed with saturated aqueous sodium thiosulphate solution (2×10 mL) and dried over anhydrous Na_2SO_4, and evaporated to crude mass, which was purified through column chromatography (SiO_2 60-120 mesh) using a gradient of ethyl acetate/hexane (2:8-3:7, v/v) as eluent to give the respective quinolines.

3-(3-Hydroxypropyl)-2-(4-methoxyphenyl)quinoline **4a**

It was obtained as light yellow solid in 57 % yield; m.p. 200-203 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3205, 2740, 1651, 1599, 1498, 1256, 1026, 768; ^{1}H NMR (300 MHz, DMSO-d_6) δ = 9.10 (s, 1H, ArH), 8.31-8.28 (m, 2H, ArH), 8.08-8.03 (m, 1H, ArH), 7.92-7.87 (m, 1H, ArH), 7.72-7.69 (d, 2H, *J* = 8.3 Hz, ArH), 7.23-7.20 (d, 2H, *J* = 8.3 Hz, ArH), 3.94 (s, 3H, OCH_3), 3.46 (t, 2H, *J* = 5.6 Hz, CH_2), 3.01 (t, 2H, *J* = 7.4 Hz, CH_2), 1.82-1.74 (m, 2H, CH_2); ^{13}C NMR (50 MHz, DMSO-d_6) δ = 163.4, 157.7, 146.8, 138.4, 137.1, 134.9, 132.0, 130.4, 129.4, 129.1, 124.7, 121.0, 115.4, 61.5, 55.9, 33.4, 29.3; Anal. Calcd for $C_{19}H_{19}NO_2$: C, 77.79; H, 6.53; N, 4.77; found C, 77.82; H, 6.56; N, 4.75; ESMS *m/z* = 294 $(M+H)^+$.

2-(4-Imidazol-1-yl-phenyl)-3-(3-hydroxypropyl)-6-methoxyquinoline **4b**

It was obtained as brown solid in 45 % yield; m.p. 150-153 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3212, 2944, 1620, 1523, 1490, 1230, 1056, 830, 737; ^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.98 (d, 2H, *J* = 7.0 Hz, ArH), 7.85 (s, 1H, ArH), 7.64 (d, 2H, *J* = 7.0 Hz, ArH), 7.42 (d, 2H, *J* = 6.9 Hz, ArH), 7.33-7.28 (m, 2H, ArH), 7.17 (s, 1H, ArH), 7.03 (s, 1H, ArH), 3.93 (s, 3H, OCH_3), 3.56 (t, 2H, *J* = 6.0 Hz, CH_2), 2.88 (t, 2H, *J* = 7.2 Hz, CH_2), 1.80-1.71 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 158.0, 156.2, 142.6, 140.3, 136.8, 135.3, 135.0, 133.2, 130.6, 130.3, 128.7, 122.0, 121.0, 118.0, 104.2, 61.39, 55.43, 33.41, 29.19; Anal. Calcd

for $C_{22}H_{21}N_3O_2$: C, 73.52; H, 5.89; N, 11.69; found C, 73.56; H, 5.92; N, 11.65; ESMS *m/z* = 360 $(M+H)^+$.

2-Benzo[1, 3]-dioxol-5-yl-3-(3-hydroxypropyl)-6-methoxyquinoline **4c**

It was obtained as brown solid in 52 % yield; m.p. 120-123 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3380, 2938, 1624, 1492, 1225, 1037, 769; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.00-7.91 (m, 2H, ArH), 7.33-7.27 (m, 1H, ArH), 7.04-6.86 (m, 4H, ArH), 5.98 (s, 2H, OCH_2O), 3.92 (s, 3H, OCH_3), 3.54 (t, 2H, *J* = 6.1 Hz, CH_2), 2.87 (t, 2H, *J* = 7.4 Hz, CH_2), 2.59 (bs, 1H, OH), 1.80-1.71 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 157.7, 157.3, 147.5, 142.4, 134.8, 133.2, 130.5, 128.4, 122.5, 121.7, 109.6, 108.1, 104.1, 101.0, 61.6, 55.3, 40.8, 33.32, 29.1; Anal. Calcd for $C_{20}H_{19}NO_4$: C, 71.20; H, 5.68; N, 4.15; found C, 71.24; H, 5.68; N, 4.13; ESMS *m/z* = 338 $(M+H)^+$.

2-(4-Chlorophenyl)-3-(3-hydroxypropyl)-6-methoxyquinoline **4d**

It was obtained as white solid in 56 % yield; m.p. 185-189 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3412, 3021, 166, 1434, 1216, 1030, 762; ^1H NMR (300 MHz, $CDCl_3$) δ = 7.95-7.91 (m, 2H, ArH), 7.42-7.27 (m, 5H, ArH), 7.04 (d, 1H, *J* = 2.61 Hz, ArH), 3.91(s, 3H, OCH_3), 3.45 (t, 2H, *J* = 6.3 Hz, CH_2), 2.79 (t, 2H, *J* = 7.6 Hz, CH_2), 2.60 (bs, 1H, OH), 1.73-1.64 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 158.0, 156.6, 142.4, 139.1, 135.0, 134.0, 133.2, 130.4, 130.2, 128.6, 128.4, 122.0, 104.3, 61.4, 55.4, 33.2, 29.0; Anal. Calcd for $C_{19}H_{18}ClNO_2$: C, 69.62; H, 5.53; N, 4.27; found C, 69.66; H, 5.56; N, 4.24; ESMS *m/z* = 328 $(M+H)^+$.

3-(3-Hydroxypropyl)-6-methyl-2-(4-methoxyphenyl)quinoline **4e**

It was obtained as white solid in 56% yield; m.p. 130-133 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3405, 2930, 1608, 1455, 1248, 1103, 769; ^1H NMR (300 MHz, $CDCl_3$) δ = 7.99 (d, 1H, *J* = 8.3 Hz, ArH), 7.87 (s, 1H, ArH), 7.48-7.41 (m, 4H, ArH), 6.93 (d, 2H, *J* = 8.4 Hz, ArH), 3.81(s, 3H, OCH_3), 3.45 (t, 2H, *J* = 6.0 Hz, CH_2), 2.84 (t, 2H, *J* = 7.3 Hz, CH_2), 2.53 (s, 3H, CH_3), 2.40 (bs, 1H, OH), 1.71-1.66 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 159.4, 159.1, 145.0, 135.9, 135.2, 133.2, 131.1, 130.1, 128.7, 127.4, 125.6, 113.6, 61.4, 55.1, 33.3, 29.2, 21.6; Anal. Calcd for $C_{20}H_{21}NO_2$: C, 78.15; H, 6.89; N, 4.56; found C, 78.18; H, 6.93; N, 4.52; ESMS *m/z* = 308 $(M+H)^+$.

3-(3-Hydroxypropyl)-6-methoxy-2-phenylquinoline **4f**

It was obtained as yellow solid in 61 % yield; m.p. 205-208 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3137, 2729, 1613, 1496, 1223, 1017, 759; ^1H NMR (300 MHz, DMSO-d_6) δ = 8.99 (s, 1H, ArH), 8.18 (d, 1H, ArH), 7.72-7.68 (m, 7H, ArH), 3.99 (s, 3H, OCH_3), 3.40 (t, 2H, *J* = 6.0 Hz, CH_2), 2.88 (t, 2H, *J* = 7.5 Hz, CH_2), 1.77-1.68 (m, 2H, CH_2); ^{13}C NMR (50 MHz, DMSO-d_6) δ = 159.7, 153.4, 143.6, 136.0, 133.8, 132.7, 131.2, 130.1, 129.8, 129.2, 126.8, 123.1, 106.2, 60.2, 56.6, 33.0, 28.5; Anal. Calcd for

$C_{19}H_{19}NO_2$: C, 77.79; H, 6.53; N, 4.77; found C, 77.83; H, 6.58; N, 4.75; ESMS *m/z* = 294 $(M+H)^+$.

7-Chloro-2-(4-chlorophenyl)-3-(3-hydroxypropyl)quinoline **4g**

It was obtained as brown solid in 36 % yield; m.p. 100-103 °C; R_f 0.5 (35:65, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3347, 2931, 1605, 1482, 1218, 1086, 766; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.09 (s, 1H, ArH), 8.03 (s, 1H, ArH), 7.73 (d, 1H *J* = 8.6 Hz,, ArH), 7.50-7.43 (m, 5H, ArH), 3.55 (t, 2H, *J* = 6.1 Hz, CH_2), 2.89 (t, 2H, *J* = 7.5 Hz, CH_2), 1.76-1.70 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 160.1, 146.7, 138.7, 135.9, 134.9, 134.6, 132.2, 130.1, 128.5, 128.1, 128.0, 127.8, 125.9, 61.4, 33.1, 29.1; Anal. Calcd for $C_{18}H_{15}Cl_2NO$: C, 65.07; H, 4.55; N, 4.22; found C, 65.10; H, 4.59; N, 4.20; ESMS *m/z* = 332 $(M+H)^+$.

5-Chloro-2-(4-chlorophenyl)-3-(3-hydroxypropyl)quinoline **(4g)**

It was obtained as brown solid in 17 % yield; m.p. 120-123 °C; R_f 0.5 (35:65, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3419, 2929, 1606, 1467, 1219, 770; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.46 (s, 1H, ArH), 8.04-8.01 (m, 1H, ArH), 7.63-7.46 (m, 6H, ArH), 3.62 (t, 2H, *J* = 6.1 Hz, CH_2), 2.98 (t, 2H, *J* = 7.7 Hz, CH_2), 1.87-1.78 (m, 1H, CH_2), 1.37 (bs, 1H, OH); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 159.8, 147.1, 138.6, 134.7, 134.1, 132.9, 130.5, 130.2, 128.7, 128.6, 128.5, 126.5, 125.7, 61.7, 33.3, 29.3; Anal. Calcd for $C_{18}H_{15}Cl_2NO$: C, 65.07; H, 4.55; N, 4.22; found C, 65.11; H, 4.59; N, 4.19; ESMS *m/z* = 332 $(M+H)^+$.

6-Methoxy-2-(3, 4-dimethoxyphenyl)-3-(3-hydroxypropyl)quinoline **4h**

It was obtained as yellow solid in 56 % yield; m.p. 140-143 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3383, 2797, 1656, 1431, 1217, 1038, 767; ^1H NMR (300 MHz, DMSO-d_6) δ = 8.94 (s, 1H, ArH), 8.18 (d, 1H, *J* = 9.6 Hz, ArH), 7.70-7.67 (m, 2H, ArH), 7.34-7.20 (m, 3H, ArH), 3.99 (s, 3H, OCH_3), 3.91 (s, 3H, OCH_3), 3.99 (s, 3H, OCH_3), 3.44 (t, 2H, *J* = 5.9 Hz, CH_2), 2.95 (t, 2H, *J* = 7.5 Hz, CH_2), 1.81-1.72 (m, 2H, CH_2); ^{13}C NMR (50 MHz, DMSO-d_6) δ = 164.3, 158.1, 156.1, 153.9, 148.2, 141.0, 138.3, 134.5, 131.4, 129.4, 127.8, 118.1, 116.8, 110.9, 65.0, 61.2, 61.1, 61.0, 37.8, 33.3; Anal. Calcd for $C_{21}H_{23}NO_4$: C, 71.37; H, 6.56; N, 3.96; found C, 71.39; H, 6.59; N, 3.93; ESMS *m/z* = 354 $(M+H)^+$.

2-(4-Isopropylphenyl)-3-(3-hydroxypropyl)quinoline **4i**

It was obtained as brown viscous liquid in 66 % yield; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3367, 2959, 1608, 1490, 1217, 1056, 763; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.13 (d, 1H, *J* = 8.4 Hz, ArH), 7.9 (s, 1H, ArH), 7.75 (d, 1H, *J* = 7.9 Hz, ArH), 7.67-7.62 (m, 1H, ArH), 7.51-7.46 (m, 1H, ArH), 7.43 (d, 2H, *J* = 8.0 Hz, ArH), 7.28 (d, 2H, *J* = 8.0 Hz, ArH), 3.43 (t, 2H, *J* = 6.2 Hz, CH_2), 2.97-2.90 (m, 1H, CH), 2.87 (t, 2H, *J* = 7.5 Hz, CH_2), 1.75-1.66 (m, 2H, CH_2), 1.29 (s, 6H, $2CH_3$); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 160.5, 148.7, 146.3, 138.1, 135.9, 133.3, 129.1, 128.8, 128.7, 127.5, 126.8, 126.3, 61.3, 33.9, 33.3, 29.0; Anal. Calcd for $C_{21}H_{23}NO$: C, 82.58; H, 7.59;

N, 4.59; found C, 82.61; H, 7.63; N, 4.56; ESMS *m/z* = 306 $(M+H)^+$.

2-(4-Benzyloxyphenyl)-3-(3-hydroxypropyl)quinoline **4j**

It was obtained as brown viscous liquid in 54 % yield; R_f 0.5 (25:75, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3418, 2934, 1609, 1511, 1456, 1220, 1020, 761; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.20 (d, 1H, *J* = 7.3 Hz, ArH), 8.01 (s, 1H, ArH), 7.82 (d, 1H, *J* = 7.0 Hz, ArH), 7.69-7.64 (m, 1H, ArH), 7.53-7.33 (m, 7H, ArH), 7.05-6.89 (m, 3H, ArH), 8.01 (s, 2H, CH_2), 3.50 (t, 2H, *J* = 6.1 Hz, CH_2), 2.91 (t, 2H, *J* = 7.3 Hz, CH_2), 2.40 (bs, 1H, OH), 1.78-1.69 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 160.0, 158.8, 146.4, 136.8, 136.0, 133.4, 130.2, 129.0, 128.9, 128.5, 127.9, 127.5, 127.4, 126.8, 126.3, 115.0, 69.9, 61.5, 33.3, 29.2; Anal. Calcd for $C_{25}H_{23}NO_2$: C, 81.27; H, 6.27; N, 3.79; found C, 81.29; H, 6.30; N, 3.76; ESMS *m/z* = 370 $(M+H)^+$.

3-(3-Hydroxypropyl)-2-phenylquinoline **4k**

It was obtained as white solid in 42 % yield; m.p. 173-175 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3410, 2105, 1636, 1487, 1217, 1056, 766; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.12 (d, *J* = 8.3 Hz, 1H, ArH), 8.02 (s, 1H, ArH), 7.78 (d, *J* = 7.8 Hz, 1H, ArH), 7.68-7.63 (m, 1H, ArH), 7.53-7.39 (m, 6H, ArH), 3.46 (t, 2H, *J* = 6.1 Hz, CH_2), 2.87 (t, 2H, *J* = 7.4 Hz, CH_2), 2.12 (bs, 1H, OH), 1.75-1.66 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 160.4, 146.4, 140.7, 135.9, 133.1 , 129.2, 128.9, 128.7, 127.6, 126.8, 126.4, 61.4, 33.3, 29.1; Anal. Calcd for $C_{18}H_{17}NO$: C, 82.10; H, 6.51; N, 5.32; found C, 82.13; H, 6.54; N, 5.30; ESMS *m/z* = 264 $(M+H)^+$.

2-(4-Bromophenyl)-3-(3-hydroxypropyl)-6-trifluoromethoxyquinoline **4l**

It was obtained as white solid in 48 % yield; m.p. 145-148 °C; R_f 0.5 (35:65, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3380, 2930, 1625, 1519, 1259, 1217, 770; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.16 (d, 1H, *J* = 9.1 Hz, ArH), 8.08 (s, 1H, ArH), 7.65-7.63 (m, 3H, ArH), 7.56-7.53 (m, 1H, ArH), 7.45 (d, 2H, *J* = 7.1 Hz, ArH), 3.61 (t, 2H, *J* = 6.1 Hz, CH_2), 2.92 (t, 2H, *J* = 7.6 Hz, CH_2), 1.84-1.74 (m, 2H, CH_2), 1.69 (bs, 1H, OH); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 159.7, 147.1, 144.6, 139.1, 135.9, 134.1, 131.6, 131.5, 130.4, 127.7, 123.2, 122.8, 116.8, 61.5, 33.0, 29.1; $C_{19}H_{15}BrF_3NO_2$: C, 53.54; H, 3.55; N, 3.29; found C, 57.10; H, 4.96; N, 4.76; ESMS *m/z* = 426 $(M+H)^+$.

3-(3-Hydroxypropyl)-2-(4-methoxyphenyl)-6-trifluoromethoxyquinoline **4m**

It was obtained as white solid in 46 % yield; m.p. 150-154 °C; R_f 0.5 (35:65, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3411, 2932, 1611, 1516, 1459, 1217, 1063, 770; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.15 (d, 1H, *J* = 9.1 Hz, ArH), 8.02 (s, 1H, ArH), 7.60 (s, 1H, ArH), 7.53-7.47 (m, 3H, ArH), 7.01 (d, 2H, *J* = 7.1 Hz, ArH), 3.87 (s, 3H, OCH_3), 3.55 (t, 2H, *J* = 6.1 Hz, CH_2), 2.95 (t, 2H, *J* = 7.5 Hz, CH_2), 1.80-1.70 (m, 2H, CH_2), 1.63 (bs, 1H, OH); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 159.9, 147.3, 144.9, 139.4, 135.7, 134.3, 131.8, 131.3,

130.1, 127.9, 123.4, 122.6, 116.5, 61.7, 55.8, 33.3, 29.3; $C_{20}H_{18}F_3NO_3$: C, 63.66; H, 4.81; N, 3.71; found C, 63.69; H, 4.84; N, 3.68; ESMS *m/z* = 378 $(M+H)^+$.

General procedure for iodine mediated synthesis of 2-aryl, 3-(2-hydroxyethyl)-quinolines *4n-s*

A mixture of aldehyde **1** (1 mmol) and aryl amine **2** (1 mmol) was dissolved in methanol (20 ml) and stirred at room temperature till the formation of Schiff base, as indicated by TLC. To this solution, 2,3-dihydrofuran **3b** (1.5 equv) and 25 mol % of iodine were added and reaction mixture was refluxed for the time period specified in Table 3. After completion of reaction (TLC), the mixture was evaporated under vacuum. The residual mass was extracted with ethyl acetate (2×40 mL), washed with saturated aqueous sodium thiosulphate solution (2×10 mL), dried over anhydrous Na_2SO_4, and evaporated to afford crude mass of **4n-s**. The latter was purified through silica column (SiO_2 60-120 mesh) chromatography using ethyl acetate/hexane mixture (2:8 to 3:7, v/v) as eluent.

3-(2-Hydroxyethyl)-6-methoxy-2-(4-methoxyphenyl)quinoline **4n**

It was obtained as white solid in 56 % yield; m.p. 140-143 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3283, 2936, 1616, 1451, 1238, 1027, 833; ^1H NMR (300 MHz, $CDCl_3$) δ = 7.98-7.94 (m, 2H, ArH), 7.44 (d, 1H, *J* = 8.5 Hz, ArH), 7.31-7.27 (m, 1H, ArH), 7.00-6.93 (m, 3H, ArH), 3.93 (s, 3H, OCH_3), 3.85 (s, 3H, OCH_3), 3.71 (t, 2H, *J* = 6.5 Hz, CH_2), 3.02 (t, 2H, *J* = 6.4 Hz, CH_2), 2.04 (bs, 1H, OH); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 159.4, 157.7, 157.6, 142.6, 135.7, 133.0, 130.5, 130.3, 130.2, 128.2, 121.8, 113.7, 104.2, 62.3, 55.3, 55.1, 36.03; Anal. Calcd for $C_{19}H_{19}NO_3$: C, 73.77; H, 6.19; N, 4.53; found C, 73.73; H, 6.21; N, 4.56; ESMS *m/z* = 310 $(M+H)^+$.

2-Benzo[1, 3]-dioxol-5-yl-3-(2-hydroxyethyl)quinoline **4o**

It was obtained as pale yellow solid in 59 % yield; m.p. 210-213 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3215, 2789, 1639, 1460, 1256, 1027, 767; ^1H NMR (300 MHz, CD_3OD) δ = 9.10 (s, 1H, ArH), 8.30-8.20 (m, 2H, ArH), 8.12-8.07 (m, 1H, ArH), 7.95-7.90 (m, 1H, ArH), 7.25-7.10 (m, 3H, ArH), 6.16 (s, 2H, OCH_2O), 3.86 (t, 2H, *J* = 6.1 Hz, CH_2), 2.87 (t, 2H, *J* = 6.0 Hz, CH_2), 2.12; ^{13}C NMR (50 MHz, CD_3OD) δ = 159.1, 153.1, 151.0, 149.2, 140.3, 136.7, 135.9, 132.1, 131.0, 130.6, 127.6, 126.8, 122.9, 111.8, 111.3, 104.9, 63.1, 36.9; Anal. Calcd for $C_{18}H_{15}NO_3$: C, 73.71; H, 5.15; N, 4.78; found C, 73.74; H, 5.18; N, 4.74; ESMS *m/z* = 294 $(M+H)^+$.

6-Chloro-2-(4-chlorophenyl)-3-(2-hydroxyethyl)quinoline **4p**

It was obtained as light yellow solid in 53 % yield; m.p. 134-137 °C; R_f 0.5 (35:65, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3236, 2932, 1654, 1596, 1440, 1370, 1060, 836; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.01 (s, 1H, ArH), 7.98 (s, 1H, ArH), 7.75 (d, 1H, *J* = 2.1 Hz, ArH), 7.62-7.58 (m, 1H, ArH), 7.45 (s, 1H, ArH), 3.74 (t,

2H, *J* = 6.2 Hz, CH_2), 3.01 (t, 2H, *J* = 6.4 Hz, CH_2), 2.00 (bs, 1H, OH); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 159.4, 144.8, 138.4, 136.0, 134.6, 132.5, 131.0, 130.6, 130.2, 128.5, 127.9, 125.6, 62.0, 35.6; $C_{17}H_{13}Cl_2NO$: C, 64.17; H, 4.12; N, 4.40; found C, 64.19; H, 4.15; N, 4.38; ESMS *m/z* = 318 $(M+H)^+$.

3-(2-Hydroxyethyl)-6-methoxy-2-(4-nitrophenyl)quinoline **4q**

It was obtained as white solid in 41 % yield; m.p. 205-208 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3450, 3022, 1587, 1483, 1217, 1023, 768; ^1H NMR (300 MHz, $CDCl_3$) δ = 7.98 (d, 2H, *J* = 7.0 Hz, ArH), 7.85 (s, 1H, ArH), 7.64 (d, 2H, *J* = 7.0 Hz, ArH), 7.42 (d, 2H, *J* = 6.9 Hz, ArH), 7.33-7.28 (m, 2H, ArH), 7.17 (s, 1H, ArH), 7.03 (s, 1H, ArH), 3.93 (s, 3H, OCH_3), 3.56 (t, 2H, *J* = 6.0 Hz, CH_2), 2.88 (t, 2H, *J* = 7.2 Hz, CH_2), 1.80-1.71 (m, 2H, CH_2); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 162.8, 160.2, 152.3, 152.0, 147.3, 140.9, 135.8, 135.5, 135.3, 133.6, 128.1, 127.0, 109.5, 66.3, 60.49, 40.51; Anal. Calcd for $C_{18}H_{16}N_2O_4$: C, 66.66; H, 4.97; N, 8.64; found C, 6.63; H, 4.99; N, 8.62; ESMS *m/z* = 325 $(M+H)^+$.

3-(2-Hydroxyethyl)-2-(4-pyridyl)-8-methylquinoline **4r**

It was obtained as white solid in 47 % yield; m.p. 145-147 °C; R_f 0.5 (30:70, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3377, 3020, 1598, 1413, 1217, 1049, 767; ^1H NMR (300 MHz, $CDCl_3$) δ = 8.62 (d, 2H, *J* = 5.1 Hz, ArH), 8.12 (s, 1H, ArH), 7.67-7.42 (m, 5H, ArH), 3.83 (t, 2H, *J* = 6.7 Hz, CH_2), 3.13 (t, 2H, *J* = 6.6 Hz, CH_2), 2.78 (s, 3H, CH_3), 2.56 (bs, 1H, OH); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 156.0, 149.2, 149.0, 145.9, 137.5, 137.4, 129.4, 129.0, 127.6, 126.9, 124.9, 124.2, 62.6, 35.8, 17.8; Anal. Calcd for $C_{17}H_{16}N_2O$: C, 77.25; H, 6.10; N, 10.60; found C, 77.27; H, 6.13; N, 10.57; ESMS *m/z* = 265 $(M+H)^+$.

2-(4-Fluorophenyl)-3-(2-hydroxyethyl)-6-methoxyquinoline **4s**

It was obtained as brown solid in 58 % yield; m.p. 135-138 °C; R_f 0.5 (35:65, EtOAc:hexane); IR (KBr) ν_{max} cm^{-1}: 3386, 2928, 1661, 1599, 1489, 1379, 1221, 768; ^1H NMR (300 MHz, CD_3OD) δ = 8.03 (s, 1H, ArH), 7.90 (d, 1H, *J* = 9.1 Hz, ArH), 7.48-7.43 (m, 2H, ArH), 7.31-7.27 (m, 1H, ArH), 7.16-7.06 (m, 3H, ArH), 3.90 (s, 3H, OCH_3), 3.66 (t, 2H, *J* = 6.8 Hz, CH_2), 3.93 (t, 2H, *J* = 6.7 Hz, CH_2); ^{13}C NMR (50 MHz, CD_3OD) δ = 169.1, 164.1, 162.0, 160.8, 146.0, 140.4, 140.2, 140.1, 134.7, 134.6, 134.5, 133.4, 132.7, 126.3, 119.3, 118.9, 108.3, 65.6, 59.2, 39.6; $C_{18}H_{16}FNO_2$: C, 72.71; H, 5.42; N, 4.71; found C, 72.73; H, 5.46; N, 4.74; ESMS *m/z* = 298 $(M+H)^+$.

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An Ancient therapy in Modern Sight for Diabete : A forgotten Doctrine

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ABSTRACT

Ayurveda known for its holistic approach and its natural and safe methods for treatment of diseases. It is potential medicinal system for taking care of present day health needs, are getting recognized globally. Modern medicine systems are always efforts to understand and interpret description pathogenesis of diabetes mellitus and its complications as in Ayurveda, in their words. But Ayurveda needs research designed to test and validate its fundamental concepts as well as its treatments.

INTRODUCTION

The history of exercise pathophysiology and cure of diseases begins from ancient time in India. The oldest literature in the world is sacred Riguveda, it contains 1,028 hymns. Written in Sanskrit, it includes a history of the Aryans, a view of prehistoric times, requests for kindness and blessings from various mythological gods and goddesses, and divine remedies for disease and disorders. Health was mentioned as it was not related to disease or recovery from disease, rather it was a condition that reflected the pleasure or displeasure of the gods. The dates cited for the Rgveda range from 4000 B.C to 2500 B.C. to 1500 B.C., with the latter date being most frequently mentioned by historians (Wilson HH. 1977, Kutambish P. 1962, Charles M. Tipton 2008).

Further the era (1000 B.C.) of second sacred texts Atharvaveda comes which contains the most detailed information dealing with medicine, health, and diseases. It includes 20 books by multiple authors with 731 hymns (Charles M. Tipton 2008, Gordon BL 1949, Whitney WD. 1962).

During the late Vedic period (circa 1500–800 B.C.) the tridosa doctrine (also known as the trihautu doctrine and considered to be the Indian humoral theory) was formulated and developed by Susruta (Bhatia SL 1977, Kutambish P. 1962) Ayurveda later developed as a separate system of medical knowledge and has given the status of Upveda. This doctrine was introduced to help explain the meaning of life, death, health, and diseases. Ayurveda also describes how the

five elements (panchmahabhut), water, fire, air, earth, and ether (space) contribute to the formation of the living and nonliving beings (Berryman JW 2003).

Ayurveda is a not science of medicine, but is more than a science; it seeks to restore an individual's innate harmony. Ayurveda ("knowledge of life" or "knowledge of longevity") is an indigenous popular holistic ethnic medicinal system of India. Ayurveda has now spread beyond India's borders to include the rest of the Indian subcontinent, Sri Lanka, Malaysia, Mauritius, South Africa, Japan, Russia, Europe, and North Americ (Paul G. Shekelle et.al. 2005).

Diabetes Mellitus (Madhumeha) is characterized by altered carbohydrate, protein and fat metabolism caused by the complete or relative insufficiency of insulin secretion or insulin action. Diabetes mellitus has become a global problem in spite of advances in modern science. India has been projected by WHO as the country with the fastest growing population of diabetic patients, estimated 19.4 million (1995) individuals affected by the disease. This number is expected to increase to 57.2 million by 2025 (Ramachandran A et.al. 1992).

The description available in Kaushika sutra of Atharvaveda is considered as the first reference related to diabetes, by the name of 'ASRAVA' (Athrva Veda; 1-2-4; 2-2-1, 2, 3, 4; 6-44). Sayana and Kesavabhatta, the well known commentators of the sacred Vedas interpret Asrava as mutratisara (excessive urination). The word Prameha was first time mentioned in Charaka Samhita, which is similar to diabetes. The word Prameha means "to flow", which is derived from Sanskrit root "Mih-Sechane". Meha literarily means to micturate. The verbal Mehanam signifies urination. The prefix 'Pra' means excess both in quantity and frequency. According to Susruta and Vagbhata *Prameha* is characterized by excessive flow of cloudy or turbid urine (Goli Penchala Prasad et.al. 2006).

This article describes a comprehensive therapeutic approach used in Ayurveda and modern medicine to treat diabetes mellitus.

According to Sharaka Diabetes Caused By-

आस्यासुखं स्वप्नसुखं दधीनि ग्राम्यौदकानूपरसाः पयांसि।

नवान्नपानं गुडवैकृतं च प्रमेहहेतुः कफकृच्च सर्वम्।।

-चरक संहिता

Classification of Diabetes Mellitus According to Dosha System

As we that Ayurveda is based on tridosha system, Diabetes can be divided in three main parts as-

जलोपमं चेक्षुरसोपमं वा धनं धनं चोपरि विप्रसन्नम्।

शुक्लं सशुक्रं शिशिरं शनैर्वा लालेव वा वालुकया युतं वा।।

विद्यात् प्रमेहान् कफजान् दशैतानु

क्षरोपमं कालमथापि नीलम्

हरिद्रमाञ्जिष्ठमथापि रक्तमेतान् प्रमेहान् षडुशन्ति पित्तात्।

मज्जौजसा वा वासयऽन्वितं वा लसीकया वा सततं विबद्धम्।

चतुर्विधं मूत्रयतीह वाताच्छेषेषु धातुष्वकपर्षितेषु।।

-चरक संहिता

An Indian physician Charaka and Susruta afterward Thomas Willis (17th Century) describes urine of diabetic patients taste like honey (madhu). According to Charaka, he classified diabetes in three types (tridosha system Kapha, Pitta, Vata). Further he classifies these on basis of color, looking and smell of urine into 20 types.

1. Kapha type (again divided into 10 types).
2. Pitta type (again divided into 6 types).
3. Vata type (divided into 4 types).

ANCIENT CLASSIFICATION OF DIABETES IN MODERN VIEW

Modern medicine systems are always efforts to understand and interpret description pathogenesis of diabetes mellitus and its complications as in Ayurveda in their words. Ayurveda describes diabetic patients are two types in this shloka and modern theory support this-

स्थूलः प्रमेही बलवानिहैकः कृशस्तथैकः परिदुर्बलश्रव्य।
संबृंहणं तत्र कृशस्य कार्य संशोधनं दोषबलाधिकस्य।।

-चरक संहिता

Ayurveda distinguished two types of diabetes at that period, one affecting the older and obese, and the other affecting thin people who did not survive long. The modern medicinal systems now subdivide of diabetes into insulin-dependent and non-insulin-dependent types which are similar as that period.

Treatment of Diabetes in Ancient medical system

हरीतकीकट्फलममुस्तलोध्रं पाठाविङर्जुनधन्वनाश्रव।
उभे हरिद्रे तगरं विडंग कदम्बशालार्जुनदीप्काश्रव।
दार्वी विडंग खदिरो ध्वश्रव सुराह्वकुष्ठागुरुचन्दनानि।
दार्व्यग्निमन्थौ त्रिफला सपाठा पाठा च मूर्वा च तथा श्रवदंष्ट्रा।
यवान्युशीराण्यभयागुडूचीचव्याभयाचित्रकसप्तपर्णाः
पादैः कषायाः कफमेहिनां ते दशोपदिष्टा मधुसम्प्रयुक्ताः।

-चरक संहिता

उशीरलोध्राञ्जनचन्दाननामुशीरमुस्तामलकाभयानाम्।
पटोलनिम्बामलकामृतानां मुस्ताभयापद्यकवृक्षकाणाम्।।
लोध्राम्बुकालीयकधातकीनां निम्बार्जुनाम्रातनिशोत्पलानाम्
शिरीषसर्जार्जुनकेशराणां प्रियङ्गुपद्योत्पलकिंशुकानाम्।
अश्वत्थपाठासनवेतसानां कटकंटेर्युत्पलमुस्तकानाम्।
पैत्तेषु मेहेषु दश प्रदिष्टाः पादैः कषाया मधुसम्प्रयुक्ताः।।

-चरक संहिता

त्रिकण्टकाश्मन्तकसोमवल्कैर्भल्लातकैः सातिविषैः सलोध्रैः।
वचापटोलार्जुननिम्बमुस्तैर्हरिद्रया पद्यकदीप्यकैश्व।।
मञ्जिष्ठया चागुरुचन्दनैश्च सर्वैः समस्तैः कफवातजेषु।
मेहेषु तैलं विपचेद्, धृतं तु पैत्तैषु, मिश्रं त्रिषु लक्षणेषु।।

-चरक संहिता

Treatment of Diabetes in Modern Medical system and its Side effects

Diabetes mellitus is a disease as old as humanity and is one of the major problems in clinical practice even today. To tackle this disease, the physician should identify a target level of glycaemic control for each patient and provide the patient with the educational and pharmacologic resources necessary to achieve normal sugar level in blood.

The discovery of insulin in 1922 brought in a remarkable change in the outlook for both type1 and type 2 diabetic patients who started surviving for longer periods till they developed vascular

complications or infections. Insulin increases glucose uptake in cells by stimulating the translocation of the glucose transporter GLUT4 from intracellular sites to the cell surface. Insulin circulates in blood as the free monomer and its half life in plasma is about 5 - 6 min in normal subjects. The main draw back of insulin is taken through injection (Krishna Bihari Pandeya et.al. 2013).

The development of oral hypoglycemic agents around mid 1950s provided an option to the physicians as well as the patient to use either oral medication or to continue insulin. Often oral hypoglycemic agents were preferred.

Oral Hypoglycemic drugs are those drugs that lower blood glucose level and taken orally. These drugs are synthetic and complex organic substances. Hence the search for synthetic oral active drugs is in demand. Sulfonylureas Drugs, Biguanides, Others (Acarbose, Guar Gum). These drugs are effective in diabetes but having some limitations such as hypoglycemia occurs with regular use of sulfonylurea compounds but occurrences are much fewer than with insulin therapy. It is prescribed by doctors that biguanids should not use in patients with renal diseases. On the other hand the main side effect of Acarbose is flatulence (K. A. Wadkar et.al. 2008).

In spite of fascinating advances in pharmaco-therapeutic agents, world is seeking for safer and effective remedies.

CONCLUSION

The potential of Ayurvedic philosophy and medicines needs to be recognized and converted into real life treatment paradigm. The classical medicinal system's core strength is its holistic approach to health and disease using natural remedies derived from medicinal plants and minerals. A delicate balance between biophysiological forces (*dosha*) and constitution (*prakriti*) is said to determine health and disease; several other "players" like "mind" and "metabolic fire" (*agni*) play important roles. Ayurveda's principle therapeutic aim is to harmoniously restore that balance.

Ayurveda has an extensive pharmacopoeia, predominantly herbs and minerals. Their healing properties are well summarized in modern texts. Ayurvedic formulations, often complex with several herbal-mineral ingredients, are governed by well-described pharmacological principles of preparation, compatibility and administration. Although classic texts contain descriptions of classic formulations, traditional Ayurvedic practitioners often modify them to suit the individual constitution (*prakriti*), which confers genetic predisposition toward disease and therapy response, and is vital to ensure medication safety.

Research is the prime need of fashionable Ayurveda, but modern research on Ayurveda has not been very rewarding for Ayurveda itself. Ayurveda needs research designed to test and validate its fundamental concepts as well as its treatments.

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STUDY OF ACTIVE PHARMACEUTICAL INGREDIENT (API) NICOTINAMIDE BASED BINARY DRUG PRODUCTS

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ABSTRACT

Active pharmaceutical ingredient (API) nicotinamide has also been used as pharmaceutical excipient. In this communication a bio-molecule Nicotinamide(NA) has been treated with another pharmaceutical excipient Succinic acid(SUA) as binary drug system. The system forms 1:2 cocrystal/addition compound/molecular complex followed by two side by side eutectics E1(1310C) and E2(1220C) and their compositions are at 0.442 and 0.897 mole fraction of NA. Molecular interaction, ordering and stability in the solid dispersed eutectic, non-eutectic alloys and cocrystal were discussed in the light of the evaluated value of excess thermodynamic functions. The study covers the driving force of nucleation during solidification (ΔGv) and critical size or radius (r*) at different undercoolings for binary pharmaceutical materials. Using heat of fusion data the solid-liquid interface energy and roughness parameter (α) of all the alloys are evaluated by numerical method. Interface morphology of the alloys follows the Jackson's surface roughness (α) theory and predicts the faceted growth proceeds in all the alloys of pharmaceutical materials.

Key words: Solid-liquid equilibrium data, thermodynamic excess functions, interfacial energy, critical radius, roughness parameter

INTRODUCTION

Nicotinamide is an important biomolecule for human metabolism. Nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP) function as coenzymes in a wide verity of enzymatic oxidation-reduction reactions essential for tissue respiration, lipid metabolism and glycogenolysis. Nicotinamide, an active constituent of Mallotus Japonicus leaves1 (Fig.1) Mueller-Arg (Japanes name, "akamegashiwa") and extract of Amaranthus gengeticus seeds (cv. Altapati) and pea seedlings (Bangladesh originated), strong halting activity against zoospores of the phytopathogenic fungus Aphanomyces cochlioides has been used in the treatment of Pellegra, HIV infection, blue mussel, Diabetes, Alzheimer's disease, lowering Cholesterol level, M. tuberculosis4, distorted tumor cell lines5

representing leukemia, melanoma, and cancer of the lung, colon, brain, ovary, breast, prostate as well as kidney and inflammatory action6 of skin disorder with mild redness, swelling, etching, discoloration, dermis etc. Nishimura has demonstrated that nicotinamide exhibits shell opening activity against common bivalve molluscs. It was first isolated from liveras an antipellagra factor and is also synthesized from tryptophan (Fig.2) in intestines in tissues. It is quite obvious that isolated nicotinamide cannot fulfill the demand of pharmaceutical sector. Getting synthesized nicotinamide can compensate our needs. Recently solid dispersion cocrystal of nicotinamide with Theophylline and Khellin has been reported for their better drug ability. Theophylline8, an alkaloid found from tea and chocolate is used as an anti-asthmatic and muscle relaxing drug. Khellin, extracted from the fruit and seed of herbaceous/medicinal plant Ammi Visnaga9 mainly found in Mediterranean areas in open field is usually used as drugs in angina, vitiligo, psoriasis, renal colic, diuretic, kidney stone, coronary and bronchial asthma. Pharmacological activity of Nicotinamide with drugs of different therapeutic classes such as tolbutamide, carbamazepine, Rofecoxib, Flurbiprofen, Halofantrine, Artemisinin, Indomethacine, Diazapam, Griseofulvin, Progesterone, Testosterone, Piroxicam, Nifedipine, Ethylparaben, Riboflavin, Furosemide, Naproxen, Celecoxib, Fenamic acid, Itraconazole, Ketoconazole, Lamotrigine, Theophylline, Ibuprofen, Moricizine has recently been trialed. These days, drug dose for a patient is vital and challenging of pharmacists and medical scientists for a long time and it has been grate dream to find the most effective form of drug products with market manufacturability and to satisfy the safety and efficacy requirement of pharmaceutical product. Due to poor solubility, low dissolution rate10, moisture uptake, lower permeability, chemical stability, bio-availability, least therapeutic efficacy11 and higher possibility of toxicity of the drug, multi-component form of drug product, e.g. solvates, hydrates, salts, esters and co-crystals are used with great enthusiasm to maximize the therapeutic efficacy of many drugs and significantly the market value of the drug. In addition these forms of the drug play important role design of new and better drug products particularly in the pharmaceutical area. Recently, solid dispersion systems have been demonstrated in the pharmaceutical to improve the drug ability12 and the dissolution properties of poorly water soluble drugs. The term solid dispersion represents to a group of solid products consisting of at least two different components containing hydrophilic matrix and a hydrophobic drug. The matrix can be either crystalline or amorphous whereas drug can be dispersed molecularly. Extensive research has been reported on various solid dispersion techniques for drug development involving poorly water soluble and highly permeable to biological membranes as with these drugs dissociation the rate limiting step to absorption. These techniques are particularly promising for improving the

oral absorption/intake and bioavailability of the drugs. The formulation of drugs as solid dispersion form offers a variety of processes and a number of excipient/coformer/carrier that allow the flexibility during formulating oral delivery systems for poorly water soluble drugs. Solid dispersions are classified into six major groups, namely: simple eutectic mixtures, solid solutions, glassy suspension, and amorphous precipitation of a drug in a crystalline carrier, addition compound/molecular complex/co S crystal between drug and excipient/inclusior and combination of these groups. The author has worked particularly in the area of eutectic mixture and molecular complex/co-crystal. With view to search and achieve a new and better performing drug candidate, Nicotinamide (NA) an API as well as the pharmaceutical excipients with Succinic acid (SUA) has been selected as binary system for their detailed investigation such as thermodynamic excess functions, interfacial energy, Gibb's Thomson coefficient, driving force of solidification, critical size of nucleus and interface surface structure.

Fig.1. *Mallotus japonicas*

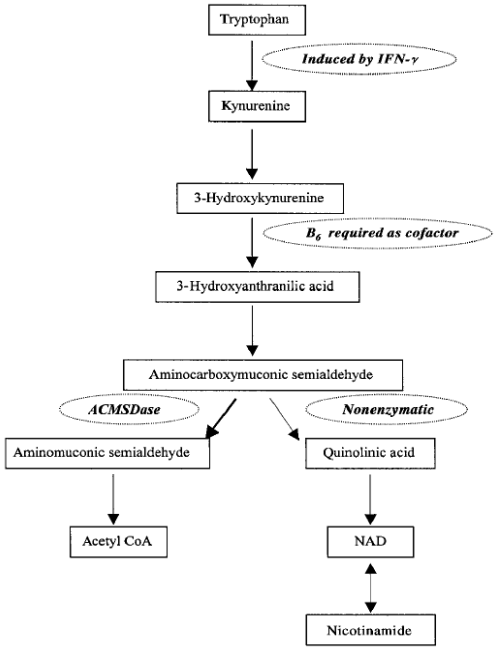

Fig. 2. Nicotinamide: an oxidative metabolic product of tryptophan in Human

EXPERIMENTAL

Nicotinamide (Thomas Baker, Mumbai) and Succinic acid (C. S. chemicals, India) were directly taken for investigation. The melting point (experimental value) of nicotinamide was found 128°C while for Succinic acid was found 180°C respectively. For measuring the solid-liquid equilibrium data of NA-SUA system, mixtures of different composition were made in glass test tubes by repeated heating and followed by chilling in ice and were determined by the thaw-melt method[13]. The melting and thaw temperatures were determined in a Toshniwal melting point apparatus using a precision thermometer which could read correctly up to ± 0.1°C. The heater was regulated to give above 1°C increase in temperature in every five minutes.

Heat of fusion of materials was measured by the DTA method using NETZSCH Simultaneous Thermal Analyzer, STA 409 series unit.

RESULT AND DISCUSSION

Solid-liquid equilibrium

The solid-liquid equilibrium data for NA-SUA system indicates the formation of 1:2 cocrystal/molecular complex C, two eutectics E_1, E_2 and non-eutectics A_1-A_{12}. The melting temperature of the cocrystal (143^0C), E_1 (131^0C) and E_2 (122^0C) and their compositions are at 0.670, 0.442 and 0.897 mole fraction of NA. On addition of NA in SUA the melting point of the mixture decreases and attains the minimum at E_1 (the first eutectic of the system). On continued addition of NA the melting point rises and attains the maximum at 'C' where the compositions of solid and liquid phase are identical. This is the congruent melting point of the compound formed in the system. A further increase in concentration of NA cause a decrease in the melting point till the minimum E_2 (the second eutectic of the system) is attained. A good length of the middle branch of the curve and the existence of a eutectic point on both side of the maximum leads the information regarding the stability of the cocrystal formation. It is formed by the reaction between the two components in the following manner

A + B $\rightleftharpoons$ AB (liquid) $\rightleftharpoons$ AB (solid)

THERMODYNAMIC STUDY

The values of heats of fusion of cocrystal, eutectic and non-eutectic alloys are calculated by the mixture law. The value of heat of fusion of binary alloys A_1-A_{12}, E_1 and E_2 is reported in Table 1. The activity coefficient and activity of components for the systems under investigation has been calculated from the equation[14] given below

$$-\ln x_i\gamma_i = \frac{\Delta H_i}{R}\left(\frac{1}{T_e}-\frac{1}{T_i}\right) \quad (1)$$

where γ_i is activity coefficient of the component i in the liquid phase respectively, ΔH_i is the heat of fusion of component i at melting point T_i and R is the gas constant. T_e is the melting temperature of alloy. Using the values of activity and activity coefficient of the components in alloys mixing and excess thermodynamics functions have been computed.

EXCESS FUNCTIONS

In order to unfold the nature of the interactions between the components forming the eutectic, non-eutectic alloys and addition compound, the excess thermodynamic functions such as integral excess integral free energy (g^E), excess integral entropy (s^E) and excess integral enthalpy (h^E) were calculated using the following equations[15]

$$g^E = RT\,(x_{NA}\ln\gamma_{NA} + x_{SUA}\ln\gamma_{SUA})$$

$$s^E = -R\left(x_{NA}\ln\gamma_{NA} + x_{SUA}\ln\gamma_{SUA} + x_{NA}T\frac{\delta\ln\gamma_{NA}}{\delta T} + x_{SUA}T\frac{\delta\ln\gamma_{SUA}}{\delta T}\right)$$

$$h^E = -RT^2\left(x_{NA}\frac{\delta\ln\gamma_{NA}}{\delta T} + x_{SUA}\frac{\delta\ln\gamma_{SUA}}{\delta T}\right)$$

and excess chemical potential or excess partial free energy of mixing

$$g_i^{-E} = \mu_i^{-M} = RT \ln \gamma_i$$

The values of $\partial \ln \gamma_i / \partial T$ can be determined by the slope of liquidus curve near the alloys form in the phase diagram. The values of the excess thermodynamic functions are given in Table 2. The value of the excess free energy is a measure of the departure of the system from ideal behavior. The reported excess thermodynamic data substantiate the earlier conclusion of an appreciable interaction between the parent components during the formation of alloys. The negative value of excess free energy indicates the possibility of a stronger association between unlike molecules while the positive value in the present system suggests an association of weaker nature between unlike molecules and of stronger nature between like molecules. The maximum positive g^E value[16] for all eutectic and non-eutectic alloys infers stronger interaction between like molecules in binary mix. The excess entropy is a measure of the change in configurational energy due to a change in potential energy and indicates an increase in randomness.

INTERFACIAL INVESTIGATION

The Solid-Liquid Interfacial Energy (σ)

It has been found that an experimentally observed value of interfacial energy 'σ' keeps a variation of 50-100% from one worker to other. However, Singh and Glickman[17] were calculated the solid-liquid interfacial energy (σ) from melting enthalpy change and values obtained are found in good agreement with the experimental values. Turnbull empirical relationship[18] between the interfacial energy and enthalpy change provides the clue to determine the interfacial energy value of alloy and is expressed as:

$$\sigma = \frac{C\Delta H}{(N)^{1/3}(V_m)^{2/3}}$$

where the coefficient C lies between 0.33 to 0.35 for nonmetallic system, V_m is molar volume and N is the Avogadro's constant. The value of the solid-liquid interfacial energy of nicotinamide and Succinic acid was found to be 5.046×10^{-02} and 4.023×10^{-02} J m^{-2} respectively and σ value of alloys was given in Table 1.

THE DRIVING FORCE OF NUCLEATION (ΔG_V)

During growth of crystalline solid there is change in enthalpy, entropy and specific volume and non-equilibrium leads Gibb's energy. Thermodynamically metastable phase occurs in a supersaturated or super-cooled liquid. The driving force for liquid-solid transition is the difference in Gibb's energy between the two phases. The theories of solidification process in past have been discussed on the basis of diffusion model, kinetic characteristics of nucleation and on thermodynamic features. The lateral motion of rudementry steps in liquid advances stepwise/ non-uniform surface at low driving force while continuous and

uniform surface advances at sufficiently high driving force. The driving force of nucleation from liquid to solid during solidification (ΔG_V) can be determined at different undercoolings (ΔT) by using the following equation[19]

$$\Delta G_V = \Delta S_v \Delta T$$

It is opposed by the increase in surface free energy due to creation of a new solid-liquid interface. By assuming that solid phase nucleates as small spherical cluster of radius arising due to random motion of atoms within liquid. The value of ΔG_V for alloys and pure components are shown in the Table 3.

THE CRITICAL RADIUS (R*)

During liquid-solid transformation embryos are rapidly dispersed in unsaturated liquid and on undercooling liquid becomes saturated and provide embryo of a critical size with radius r* for nucleation which can be expressed by the Chadwick relation[20]

$$r^* = \frac{2\sigma}{\Delta G_V} = \frac{2\sigma T}{\Delta H_V \Delta T}$$

where σ is the interfacial energy and ΔH_V is the enthalpy of fusion of the compound per unit volume, respectively. The critical size of the nucleus for the components and alloys was calculated at different undercoolings and values are presented in Table 4. It can be inferred from table that the size of the critical nucleus decreases with increase in the undercooling of the melt. The existence of embryo and a range of embryo size can be expected in the liquid at any temperature.

INTERFACE MORPHOLOGY

The science of growth has been developed on the foundation of thermodynamics, kinetics, fluid dynamics, crystal structures and interfacial sciences. The solid-liquid interface morphology can be predicted from the value of the entropy of fusion. According to Hunt and Jackson[21], the type of growth from a binary melt depends upon a factor α, defined as:

$$\alpha = \xi \frac{\Delta H}{RT} = \xi \frac{\Delta S}{R}$$

where ξ is a crystallographic factor depending upon the geometry of the molecules and has a value less than or equal to one. $\Delta S/R$ (also known as Jackson's roughness parameter α) is the entropy of fusion (dimensionless) and R is the gas constant. When α is less than two the solid-liquid interface is atomically rough and exhibits non-faceted growth. The value of Jackson's roughness parameter ($\Delta S/R$) is given in Table 1. For the entire alloy the α value was found greater than 2 which indicate the faceted[22] growth proceeds in all the cases.

CONCLUSION

The solid-liquid equilibrium phase diagram of NA-SUA system shows the formation of 1:2 cocrystal with two eutectic alloys. The activity and activity coefficient values are very useful in computing thermodynamic excess functions. Thermodynamic excess Gibbs free energy values for eutectic and non-eutectic alloys are being found positive which suggest the stronger association between like molecules. The critical radius

for all the alloys and pure components are found in nano-scale and lies between 136.3 to 38.95 nm. Jackson's roughness parameter (α) for all the eutectic and non-eutectic alloys is found greater than 2 which predicts the faceted growth leads in these cases. The small molecule nicotinamide could emerge as a heralding therapeutic agent of 21st century not only in itself but also inform of leading cocrystals. The nano particles of the nicotinamide and its cocrystals may change the face of molecular pharmaceutics.

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Table 1: Phase composition, melting temperature (MP), entropy of fusion (ΔS), heat of fusion (ΔH), interfacial energy (σ), and roughness parameter (α), activity coefficient (γ)

Alloy	X_{NA}	X_{SUA}	MP (°C)	ΔH (J/mol)	ΔS (J/mol/K)	α	σ · 10>2 (ϑ/μ2)	λνγNA	λνγΣY A
A_1	0.097	0.903	169	19015.79	43.022	5.175	4.131	3.04	-0.019
A_2	0.195	0.805	162	19708.65	45.307	5.450	4.237	2.23	0.016
A_3	0.293	0.707	157	20401.51	47.445	5.707	4.342	1.741	0.086
A_4	0.342	0.658	148	20747.94	49.283	5.928	4.394	1.435	0.049
A_5	0.392	0.608	134	21101.44	51.846	6.236	4.446	1.049	-0.052
E1	0.442	0.558	131	21454.94	53.106	6.388	4.498	0.873	-0.007
A_6	0.492	0.508	133	21808.44	53.715	6.461	4.549	0.803	0.114
A_7	0.542	0.458	138	22161.94	53.922	6.486	4.600	0.798	0.284
A_8	0.592	0.408	141	22515.44	54.385	6.541	4.650	0.763	0.438
1:2 cocrystal	0.67	0.33	143	23066.90	55.449	6.669	4.728	0.675	0.676
A_9	0.713	0.287	141	23370.91	56.451	6.790	4.771	0.578	0.79
A_{10}	0.795	0.205	135	23950.65	58.703	7.061	4.851	0.36	1.048
A_{11}	0.876	0.124	128	24523.32	61.155	7.356	4.928	0.132	1.456
E2	0.897	0.103	122	24671.79	62.460	7.513	4.949	-0.01	1.558
A_{12}	0.917	0.083	125	24813.19	62.345	7.499	4.968	0.029	1.816

Table 2: Value of partial and integral excess Gibbs free energy (g^E), enthalpy (h^E) and entropy (s^E) of NA-SUA system

Alloy	g_{NA}^{-E} J/mol	gSUA¯E J/mol	gE J/mol	hNA¯E J/mol	hSUA¯E J/mol	hE J/mol	sNA¯E J/mol/K	sSUA¯ E J/mol/K	sE J/mol/K
A_1	11170.45	-70.15	1020.19	-7412.67	-342.67	-1028.46	-42.04	-0.62	-4.64
A_2	8065.86	56.14	1618.04	3914.60	10984.60	9605.95	-9.54	25.12	18.36
A_3	6225.54	308.89	2042.47	-3656.60	3413.40	1341.89	-22.98	7.22	-1.63
A_4	5022.35	170.17	1829.62	-14202.57	-7132.57	-9550.51	-45.67	-17.35	-27.03
A_5	3548.96	-177.61	1283.20	-8411.44	-1341.44	-4112.88	-29.39	-2.86	-13.26
E1	2932.35	-23.17	1283.17	96192.99	103262.99	100138.05	230.84	255.66	244.69
A_6	2710.86	384.34	1528.99	15065.94	22135.94	18657.50	30.43	53.58	42.19
A_7	2726.33	968.86	1921.41	-868.84	6201.17	2369.23	-8.75	12.73	1.09
A_8	2627.90	1507.63	2170.83	44452.27	51522.27	47336.83	101.03	120.81	109.10
1:2 cocrystal	2335.23	2337.30	2335.91	105398.87	112468.87	107731.97	247.75	264.74	253.36
A_9	1987.78	2718.47	2197.49	49076.64	56146.64	51105.73	113.74	129.05	118.14
A_{10}	1221.59	3554.77	1699.89	25233.48	32303.48	26682.83	58.85	70.46	61.23
A_{11}	441.37	4855.35	988.71	28507.24	35577.24	29383.92	69.99	76.61	70.81
E2	-23.08	5117.80	506.43	226481.91	233551.91	227210.12	573.43	578.31	573.93
A_{12}	96.69	6010.25	587.52	212606.78	219676.78	213193.59	533.95	536.85	534.19

Table 3: Value of volume free energy change (ΔG_v) during solidification for NA - SUA system of different undercoolings (ΔT)

Alloy ↓ Undercoolins →	ΔG_v (kJ/m^3)					
	1.0	1.5	2.0	2.5	3.0	3.5
A_1	0.650	0.974	1.299	1.624	1.949	2.274
A_2	0.651	0.976	1.301	1.626	1.952	2.277
A_3	0.648	0.972	1.296	1.621	1.945	2.269
A_4	0.657	0.985	1.314	1.642	1.971	2.299
A_5	0.674	1.011	1.348	1.685	2.022	2.359
E1	0.673	1.010	1.347	1.683	2.020	2.357
A_6	0.664	0.996	1.329	1.661	1.993	2.325
A_7	0.651	0.976	1.301	1.626	1.952	2.277
A_8	0.640	0.960	1.280	1.600	1.920	2.240
1:2 cocrystal	0.628	0.942	1.256	1.570	1.883	2.197
A_9	0.626	0.938	1.251	1.564	1.877	2.190
A_{10}	0.625	0.937	1.249	1.562	1.874	2.186
A_{11}	0.625	0.938	1.250	1.563	1.875	2.188
E2	0.632	0.948	1.264	1.579	1.895	2.211
A_{12}	0.624	0.936	1.249	1.561	1.873	2.185
NA	0.726	1.089	1.452	1.815	2.178	2.541
SUA	0.539	0.808	1.077	1.347	1.616	1.885

Table 4: Critical size of nucleus (r*) at different undercoolings (ΔT)

Alloys ↓ Undercoolings →	r*(nm)					
	1.0	1.5	2.0	2.5	3.0	3.5
A_1	146.5	97.67	73.25	58.60	48.84	41.86
A_2	144.9	96.62	72.47	57.97	48.31	41.41
A_3	144.0	95.60	72.00	57.60	48.00	41.14
A_4	141.3	94.22	70.67	56.53	47.11	40.38
A_{51}	137.0	91.32	68.49	54.79	45.66	39.14
E	136.3	90.88	68.16	54.53	45.44	38.95
A_6	137.3	91.55	68.67	54.93	45.78	39.24
A_7	139.4	92.91	69.68	55.75	46.46	39.82
A_8	140.7	93.82	70.37	56.29	46.91	40.21
1:2 cocrystal	142.0	94.63	70.98	56.78	47.32	40.56
A_9	141.6	94.38	70.78	56.63	47.19	40.45
A_{10}	140.1	93.37	70.03	56.02	46.69	40.02
A_{11}	138.2	92.12	69.09	55.27	46.06	39.48
E2	136.3	90.84	68.13	54.50	45.42	38.93
A_{12}	137.4	91.61	68.71	54.97	45.81	39.26
NA	139.9	92.66	69.49	55.60	46.33	39.71
SUA	149.4	99.59	74.69	59.75	49.79	42.68

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SOME IMPORTANT MEDICINAL HERBS USED BY TRIBES OF CHITRAKOOT

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ABSTRACT

Plants have been an integral part of Indian culture. It is evident that large population in under developed/developing countries still depends on natural resources for food, cloth, dyes, oil, detergent, drink, fodder and medicines. WHO's technical reports (Anonymous,1978) defined traditional medicines as "the sum of all the knowledge and practices whether applicable or not, used in diagnosis prevention and elimination of physical mental or social imbalance and relying exclusively or practical experience and observation handed down from generation to generation whether verbally or in writing. Traditional medicine might be considered as a solid amalgamation of dynamic medicinal know how and ancestral experience. The traditional knowledge about the plant is also gradually disappearing from tribal/rural population because of the impact of civilization & modernization.

An effort has been made to identify the medicinal plants of Chitrakoot, and the area where particular plant is present or present in abundance was enlisted in this article.

Key word- Medicinal herbs, Chitrakoot forest.

INTRODUCTION

There are two systems of health care in the developing world, one being traditional and the other is western in derivation. The concept of traditional medicine is a conventional term used by medical scientists to refer to the empirical medical system used in different cultures all over the world. Each society has its own world view of origin, causes, concepts, practical therapies of sickness and has also developed the specialists that know how to apply them (Bhasin 2007). *Adivasis,* that is, tribal people or original settlers, described as a distinct ethno group living in the planes, forests or hills are no exceptions for that. They also have their own systems of medicines dispensed through the herbalists or senior citizens of the society along with traditional healers (Petkar 2002 and Mitra 2007). Madhya Pradesh has the largest tribal population of all the states with 14.51% of total tribal population of the country.

India has vast resources of medicinal plants. The use of the plants as medicine is nothing new but according to an estimate there are more than 25000

effective herbal formulations exist in the country (Brahmavarchasva 2005 and Aneesh 2009). But many of them are unwrit- © Kamla-Raj 2011 Ethno Med, 5(3): 205-208 (2011) ten. Ahead to this it can be said that each time a tribal medicine man dies, it is as if a library has burned down so there is urgent need of documentation of native knowledge of the before its extinction forever. Despite of fair scope to achieve great global share in the market of medicinal and aromatic plants, India is lagging behind in world trade and is ranked third in the herbal medicine category.

Area of study-

Chitrakoot is situated in the northern region of satna district of M.P. and surrounded on North, Northwest and Northeast by Karwi (Chitrakoot) district of U.P. and west byPanna district of M.P. It lies between 80^0 52' to 80^0 73'N latitude, covering an area of 1,584 sq km. Lard Ram with her wife Sita and brother Lakshman resided here during their 14 years of exile and spent about 11.5 years in Chitrakoot. Several tribal communities like Kol, Gond, Mawasi, etc. reside in Chitrakootforest area of Majhgawan block of Satna district of M.P.

METHODOLOGY

The present study on Mawasi tribe of Chitrakoot region was carried out. The first hand information about the uses of plants such as mode of preparation, administration, doses, duration amount etc. were collected from old and experienced medicine man and women with the help of prescribed Performa.

Name - Satavari (*Asparagus racemosus*)
Family - Liliaceae
Useful Parts - Root
Uses - Treatment of gastric ulcers, dyspepsia, nervous disorders and as a galactogogue

Name - Medhaki (Vitexnegundo)
Family - Verbanaceae
Useful part - Root, bark and leaves
Uses - Headache, gastric, ulcer, swollen joints & testes and lactation for breast feeding women.

Name- Ikshugandha, Gokharu (Tribulus terrestris)
Family- Zygophyllaceae
Useful part- Roots, barks, leafs, stem, flower, fruits
Uses- Root paste is used for treatment of Cancer and whole plant paste with milk is used for normal delivery.

Name- Bhunimba, Kalmegh & Kirayat (Andrographis paniculata)
Family- Acanthaceae
Usuful part- Whole part of plants
Uses- The decoction of whole plant is useful in weakness, gastric disorders, malaria & fevers.

Name- Salparni, Guha (Desmodium gangeticum)
Family- fabaceae
Useful part- Whole parts of plant
Uses- Cardiomyopathy, edema.

Name- Tulsi (Ocimum sanctum)
Family- Lamiaceae
Useful part- Whole parts of plants
Uses- Cancer, hepatic, urinary stone track disease, nervous disorder, diabetes, leprosy & cough

Name- Nagarmotha (Cyperus rotundus)
Family- Cyperaceae
Useful part- Whole parts of plant
Uses- headache, swelling.

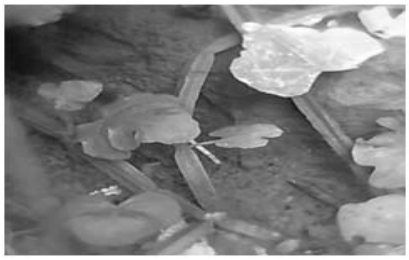
Name- Apamarg, Chichira (Achyranthus aspera)
Family- Acanthaceae
Useful part- Root, leaves, flower & fruit
Uses- Bronchitis, cold, whooping cough & asthma

Name- Dhatura (Datura metel)
Family- Solanaceae
Useful part- Seed, root, leaves, leaves milk & fruit
Uses- Dog bite, suffering from madness & pain

Name- Arand (Ricinus communis)
Family- Euphorbiaceae
Useful part- leaves, seed, root
Uses- Eczema, asthma, rhinitis

Name- Safed Madar. Ark (Calotropis gigantea)
Family- Asclepiadaceae
Useful part- Root & leaves
Uses- Cholera, leaves decoction is used in fever

Name- Safed bhatkataiya, Kantikari
(Solanum surattense)
Family- Solanaceae
Useful part- Root and leaves
Uses- digestion, cough, dropsy, constipation and aperient



Name- Harjod, Harhjora (Cissus quadrangularis)
Family-Vitaceae
Useful part- Whole parts of plant
Uses- Joint pain, bone facture or dislocation and earache.

Name- Safed ghunghachu (Abrus pricatories)
Family- Fabaceae
Useful part- Seed
Uses- Lyprocy

CONCLUSION

Above fifteen plants are used for fourty two diseases by the tribal population of Chitrakoot these fifteen plants belongs to elevene families. Some plants like safed ghunghachu and satawari, tulsi are used for lyprosy, nervous desorder and diabetes treatment which are commonly found in urban population. The study reveals a number of interesting claims and mode of their application either as a single plant species or in combination with some additives. Further, detailed investigations on therapeutic used are needed to establish the medicinal importance of these species.

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आधिव्याधि हरिनित्यं तुलेसित्व नमोस्तुते

अवध श्रीवास्तव,
विज्ञान एवं पर्यावरण संकाय, म0गा0चि0ग्रा0वि0वि0चित्रकूट

विभिन्न प्रकार की वनस्पतियो मे एक सबसे शक्तिशाली वनस्पति तुलसी है। यह पवित्र और पूजनीय के साथ प्रकृति का सबसे बड़ा वरदान माना गया है। वैसे तो अमृत मन्थन के उपरान्त ही अमृत कलश से तुलसी और भगवान धन्वन्तरी बाहर आये इस प्रकार आर्युवेद चिकित्सा विधान का जन्म हुआ। ईश्वर ने मनुष्य की सर्वोत्कृष्ट हितकारी इस वनस्पति का जन्म कर दिया। तुलसी का अस्तित्व अमृत मन्थन से पूर्व माना गया है।

सर्वोषधि रसेनैव पुरा ह्रदयमृत मन्थने।
सर्वसत्वोप काराव विष्णुना तुलसी कृता।।

तुलसी का गुणगान वैदिक–काल से चला आ रहा है। तुलसी की उत्पत्ति के संबंध में नाना प्रकार की पौराणिक गाथाऐं प्रचलित हैं। तुलसी को हिन्दु धर्म में जगजन्नी का पद प्राप्त है। इसे संस्कृत मे वृंदा, बहुमंजरी हिंदी मे तुलसी, रामतुलसी अंग्रेजी मे होली बेसिल कहा गया है। सर्वरोग निवारण तथा जीवन शक्ति संवर्धक के लिये सस्ति, सुलभ, सुन्दर, उपयोगी वनस्पति मनुष्य समुदाय के लिए कोई और नहीं है।

वानस्पतिक परिचय

तुलसी का पौधा सदा हरित रहता है। इसके बीज मार्च से जून तक बोये जाते हैं। बरसात मे तीव्र गति से विकसित होकर सितम्बर और अक्टूबर में यह फूलता है। सारा पौधा सुगंधित मंजरियों से लद जाता है। ठण्डी में मंजरी बीज पकते हैं। यह वर्ष भर किसी न किसी रूप में प्राप्त किया जा सकता है।

तुलसी की विभिन्न प्रजातियॉ

(1) ओसीमम अमेरिकेनम (काली तुलसी) गम्भीरा या मामरी

(2) ओसीमम बेसिलिकम (मरूआ तुलसी)

(3) ओसीमम ग्रेटिसिरूम (राम तुलसी या वन तुलसी)

(4) ओसीमम किलिमण्ड चेरिकम (कपूर तुलसी)

(5) ओसीमम सेक्टम

(6) ओसीमम विरिडी

उपरोक्त सभी प्रकार में ओसीमम सेक्टम को प्रधान या पवित्र तुलसी माना है। भारत में इसकी दो प्रजातियॉ हैं। श्री तुलसी जिसकी पत्ती हरी होती है तथा कृष्ण तुलसी जिसकी पत्ती निलाभ कुछ बैंगनी रंग लिए होती हैं। श्री तुलसी के पत्र तथा शाखाएं श्वेताभ होते हैं जबकि कृष्ण तुलसी के पत्राधि कृष्ण रंग के होते हैं। गुण धर्म की दृष्टि से

काली तुलसी को श्रेष्ठ माना गया है। दोनों तुलसी के गुण समान हैं।

तुलसी गोले या गुल्म के समान एक से तीन फुट ऊॅचा, शाखा युक्त, रोमस, बैगनी आभा लिए होता है। पत्र एक से दो इंच लम्बे अण्डाकार या आयताकार होते हैं। प्रत्येक पत्र में तीव्र सुगन्ध होती है। पुष्प, मंजरी अति कोमल एवं आठ इंच लंबी अनेकों रंग की छटाओं से मंडित होती है। इस पर बैंगनी या रक्त सी आभा लिए छोटे छोटे पुष्प चक्रों में लगते है। बीज चपटे पीत वर्ण के छोटे काले चिन्हों से युक्त अण्डाकार होते है। पुष्प शीत काल में खिलते है।

संग्रह एवं संरक्षण

पत्र, मूल, बीज उपयोगी अंग है। संग्रह के लिये इसे सुखाकर मुख बन्द पात्रों में सूखे शीतल स्थानों पर रखा जाता है। सर्वत्र एवं सर्वदा सुलभ होने से पत्तो का व्यवहार ताजी अवस्था में करना श्रेष्ठ है। ऐसा शास्त्रीयों का मत है कि पत्तो को रविवार, पूर्णिमा, अमावस्या, द्वादशी, सूर्य संक्रांति के दिन, मध्यकाल रात्रि दोनों संध्याओं के समय तथा बिना नहाये धोये न तोड़ा जाये। ताजा पत्तों को जल में डालने से वह जल तीन दिन तक पवित्र रहता है।

यह पौधा सामान्यतः दो से तीन वर्षो मे अपना जीवान काल पूर्ण कर वृद्धावस्था मे पत्तों की संख्या कम व आकार भी छोटा हो जाता है। मध्य मे सूखी सूखी–सूखी डण्ठलें दिखाई देती हैं अतः अब इस पौधे को हटाकर उस स्थान पर नया पौधा लगाना चाहिए।

गुण कर्म संबंधी विभिन्न मत

हिंदु धर्म संस्कृति के चिर पुरातन वेद ग्रन्थों में तुलसी के गुणों एवं उसकी उपयोगिता का वर्णन मिलता है।

सरुपकृत त्वयोषधेसा सरूपमिद कृधि श्यामा सरूप करणी
पृथिव्या अत्यदभुता इन्द्रम् सुप्रसाधय पुना रूपाणी कल्पया।। (अथर्ववेद 1.24)

श्याम तुलसी मानव के स्वरूप को बनाती है। शरीर की त्वचा के सफेद दाग धब्बे अथवा अन्य प्रकार के त्वचा से संबंधी रोग को नष्ट करने वाली महा औषधी है।

हिक्काकासविषष्वासः पार्ष्वषूल विनाषनः।
पित्तकृत् कफवातघ्नः सुरसः पूतिगधहाः।।
(चरकसंहिता)

तुलसी हिचकी खासी, विष, श्वास रोग और पार्श्व शूल को नष्ट करती है। यह पित्त कारक, कफ, वामनाशक तथा शरीर एवं भोज्य पदार्थ की दुर्गन्ध को दूर करती है।

रासायनिक संगठन

तुलसी में अनेकों जैव सक्रिय रसायन पाये गये हैं जिनमें ट्रैनिम, सैवोनिन, ग्लाइकोसाइड और एल्केलाहड्स प्रमुख हैं। इनके पत्तों में एक प्रकार का पीला उड़नशील तेल जिसकी मात्रा संगठन स्थान व समय के अनुसार बदलते रहते हैं। सामान्यतः 0.1 से 0.3 प्रतिशत तक तेल पाया जाता है वेल्थ आफ इण्डिया के अनुसार इस तेल में लगभग 71 प्रतिशत यूजीनाल, 20 प्रतिशत यूजीनाल मिथाइल ईथर तथा 3 प्रतिशत कार्बोकोल होता है। श्री तुलसी में श्याम तुलसी की अपेक्षा कुछ अधिक तेल होता है। इस तेल का सापेक्षिक घनत्व भी कुछ अधिक होता है। तेल के अतिरिक्त पत्तो में 83 मिलीग्राम प्रतिशत विटामिन सी एवं 2.5 मिलीग्राम प्रतिशत केरोटीन होता है।

तुलसी बीजों में हरे पीले रंग का तेल 17.8 प्रतिशत की मात्रा में पाया जाता है इसके घटक कुछ इस प्रकार हैं। कुछ सीटोस्टेराल,

अनेक वसा अम्ल मुख्यतः पामिटिक स्टीयरिक, ओलिक लिनोमिक, और लिनोलेनिक अम्ल। तेल के अलावा बीजों में श्लेष्मक प्रचुर मात्रा में होता है। इस म्युसिलेज के प्रमुख घटक हैं। पेन्टोस, हेक्जा यूरोनिक अम्ल और राख। राख की मात्रा लगभग 0.2 प्रतिशत होती है।

वैज्ञानिक उपयोगिता

वैज्ञानिकों ने स्वीकार किया कि तुलसी का तेल क्षय रोग (टी.बी.) के कीटाणुओं को समाप्त कर देता है। मलेरिया उपचार की उत्तम दवा तुलसी है।

अमेरिका के डा. ओवन ट्यूर ने आंतों की सफाई के लिए तुलसी का रस (पत्तियॉ चबा कर खाना) सर्वश्रेष्ठ माना है। आंतों में अनावश्यक जमे तत्व तुलसी रस के द्वारा शरीर के बहर हो जाते हैं। क्योकि आंतों की इस जमा गन्दगी के कारण मानव शरीर में विभिन्न प्रकार के रोग उत्पन्न होते हैं। इस रस के प्रयोग से अनेकों प्रकार की दवाइयों, टिकियों, इंजेक्शन में हो रहा है।

कैलीफोर्निया के डा. विलियम बोरिक के अनुसार तुलसी से विभिन्न प्रकार के स्त्री रोगों पर अत्यन्त गुणकारी प्रभाव देखने मे आये है जैसे खुजली, शरीर एवं मन का भारीपन, सीने में दर्द, योनी भ्रंश, स्तन पीड़ा में लाभ दायक है। भगोष्ठ को लटकने नहीं देता, मूत्र एवं प्रजनन क्षेत्र की सुरक्षा करता है।

दैनिक जीवन में उपयोग

तुलसी का भरपूर लाभ उठाने के लिए कुछ बातों का ध्यान रखना आवश्यक है। सर्वप्रथम तुलसी का पौधा घर आंगन में अवश्स लगाया जाये व चारो ओर चबूतरा या चौतरा अवश्य बनायें। पौधे का सीधा संबंध पृथ्वी अथवा जमीन से होना आवश्यक है।

1. कार्तिक माह में तुलसी के पत्तों का प्रातः काल सेवन से पूरे वर्ष शरीर निरोगी रखता है।
2. तुलसी का पौधा स्वभाव से सात्विक तथा चित्त को एकाग्र करता है। इसके समीप बैठनें या खड़े होने पर मन एकाग्र रहता है।
3. सूर्य या चन्द्र ग्रहण के समय पीने के पानी व खाद्य पदार्थों में तुलसी पत्र डालने से ग्रहण के साथ दूषित हो गये पर्यावरण का प्रभाव नहीं पड़ता है।
4. तुलसी का पौधा आध्यात्मिक शक्ति का प्रतीक है इसके समीप खड़े होने, पढ़ने, चिन्तन–मनन व दीप जलाने व परिक्रमा करने से अपूर्व मानसिक शांति मिलती है।
5. तुलसी की गन्ध रक्त विकार को दूर करती है।
6. मन में गन्दे विचार नहीं आते व क्रोध को कम करता है।
7. स्नान के जल में तुलसी के पत्ते डालने से त्वचा के रोग नहीं होते।
8. पीने के पानी में तुलसी पत्र से उदर संबंधी रोग नहीं होते हैं।
9. तुलसी की माला, गजरा, कर्धनी और कंठी धारण करने पर शरीर फुर्तीला तथा स्वस्थ रहता है।

10. तुलसी पत्ते चबाने से दातों में कीड़े नहीं लगते दांत मजबूत चमकदार होते हैं व इनकी आयु बढ़ती है।

11. तुलसी रस को उपटन के साथ मिलाकर प्रयोग करने पर हड्डियां मजबूत होती हैं।

विषेष ध्यान रखें

1. तुलसी के पत्ते अंधकार में न तोड़ें रात्रि में तुलसी का स्पर्श वर्जित माना गया है। रात्रि में अंधकार में तुलसी की ऊर्जा अत्यन्त प्रखर हो जाती है इस कारण शरीर के लिए हानिकारक है।

2. तुलसी के पत्तों का सेवन पश्चात् दूध न पियें यह रोगों को जन्म देता है। दूध पीना ही है तो तुलसी के साथ शहद गंगाजल में से किसी एक को मिलाकर सेवन करें।

3. तुलसी के पत्ते, छाल, लकड़ी को अग्नि में न डालें

उपचार रोगों के नाम

अफरा, अतिसार, अर्द्धांग, अति मासिक, अनिद्रा, अम्लता, अम्लपित्त, अरुचि, अण्डकोश, आग से जलने पर, आधा शीशी, आख मे रोहे, आखो मे सूजन, आतो मे मल, उन्माद, उल्टी, कब्ज, कान का दर्द, खाज खुजली, खासी, बुखार, जुकाम, गर्भ ठहराव, गर्भ नियंत्रण, गर्भाश्य विकार, गर्भाणी की खाज, गला बैठना, छाले, जवान रहे, झाइया, त्वचा के रोग, तिल्ली का बठना, दात दर्द, नजला, पथरी, पाचक, पायरिया, पीलिया, प्रदर, बालो का झडना, बालतोड, मासिक धर्म, लकवा, वीर्य क्षीणता, शरीर की गिरावट, शीघ्र पतन, सिर दर्द, सफेद दाग।

तांत्रिक अनुष्ठान मे भी तुलसी का प्रयोग किया जाता है।



अकालमृत्यु हरणं सर्व व्याधि विनाशनम्।

तुलसी को अकालमृत्यु को हरण करने वाली और सम्पूर्ण रोगों को दूर करने वाली मना गया है।

महाप्रसाद जननी सर्व सौभाग्यवर्धनी।

आधिव्याधि हरिनित्यं तुलेसित्व नमोस्तुते।।

हे तुलसी आप सम्पूर्ण सौभाग्य को बढ़ाने वाली हैं। सदा आदि व्याधि को मिटाती हैं। आपको नमस्कार।

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पारम्परिक हर्बल दवाओं पर एक गंभीर समीक्षाः मधुमेह के संदर्भ में

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1. प्रस्तावना

मधुमेह शब्द की उत्पत्ति ग्रीक चिकित्सक एरिटिएस के द्वारा पहली शताब्दी ईस्वीं में की गई। मधुमेह की जानकारी काफी पुरानी है तथा इस व्याधि में मूत्र में शर्करा की उपस्थिति का उल्लेख सुश्रुत के द्वारा 'आयुर्वेद' में भी किया गया। मधुमेह की औषधीय चिकित्सा 80 साल पुरानी है। इस व्याधि में मूत्र में शर्करा की उपस्थिति सर्वप्रथम डॉबसन के द्वारा 1755 में बताई गई।

यद्यपि हमने नई शताब्दी का एक दशक पार कर लिया है फिर भी मधुमेह के विषय में हमारा ज्ञान अपूर्ण है। मधुमेह सर्वाधिक गंभीर, उपापचयन में होने वाले विकार तथा उच्च रक्त शर्करा स्तर से होने वाली व्याधि है।

उच्च रक्त शर्करा (Hyperglycemia) का कारण इन्सुलिन हार्मोन की सापेक्ष या निरपेक्ष कभी, अथवा कोशिकीय स्तर पर इन्सुलिन की कार्यप्रणाली में प्रतिरोध उत्पन्न होना है। यह सबसे सामान्य इन्डोक्राइन विकार है, जो भारत में 41 मिलियन लोगों तथा विश्व में 200 लाख लोगों को व्यापक रुप से प्रभावित कर रहा है। वर्ष 2000 में विश्व भर में सभी आयु समूहों को व्यक्तियों पर मधुमेह की व्यापकता का अनुमान 2.8 प्रतिशत लगाया गया था, जो कि सन् 2025 में 5.4 प्रतिशत होना अनुमानित है।

मधुमेह के लिए वर्तमान में उपलब्ध उपचार में इन्सुलिन तथा मौखिक रुप से लिये जाने वाले मुधमेह रोधी पदार्थ (Antidiabetic agents) जैसे कि सल्फोनिल यूरिया, बाइग्वानाइड्स alpha-glucosidase inhibitors (अल्फा ग्लूकोसाइडेज संदमक) तथा ग्लीनाइड विकासशील देशों में उपलब्ध हैं, परन्तु ये मँहगे और आसानी से सुलभ नही है। (राव एवं अन्य, 2010)

आज मधुमेह सामान्य चिकित्सा के लिये एक नैदानिक मॉडल (Clinical model) बन चुकी है। शरीर में ईधन उपापचयन मे होने वाला प्राथमिक विकार बड़े पैमाने पर होता है जिसके परिणाम स्वरुप बहुअंगीय जटिलताएँ (Multiorgan conplications) होते है जो अंततः शरीर की सभी प्रणालियों को प्रभावित करते है।

यद्यपि चिकित्सकीय दृष्टिकोण से यह सत्य हो सकता है कि इस बीमारी की pathophysiology के प्रति हमारे बढ़ते हुए ज्ञान तथा इसकी दीर्घकालिक जटिलताओं

(long term complications) ने मधुमेह शोध कार्य को प्रतिरक्षा तंत्र विज्ञान (Immunology) तथा आण्विक जीव विज्ञान (Molecular biology) के शोध से भी आगे कर दिया है।

2. मधुमेह के इलाज का रोग निदान–

मधुमेह की उपस्थिति का पता विभिन्न तकनीकों द्वारा, रक्त तथा मूत्र में शर्करा की मात्रा को नाप कर पता किया जा सकता है। इटियोलॉजी के आधार पर मधुमेह को दो मुख्य श्रेणियों में बाँटा गया है–

1. प्राथमिक मधुमेह या इन्सुलिन निर्भर डायबिटीज मेलिटस (Insulin Dependent Diabetes mellitus or IDDM)
2. माध्यमिक मधुमेह या गैर इन्सुलिन निर्भर डायबिटीज मेलिटस (Non Insulin Dependent Diabetes Mellitus or NIDDM)

प्राथमिक मधुमेह नैदानिक रुप से इन्सुलिन हार्मोन पर निर्भर है, क्योकि यह लैंगर हैन्स द्वीप समूह में पायी जाने वाली बीटा कोशिकाओं की संख्या में कमी का परिणाम है और इसलिये यह इन्सुलिन निर्भर या प्रथम प्रकार मधुमेह के रुप में जाना जाता है। इसका प्रमुख उपचार इन्सुलिन है।

माध्यमिक मधुमेह, गैर इन्सुलिन निर्भर मधुमेह के रुप में जाना जाता है क्योंकि इसके रोगी, इन्सुलिन के प्रति प्रतिरोधी होते हैं तथा इन्सुलिन स्राव में होने वाली कमी इस प्रकार की बीमारी का कारण है। आमतौर पर, इसके रोगी मोटापे से ग्रस्त होते हैं, इसका उपचार आहार पर आधारित होता है, जिसमे मौखिक रुप से लिये जाने वाले अतिरिक्त हाइपोग्लाइसीमिक दवाएं शामिल है। क्योंकि मधुमेह के द्वारा उत्पन्न जटिलताएं अत्यन्त गंभीर तथा दिन–प्रतिदिन बद्तर होती जाने वाली है, अतः इसे ठीक करने वाली औषधियों की प्रबल आवश्यकता है। इस समीक्षा में हम मधुमेह की जटिलताओं के सभी सम्भव उपचारों का अध्ययन करेगें एवं संश्लेषित दवाओं (Synthetic Drugs) के विकल्प खोजने का प्रयास करेगे जो कम कीमत व कम दुष्प्रभाव वाले हो और जन सामान्य की पहुँच में हो।

3. मधुमेह के इलाज की रणनीतिः–

मधुमेह के इलाज के लिये आधारभूत चिकित्सकीय प्रयास यह हो सकता है कि अल्फा ग्लूकोसाइडेज तथा अल्फा एमाइलेज जैसे जठरांत्रीय एन्जाइमों (Gastrointestinal enzymes) की कियाविधि को धीमा कर दिया जाए, जिससे ग्लूकोज का अवशोषण बाधित हो जाए। क्योंकि इस व्याधि की जटिलतायें मुख्य रुप से रक्त में ग्लूकोज की अत्यधिक मात्रा के कारण शरीर के अन्य अंगों में शिथिलता (dysfunction) के रुप में होती है, अतः हम कह सकते है कि प्रभावी अल्फा ग्लूकोसाइडेज संदमक (alpha-glycosidase inhibitor) मधुमेह तथा मोटापे के उपचार के लिये एक कीमोथेराप्यूटिक एजेन्ट की तरह कार्य करते है। (पार्क एवं अन्य, 2008)

3.1 मधुमेह के उपचार के लिये दवाएं

3.1.1 इन्सुलिनः–

इन्सुलिन कोशिकाओं में ग्लूकोज ट्रान्सपोर्टर ग्लूट 4 को अतःकोशिकीय स्थानों (intracellular sites) से कोशिकीय सतह (Cell surface) पर स्थानांतरित करके कोशिकाओं द्वारा ग्लूकोज अंतर्ग्रहण को बढ़ाता है।

इन्सुलिन रक्त में स्वतंत्र इकाई के रुप में संचरित होता रहता है और रक्त प्लाज्मा में इसका अर्ध आयुकाल सामान्यतः 5–6 मिनट होता है। यद्यपि मनुष्यों में इन्सुलिन स्राव का प्रमुख प्रेरक ग्लूकोज है, परंतु यह सम्पूर्ण

प्रक्रिया पोषक तत्वों के समन्वयन, जठरांत्र तथा अग्नाशय के हारमोन और स्वायत्त न्यूराट्रान्समीटरो के द्वारा दृढ़तापूर्वक नियंत्रित रहती है।

3.1.2 मौखिक हाइपोग्लासीमिक दवाएं:–

ये मौखिक रुप से ली जाने वाली वे दवाएं है जो रक्त शर्करा स्तर को कम करती है। ये मुख्यतः संश्लेषित तथा जटिल कार्बनिक पदार्थों के रुप में होती है, अतः प्रभावी हाइपोग्लासीमिक दवाओं की खोज जारी है।

संश्लेषित दवाएं मधुमेह में उपयोगी है परन्तु कुछ सीमाओं के साथ जैसे कि सल्फोनिल यूरिया के नियमित प्रयोग से हाइपोग्लाइसीमिया हो जाता है परन्तु इसके दुष्प्रभाव इन्सुलिन चिकित्सा की तुलना में कम है।

चिकित्सकों द्वारा यह निर्धारित किया गया है कि गुर्दे की बीमारी से ग्रस्त रोगियों को बाइग्वानाइड का इस्तेमाल नही करना चाहिए। दूसरी ओर एस्कार्बोज का प्रमुख दुष्प्रभाव है–पेट फूलना (Flatulence).

3.1.3 मैटेलोथेरेपी :–

वर्तमान साहित्य से हमे यह भी पता चलता है कि मैटेलोफार्मासूटिकल्स बढ़ती हुई रुचि का क्षेत्र है, और यह विश्वव्यापी पैमाने पर उन नैदानिक परीक्षणों (clinical trials) से प्रमाणित होता है, जिसमे विभिन्न धातुओं का उपयोग चिकित्सा में किया जा रहा है।

सर्वप्रथम 1980 में कल्सन और डैनडोना के द्वारा यह अध्ययन किया गया कि जिंक क्लोराइड ($ZnCl_2$) चूहे की एडिपोसाइट कोशिकाओं में लिपोजेनेसिस की प्रक्रिया को इन्सुलिन की भॉति प्रोत्साहित करती है। तीन दशकों में कई शोधकर्ताओं द्वारा इन्सुनिल मिमिटिक प्रभाव, अल्फा ग्लूकोसाइडेज तथा अल्फा एमाइलेज संदमन प्रभाव को अलग–अलग लिगैन्ड और संक्रमण धातुओं के समन्वयन द्वारा रिपोर्ट किया गया। जो भी हो, मधुमेह को धातु काम्प्लेक्सों द्वारा उपचारित करने की चिकित्सकीय रणनीति अभी प्रारंभिक चरणों में हैं, इसलिये अब तक इनके कोई भी दुष्प्रभाव ज्ञात नही है। कुछ धातु कॉम्प्लेक्स, मधुमेह के इलाज के लिये परीक्षण के चरण में हैं।

3.1.4 हर्बल ड्रग्स :–

वर्तमान में उपलब्ध मधुमेहरोधी चिकित्सा के द्वारा भी मधुमेह पूर्णतः इलाज योग्य नही है। केवल इन्सुलिन चिकित्सा ही इसके लिये एक संतोषजनक माध्यम है, हालांकि इसके भी कई दुष्परिणाम है, जैसे कि इन्सुलिन प्रतिरोधकता (insulin resistance), एनोरेक्सिया (Anorexia), ब्रेन एट्राफी brain atrophy तथा fatty liver chronic treatment. (वाइडमैन एवं अन्य, 1993)

कई पौधे, तथा इनमे उपस्थित सक्रिय रासायनिक पदार्थों के द्वारा विभिन्न व्याधियों के उपचार की गतिविधि प्रदर्शित की जाती है। एथेनोबॉटेनिकल सूचना के अनुसार 800 से भी ज्यादा पादप प्रजातियों का उपयोग, मधुमेह के इलाज हेतु परम्परागत उपचार के रुप में किया जाता है। पादप व्युत्पन्न पदार्थ अपने बहुमुखी अनुप्रयोगों के कारण आज रुचि का विषय बन गये है। औषधीय पौधे पारंपरिक चिकित्सा प्रणाली, आधुनिक दवाओं, भोजन की आपूर्ति, लोक दवाओं, फार्मास्यूटिकल मध्यवर्ती दवाएं और संश्लेषित दवाओं के रासायनिक तत्वों के सबसे धनी जैव संसाधन है।

मधुमेह रोधी गतिविधियों पर पौधों के अर्क के प्रभाव के क्षेत्र में उत्साहजनक परिणाम देखने को मिले हैं। परंतु अभी तक पादप जगत में उपस्थित पौधों के अल्प प्रतिशत का ही ज्ञान हो पाया है। (अरोकिराज एवं अन्य, 2009)

कई ऐसे हर्बल उत्पाद/हर्बल अर्क हैं जो मधुमेह के उपचार में कारगर हैं। इन्हें इनकी क्रियाविधि के अनुसार निम्न भागों में वर्गीकृत किया जा सकता है।

3.1.4.1 अर्क/दवाएं जो अल्फा ग्लूकोसाइडेज़ तथा अल्फा एमाइलेज़ एन्जाइमों के संदमन का कार्य करती हैं।

इस प्रकार के अर्क या दवाएं गैस्ट्रिक एन्जाइमों को संदमित कर रक्त शर्करा स्तर को कम करती हैं। ये गैस्ट्रिक एन्जाइम पॉलीसैकेराइड्स को साधारण शर्करा में तोड़ने के लिये आवश्यक होते हैं। Syzgium cumini (जामुन) तथा Psidium guazava(अमरूद) की पत्तियों के जलीय तथा मेथेनॉलिक अर्क अल्फा एमाइलेज़ संदमन का गुण रखते हैं। जबकि रस वर्निसिफेरा (Rhus verniciflua) के तने के अर्क में अल्फा ग्लूकोसाइडेज़ संदमन का प्रबल प्रभाव देखा जाता है। इनके अतिरिक्त कई और भी पौधे हैं जिनमें अल्फा ग्लूकोसाइडेज़ तथा अल्फा एमाइलेज़ के संदमन की क्षमता होती है तथा इन्हें प्राथमिक और माध्यमिक मधुमेह के उपचार हेतु उपयोग में लाया जाता है। जैसे कि चाय (Camellia sinensis), शहतूत (morus alba), करंज (Pongamia pinnata), ज्वार (Sorghum), अंगूर (Vitis Vinifera) आदि पौधों में अल्फा ग्लूकोसाइडेज व अल्फा एमाइलेज का संदमन करने की क्षमता होती है। वही पिस्ता (Pistacia vera), अल्पाइन (Alpinia officinarum), डेरिस (Deris scanders), निम्फिया (Nyamphaea Stellata), अल्फा ग्लूकोसाइडेज एंजाइम को संदमित करने का गुण रखते है और सोयाबीन (Glycie max) में अल्फा एमाइलेज संदमन का प्रभाव देखा जा सकता है। (पाण्डेय एवं अन्य, 2013)

3.1.4.2 दवाएं/अर्क जो इन्सुलिन स्रवण या बीटा कोशिका पुनर्जनन को बढ़ाती हैं।

इस प्रकार की दवाएं प्रथम प्रकार मधुमेह से सीधे ही संबंधित होती हैं, जिसमें कि इन्सुलिन हार्मोन की काफी कम मात्रा का स्राव होता है।

एकोरस कैलेमस (Acorus calamus) के रेडिक्स का उपयोग अमेरिका तथा इन्डोनेशिया में मधुमेह के उपचार हेतु पारंपरिक लोक औषधि की भॉति किया जाता है। इसके इथाइलेटेड अर्क में इन्सुलिन गतिविधि को संवेदनशील करने की क्षमता होती है।

दूसरी ओर पेनेक्स जिन्सेंग की जड़ में पाया जाने वाला एक सक्रिय यौगिक जिन्सेनोसाइड आर एच टू (Ginsenoside Rh2) प्लाज्मा इन्सुलिन के स्तर को बढ़ाने के साथ–साथ प्लाज्मा शर्करा स्तर को कम करता है।

जामुन (Syzgium cumini) की छाल का जलीय अर्क अग्नाशय वाहिनी में बीटा कोशिकाओं की अग्रदूत कोशिकाओं (Precursor cells) के प्रसार को प्रेरित कर इनके पुनर्जनन को बढ़ाता है।

3.1.4.3 अर्क/दवाएं जो हाइपाग्लाइसीमिक, एन्टी हाइपर ग्लाइसीमिक तथा मधुमेह रोधी (Anti diabetic) प्रभाव प्रदर्शित करती हैं:–

महामारी विज्ञान का अध्ययन और नैदानिक परीक्षण इस बात का जोरदार समर्थन करते हैं कि हाइपर ग्लाइसीमिया ही कोरोनरी धमनी रोग, सेरेब्रोवैस्कुलर रोग, गुर्दे की विफलता, अन्धापन, अंग विच्छेदन, स्नायुविक जटिलताओं और समय से पूर्व होने वाली मृत्यु का कारण है।

इस वर्ग में वे दवाएं आती हैं जो सीधे ही रक्त शर्करा स्तर को कम कर देती हैं ये दोनो प्रकार की मधुमेह के उपचार में उपयोगी हैं।

Mangifera indica (आम) मधुमेह रोधी गुण रखता है। इसकी पत्तियों तथा छाल के एथेनॉलिक–जलीय सत् में एन्टी–

हाइपरग्लाइसीमिक प्रभाव पाया जाता है। हिडाइशियम स्पिकेटम (Hedychium spicatum) के राइज़ोम में भी एन्टीहाइपरग्लाइसीमिक प्रभाव पाया जाता है। (रेड्डी एवं अन्य, 2009)

फाइकस बेन्गालेन्सिस (Ficus bengalensis) की छाल में भी मधुमेह रोधी तथा एमेलियोरेटिव (Ameliorative) गुण उपस्थित होते हैं, जबकि काक्सीनिया इण्डिका *(Coccinia indica)* के वायवीय भागों के एल्कोहलिक–जलीय अर्क में हाइपोग्लाइसीमिक प्रभाव होता है। और *फाइकस ग्लोमेरुलेटा* के फल भी हाइपरग्लाइसीमिक गतिविधि प्रदर्शित करते हैं। घीक्वार (Aloe vera), सरसों (Brassica Juncea), कद्दू (pumpkin), सर्पगंधा (Rouwolfia Serpentine), काक्सीनिया (coccinia cordifolia) मे भी हाइपोग्लाइसीमिक गुण होता है। आम के अतिरिक्त छुईमुई (Mimosa Pudica), सतावरी (Commiphora mukul), सिलेजिनेला (Selaginella ftamariscine) तथा मेथी (Foemun graecum) में एन्टीहाइपरग्लाइसीमिक प्रभाव होता है। लहसुन (Allium sativum), नीम (Azadirachta indica), अनानास (Annona squamosa), नारियल (Cocus nucifera), चुकन्दर (Beta vulgaris) मधुमेह रोधी गुण प्रदर्शित करते है। (पाण्डेय एवं अन्य, 2013)

3.1.4.4 अर्क/दवाएं जो मधुमेह की जटिलताओं को कम करते हैं।

मधुमेह एक उपापचयन संबंधी विकार है, जिसका कारण कार्बोहाइड्रेट उपापचय में होने वाला अनियंत्रण है। इसमें इन्सुलिन स्राव अथवा इन्सुलिन क्रियाविधि में दोष के कारण रक्त शर्करा स्तर बढ़ जाता है और विभिन्न जटिलताएं उत्पन्न होती हैं। इस समस्या के उपचार के लिए कई हर्बल दवाएं तथा हर्बल सत् महत्वपूर्ण भूमिका निभा सकते हैं।

फाइकस रिलिजिओसा (Ficus riligiosa) की छाल का जलीय सत् मधुमेह प्रकार–2 चूहे के मॉडल में ऑक्सीडेटिव स्ट्रेस को कम करता है।

बेनिम्कसा जिप्सिडा (Benimcasa gipsida) के फल डायबेटिक चूहे के मॉडल में गैस्ट्रिक अल्सर को कम करता है।

डेरिस स्कैन्डर्स के हैक्सेन अर्क प्रबल अल्फाग्लूकोसाइडेज़ संदमन प्रक्रिया तथा फ्री रेडिकल स्केवेजिंग प्रभाव प्रदर्शित करता है।

पोन्गामिया पिन्नाटा (Pongamia pinnata) के फूल एन्टीहाइपरग्लाइसीमिक तथा एन्टीलिपिड परऑक्सीडेटिव प्रभाव दिखाते हैं। (पुनीता एवं अन्य, 2006)

कॉक्सीनिया इन्डिका (Coccinia indica) की पत्तियों के अर्क (200mg/kg शरीर भार) 45 दिनों तक लेने से थायोबारब्यूटिरिक अम्ल नामक सक्रिय यौगिक कम हो जाता है। यह अर्क ग्लूटाथिऑन, सुपरऑक्साइड, डिस्म्यूटेज, कैटालेज, ग्लूटाथिऑन परऑक्सीडेज और ग्लूटाथिऑन 5 ट्रान्सफेरेज की कम मात्रा को यकृत तथा स्ट्रेप्ट्रोजोटोसिन प्रेरित डायबेटिक चूहों के गुर्दे में बढ़ाने का कार्य करता है जिससे इसके मधुमेह रोधी गुणों का पता चलता है।

4. वे पौधे जो मधुमेह के इलाज हेतु आयुर्वेद में उपयोग होते हैं:–

भारत में पारंपरिक चिकित्सा की एक महान प्राचीन विरासत है। भारतीय औषधि सामग्री महत्वपूर्ण प्राकृतिक उत्पादों पारंपरिक पहलुओं पर ज्ञान प्रदान करती हैं।

भारतीय पारंपरिक चिकित्सा आयुर्वेद, सिद्ध तथा यूनानी समेत विभिन्न प्रणालियों पर आधारित है। इन पारंपरिक प्रणालियों के अध्ययन और विभिन्न स्वास्थ्य संबंधी दृष्टिकोणों के प्रति विश्व की बढ़ती हुई रूचि को देखते

हुए यह आवश्यक हो गया है कि कुछ पौधे जो मधुमेह के उपचार हेतु प्राचीन समय से प्रयोग होते हैं, को सूचीबद्ध किया जाए।

5. पारंपरिक दवाओं के परीक्षण

कुछ हर्बल दवाओं को उनके एथेनोबॉटनी ज्ञान के आधार पर तैयार किया गया है। इनमें उपस्थित जैव सक्रिय अणुओं की जॉच कई मधुमेह मॉडलो पर की जा चुकी है और कई अभी भी परीक्षण चरण में हैं।

Wendell D Winters *et al.*(2003) ने एक मधुमेह रोधी माउस मॉडल/C57BL6J/में चीनी जड़ीबूटियों से तैयार किए गए मधुमेह रोधक हर्बल सूत्र का अध्ययन किया जो कि मानक विधियों के माध्यम से मिश्रित तथा सक्रिय किया गया था। इस हर्बल सूत्र में 8 प्रमुख औषधियॉ थी–

- जिन्सेग रेडिक्स Ginseng Radix(17%)
- रहमानिया रेडिक्स Rehmannia Radix(17%)
- एस्ट्रागली रेडिक्स Astragli Radix(10%)
- ट्राइकोसैन्यिस रेडिक्स Trichosanthis Radix(10%)
- ऑफियोपोगस रेडिक्स Ophiopogous Radix(10%)
- प्यूरेरी रेडिक्स Puerariae Radix(10%)
- लइसी ओफियोगस रेडिक्स Lycii Ophiopogous Radix(10%)
- डाइस्कोरिया राइजोम Discoreae Rizome(10%)

और यह पाया गया कि 4%–8% ADHF के नियमित सेवन से रक्त शर्करा स्तर में महत्वपूर्ण कमी होती है। साथ ही यह इन्सुलिन स्तर को बढ़ाता है। इन्होने आगे ADHF को आहार पूरक के रूप में उपयोग करने का सुझाव दिया।

किमुरा एवं अन्य, 1999 द्वारा पारम्परिक चीनी दवा बक्को–का निन्जिन के एन्टीहाइपरग्लाइसीमिक प्रभाव का अध्ययन एलोक्सेन प्रेरित और डायबेटिक kk-CAy चूहों पर किया तथा निष्कर्ष निकाला कि बक्को–का निन्जिन के जलीय अर्क जिसमें जिन्सेंग जड़, लिकोरिक जड़ एनेमारेन एस्फोडेलॉइड (*Anemarrhen Asphodeloides)* राइजोम, फाइब्रोसम जिप्सियम (*Fibrosum Gypsum),* चावल और कैल्सियम आयन का मिश्रण एन्टीहाइपरग्लाइसीमिक प्रभाव दिखाता है।

मधुमेह प्रकार II के प्रबंधन हेतु भारत के विभिन्न स्थानों पर ICMR समूह द्वारा विजयासर पेट्रोकार्पस मार्सूपियम (Pterocarpus marsupium) के प्रभाव का अध्ययन संश्लेषित दवा टॉलब्यूटामाइड की तुलना में किया गया। इस अध्ययन का यह निष्कर्ष निकला की विजयासर रक्त शर्करा को कम करने वाला एक प्रभावी पौधा है। इसका ग्लाइसीमिक प्रभाव टॉलब्यूटामाइड के साथ तुलनीय है, तथा यह किसी भी प्रकार के दुष्प्रभाव से स्वतन्त्र है। (आईसीएमआर स्टडी ग्रुप, 2005)

6. मधुमेह के उपचार में कुछ हर्बल दवाऐं एवं इनके कार्बनिक यौगिकः–

मधुमेह के आधुनिक उपचार(संश्लेषित दवाओं द्वारा) रक्त में शर्करा के स्तर को कम करके सामान्य स्तर तक लाने में ध्यान केन्द्रित कर रहे हैं, जबकि परम्परागत दवाऐं/अर्क अपनी प्रकृति तथा क्रियाविधि में जटिल है। आयुर्वेदिक दवाऐं जो कि अक्सर कुछ हर्बल–खनिज तत्वों के साथ सूत्रित है, अच्छी तरह से वर्णित औषधीय सिद्धान्तों द्वारा निर्मित होती है।

सभी पौधों के अलग–अलग अर्क में पाये जाने वाले यौगिकों को पृथक कर उन्हें पहचानना अत्यधिक श्रमसाध्य कार्य है। हालाकि शोधकर्ताओं ने पौधों के अर्क से कुछ यौगिकों की खोज कर ली है और इनकी क्रियाविधि का अध्ययन भी हो सकता है।

7. हर्बल दवाओं की उपयोगिता तथा इनकी जरुरतः–

जैसा कि मधुमेह के इलाज का ऊपर आयुर्वेद में उल्लेख किया गया है, पिछले 50 वर्षों के दौरान इस विषय पर कोई भी उल्लेखनीय शोध नही हुआ है।

इसके अतिरिक्त अब संश्लेषित दवाओं का युग आ चुका है परन्तु दुर्भाग्य से सल्फोनिल यूरिया तथा मेटफॉर्मिन की शुरुआत के 50 वर्ष बाद भी, मधुमेह के औचित्यपूर्ण उपचार की दिशा में अब तक कोई महत्वपूर्ण शोध नहीं हुआ है। यह मधुमेह के इलाज हेतु उपयोग में आने वाली संश्लेषित दवाओं पर एक बड़ा प्रश्न चिन्ह है।

पारम्परिक चिकित्सकों द्वारा पौधों के अर्क या लोक पारम्परिक पौधों के द्वारा विनिर्मित पदार्थ प्रस्तावित किये जाते रहे हैं और ये कई देशों में मधुमेह तथा अन्य बीमारियों से ग्रस्त उपयोगकर्ताओं द्वारा, स्वीकार किये जा चुके है, विशेषकर तीसरी दुनिया के देशों में। अतः इस संबंध में उचित वैज्ञानिक मूल्यांकन, औषधीय तथा रासायनिक परीक्षण आवश्यक है।

पादप दवाओं तथा अर्क में मधुमेह के इलाज की अद्भुत क्षमता होती है, वह भी बिना किसी दुष्परिणाम के।

वतर्मान में कई पारम्परिक चीनी सूत्रित दवाऐं बाजार में उपलब्ध है परन्तु मधुमेह के इलाज के सही जवाब की प्रतीक्षा अभी बाकी है।

WHO के अनुसार विकासशील देशों में विश्व जनसंख्या का 65%–80% अपने प्राथमिक स्वास्थ्य की देखभाल तथा अन्य आवश्यक प्रयोजनों के लिए, आधुनिक दवाओं की कमी के कारण पौधों पर ही निर्भर है।

ऐतिहासिक रुप से, सभी औषधीय विनिर्मित पदार्थ पौधों से प्राप्त होते है, चाहे वे साधारण रुप में हों या कूड अर्क मिश्रण (Crude extract mixture) के जटिल रुप में।पौधों से प्राप्त दवाओं के उपयोग का प्राथमिक लाभ यह है कि ये संश्लेषित दवाओं की तुलना में अधिक सुरक्षित है।

औषधीय पौधों के शोध में एथेनोबॉटेनिकल सूचनाओं का उपयोग वैज्ञानिक समुदाय के लिए काफी महत्वपूर्ण है। जैसा कि हम जानते है कि भारत में परम्परागत दवाओं की प्राचीन विरासत है, यहाँ पर जहाँ 75 प्रतिशत जनसंख्या दूर–दराज के क्षेत्रों से है तथा 50 प्रतिशत से भी अधिक लोग गरीबी रेखा के नीचे जीवन वहन कर रहे हैं, वे उत्साहपूर्वक बीमारियों के इलाज के लिये इन परम्परागत तरीकों का उपयोग करते है।

पिछले कुछ दशकों में देश के विभिन्न भागों में औषधीय पौधों के अध्ययन तथा इनके परम्परिक उपयोगों के विषय में लोगों की रुचि में वृद्धि हुई है। हाल के वर्षों में तो जनजातीय लोगों और भारत के स्वदेशी समुदयों द्वारा पारम्परिक चिकित्सा में पौधों के उपयोग पर विवरणों की संख्या भी बढ़ी है।

Mu-niappan Ayyanar et al. 2011 ने भारत के पश्चिमी घाट की तिरुनेलवेली पहाड़ियों पर एक अध्ययन किया और यह पाया कि यहाँ कॉस्टम स्पेसियस स्मिथ (*Costum specisus smith, Costaceae), जिम्नेमा सिल्वेस्ट्री (Gymnema sylvestre linn., Apocynaceae)* का उपयोग मधुमेह के इलाज हेतु होता है।

इस समीक्षा में हमने यह निष्कर्ष निकाला कि मधुमेह के उपचार के लिए पौधें वैकल्पिक दवाओं के सबसे अच्छे स्रोत हैं जिनके कोई भी दुष्प्रभाव नहीं है और ये कम लागत के हैं, अतः आम आदमी के उपचार के लिए यह एक साधारण तरीका है। परन्तु अब भी अन्य पारम्परिक दवाओं की खोज की आवश्यकता है।

8. निष्कर्षः–

इस समीक्षा में वर्णित सभी दवाऐं तथा उनकी क्रियाविधि मधुमेह की चिकित्सा में अत्यन्त महत्वपूर्ण हैं। इसके विपरीत पौधों में उपस्थित सक्रिय जैविक फाइटो मॉलीक्यूलस के बारे में बहुत कम ज्ञान है, परन्तु मधुमेह के विरुद्ध पौधों की भूमिका में कोई संदेह नही है।

विश्व में पौधों की जैव विविधता की जानकारी तथा व्यापक रुप से अधिकाधिक जैव सक्रिय यौगिकों की जाँच आवश्यक है जो मधुमेह के उपचार में उपयोगी हो। दूसरी ओर मधुमेहरोधी दवाओं के पारम्परिक सूत्रों पर आवश्यक रुप से शोध किया जाना चाहिये और नयी तकनीकों तथा विधियों द्वारा इन्हें मानकीकृत किया जाना चाहिये जिससे कि मधुमेह का प्रबंधंन हो सके और साथ ही ये दवायें उन लोगों के लिये सुलभ होगीं जो अत्यधिक मँहगी और संश्लेषित दवायें खरीदने में असमर्थ हैं। अतः हम कह सकते हैं कि मधुमेह के उपचार के लिये हर्बल दवाएँ संश्लेषित दवाओं का एक अच्छा उभरता हुआ विकल्प हो सकती हैं।

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PART V

PRASENTATION & SLIDES

International E – Publication
www.isca.co.in

Chemistry, Biochemistry and Ayurveda of Indian Medicinal Plants, 2013, pp. 208-211
Ed : Prof. I.P. Tripathi
Publisher : M.G.C.G.V.,Chitrakoot, Satna (M.P.) 485780

SHORT TERM STORAGE OF TWO IMPORTANT MEDICINAL PLANTS THROUGH ALGINATE ENCAPSULATION OF APICAL AND AXILLARY MICRO-CUTTINGS

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A large number of medicinal plants synthesize and accumulate important pharmaceutically active compounds in their underground parts. List of selected plant species producing pharmaceutically active secondary metabolites in roots

Plant species	Secondary metabolite
Atropa belladonna	Tropane indole alkaloids
Withania somnifera	Withanolides
Rauvolfia species	Indole alkaloids
Valeriana walichii	Valpotriates
Picrorrhiza kurroa	Picrosides
Catharanthus roseus	Indole alkaloids
Duboisia myoporidis	Tropane alkaloids
Hypericum	Hypericin
Asparagus officinalis	Triterpenoid saponins
Panax ginseng	Ginsenosides
Glycyrrhiza glabra	Glycyrrhizin
Lycopersicon esculentum	Alkaloids
Coleus forskohlii	Forskohlin
Hyoscyamus species	Trpane alkaloids
Plumbago zylenica	Plumbagin
Artemisia annua	Artimisnin

Glycyrrhiza glabra.....

- ***Glycyrrhiza glabra*** **is a plant of central, south western Asia and Mediterranean regions.**
- **A perennial herb of family Fabaceae**
- **Rhizome and roots are the plant part with medicinal importance.**
- **Commonly known as Licorice (Mulethi)**

The pharmaceutical and other commercial properties of this plant are all due to:

- **Triterpenoid saponin 'Glycyrrhizin'**
- **Aglycon glycyrrhitinic acid,**
- **Various flavonoids, essential oils, polysaccharides, polyamines and fatty acids**

Glycyrrhiza glabra and *Rauvolfia vomitoria* are two such important medicinal plants that contain variety of bioactive chemical compounds in their roots.

Presence of these compounds attributes to the various commercial and medicinal properties of these plants.

Glycyrrhiza glabra

Rauvolfia vomitoria

Uses in medicinal world

- **Major constituent of the drugs used for the treatment of gastric and duodenal ulcers.**
- **Expectorant, anti tussive, demulcent, anti-arthritic, anti-dental caries agent and anti inflammatory in nature.**

Uses in other industries

- **Owing to the fine aroma and sweetness, the licorice extract is used worldwide as a flavouring agent and sweetener in confectionery and tobacco industries.**

Commercial cultivation of licorice

Commercial cultivation of licorice is difficult .

1. **Poor flowering**
2. **poor seed viability**
3. **very slow growth rate**

Vegetative propagation using underground stem runners is the only implemented method for the commercial cultivation of licorice.

A large amount of industrial requirement of the plant from all over the world is not being fulfilled.

Taking into account on the limited availability of this plant for industrial use, an efficient and commercially feasible micropropagation protocol for the production of genetically stable and alike plants using liquid culture system was previously established utilizing small bioreactor set up.

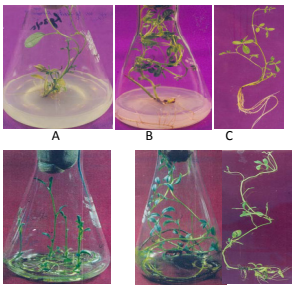
Need for short term storage and multiplication……

Because of inherent problems of regeneration, cultivation of licorice has not been popularized from commerce point of view and is restricted to its native places. Thus a large amount of industrial requirement of the plant from all over the world is not being fulfilled.

Taking into account on the limited availability of this plant for industrial use, conservation of Glycyrrhiza glabra plants employing synthetic seed technology is shown as a means to ensure stable and secure round the year supply of genetically uniform and high quality plant material.

Efficiency of Liquid System for Mass Multiplication of Glycyrrhiza Glabra and Evaluation of Genetic Fidelity of Micropropagated Plants

International Journal of Biotechnology and Biochemistry
ISSN 0973-2691 Volume 5 Number 2 (2009) pp. 157–169



Morphological response of G. glabra nodal explants in solid and liquid cultures

(A) 20 days old culture
(B) 40 days old culture
(C) Complete in vitro raised plant in two systems

Rauvolfia vomitoria…….

(Poison devil's pepper)

Native to Nigeria, Cameroon, Democratic Republic of Congo, Ghana, Liberia Senegal, Sudan, Uganda.

Occurs naturally in covered forests where uncultivated periods are prolonged.

***R. vomitoria* is associated with palms, Trema guineensis and Combretum spp.**

The pharmaceutical and other commercial properties of this plant are all due to:
- **Reserpine**
- **Ajmaline**
- **Perakine**
- **Carpanaubine**
- **isoreserpiline**

Mass multiplication of *G. glabra* in bioreactor

Alkaloids reported In *R. vomitoria*

- Geissoschizol (a,b)
- Acetyl geissoschizol (b)
- 10-hydroxy-geissoschizol (b)
- 11-methoxygeissoschizol (b)
- Geissooschizine (b)
- Pleicarpiminol (b)
- Picrinine (a,b)
- Quaternine (b)
- Picraline (b)
- Deacetyl deformopicraline (a)
- Akuammiline (a)
- Strictamine (a,b)
- Desacetyl- akuammaiine (a)
- Akkuamicine (b)
- Normascusine B (a,b)
- Sarpagine (b,c)
- Norajmailine (b)
- Norpurpeline (b)
- 10-hydroxynortetraphyllicine(b)
- Norscredamine (b)
- Norrauvomitine (b,c)
- Endolobine (b)
- Tetraphyllicine (b)
- 10 methoxy tetraphyllicine(b,c)
- Ajmaline (c)
- Purpeline (b,c)
- Seradamine (b,c)
- Sandwicine (c)
- Isosandwicine (c)
- Acetyl ajmaline (c)
- Mitoridine (b,c)
- Rauvomitine (c)
- Vomalidine (c)
- Suaveoline (c)
- Carapanaubine(a,b,c)
- Iso carapanaubine(b,c)
- Rauvoxine (a,b,c)
- Reserpine oxindole (a)
- Isoreserpiline indoxyl(b,c)
- Kaempferol (c)
- Quercetin (c)
- Reserpic acid (c)
- Gallic acid (c)
- Neonorreserpine (c)
- Ajmalinol (c)
- N-methyl ajmailine (c)
- Ajmalidine (c)
- Ajmalinine (c)
- Neoajmaline (c)
- Vellozimine (c)

- **a-leaf, b-stem, c-root, d-bark**

Medicinal and commercial importance of *R. vomitoria*

Reserpine is used in treatment of hyper tension and anxiety, stimulates central nervous system (CNS) and reduces high blood pressure.

The roots are also extensively used as a sedative, aphrodisiac or antispasmodic.

A possible alternative plant species :

It has been reported that alkaloid compositions of cell suspension and hairy roots of *R. serpentina* and *R. vomitoria* are identical.

Synthetic seed Technology…..

Synthetic seed technology or alginate encapsulation of explants (embryogenic / non-embryogenic) is a well established practice and has been employed in conjunction with micropropagation to establish in vitro gene banks of various pharmaceutically important species.

The efficiency of using alginate encapsulated propagules lies in their small size and relative ease of handling and transportation.

Besides, increased productive potential and ease of long or short term storage gives additional significance.

The main idea behind utilizing synthetic seed technology in present study is that the technique is endowed with the shared advantages of clonal multiplication and germ plasm storage and conservation.

Clonal multiplication of Rauvolfia vomitoria using liquid culture system and growtek bioreactor

a. Plant under natural conditions in CIMAP farms

b. & d. In vitro growing shoots in shoot multiplication solid and liquid medium respectively

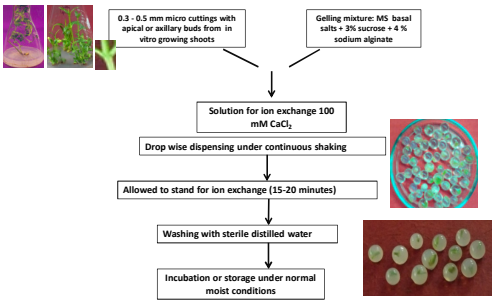
c. & e. In vitro shoots in rooting solid and liquid medium respectively

f. & g. mass multiplication in growtek

h. In vitro raised plants in earthen pots

Encapsulation and storage of axillary/apical micro cuttings

Methodology followed



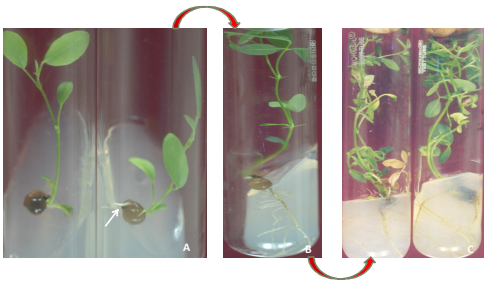
Need for mass multiplication and conservation of *R. vomitoria*…….

The harsh and heavy collection of *R. vomitoria* for medicinal uses coupled with the growth of other invasive and insidious plant populations resulting in fast decline of natural populations of *R. vomitoria* and thus pushing the plant towards endangered category.

The selective extraction of the species in order to supply continuously expanding pharmaceutical market is the major reason of loss of natural habitat.

Therefore, to protect the germ plasm and to keep pace with the rising demand of this plant, conservation and mass multiplication of *R. vomitoria* is the need of present hour.

Beads were then thoroughly washed with pre sterilized distilled water and immediately kept for storage in sterile petriplates (10 beads / pteriplate) under moist conditions maintained by placing sterile filter paper lining soaked with sterile distilled water at 25 ± 2ºC. To maintain moist conditions filter paper lining was frequently (20 d interval) sprayed with sterile distilled water.



A. Encapsulated micro shoots on multiplication media

B. Complete plant re grown from synthetic seeds

C. In vitro raised complete plant

CONCLUSION

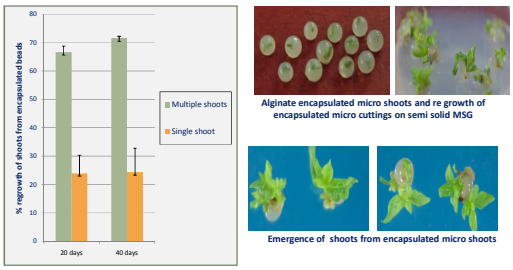
Glycyrrhiza glabra

Following 6 months of normal storage at 25 ± 2ºC the re growth of encapsulated G. glabra micro shoots, reached 98% within 30 days of incubation on MS medium supplemented with 0.1 mgl-1 IAA.

Re growth was characterized by the development of both shoot and root from single encapsulated micro shoot.

Healthy plants were established to glass house with 95% survival.

Growth response of encapsulated and normally stored axillary/apical micro cuttings of R. vomitoria



Alginate encapsulated micro shoots and re growth of encapsulated micro cuttings on semi solid MSG

Emergence of shoots from encapsulated micro shoots

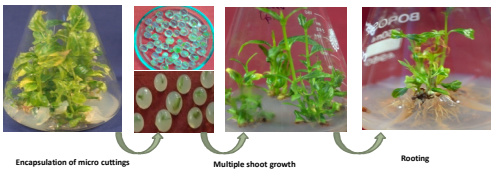
Rauvolfia vomitoria

In vitro repository for germ plasm of endangered plant can be established for short term.

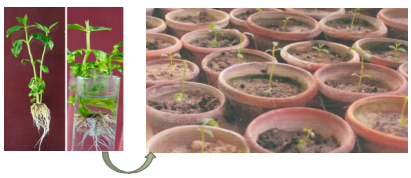
Quality plant material of an endangered species can be produced round the year irrespective of climatic and geographic barriers.

Handling during transportation to other areas for large scale plantation become easy.

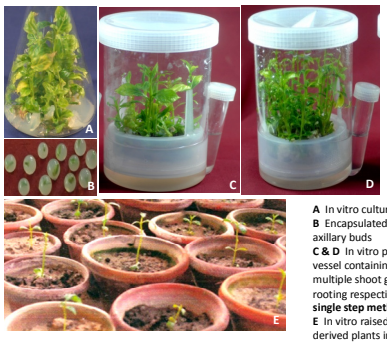
Encapsulated and stored explants can be used directly to inoculate bioreactors (large scale multiplication under in vitro conditions) to produce quality plant material.



Encapsulation of micro cuttings — Multiple shoot growth — Rooting



Hardening of *in vitro* raised synthetic seed derived plants



A In vitro culture
B Encapsulated apical and axillary buds
C & D In vitro plant in Growtek vessel containing medium for multiple shoot growth and for rooting respectively **(Biphasic single step method)**
E In vitro raised synthetic seed derived plants in glass house

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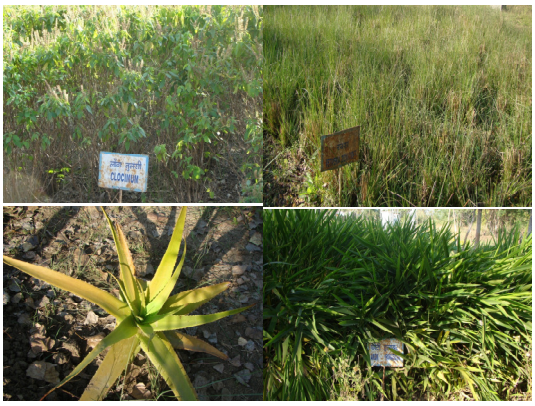
Chemistry, Biochemistry and Ayurveda of Indian Medicinal Plants, 2013, pp. 212-213
Ed : Prof. I.P. Tripathi
Publisher : M.G.C.G.V.,Chitrakoot, Satna (M.P.) 485780

PLANT TISSUE CULTURE TECHNIQUES

Dr. Rajesh Saxena, Dr. K.K. Tripathi & Mr. Ankit Agrawal
Prof. T. S. Murthy Science and Technology Station,
(M. P. Council of Science and Technology)
Dept. of Science &Technology, M.P. Govt.Mahavir Colony, Obaidullaganj, Raisen, (M.P.)

Thrust areas

1. **Conservation of medicinal and aromatic plants**
2. **Plant tissue culture**
3. **Mushroom Cultivation**
4. **Organic faming**
5. **Conservation of Biodiversity**
6. **Training activities**



Conservation of Medicinal and Aromatic Plants

Plant Tisue Culture

Mushroom Cultivation

Training Activities

1. Plant tissue culture techniques
2. Low cost mushroom cultivation
3. Organic farming as a green chemistry
4. Application of Organic farming
5. Cultivation of medicinal plants
6. Dissertation work for graduate and Postgraduate students

Organic Farming

Conservation of Biodiversity

Low Cost Mushroom Cultivation

Duration:	3 days
Fees:	Rs. 1500/person*
	* Fee is exempted for SC/ST and BPL card holder
Eligibility:	1. Graduate, Postgraduate student and Research Scholars of life sciences 2. Farmers (men/women)

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BIODIVERSITY: TOOL FOR BIOTECHNOLOGY AND BIOPROSPECTING

Prof. T.R.Sahu
Dept. of Botany,
Dr. H.S.Gour Central University, Sagar (M.P.)

IMPORTANCE OF BIODIVERSITY

- Biodiversity provides to the humankind enormous direct economic benefits in the form of timber, food, fibre, medicines, Industrial enzymes, food flavors, fragrances, cosmetics, emulsifiers, dyes, plant growth regulators and pesticides.
- The indirect ecological benefits from biodiversity include the regulation of the gaseous composition of the atmosphere, soil formation, processing and acquisition of nutrients, trophic dynamic regulation of population etc. / Biodiversity help in maintaining stability of life on the planet through the interactive dynamics of ecosystem

- India is one of the 20 mega diversity countries, 12 top mega diversity countries, 17 LMMDC's
- Out of 34 Hot spots of the globe India harbors 4 Hot spots including 2 Hottest Hot Spots.
- Home of 166 species of crops (4 are major-Maize, Wheat, Rice & Potato)
- 334 species of wild relatives of cultivated plants.
- 8 Phyto-geographical zones.
- 18 Agro-biodiversity hot spots in India (Nagarajen et al 2007) on the basis of crop varieties No. of crop species and wild relatives.
- 22 Agro-biodiversity region based on endemism of plant of agro biodiversity importance and their association with agro-ecosystem, local tribes and cultures.

BIOGEOGRAPHICAL ZONES IN INDIA

- **Strategic position of India having connection with adjustment region.**
- **Situated as tri-junction of 3 natural realms:**
  - **Indo-Malayan, Eurosia, Afro-tropical**
- **Diverse ecological condition**
- **Diverse geographical area of 329 Million Ha (i.e.2.4% of the total land mass, 7500 km long coastal line)**
- **3 Major bio-geographical Realms:**
  - **The oriental, The Paleo-arctic, Ethiopian**
- **This indicate the rich and varied Indian Flora & Fauna a meeting ground of tropical, temperate and arid biodiversity elements.**
- **4 Mega centers of Endemism with 25 micro centers of endemism with 33% of endemic species (6000 endemic out of 19500 spp.)**
- **12 Provinces**
- **10 bio-geographic zones**
- **16 Major and 34 subgroups of forest types.**
- **20 Poly-geographical division**

DISTRIBUTION OF BIODIVERSITY

DISTRIBUTION IS NOT UNIFORM !!!

It increases :

- from pole to equator
- from high to low altitude
- From smaller island to bigger island

This results into patchy distribution of biodiversity

Therefore, need to prioritize conservation area

TREASURE HOUSE OF BIODIVERSITY

- Tropical Rain Forests -
- Only 7% of the total land surface but > ½ of the spp. on earth
- 80% of word's Insects live in these forests.
- ⅓ Flora of India occur in Western Ghats (TRF) of Peninsular India

- REASONS -

Ø Evolution are optimum
Ø Extinction Fewer
Ø Constancy of Environment
Ø Varied Habitats
Ø Interaction between organisms, with climate topography, soil, rock result, Biodiversity.
Ø Certain extra Terrestrial Factors.
Ø % of Endemism is more

Biodiversity of any given area is a reflection of both of range of habitat and diversity of the components exist in them"

MEGADIVERSITY COUNTRIES & HOT SPOTS

1.Total Mega diversity countries: 20 (Including India)

2.Top Mega-diversity Countries: 12 (Including India)

3.Total Hot Spots : 34 (4 in India)

4.Hottest Hot Spot : 08 (2 In India)

Western Ghats &

Indo-Burma

Value of Biological Resources

Direct (consumptive) | Future | Indirect (non-consumptive)

Discovery of unknown spp.

- Source of food,fire
- Material for breeding improved varieties
- Drug & Medicines
- Fibre: Cotton, flax, jute, hemp, sunn
- Useful products: Gums, resins, tannins, dyes, paper, tea, coffee etc.
- Commercial value:-fishes fodder, fuel, timbers etc.
- Scientific value: material for study

- Ecological balance: CO2 & O2, reduce pollution, Check soil erosion, food chain, food web, nutrient cycle etc.
- Aesthetic value: Green forests, beautiful flowers, song of birds, colorful butterflies, fishes, birds, landscape, ecotourism etc.
- Cultural value: Inspires poets and artists to compose poems, songs,and to make paintings, sculptures, photography, etc.
- Right to live:
- Recreation: visit to gardens, NP, Sanctuaris, Zoo etc.

WORLD RANKING OF MEGA-DIVERSITY COUNTRIES (Paine, 1997)

S.No.	Countries	No of Fl. Species	Mammal	Bird
1.	Brazil	55,000	394	1695
2.	Columbia	35,000	359	1635
3.	China	30,000	304	1244
4.	Mexico	25,000	450	1026
5.	Indonesia	27,500	436	1531
6.	India	19,500	316	1219
7.	Ecuador	18,250	302	1559
8.	Peru	17,121	344	1678
9.	Australia	15,000	252	751
10.	Malaysia	15,000	286	736
11.	Madagascar	12,000	105	253
12.	Zaire	11,000	415	1096
13.	South Africa	23,000	247	790
14.	Venezuela	20,000	305	1296
15.	Costa Rica	11,000	205	850
16.	Papua New Guinea	10,000	213	761
17.	Panama	9,000	218	926
18.	Cameroon	8,000	297	874
19.	Philippines	8,000	153	556
20.	Vietnam	7,000	213	761

GENOME SIZE OF TYPE ORGANISMS

Sr. No.	Organism	Scientific Name	Base Pairs (In Million)
1.	Bacterium	E. Coli	4.8
2.	Yeast	S. cerevisae	14.4
3.	Man	Homeo sapiens	3000
4.	Modern Plant	Arabidopsis thaliana	100
5.	Fruitfly	D. melanogaster	170
6.	Worm	C. elegans	90

"The green revolution and genetic selection in plant and animal depends upon diversity among genetic types"

Like-minded Megadiverse Countries (Cancún initiative)

✓ Out of mega diverse countries decayed so far, 17 of them formed the group of Like Minded Mega diverse Countries (LMMC's) On 18 February 2002, the Ministers in charge of the Environment and the Delegates of Brazil, China, Colombia, Costa Rica, India, Indonesia, Kenya, Mexico, Peru, South Africa and Venezuela assembled in the Mexican city of Cancún.

✓ These countries declared to set up a **Group of Like-Minded Megadiverse Countries** as a mechanism for consultation and cooperation so that their interests and priorities related to the preservation and sustainable use of biological diversity could be promoted.

✓ Group of LMMDC are characterised by (a) Rich biological diversity & (b) Associated T. Knowled.

✓ They also declared that they would call on those countries that had not become Parties to the Convention on Biological Diversity, the Cartagena Protocol on Biosafety, and the Kyoto Protocol on climate change to become parties to these agreements.

✓They agreed to meet periodically, at the ministerial and expert levels, and decided that upon the conclusion of each annual Ministerial Meeting, the next rotating host country would take on the role of Secretary of the group, to ensure its continuity.

Bolivia
Brazil
China
Colombia
Costa Rica
Demo. R. of the Congo
Ecuador
Indonesia
India
Kenya
Madagascar
Malaysia
Mexico
Nepal
Peru
Philippines
South Africa
Venezuela

Hotspots in India

Sr.No	HOTSPOTS	AREA (K m2)	VEGETATION (km2)	TOTAL SPP.	ENDEMIC SPP.
1	Himalaya	74,1406	18,5427	8500	3160
2	Western Ghat	18,9611	43,611	4500	3049
3	N.E. Indo Burma	23,73057	11,8653	4000	700
4	A. & N. Island (572 Islands)	8249	7163	2500	250

33-34% of Endemism in flowering plants
Of the total 141 endemic genera in India -114 are monotypic, 131 Primitive living spp., 1/2 of Aquatic spp. of world.
No family of flowering plant is endemic to India.

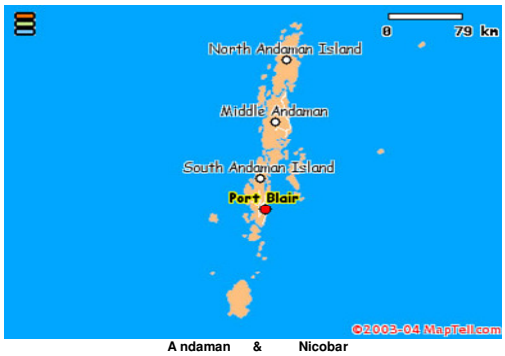
"Nature can feed the *Needy*, but not the *Greedy*"

Western Ghats- SriLanka (3049 Endemic spp.)

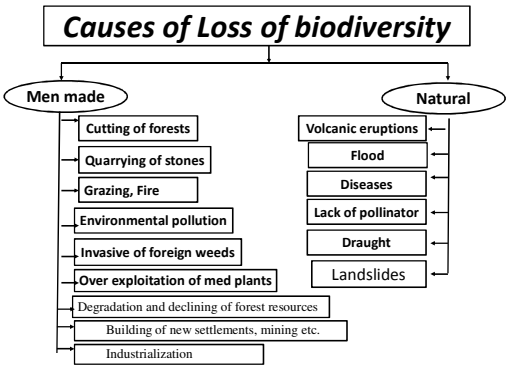
FOUR INDIAN HOT SPOT

Himalaya (3160 Endemic spp.)

Indo-Burma (7000 Endemic spp.)



A ndaman & Nicobar



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SIGNIFICANCE OF IN VITRO TECHNIQUES IN THE CONSERVATION OF BACOPA MONNIERI AND PRODUCTION OF BACOSIDES

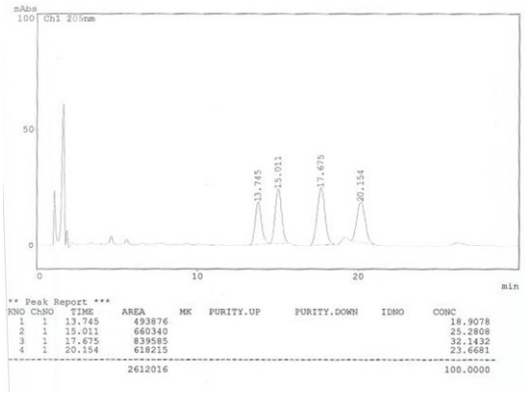
Prof. Tejovathi Gudipati
Principal
Boston College for Professional Studies, Gwalior

BACOPA MONNIERI

- Brahmi, Jalanimba
- Scrofulariceae
- Succulent, Creeping herb
- Damp, wet, Marshy
- Stem 10-30 cm
- Rooting at the nodes
- Leaves sessile, Opposite decussate
- Flowers are axillary, solitary
- Pale blue or almost white

MEDICINAL SIGNIFICANCE OF THE PLANT

- Improve memory
- Intelligence
- Fevers
- mental stress
- Anxiety
- Epilepsy
- Hepatoprotective
- Anti-cancerous
- Neuroprotective
- Antidiabetic,
- Antioxidant,



** Peak Report ***

PKNO	ChNO	TIME	AREA	MK	PURITY.UP	PURITY.DOWN	IDNO	CONC
1	1	13.745	493876					18.9078
2	1	15.011	660340					25.2808
3	1	17.675	839585					32.1432
4	1	20.154	618215					23.6681
			2612016					100.0000

- The pharmacological Properties of *Bacopa monnieri* were attributed mainly due to the presence of characteristic saponins called as "Bacosides"
- Active constituent, identified and found to be responsible for the pharmacological benefits of *Bacopa* are Bacoside- A and B, are found in all parts of the plant.
- Bacoside A - a mixture of saponins - Bacoside A3, Bacopaside II, jujubogenin isomer of Bacopasaponin C and Bacopasaponin.

Brahmi

According to -

NMPB (National Medicinal Plant board)

TIFAC (Technology Information Forecasting and Assessment Council),

DST (Department of Science and Technology) Govt. of India

It is one among the 7 important medicinal plants recommended for immediate attention.

- Included in the list as a highly endangered medicinal plant in India

In M.P. alone –

- The natural cover has been reduced by 30-49% in just one decade (FRLHT, 2006, Red Data IUCN, 2010).
- Declared *B. monnieri* as threatened species

In vitro techniques

Tissue culture

- Germplasm conservation
- Production of medicinally important bioactive molecules- bacoside-A

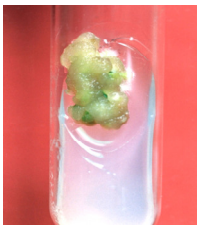
Molecular analysis and biochemical studies

- **Germplasm conservation**
  collection of MP accessions
  in vitro micropropagation *Bacopa monnieri*
  Multiplication and transfer to fields.
- **Production of bioactive molecules- Bacoside-A**
  Increasing production –influence of various parameters
  Manipulation at callus level for variants

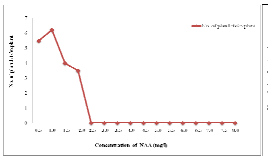
In vitro micropropagation

- 2,4-D, NAA, IAA, IBA, BAP and Kinetin
- Type/% response/No. of plantlets/explant

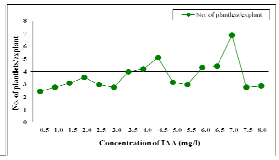
2,4-D

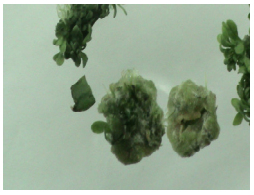


NAA



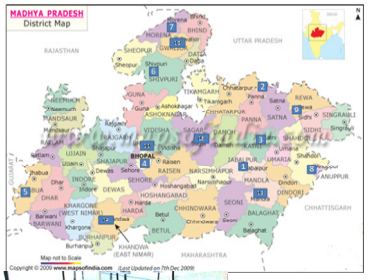
IAA





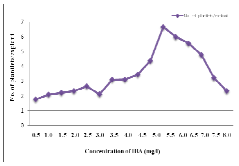
Molecular techniques

- **Detection of Genetic Diversity**
- molecular marker (RAPD) for determination of genetic diversity
- Quantification of bacoside-A levels in the plant/ callus levels



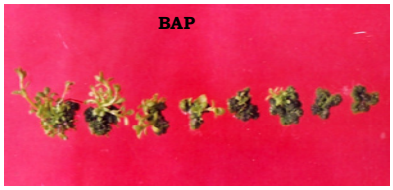
Germplasm maintained in green house

IBA

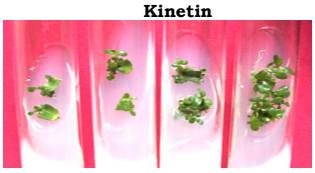


BAP

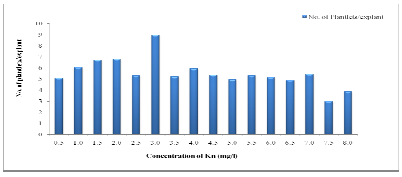
BAP



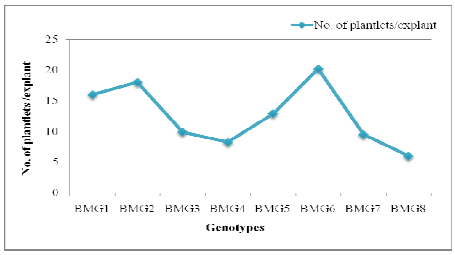
Kinetin



Kinetin



conservation



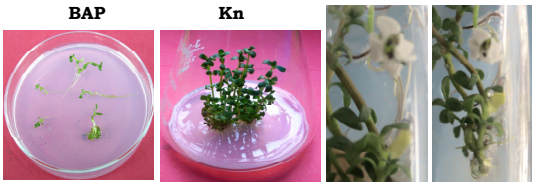
***In vitro* Studies- Production of medicinally important bioactive molecules- bacoside-A**

- Cell culture system, is an excellent and alternative source for the production of secondary metabolites.

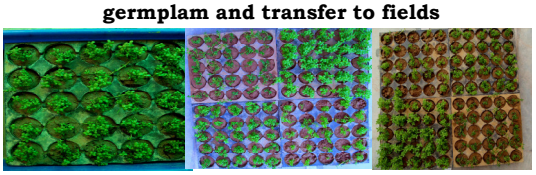
***In Vitro* Manipulations for Bacoside A Production**

- By manipulating the physical and chemical environment, optimum production of important metabolites can be achieved.
- How age, light, RPM effect the growth?

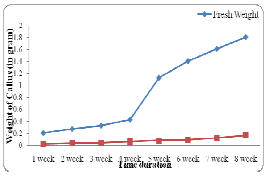
BAP Kn



Multiplication of *Bacopa monnieri* germplam and transfer to fields



Hardening and Transfer to soil



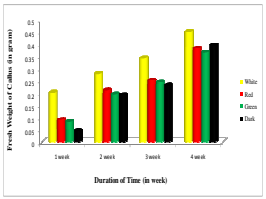
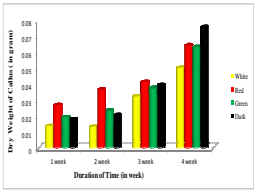
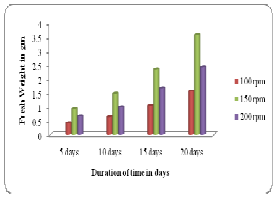
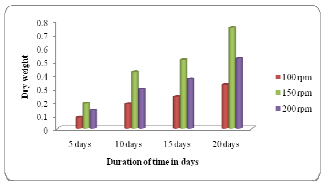


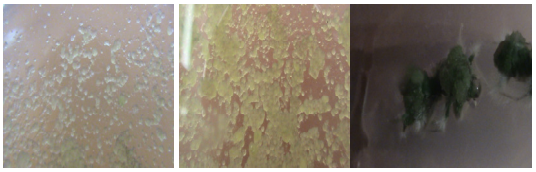
Figure-: Variation is Fresh and Dry Weight of the callus with increase in the age.

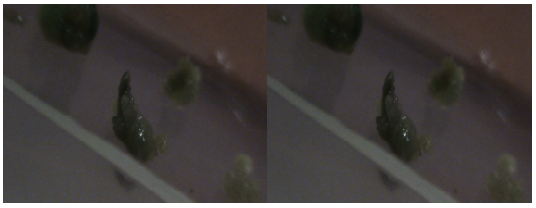






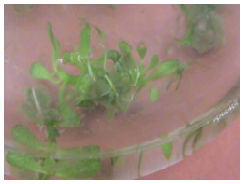
S. No.	Concentration of chemical	Response
1	0.00005%	Callusing
2	0.00025%	Callusing
3	0.0005%	Browning of the explants
4	0.0025%	Browning of the explants
5	0.005%	Browning of the explants
6	0.0025%	Browning of the explants
7	0.01%	Browning of the explants





***In vitro* Studies- Production of medicinally important bioactive molecules- bacoside-A**

- Cell culture system, is an excellent and alternative source for the production of secondary metabolites.



S. No.	Number of in vitro plants developed				Total number of plants raised
	Exp. I	Exp. II	Exp. III	Exp. VI	
1	14	9	11	9	43
2	12	4	19	17	52

Molecular techniques

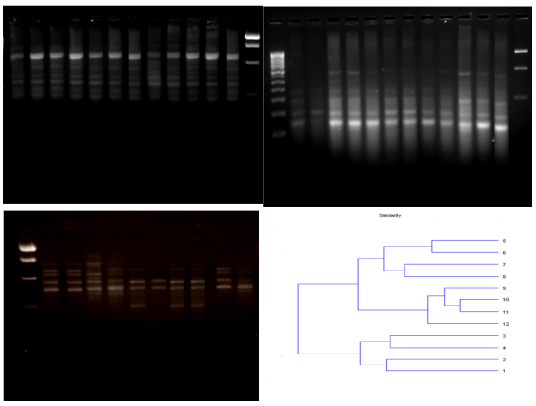
- **Detection of Genetic Diversity**

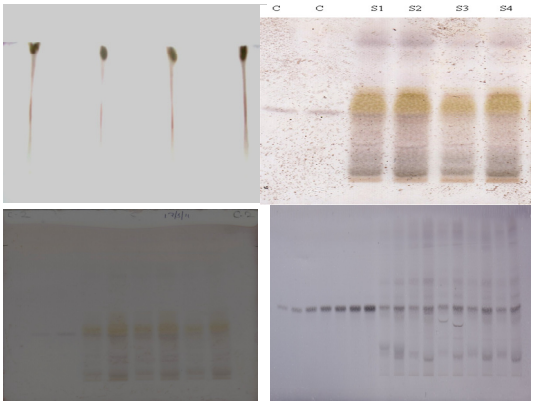
  molecular marker (RAPD) for determination of genetic diversity

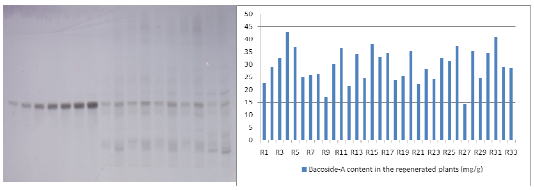
- Quantification of bacoside-A levels in the plant/ callus levels

Detection of Genetic Diversity
Random Amplified Polymorphic DNA (RAPD)

• RAPD markers are efficient, quick and detect polymorphism at a very large number of loci.
• RAPD fingerprinting approach was applied to access the genetic variability in different accessions of medicinal plants (Panda et al., 2007; Bhau *et al*., 2009; Cesar *et al*., 2010; Khan *et al.*, 2009).
• The technique requires no prior knowledge of the genome.
• It needs only a small amount of DNA.
• Polymorphism can be detected in closely related organisms.
In the present study genetic variability
• 12 accessions of bacopa collected from various regions of Madhya Pradesh
was analysed by RAPD method using.
• 31 primers of 10mer obtained from '**Operon Inc., USA'**.
• Amplified DNA fragments with each primer for all the 12 accessions were separated by agarose gel electrophoresis along with a 250bp ladder.





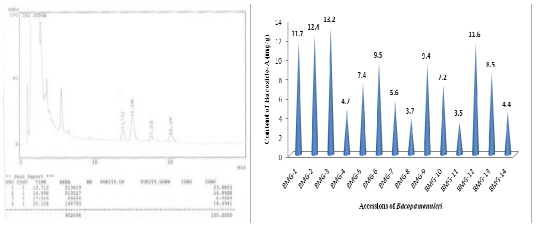


Tissue culture and Biotechnology anr the powerful tools which help us to improve the plants

But they can not replace the conventional methods.

Molecular techniques

- Quantification of bacoside-A levels in the plant and callus levels



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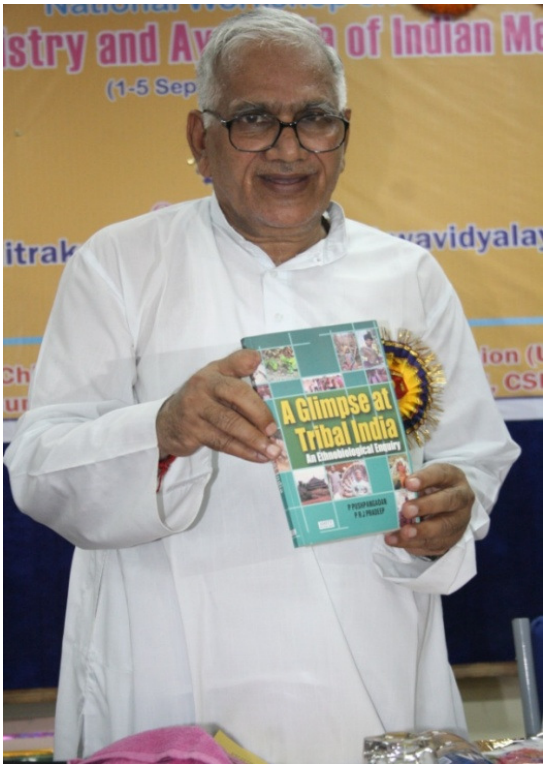
- Prof, **GBKS Prasad**, Head, S.O.S. In Biochemistry, Jiwaji University, Gwalior
- **Mrs. Pratima Shrivatava , Ph.D student**
- **Dr. Harisharan Goswami, Ph.D. student**
- **Ankit Agarwal, Pramod, MPCST**

PART VI

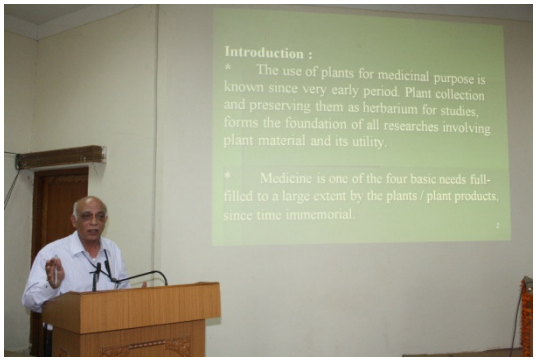
PHOTOGRAPHS

INAUGURAL SESSION


A Glimpse at Tribal India


Ayurveda of Indian Medicinal Plants

TECHNICAL SESSION



FIELD VISIT

PART VII

WORKSHOP DETAILS

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ABOUT THE EDITOR

Prof. Indra Prasad Tripathi is a Pro-Vice-Chancellor & Dean of Faculty of Science & Environment in Mahatma Gandhi Chitrakoot Gramodaya University Chitrakoot and has been teaching for 20 years. He obtained Ph.D. in 1992 from APS University Rewa, India. He has published 48 papers in National and International Journals. He is founder editor-in-chief of Merit Research Journal of Biochemistry and Bioinformatics, Chief editor The Science (An International Science Research Journal), editor Journal of Current Research in Ayurvedic and Pharmaceutical Sciences and member in the advisory board and editorial team of several National and Internation Journals.

Prof. Tripathi major field of interest are Inorganic Organometallic Chemistry, Environmental & Bio-Chemistry, Medicinal Chemistry, Environmental Monitoring, Industrial Chemistry and Occupational Health. He has conducted five research project sponsored by UGC, MPCOST, M.P. Govt. etc. He has supervised 100 M.Sc. Dissertations and 05 M.Phil and 15 Ph.D. students.

Prof. Tripathi has received several awards including Professor R. D. Desai 80th Birthday Commemoration Award-2007 (Indian Chemical Society), Research Board of Advisors (The American Biographical Institute), Fellowship Award BIOVED Fellowship Award-2012 and Best Science Research Award-2012 (MP Council of Science & Technology, Bhopal). He is founder President of Parivesh Vikash Avam Paryavaran Samiti (1996-2013), Madhav Sewa Samiti (2005-08), M.P. Hindi Sahitya Sammelan Chitrakoot (2005-08), Vice-president- Sanjeevani Parivar Sewa Sansthan (2005-11) and Associated several National & International professional societies.

कुलगीत

हे ग्राम विद्या की राजधानी, तुम्हारी जय हो तुम्हारी जय हो ।
न तेरी दुनिया में कोई सानी, तुम्हारी जय हो तुम्हारी जय हो ।।

तू पूज्य बापू की कल्पना है, तू पूज्य नाना की अल्पना है ।
तू उस दधीचि की है निशानी, तुम्हारी जय हो तुम्हारी जय हो ।।

तू ग्राम में विश्व की प्रतिष्ठा, तू बन्धु में बन्धु की है निष्ठा ।
कहे चरण पादुका कहानी, तुम्हारी जय हो तुम्हारी जय हो ।।

प्रभू-चरण-रज की तू है थाती, सिया को आँचल में थी छुपाती ।
शिला स्फटिक नित कहे कहानी, तुम्हारी जय हो तुम्हारी जय हो ।।

पयस्विनी माँ की धार है तू, श्री कामदा का सिंगार है तू ।
तू गुप्त गोदावरी सुहानी, तुम्हारी जय हो तुम्हारी जय हो ।।

सुतीक्ष्ण शरभंग तपस्थली हो, तुम अत्रि अनुसुइया की लली हो ।
तुम आदि कवि की हो आदि बानी, तुम्हारी जय हो तुम्हारी जय हो ।।

तुही है चन्दन तुही है तुलसी, तू राम बोला की मातु हुलसी ।
हृदय में रत्ना के तू समानी, तुम्हारी जय हो तुम्हारी जय हो।।

तू ग्राम प्रौद्योगिकी पढ़ाये, तू ग्राम कौशल कला सिखाये ।
कृषि प्रबन्धन में तू सयानी, तुम्हारी जय हो तुम्हारी जय हो ।।

अशक्त हैं जो, जो बेसहारे, कभी न कोई जिन्हें निहारे ।
गले लगाने को उनको ठानी, तुम्हारी जय हो तुम्हारी जय हो।।