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Lead Paper-1

LEAD PAPERS

Perspectives on the Global Medicinal Supply Chain

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In the US, consumers of herbal supplements tend to believe that in buying products made with plants, they're making the environmentally responsible choice. Unlike the food industry where attention to traceability and sustainable and ethical sourcing is gaining traction, however, neither consumers, the media nor natural products companies pay much attention to the crucial connections between the quality of the raw material, traceability in the supply chain, and the efficacy of the finished product. Even for those seeking to know more, in an industry not known for transparency, it is very difficult to find accurate information about the supply chain or about the human and environmental costs.

This presentation will discuss the Sustainable Herbs Project (SHP), an online multi-media project dedicated to educating consumers about quality, sustainability, and equity in the botanical industry. The goal of this project is to 1) inform consumers and the media about quality, sustainability and social justice in the herb industry; 2) connect individuals and organizations working in different sectors of a fragmented industry; and 3) empower individuals to act on this knowledge and these connections. I will present perspectives on the global medicinal plant supply chain and the necessity of addressing quality, sustainability, and equity issues in order to reach a socially and environmentally conscious consumer.

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Medicinal plants and herbal drugs : Challenges and Opportunities

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There is an ever increasing demand for herbal drugs, especially in developed countries. In all these countries, consumers are advised to look for only standardized herbal drugs. Herbal drugs, therefore, need to be standardized. The primary reason for standardization of herbal drugs is to achieve as much control as possible in double blind clinical studies. But then, botanicals are highly variable in their chemical makeup. This natural variation in the chemical makeup of medicinal plants presents a considerable challenge for researchers in order to obtain reproducible results. With the current technology, it is not possible to quantify the hundreds of chemical constituents present in medicinal plants in a timely and cost efficient manner. The compromise solution to this dilemma has been to select a marker compound(s) and then ensure that every batch contains the same amount of these marker compound(s). The market's over emphasis on marker content and standardization, however, has been a boon for unethical businessmen. What is more, markers have not been identified for the vast majority of botanicals. While marker content is an important issue, some may lose sight of the fact that one has to deal with the plant first of all. In other words, chemical analysis is moot if one does not have the right plant or if the plant material is not pure. Three other cross cutting themes that have emerged are the need for authenticated reference materials, national quality standards and pharmacognosy education and training.

Despite the tremendous success of chemo- and antibiotic therapy, it is believed that only 30% of about 2000 existing diseases can be cured today. Others can be treated only symptomatically or insufficiently and some not at all. There is an urgent need, therefore, to discover efficient and causality acting drugs to treat several diseases. In this context, combinatorial chemistry, a collection of methods whereby simultaneous chemical synthesis of a large number of compounds using a variety of starting materials



can be produced quickly and high throughput screening, a process whereby the large number of compounds can be tested against biological targets to find active compounds, have been used as drug discovery source for the past more than 30 years. Since 1980 onwards a great number of screening programs have been initiated by industries, universities, and research institutions, searching for new bioactives. Several big pharmaceutical industries have, therefore, either terminated or scaled down natural product research. But then, to date we find only a couple new chemical entities/drugs approved by FDA, resulting from these techniques. In other words, the expected surge has not materialized.

On the other hand, natural products, especially those derived from plant sources, have played an important role in the drug discovery process. When one analyzes the data on new chemical entities/drugs developed for all diseases and from different natural sources the world over for the past nearly 30 years, it shows that only less than 30% of them are of synthetic origin. This clearly demonstrates the influence of natural products in drug discovery process. Nature seems to continue to serve as an excellent source of novel active agents that will serve as leads and scaffolds for developing the drugs, desperately needed for the multitude of diseases. The functional group diversity and architectural platforms built into natural products during their biosynthesis continue to provide lessons for the medicinal chemists. What is more, the inventory of natural molecules remains incomplete and chemomics, understanding the molecular logic of biosynthetic enzymes and pathways, has opened up new approaches to reengineer newer natural products. Discovery of new molecules and their functions are, therefore, likely to continue as sources of natural products are more systematically evaluated.

In this connection, a multidisciplinary approach for drug discovery, involving the generation of truly novel molecular diversity from natural product sources combined with total and combinatorial synthetic methodologies including the manipulation of biosynthetic pathways, should provide the best solution to the current productivity crisis facing the scientific community engaged in the drug discovery and development. It is, therefore, necessary that we should expand and not decrease the exploration of nature, and in particular plant sources, for novel bioactive agents that may serve as leads and scaffolds for elaboration into the desperately needed efficacious drugs for the multitude of disease indications.



Medicinal Plants Genetic Resource in India: Current Scenario and Future Prospects

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Medicinal plants offer alternative remedies with tremendous opportunities to generate income, employment and foreign exchange in developing countries like India. The global market for the medicinal plants and herbal medicine is increasing every year. India is one of the leading countries in Asia in terms of the wealth of traditional knowledge systems related to herbal medicine and employs a large number of plant species which includes Ayurveda (2000 species), Siddha (1121 species), Unani (751 species) and Tibetan (337 species). Consumption of herbal medicines is widespread and increasing in recent years because of its low or nil side effects than the modern medicines. Majority of the medicinal plants are being collected from its wild habitats and used. But, due to its increased demand of many species, the harvesting was done in an unsustainable manner and leading to not only short supply of these materials but also brought some species into red, endangered and threatened (RET) status. Several of these medicinal plant species have slow growth rates, low population densities, and narrow geographic ranges; therefore they are more prone to extinction. This situation called for an alternative strategy, and many species were brought under cultivation. Economic cultivation of any medicinal plants requires high yielding varieties, good agricultural practices. The development of improved varieties in any species is soled depending upon the availability of genetic variability. Hence, the germplasm management i.e. collection, conservation, evaluation and documentations plays an important role. In the present paper, an over-view of the present status of medicinal plant genetic resources in India and its future prospects were discussed.



History: The history of genetic management of medicinal and aromatic plants (MAPs) coevolved along the civilization when man started using the plants as medicines. In earlier days, the plants were naturally conserved in natural habitat and sustainability used by the healers. Even though most of the medicinal plant species are used from time immemorial, its genetic resource management process has been systematically started in 1960s after Indian Council of Agricultural Research (ICAR) has started a separate project for Medicinal plants at the National Bureau of Plant Genetic Resources (NBPGR), New Delhi.

Germplasm status of medicinal plants in India

The genetic resource management in medicinal and aromatic plants has assumed a great significance to breeders, foresters and conservation scientists in India. Once the concept of field gene bank, these species were assembled and maintained. The field gene bank is place where the germplasm of plant species are being maintained. There are now a large number of field gene banks, herbal gardens and long term repositories at several parts of our country (<http://herbalgardenindia.org>). Ministry of AYUSH through NMPB also provide support to conservation of the genetic resources of medicinal plants (<http://www.nmpb.nic.in>).

Collection and conservation: The systematic germplasm collection was initiated in late 1960s since inception of the All India Coordinated Project on Medicinal and Aromatic Plants (AICRP-MAP) by the different centres and considerable progress has been made in this direction viz. at present there are about >3200 accessions of 35 species are being maintained. The ICAR-DMAPR, Anand, a designated national active germplasm site (NAGS) of ICAR-NBPGR for MAP is maintaining >1300 accessions of different medicinal and aromatic plants (MAPs) in field gene bank. Apart from this CSIR-CIMAP, Lucknow and some Agricultural and General universities also maintains germplasm of some medicinal plants on need basis. In national gene bank at ICAR-NBPGR at New Delhi, >7800 accessions of MAPs are being maintained in the long term storage, >150 in in-vitro conservation and >970 accessions are cryo-preserved. These long term stored seeds are periodically rejuvenated and stored again for future use.



Table 1. Germplasm being maintained at ICAR-DMAPR, Anand (Annual report, 2015-16)

S.No.	Species	Total
1.	<i>Aloe</i> spp.	89
2.	<i>Andrographis paniculata</i>	126
3.	<i>Asparagus</i> spp.	88
4.	<i>Chlorophytum borivillianum</i>	58
5.	<i>Commiphora</i> spp.	225
6.	<i>Desmodium gangeticum</i>	52
7.	<i>Gymnema sylvestre</i>	43
8.	<i>Plantago</i> spp.	91
9.	<i>Tinospora cordifolia</i>	52
10.	<i>Withania somnifera</i>	264
11.	<i>Cymbopogon</i> spp.	40
12.	<i>Cassia angustifolia</i>	256
Total		1384

The aim of conservation is to support sustainable development by protecting and using biological resources in such a way that do not diminish the diversity available in genus and species or destroy important habitats and ecosystems. Biodiversity can be conserved either *in-situ* or *ex-situ*.

In-situ conservation

In-situ conservation is on-site conservation or the conservation of genetic resources in natural populations or in the area where it grows naturally. It includes establishment of national park, biosphere reserve or gene sanctuary. In India, government has established 18 biosphere reserves for conservation of flora and fauna under Ministry of Environment, Forest and Climate change based on the UNESCO Man and the Biosphere (MAB) Programme. Other than, since 1993 FRLHT has pioneered the *in situ* conservation of India's medicinal plant diversity. A Medicinal Plant Conservation Area (MPCA), a network of approximately 10 conservation sites is officially designated



by FRLHT of 200 to 300 hectares in the states of Karnataka, Tamil Nadu, Kerala, Andhra Pradesh and Maharashtra. Presently, 55 MPCA sites represent models for other communities worldwide to implement for maintaining their own indigenous health traditions along with biological and cultural diversity.

Ex-situ conservation

Conservation of plant genetic resources outside their natural habitat is known as *ex-situ* conservation. It facilitates conservation in controlled conditions and makes possible reintroduction of species into wild. It can be achieved in the following ways (1) Seed gene banks, (2) Botanical garden/field gene banks, (3) *in-vitro* banks, (4) Cryopreservation banks, and (5) DNA banks.

Seed gene banks

A total of about 7822 accessions of prioritized medicinal plants species are conserved as base collections at National Seed Gene Bank, NBPGR, New Delhi (www.nbpgr.ernet.in).

Botanical garden/field gene banks

There are many field gene banks/botanical gardens maintained by government and non-governmental organizations in India. National biodiversity authority (NBA), an autonomous and statutory body of the Ministry of Environment and Forests, Government of India listed existence of 109 botanical gardens across 18 states in India (<http://nbaindia.org/link/241/34/1/SBBs.html>). Ministry of agriculture under horticultural division has established 16 herbal gardens all over the India which are maintaining about 150 medicinal plants. Botanical garden at ICAR-DMAPR, Anand in an area of about 10 ha maintains 140 tree species, 65 shrubs, 40 creepers and 250 herbs and at field gene bank 1384 accessions of 12 medicinal plant species including 9 mandated crops are being maintained (Annual Report 2015-16, DMAPR). In addition, a web based “Herbal Gardens of India” system developed by the Directorate with the financial support of NMPB and hosted at <http://www.herbalgardenindia.org> provides online information about the herbal gardens and facilitate the exchange of medicinal species



among the member herbal gardens within the country.

In-vitro and cryopreservation repository

In order to strengthen the efforts of *in vitro* conservation of MAPs a tissue culture repository has been established at NBPGR, New Delhi. At present, 155 accessions of 28 MAPs (e.g. *Coleus*, *Rauvolfia*, *Tylophora*, *Valeriana* etc.) were *in vitro* conserved and 975 accessions of various MAPs were cryopreserved at NBPGR, New Delhi (Annual report, 2015-16, NBPGR, New Delhi).

Characterization and documentation: The minimum DUS descriptors have been developed for most of the important MAPs. The characterisation of important medicinal plants like Isabgol, Ashwagandha, Senna, Kalmegh, *Tinospora*, *Aloe*, Guggal, *Desmodium*, *Asparagus*, Madhunasini, etc. have been done for the presently available germplasm at the DMAPR, Anand using the descriptors. Besides, the AICRP-MAP&B centers have also characterized and documented the medicinal plants of their region.

Evaluation: Evaluation of germplasm for yield, chemical properties, and other desirable traits are being undertaken under ICAR and CSIR regularly. Both DMAPR and AICRP-MAP centers have periodically evaluating the germplasm and elite and useful germplasm have been identified.

Registration: Protecting the intellectual property rights of our medicinal plant accession is an important task in the international era of open commerce. The elite germplasm lines identified/developed are being regularly registered at NBPGR, New Delhi and so far 35 elite germplasm of 21 species have been registered (some are listed in Table.2).

Future thrust area for medicinal plant genetic resources

- Even if we considered germplasm collection of species whose therapeutically useful products are primarily used in crude form, the numbers of species to be conserved are very high. Hence, prioritization based on its importance is to be done. Furthermore, plants that are extracted for their roots and barks should



Table 2. Status of germplasm registered in medicinal and aromatic plants with NBPGR, New Delhi

S. No.	Botanical name	INGR no.	Year	Developing Institute	Novel features
1	<i>Aloe barbadensis</i>	6023	2006	ICAR-DMAPR, Anand, Gujarat	Superior gel (2191.18 g/plant)
2	<i>Aloe barbadensis</i>	6024	2006	ICAR-DMAPR, Anand, Gujarat	Superior aloin-A (26.13%)
3	<i>Aloe bardadensis</i>	13043	2013	ICAR-DMAPR, Anand, Gujarat	Yellow flowered plant type.
4	<i>Centella asiatica</i>	8105	2008	ICAR-DMAPR, Anand, Gujarat	Morphotype with high leaf area & high asiaticoside (1.62%)
5	<i>Withania somnifera</i>	11026	2011	ICAR-DMAPR, Anand, Gujarat	Dwarf plant type
6	<i>Withania somnifera</i>	13047	2013	ICAR-DMAPR, Anand, Gujarat	A new plant type is a unique and distinct than normal erect type and is useful in future breeding programs.
7	<i>Andrographis paniculata</i>	7041	2007	ICAR-DMAPR, Anand, Gujarat	Compact plant type with higher andrographolide content (4.05% in leaf)
8	<i>Andrographis paniculata</i>	13042	2013	ICAR-DMAPR, Anand, Gujarat	Narrow leaf germplasm with very good andrographolide (2.97%).
9	<i>Chlorophytum borivilianum</i>	4114	2004	ICAR-DMAPR, Anand, Gujarat	Fleshy short roots, with blunt end, light diverged type with excellent storage quality



Table 2. Continued

S. No.	Botanical name	INGR no.	Year	Developing Institute	Novel features
10	<i>Chlorophytum borivilianum</i>	4113	2004	ICAR-DMAPR, Anand, Gujarat	Fleshy long roots, with blunt end, dark colour and compact bunch type, with excellent storage quality
11	<i>Plantago ovata</i>	8104	2008	AAU, Anand, Gujarat	Heterostyled stigma protruding out
12	<i>Plantago ovata</i>	11035	2011	ICAR-DMAPR, Anand, Gujarat	Early maturing (80-85 days), high harvest index (>22%)
13	<i>Plantago ovata</i>	14010	2014	ICAR-DMAPR, Anand, Gujarat	Golden yellow leaf colour mutant.
14	<i>Tinospora cordifolia</i>	6025	2006	ICAR-DMAPR, Anand, Gujarat	High starch (13.32%)
15	<i>Mucuna utilis</i>	3045	2002	ICAR-IIHR Bengaluru	High L-DOPA (9.5%) content in seeds
16	<i>Mucuna utilis</i>	3046	2002	ICAR-IIHR Bengaluru	High L-DOPA (5.5%) content in seeds
17	<i>Mucuna pruriens</i>	9066	2009	ICAR-NBPGR, New Delhi	High L-DOPA content (6.30%)
18	<i>Cymbopogon flexuosus</i>	16020	2016	CSIR-NEIST, Jorhat, Assam	High herbage yield with high essential oil content.
19	<i>Cymbopogon winterianus</i>	16021	2016	CSIR-NEIST, Jorhat, Assam	High herbage yield with high essential oil content.
20	<i>Gymnema sylvestre</i>	13041	2013	ICAR-DMAPR, Anand, Gujarat	High fruit producing Madhunashini.



Table 2. Continued

S. No.	Botanical name	INGR no.	Year	Developing Institute	Novel features
21	<i>Comiphora wrightii</i>	13044	2013	ICAR-DMAPR, Anand, Gujarat	Male plant of divergent /erect branch type.
22	<i>Comiphora wrightii</i>	13045	2013	ICAR-DMAPR, Anand, Gujarat	Weeping branch type female plant.

receive special attention. Meanwhile the future of medicinal plants that are harvested for their leaves, flowers and fruits is to a certain extent relatively safe and they become endangered if they are sensitive to habitat disturbances and grow only in forests that may be clear cut indiscriminately at any time. Hence, efforts should be made for introduction of germplasm, germplasm enhancement, identification of high quality genotypes, study of floral biology, search for resistance to biotic and abiotic stresses, G x E interaction to identify best location for best performance, genetic finger printing of selected species and conservation of medicinal plants in field gene bank.

- More medicinal plants should be cultivated to save the forests and at the same time, meet the rising demands of herbs to improve the livelihoods of the farmers.
- On priority, with involvement of government representatives, scientists and NGOs to devise mechanisms to promote traditional health-care system and engage rural inhabitants in conservation, cultivation, processing and marketing of raw material.
- Documentation and preservation of medicinal plant species of India and their traditional knowledge system are the most important aspect, for the benefit of humankind, before it is lost forever. This will require a systematic approach which contains technology development, technology dissemination, technology assessment and refinement. It is a three directional process interlinking each step with the other. Research and development institutions have a role in the development of suitable and sustainable technology; state government and forest



agencies have the role to implement the technology into field level, and entrepreneurs have the role to make a sustainable market for the sector. However, no single institution/agency can meet all the challenges involved in this sector. The problems can only be overcome by building effective partnerships between farmers/ growers, extension agents, private sector, NGOs/GOs, researchers, policy makers and, more importantly by enhancing information exchange.

- Cataloguing of generated information for the available germplasm is another important aspect that needs attention in future.
- *In-vitro* conservation to be extended some more species that are economically important.
- Using the modern information technologies the germplasm information systems are to be developed for comprehensive use and utilization of medicinal plants.
- The augmentation of present genetic resources should be done not only by adding local collections, but also through exotic collections.



Potential drugs from medicinal plants for human health

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In recent years there has been growing interest in alternative therapies and the therapeutic use of natural products, especially those derived from plants. *Clausena dentata* was taken for phytochemical, pharmacological and antibacterial investigations. Three coumarins and one alkaloid, extracted from stem bark, showed very good pharmacological activities. The investigation revealed that the leaves, stem and root of *C. dentata* contained appreciable amount of vitamins such as carotene, thiamine, riboflavin and ascorbic acid and minerals like, iron and zinc, proximate principles such as protein, fat and carbohydrate. The amount of these vitamins, minerals and proximate principles were comparatively in higher amount in leaves of *C. dentata* than leaves of *M. koenigii*.

Three compounds isolated from *Leptadenia reticulata* showed very good antibacterial as well as antidermatophytic activities. The amount of vitamins and minerals were comparatively in higher amount in *L. reticulata* than in many commonly used green leaf and stem vegetables. In the *in vitro* cyclooxygenase enzyme inhibitory assay, the extracts from *Cissus quadrangularis* and *Hypericum mysorense* showed remarkable COX-I and COX-II inhibition which is comparable to aspirin and celebrax. The positive results shown by *C. quadrangularis* and *H. mysorense* reveals the potential use of these plant extracts as an anti-inflammatory drug. Two biomolecules isolated from *Ipomoea sepiaria* showed very good activity against the multi-drug resistant bacteria. Two compounds isolated from *Scoparia dulcis* exhibited remarkable anti-dermatophytic activity. A compound isolated from *Solanum trilobatum* was tested for anticancer activity against 4-NQO induced oral cancer in rats. The compound at the concentration



of 30 mg/kg/b.wt. was found to have anti-tumor effect. The anticancer and antioxidant potential of selenium and selenium enriched garlic and tomato along with other biochemical properties were evaluated in DEN induced tumour bearing animals. From the results of docking studies, it was found that a compound isolated from *Scoparia dulcis* may be a PNP inhibitor as per the minimized energy values of the complexes and has lower energy level and more binding energy than PNP: Immucillin-H complex. Thin layer chromatography was performed, three compounds (HS1, HS2 and HS3) from fractionized methanolic extract of *Helicteres isora* and one compound HS4 from hot water extract were purified and characterized. The compounds were identified as HS1- (2z)-2-methyl -4-(3-2((z)-3-methylpent-2-enyl)cyclopentyl) cyclohexyl) but-2-en-1-ol , HS2- tetra hydro-6-methyl-3-(2,3-dimethylpentyl)-2H-pyran-2-ol and HS3- 1,2,3,4-tetrahydro-1,5,6,8-tetramethyl-7-(2-methylprop-1-enyl naphthalene-4-ylpivalate derivatives of sesquiterpenes. whereas compound isolated from hot water extract HS4- (3,4-dihydroxyphenyl)-5,7-dihydroxy-3-[(2S,3R,4S,5S,6R)- 3,4,5-trihydroxy- 6-(hydroxymethyl) oxan-2-yl] oxychromen-4-one) is glycosilated flavonoids. *In silico* docking studies were carried out for five diabetic receptors. The interaction showed that the compounds binds with the active sites of the receptors. The QSAR properties of the compounds showed the drug likeliness of the compounds. All four isolated compounds exhibited good logP value (2-3). Based on the docking score and QSAR properties, the compounds HS1 and HS4 have higher activity against diabetic receptors than other compounds.

Polyherbal formulations are also potential drugs to combat several diseases. The invention of AYUSREM, the herbal remedy for swine flu will also be discussed in this presentation.



Diversity utilization and conservation of medicinal plants from the state of Tamil Nadu, India - A case study

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Traditional medicinal plants in India have been used for centuries for treatments against various diseases. From the quarter of the 20th century onwards, interest in medicinal plants has increased enormously. The untapped wealth of the plant kingdom has become a target for the search by every investigator including the multinational drug companies and research institutes for new drugs and lead compounds. As a result, it is now possible to approach the study of medicinal plants from the botanical, phytochemical and the pharmacological view points, large numbers of plants are constantly being screened for their anti-inflammatory, hypotensive, hypoglycaemic, amoebicidal, antifertility, cytotoxic, antibiotic and anti parkinsonism properties.

The great herbal restoratives of the nervous system are *Avena sativa* L. (Oats), *Scutellaria lateriflora* L. (Sculllcap) and *Turnera diffusa* Willd. ex Schult. (Damiana). The leaves of *Ocimum sanctum* L. (Tulsi), *Bambusa* sp. and *Dendrocalamus* sp. also have hypoglycaemic effect. The discoveries of Reserpine from *Rauvolfia serpentina* (L.) Benth. ex Kurz (Apocynaceae), Forskohlin from *Plectranthus barbatus* Andr. (Lamiaceae), Bacoside a memory enhancer isolated from Brahmi *Bacopa monnieri* (L.) Pennell (Scrophulariaceae) and therapeutic use of natural products especially those derived from plants. *Clausena dentata* (Willd.) M. Roem (Rutaceae) was taken up for phytochemical, pharmacological and antibacterial investigations. Similarly the three compounds isolated from *Leptadenia reticulata* (Retz.) Wight & Arn. (Asclepiadaceae) showed very good antibacterial as well as antidermatophytic activities. Curcumin present in *Curcuma longa* L. was found to be effective against lung tumors.



Tribulus terrestris L. used as a diuretic agent is also used for the treatment of kidney stone. *Coleus aromaticus*, *Berberis vulgaris*, *Crataeva religiosa*, *Spinacia oleracea* L., *Dolichos biflorus*, *Tamarindus indica* are known to have the ability to dissolve the oxalates produced in the renal system. Thus plants are loaded with chemicals which can be used for the treatment of various diseases.

Plant derived polyphenolic compounds and sulphur based compounds are known to have inhibitory control over tumor formation and metastasis. The well known Aarogyapacha - *Trichopus zeylanicus* Gaertn. ssp. *travancoricus* Burkill ex Narayanan (Dioscoreaceae) has brought laurel to the Indian ethnobotanist Dr. Pushpangathan for his discovery of Jeevani and rewarded “Earth equator” award in the recent past and it is also referred as Pushpangathan’s Model. Similarly, many plants have to be studied in detail for the therapeutic value. Ethnopharmacological information is an important component in both traditional health systems and for the future medicine development. Admission of local knowledge on traditional medicine as an intellectual property right is gathering more widely accepted. Thus, the conservation of local and indigenous property rights over their knowledge and resources are an important element of all contemporary conservational approaches.

Peninsular India forms a rich repository of ethnic knowledge on medicinal uses of plants owing to its cultural and floristic diversity. Forests of Tamil Nadu are endowed with luxuriant vegetation, rich in species, due to the varied climatic conditions. Medicinal properties are reported for about 875 species of the forest plants of Tamil Nadu. Among these medicinal plants nearly 250 species are used in the manufacture of Ayurvedic medicines on a commercial scale, while others are used by traditional Ayurvedic / Siddha practitioners and the tribals in most cases as single plant drugs.

The medicinal plants are distributed across diverse habitats and landscapes and the analysis of the same shows that 80% of them are found in the tropical areas mostly in the various forest types across the Western and Eastern Ghats. While less than 20% of the medicinal plants are found in the temperate and other grasslands of higher altitudes which include species of same medicinal value. It was also noticed that a



small number of medicinal plants are also found in aquatic habitats and mangroves. The extensive field studies carried out by the author shows that, 60-70 % of the known medicinal plants occur in the dry and moist deciduous forests as compared to that of the evergreen or shola vegetation.

Medicinal plant species are found in groups like Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. Among angiosperms 875 species are spread over 125 families in which the families Asteraceae, Euphorbiaceae, Lamiaceae, Fabaceae, Rubiaceae, Acanthaceae, Apiaceae, Solanaceae and Asclepiadaceae share the larger proportion of medicinal plants, with the highest number of species (42) falling under Asteraceae. An analysis done in order to know the habit wise distribution of medicinal plants indicates that 36% are trees, whereas herbs forms 28 % of the population and shrubs and climbers form the remaining 36%.

It is in the background, measures have to be initiated to protect the rights of stakeholders by validating the knowledge and shaping the knowledge into valuable herbal medicines and nutraceuticals thereby providing a transparent platform to share the benefits. The ethnobotanical plants which were listed by me and my co-authors well recognized and quoted by various botanists around the world in the areas of medicinal plants for their phytochemical and pharmacological studies will be highlighted. In the era of biotechnology and synthetic chemistry, it is possible to use many tropical plant species to isolate, identify many useful compounds or ever molecules that would help to synthesise new drugs to prevent various modern human diseases.

The plants which are prioritized by the National Medicinal Plant Board, the highly traded medicinal plants and the threatened medicinal plants from the state of Tamil Nadu will be highlighted and discussed further.



POTENTIAL MEDICINAL AND AROMATIC PLANTS FOR THE COSTAL ECO-SYSTEM OF TAMIL NADU

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The medicinal and aromatic plants grow in diverse agro climatic conditions and production system, in which they are capable of managing the adversity of climate change and global warming. Since the coastal lands of south Tamilnadu has been severely damaged due to the impact of Tsunami, intrusion of sea water into the cultivated lands and depletion of underground soil moisture, the farming community is finding difficult to go for conventional cropping. Some of the important medicinal plants like Noni, *Aloe*, *Ocimum*, *Catharanthus*, Ashwagandha, *Gloriosa*, Vetiver and Coleus besides some of the mangrove species are having great potential for cultivation on large scale. These are low input, high potential crops compared to the traditional ones. These are also the best option for crop diversification and to overcome economic losses caused due to adverse climatic conditions. Only through cultivation, demand could be met for the growing market potential.

Increase in harvesting of indigenous flora to sustain the needs of the population has led to subsequent decline in medicinal plants. Although rural communities are known to the traditional medicines, the urban populace has gained momentum due to its curative properties. This has exacerbated the harvesting pressure on indigenous plant species which has led to many of them being entered into the Red Data Species list. There is also an increased need by consumers, to consume medication for weight loss, appetizers, as immune booster, sexual boosters and other health tonics. This presentation will attempt to address the current uses of a few indigenous medicinal plants of coastal ecosystem and to provide recommendations for sustaining of plant populations for future generation.



Biotechnological approaches for conservation of medicinal plants

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India is a home for thousands of medicinally important plant species; it is ranked sixth among 12 mega diversity countries of the world. Out of the estimated 18, 000 species of vascular plants in India, around 15% are feared to be under threat. Medicinal plants are now under immense danger, due to their over collection or exploitation for medicinal, ornamental and economical purposes. In many tropical plant species of economic value especially of medicinal ones, flower very irregularly, infrequently or rarely, so that there is always a shortage or non-availability of the seedlings when required. In some of them, the seed production is very erratic, irregular and seed viability or germination is often poor while in others, seeds are recalcitrant and intolerant to desiccation. Conservation of the native species with their natural diversity is best achieved by *in situ* methods, which are not practical always. Moreover, simple 'preservation' of the species in native habitat is not sufficient, as the main purpose of a true genetic conservation is to make germplasm available to breeders and others, so that the resources also will have utilitarian value. This can be best achieved only by mass multiplication and delivery of clonally planting materials.

Micropropagation through tissue culture is the best biotechnological option to achieve the twin objectives 1) conservation and 2) sustainable utilization of the medicinal plants. It offers many unique advantages over conventional propagation methods. They are as follows, rapid multiplication of valuable genotypes; expeditious release of improved varieties; production of disease free plants; non-seasonal production (throughout the year); germplasm preservation and facilitating their easy exchange. Besides, medicinal plant micropropagation can produce plants to be planted for future



chemical extraction and/or plants for use in trial aimed at selecting varieties with improved yield. However, a few limitations such as cost of production, choice of elite plants with acceptable micro propagation protocols, reproducibility of protocols etc. need to be overcome for any successful venture in this line.

Tamil Nadu is having a rich diversity of medicinal plants and the areas with wealthy plant diversity are Agasthiyamalai hills, Nilgiri hills, Kolli hills and Palni hills. These areas are also having thousands of therapeutically important medicinal plants, which are in still use by the various tribal people. In view of these, we have successfully developed standard tissue culture protocols for the plants such as *Artemisia annua*, *Decalepis hamiltonii*, *Exacum travancoricum*, *Justicia gendarussa*, *Nothapodytes foetida*, *Plumbago rosea*, *Ruta graveolens*, *Stevia rebaudiana*, *Spilanthes calva*, *Orthosiphon spiralis* and *Tylophora indica* which are having a high trade value and also widely used for treating different ailments. Production of commercially important medicinal plants in this approach will be sufficient to meet the massive requirements raised due to unrestrained increase in human population. Conservation measures targeted at endemic and threatened plants as well as most important medicinal plants of an area would prevent the destruction of natural vegetation for sustainable use in the field of phyto-pharmaceutical industries.



TECHNICAL SESSION

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Session I Genetic Resources



Intraspecific variability for phenol, flavonoid content and antioxidant activity in betelvine (*Piper betle* L.)

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Plant secondary metabolites such as, alkaloids and phenolic compounds are reported to have many biological activities with diverse applications. Phenolic compounds have been associated with antioxidant activity. Present study was aimed to determine intraspecific variation in total phenol and flavonoid contents and antioxidant activity in *Piper betle* (L.), a commercially cultivated heritage crop of India. Effect of different solvents was also investigated. Extractions were performed from freshly harvested leaves of five cultivars and six hybrids using solvents with varied polarity i.e. petroleum ether, ethyl acetate, methanol and aqueous. The total phenol and flavonoid contents (mg/100g) of the extracts were determined spectrophotometrically using gallic acid and catechin as standards. Among the different solvents used the higher quantification of total phenol and flavonoid was recorded in methanol extract. Aqueous extract showed very less flavonoid content and petroleum ether has given low phenolic content. Hybrids recorded more phenol content (107.79 ± 1.48 to 146.64 ± 0.96) than the cultivars (31.82 ± 0.74 to 136.39 ± 1.06), on the other hand cultivars showed more flavonoid content (58.31 ± 0.52 to 84.40 ± 0.30) compared to hybrids (16.44 ± 0.17 to 52.11 ± 0.23). The FRAP (Ferric Reducing Antioxidant Potential) estimated using ascorbic acid ($\mu\text{g/g}$) as standard was significantly higher in hybrids (3928.25 ± 5.2 to 8270.55 ± 7.63) than that of cultivars (3460.39 ± 5.1 to 5762.33 ± 8.56). Among the four solvent systems used 80% methanol found to be most efficient in extracting the secondary metabolites. Significant variability was recorded both within and among cultivars and hybrids for phenol and flavonoids content. Though the content of flavonoids was higher in cultivars, the antioxidant activity is relatively lower compared to hybrids. The enhanced antioxidant activity exhibited by hybrids may be due to the higher phenolic content present in the leaves.



Evaluation of gloriosa (*Gloriosa superb l.*) genotypes for economic traits

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Glory lily (*Gloriosa superba* L.) is an important medicinal plant grown commercially for a chemical compound, colchicine. Seeds and tubers contain valuable alkaloids viz., colchicine and colchicoside which is used to treat gout and rheumatism. Glory lily is mainly cultivated in an area of 4000 ha. Collection of elite genotypes for economic traits was attempted with twelve genotypes of Gloriosa collected from various sources in Tamil Nadu. The evaluation was done in field at the Department of Medicinal and Aromatic crops, during kharif season 2015-16. The genotypes collected from different geographical locations include Dharapuram, Oddanchatram, Karur, Paravalasu, Mettupalayam, Kumarapalayam, Jayankondam, Kallipalayam, Moolanur, Markampatti, Udankudi and Andhra. Among the genotypes studied, significant differences were recorded for characters viz., vine length, number of flowers per plant, days to flowering, number of pods per plant and pod yield. The land race (Kallipalayam 8) recorded vine length of 175.30 cm while Jayankondam 11 recorded higher pod yield (65g /plant). The pod length (8.02 cm), girth (9.55 cm) and stem girth (0.85 cm) was higher in Gs 2 collected from Andhra Pradesh.

Key words: Gloriosa, Genotypes, pod yield



Variability, heritability and genetic advance of qualitative and qualitative traits in velvet bean (*Mucunapruriens* L.) genotypes

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The present research was conducted to determine the genetic viability in velvet bean genotypes based on growth, yield and quality traits. Analysis of variance revealed that there were significant differences among the genotypes for all the characters studied. For all the characters under study, phenotypic coefficient of variation was higher in magnitude than genotypic coefficient of variation. Higher GCV as well as PCV was recorded for days to flower bud initiation, days to 50 per cent flowering, number of inflorescences per plant, number of flowers per inflorescence and L-DOPA yield per plant. High heritability estimates coupled with high genetic advance as percent of mean was recorded in for number of leaves at harvest, leaf area at harvest, days to 50 per cent flowering, number of inflorescences per plant, number of flowers per inflorescence, total dry matter production per plant, test weight of seeds, seed yield per plant and L-DOPA yield per plant.

Key words: *Velvet bean, Genotypes, Variability, Heritability*



Evaluation of velvet bean (*Mucunapruriensl.*) genotypes for economic traits and soil nitrogen content under rubber plantation

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The field experiment was carried out to assess the performance of eleven genotypes of velvet bean (*Mucuna pruriens* L.) at Zonal Agricultural and Horticultural Research Station, Mudigere during *rabi* season 2015-16. Significant differences were recorded for all characters studied among the genotypes viz vine length, number of trifoliate leaves, number of flowers per inflorescence, number of bunches per plant, number of pods per bunch, pod yield, seed yield, seed yield per plot, seed yield per hectare, number of root nodules, nodule weight per plant and soil nitrogen content. The genotype ArkaDhanvantari recorded significantly highest pod yield (154.69 g /plant), seed yield (82.37 g) per plant, per plot (988.48 g) and per hectare (3050.86 kg). The number of root nodules (13.53) per plant, nodule weight per plant (13.47mg) and increased nitrogen content (33.33kg ha⁻¹) in soil was recorded significantly maximum in IIHR Selection-2.

Key words: *Velvet bean, Genotypes, soil nitrogen content, seed yield*



Genetic diversity studies in *Gymnema sylvestre* R.Br.

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Gymnema is an important medicinal woody climber belonging to the family Asclepiadaceae. The leaves of this plant are in use for over 2000 years to treat diabetes, giving it a prominent place in the indigenous system of medicines in the country. The plant is popularly known as ‘Gudmar’ for its distinctive property of temporarily destroying the taste of sweetness. The anti-diabetic property of the plant is attributed to the presence of mixture of tri-terpines and saponins (gymnemic acids, gymnemagenin and gurmarin) in the leaves. It is a leading anti-diabetic product in the world market, the availability of the species in natural forests is decreasing very fast due to over and unsustainable harvesting. Identification of a high yielding genotype with alkaloid content will help the herbal industry to get the raw material and thereby wild collection will be avoided. With this objective, sixty six accessions were collected and characterized for morphological variability because germplasm collection and characterization is the prime importance in any crop improvement programme. In this study variation was observed for leaf shape, leaf base, leaf tip, leaf colour, leaf pubescence, petiole length and intermodal length. The shapes varies from elliptic, ovate, lanceolate, oblanceolate. Leaf base varied from round, cordate, obtuse and cuneate. Leaf tip varied from acute, acuminate and attenuate. Variations in leaf colour were scored based on Royal Horticultural Society colour chart. The accessions were harvested; fresh weight and dry weight of leaves recorded. Total fresh weight of the pruned material (leaf+stem) ranged from 0.55 kg to 8.78 kg; stem weight ranged from 0.180 kg to 3.70 kg fresh leaf weight ranged from 0.140 kg to 3.24 kg; dry leaf weight ranged from 0.099 kg to 0.885 kg. The accessions Gs 16, 22, 28, 34 and 35 recorded fresh leaf weight of 2.50kg/plant.



Confirmation of species and ploidy in *Solanum nigrum* complex

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Black nightshade, is one of the most important and largest genera of the family Solanaceae, comprising of about 84 genera and 3000 species. The leaves and matured green berries are medicinally important as they contain steroidal glycoalkaloids namely solasodine, solanigrin, solamargine and solasonine. The herb has antiseptic, antidysentric, emollient, diuretic, laxative properties. Therefore; it has a great demand from pharmaceutical industries and become popular with a wide range of herbal products. This is most complicated group of plant of polyploidy complex in which species mostly possess common morphological features besides their closely similar genomes. Fifty two accessions of black night shade collected from various sources of India were grown in the experimental farm of the Department of Medicinal and Aromatic Crops, Tamil Nadu Agricultural University, Coimbatore. Based on the IPGRI descriptor, the germplasm was characterized for morphological characters. Among the accessions, morphologically distinct accessions (Sn 8, 10, 12, 19, 23, 30, 32, 38, 44, 47, 51, 52 and 53) were identified and DNA barcoding was carried out for the distinct types. The results revealed that three different species viz., *Solanum nigrum*, *Solanum americanum* and *Solanum villosum* were present in the germplasm collection. The accessions Sn 10, 19 and 51 belonged to *Solanum nigrum*, the accessions , 12, 23, 38, 52 and 53 belonged to *Solanum americanum* and the accessions Sn 30, 32, 44 and 47 belonged to *Solanum villosum*. Root tip mitosis revealed that the chromosome number of *Solanum nigrum* and *Solanum americanum* species (Sn 19) and (Sn 8), was $2n=2x=24$ and the chromosome number of *Solanum villosum* was (Sn 44), $2n=4x=48$ and one accession in *Solanum nigrum* (Sn 10) had hexaploid chromosome ($2n = 6x = 72$).



Genetic diversity studies in *Plumbago zeylanica* (L.)

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An investigation was carried out on genetic diversity of *Plumbagozeylanica*(L.) with forty five accessions in the Department of Medicinal and Aromatic Crops, Horticultural College and Research Institute, TNAU, Coimbatore during 2014 - 2015 to study the extent of variability and genetic divergence for morphological, yield and quality traits. The accessions were collected from different parts of Tamil Nadu, Kerala, Himachal Pradesh, Maharashtra and Gujarat. In the present investigation, 19 morphological traits which observed positive relationship with dry root yield were subjected to D² analysis in 45 accessions studied. The results showed that the 45 accessions were grouped into seven distinct clusters. Cluster I had maximum number of 27 accessions which encompasses the accessions collected from Tamil Nadu, Kerala, Himachal Pradesh and Maharashtra. The cluster VII had eight accessions collected from different places of Tamil Nadu. Other clusters had two accessions each. The distribution pattern of accessions of diverse origin in a single cluster indicates that genetic diversity observed within *Pzeylanica* was not related to geographic origin. Noted differences in plant characters probably occurred over time with the free movement of plant material from location to location and spontaneous or natural hybridization over the time. Thus, the *Pzeylanica* accessions to be used in crop improvement programme should be selected on the basis of quantified degree of divergence as opposed to geographic origin of accessions.



Correlation and path analysis for yield and yield contributing traits in Velvet bean (*Mucuna pruriens* (L.) DC.)

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Mucunapruriens (L.) DC. is an important medicinal plant, it belongs to the family Fabaceae and it is a multipurpose medicinal legume. It has a potential as an inter crop in many fruit orchards, plantation crops as weed smoother and also as green manure crop to enrich the soil with nutrients. The seeds of velvet bean are used in Ayurvedic System of Medicine to relief the symptoms of Parkinson's disease. Correlation studies provide information about the relative contribution of various component traits on seed yield per plant and help in effective identification and selection of superior types. Six parents and along with 15F₁ crosses resulting from 6x6 half diallel design without reciprocals were evaluated for yield and yield attributes at Central Horticultural Experimental Station, Hirehalli, a substation of ICAR-IIHR, Bengaluru. In correlation studies, the characters like days taken for 50 per cent flowering ($r_g=0.50^*$, $r_p=0.47^*$), number of flowers per inflorescence ($r_g=0.54^*$, $r_p=0.51^*$) pods per bunch ($r_g=0.63^{**}$, $r_p=0.59^{**}$) and dry pod yield per plant ($r_g=1.00^{**}$, $r_p=0.92^{**}$) and seeds per pod ($r_g=0.53^*$, $r_p=0.48^*$) exhibited significant and positive association with seed yield per plant at genotypic and phenotypic level and days taken to maturity had significant negative association with seed yield per plant at both levels. The results suggest the efficiency of direct selection of those contributing traits for seed yield improvement. The other traits plant height, inflorescence length, pod width, pod weight,



number of bunches per pod and seeds per pod through positive indirect effects on seed yield per plant. For improving the seed yield in velvet bean emphasis should be on selection on the characters that are showing direct positive effect on the seed yield.



Evaluation of medicinal plants for western zone of Tamil Nadu

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Field experiments were conducted to evaluate different medicinal plants during 2012 at Forest College and Research Institute, TNAU, Mettupalayam. Fifteen medicinal plants viz., *Ocimum sanctum*, *Rhinacanthus nasutus*, *Coleus aromaticus*, *Eclipta alba*, *Costus igneus*, *Andrographis paniculata*, *Vitex trifolia*, *Plumbago auriculata*, *Vetiveria zizanioides*, *Plantago ovata*, *Pogostemon cablin*, *Gynemastylvestre*, *Plumbago zeylanica*, *Phyllanthus nodiflorus* and *Aglaia tomentosa* were tried. Among them, *Ocimum sanctum*, *Rhinacanthus nasutus*, *Coleus aromaticus*, *Eclipta alba*, *Vitex trifolia*, *Plantago ovata*, *Pogostemon cablin*, *Phyllanthus nodiflorus*, and *Aglaia tomentosa* performed well for yield and other traits and found to be suitable for this region. These species can be promoted and popularized in large scale cultivation for this zone. The crops *Costus igneus* and *Gynemastylvestre* failed to survive in this agro climatic condition. Rest of the crops poorly performed.

Key words: Medicinal plants, evaluation, Western zone



Studies on mutagenic effectiveness and efficiency in glory lily (*Gloriosa superba* L.)

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Gloriosa superba L., is a semi-woody, herbaceous, perennial climber with tuberous roots belonging to the family Colchicaceae. Seeds and tubers contain valuable alkaloids viz., colchicine and colchicoside as the major constituents, which cures gout and rheumatism. Experiments on induced mutagenesis of tubers of glory lily using different concentrations of EMS (Ethyl Methane Sulphonate) (1%, 2%, 3% and 4%) and DES (Diethyl Sulphate) (1%, 1.25%, 1.5% and 2%) was conducted at the Department of Medicinal and Aromatic Crops, Coimbatore aimed to produce short statured mutants with high seed yield. The experiment was carried out for alterations in biological parameters (survival percentage, plant height, branching characters, flowering behavior and seed yield) in M_1 generation and spectrum and frequency of macro-mutations (chlorophyll and other morphological mutations) induced in M_2 generation. Both EMS and DES produced a high frequency as well as a wide spectrum of mutation. The frequency of mutation was more in EMS (2.58) than diethyl sulphate (1.87). The mutagenic effectiveness and efficiency was calculated based on the biological damage produced by the mutagens. In M_1 generation, based on the vine lethality (L) and injury in terms of reduced plant height (I), the M_2 generation was carefully screened for various chlorophyll and viable mutations. The mutagenic effectiveness decreased with the increase in dose/concentration of the mutagen whereas the efficiency of mutagens showed variable response depending on the criteria selected for its calculation. The lower or intermediate treatments of all the mutagens were found more efficient in causing less biological damage and inducing maximum macro-mutations. In the present study, EMS was found to be more effective and efficient than DES in causing mutations in glory lily.



Assessment of growth and yield characters of different genotypes of isabgol (*Plantago ovata*) under Coimbatore conditions.

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A field experiment was conducted to evaluate different genotypes of isabgol (*Plantago ovate* Forsk.) for growth, yield and quality parameters during winter season (Nov, 2014-Feb 2015) at Department of Medicinal and Aromatic Crops, Horticultural College & Research Institute, TNAU, Coimbatore-3. The experiment was laid out in a Randomized Block Design with three replications using eight isabgol genotypes. The genotype DPO-1 produced taller plants (29.66 cm), higher number of leaves (114.00), leaf area per plant (1302.83 cm²) and leaf area index (LAI) (2.89) at 90 DAS. Whereas DPO-174 produced more number of tillers (8.27), increased Crop Growth Rate (14.27 g m⁻² day⁻¹) at 60-90 DAS and higher dry matter accumulation (52.80 q/ha). The genotype DPO-186 was early flowering type (36.66 days). The genotype DPO-174 recorded longer spike length (7.58 cm), increased number of spikes per plant (67.75) and higher number of seeds per spike (59.47). Seed yield per plant (4.64 g), unhusked seed yield per hectare (1032.60 kg/ha), husk yield per hectare (421.82 kg/ha) and seed to husk ratio (59.18:40.82) were the highest in DPO-174. The genotype also exhibited highest swelling factor (13.5cc/g) and fibre content (30.68 per cent) whereas protein content and ascorbic acid content were found higher in Niharika (45.93 cc/g and 8.54 mg/100g respectively). The performance of DPO-174 was better under Coimbatore condition.



Assessment of black nightshade (*Solanum nigrum* L. complex) accessions for growth and leaf yield

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A study was conducted to assess the yield and yield attributing parameters of black nightshade (*Solanum nigrum* L.) accessions during 2015 at Department of Medicinal and Aromatic Crops, Horticultural College and Research Institute, TNAU, Coimbatore. Fifteen accession collected from various locations were evaluated and the best performing accessions were identified. Among the genotypes, Sn 10 was categorized under *Solanum nigrum*, Sn 47 under *Solanum villosum* and others were classified under *Solanum americanum* based on the key characters. The highest leaf yield was observed in Sn 09 followed by Sn 19, Sn 23, Sn 03, Sn 26, Sn 11 and Sn 15.



Distribution and growth parameters of wonder plant Leh berry (*Hippophae rhamnoides* L.) in higher ranges of Chamoli district

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Sea buck thorn (*Hippophae rhamnoides* L.), popularly known as *Leh Berry*, is native to Eurasia and is mainly known in North America as an attractive ornamental shrub. It has silver deciduous leaves and colourful orange berries that persist most of the winter. The name is drawn from its habit of growing near sea and from the possession of many spines or thorns that are reminiscent of some buckthorn species (of genus *Rhamnus*). This is a wild edible species in the Himalayan region that plays a prominent role in providing food and medicine for human beings as well as animals. Sustainable harvesting and management practices of seabuckthorn have been listed as one of the prominent bio-resources from Uttarakhand Himalaya for economic benefits. The available distribution records indicate that the genus is well represented in Uttarakhand at elevations of 2500m msl. Information on production of fruits which are the main of food product, is poor. Various records are available from different regions of country to assess its growth potential, morphological and other parameters from Ladakh, Jammu and Kashmir and Himachal Pradesh. Present study is an attempt to assess the distribution pattern, sociological parameter and growth attributes of Seabuckthorn at various available girth classes at four ecologically different locations of Chamoli district.



Highly prioritized and threatened medicinal plants from the western Nilgiris, the western ghats of Tamil Nadu, india

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The wild plants not only help the local communities in the traditional health care system in India, but also play a significant role in their livelihood and national economy. As one of the worlds 36 biodiversity hottest hotspots, the Western Ghats is home for some of the endangered habitats and species in the world. Within the Western Ghats, the Nilgiris is considered as one of the hottest hotspot by having 2611 species and richest flora among the districts of Tamil Nadu. The intensive and extensive floristic studies were carried from November 2011 to May 2016 and it has resulted in the collection of 845 taxa belonging to 506 genera spreading over 132 families of angiosperms. Out of 845 taxa of angiosperms collected from the study area, 317 taxa have been recorded as medicinal plants used by different socio-cultural groups from the study area. The plants were used to cure common diseases like rheumatism, jaundice, breathing problems, skin care, dental care and antidote for poisonous bites etc. All individual parts of plants such as root, stem, leaf, flower, bulb, rhizome, etc. and in some cases whole plant is used as medicine. Out of total medicinal plants nine plants like *Annona squamosa* L. (Annonaceae), *Asparagus racemosus* Willd. (Asparagaceae), *Embelia ribes* Burm.f. (Myrsinaceae), *Gloriosa superba* L. (Liliaceae), *Gymnema sylvestre* (Retz.) R.Br. ex Schultes (Asclepiadaceae), *Ocimum tenuiflorum* L. (Lamiaceae), *Phyllanthus emblica* L. (Euphorbiaceae), *Santalum album* L. (Snatalaceae) and *Solanum nigrum* L. (Solanaceae) are prioritized medicinal plants. The highly traded medicinal plants are *Acacia sinuata* (Lour.) Merr. (Mimosaceae), *Alstonia scholaris* (L.) R.Br. (Apocynaceae), *Asparagus racemosus* Willd. (Asparagaceae), *Bombax ceiba* L.



(Bombacaceae), *Buchanania lanzan* Spreng. (Anacardiaceae), *Butea monosperma* (Lam.) Taub. (Fabaceae), *Careya arborea* Roxb. (Lecythidaceae), *Cassia fistula* L. (Caesalpiniaceae), *Celastrus paniculatus* Willd. (Celastraceae), *Cyclea peltata* (Lam.) Hook. f. & Thoms. (Menispermaceae), *Desmodium gangeticum* (L.) DC. (Fabaceae), *Cinnamomum sulphuratum* Nees (Lauraceae), *Phyllanthus emblica* L. (Euphorbiaceae), *Gymnema sylvestre* (Retz.) R.Br. ex Schultes (Asclepiadaceae), *Helicteres isora* L. (Sterculiaceae), *Holarrhena pubescens* (Buch. - Ham) Wall. ex G. Don (Apocynaceae), *Lobelia nicotianifolia* Roth ex Schultes (Lobeliaceae), *Mesua ferrea* L. (Clusiaceae), *Mucuna pruriens* (L.) DC. (Fabaceae), *Pterocarpus marsupium* Roxb. (Fabaceae), *Rubia cordifolia* L. (Rubiaceae), *Santalum album* L. (Santalaceae), *Wrightia tinctoria* (Roxb.) R.Br. (Apocynaceae) and *Ziziphus xylopyrus* (Retz.) Willd. (Rhamnaceae) are located from the study area. Some of the threatened plants reported from the present study are *Arenga wightii* Griff. (Arecaceae) and *Syzygium travancoricum* Gamble (Myrtaceae). validating. The advantages of traditional systems of medicine with respect to their safety and efficacy could result in a better utilization of our herbal resources with application of the scientific methods. The prioritized medicinal plants, highly traded medicinal plants and threatened medicinal plants from the study area will be highlighted.



Variability in antioxidant activity among genotypes of Kalmegh (*Andrographis paniculata* Nees.)

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Drastic changes in lifestyle expose us to varying free radical damages which are very harmful to human health. Recently, there has been a considerable interest in finding natural antioxidants from plant materials to fight against free radical damage. Natural antioxidant substances are presumed to be safe since they occur in plant foods and are seen as more desirable than their synthetic counterparts. *Andrographis paniculata* (Kalmegh) is an important medicinal plant popularly used for the treatment of an array of ailments such as leprosy, cancer, influenza, diabetes, high blood pressure, bronchitis, skin diseases, colic, dysentery, dyspepsia, malaria and ulcer. Present study was aimed at estimating the antioxidant properties in nine different genotypes of *A. paniculata* grown in the experimental farm of IIHR, Bangalore. Freshly harvested leaves were collected during the flowering stage and extractions were performed using 80% methanol as solvent. The extracts were analysed for their free radical scavenging activity using 2, 2-diphenyl- 1-picrylhydrazyl (DPPH) assay using ascorbic acid as standard. Antioxidant activity among the selected lines varied from 72.11 – 84.54 %. IIHR AP 25-4 showed the highest percentage antioxidant activity (84.54%) followed by IIHR AP 18-4 (82.01%) and IIHR AP 32-1 (80.94%). The result showed that Kalmegh has the potential to be used as a source of natural antioxidants. Large variation exists among genotypes for antioxidant capacities which provide an opportunity for selecting potential lines which are rich in antioxidants.



Documentation of medicinal plants of various forest types in Madurai Forest Division

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Medicinal plants have been used for centuries as remedies for human diseases because they contain numerous phytochemical with immense therapeutic value and more over considered to be natural and safe when compared to synthetic drugs. Medicinal plant based therapies are practiced traditionally in Ayurveda, Siddha & other indigenous systems of medicines to treat numerous microbial infections. From ancient times, different parts of medicinal plants have been used to cure specific ailments. Herbs are widely exploited in the traditional medicine and their curative potentials are well documented. A total of 120 species of plants have been identified as medicinal plants in five forest types of Madurai Forest Division, Tamil nadu.



Studies on the medicinal plants diversity of Dharmapuri district, Tamil Nadu

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Dharmapuri district is located between latitude N 11 47' and 12 33' and longitude E 77 02' and 78 40'. The total geographical area is 4497.77 km², i.e. 3.46% of Tamil Nadu. The district has two forest divisions namely, Dharmapuri and Harur. The dominant vegetation types such as i) Moist deciduous forest ii) Dry deciduous forest iii) Scrub jungle and iv) Riparian vegetation are found. In order to make an inventory on the medicinal plant diversity, six field trips were made during 2014-2016. Intensive and extensive explorations were carried out which yielded collection of 125 species belonging to 52 families of angiosperms.

An analysis of the life forms were done and found that there are 44 trees, 30 shrubs, 22 climbers/twiners, and 29 herbs. The dominant families were also studied which revealed Acanthaceae Euphorbiaceae Fabaceae, Rutaceae, Solanaceae and Verbenaceae. The National Medicinal Plants Board (NMPB) New Delhi has provided a list of 32 species prioritized for research funding, out of these the following 7 species could be collected from the study area. In present study, the following 10 species are highly traded, *Acacia nilotica* (L.) Willd. ex Del. subsp. *indica* (Benth) Brenan, *Gymnema sylvestre* (Retz.) R.Br. ex Schultes, *Pterocarpus marsupium* Roxb., *Santalum album* L., *Strychnos nux-vomica* L., *Decalepis hamiltonii* Wight & Arn., *Phyllanthus emblica* L., *P. amarus* Schum. & Thonn., *Ficus racemosa* L., *Albizia amara* (Roxb.) Boivin, *Centella asiatica* (L.) Urban, *Asparagus racemosus* Willd., *Boerhavia diffusa* L. and *Syzygium cumini* (L.) Skeels.

Cassia angustifolia Vahl (senna), *Catharanthus roseus* (L.) G.Don (periwinkle), *Plectranthus barbatus* Andr. (coleus), *Phyllanthus amarus* Schum. & Thonn. (keelanelli), *Asparagus racemosus* Willd. (sadavari), *Aloe vera* (L.) Burm.f. (aloe), *Gloriosa superba* L. (kanvalikilangu), *Hemidesmus indicus* (L.) R.Br. are some of the medicinal plants ideally suitable for dry lands which in turn ⁴¹high economic under minimum inputs and rainfall. Hence, it is felt that cultivation of medicinal plants in rural areas will help in improving the rural economy.



Underutilized Jasmine species with promise for the future

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A study is underway at the Department of Floriculture and Landscaping of the Tamil Nadu Agricultural University, Coimbatore with the objective of evaluating the performance of certain lesser known and underutilized jasmine species for horticultural importance. An evaluation was carried out with nine jasmine types (3½ old plants) under open field conditions. Three commercial jasmine cultivars namely Ramanathapuram Gundumalli (*J. sambac*), CO.1 Mullai (*J. Auriculatum*) and CO.1 Jathimalli (*J. grandiflorum*) served as standard checks in the study. The remaining six types were underutilized types which included one clonal selection each of *J. nitidum* (Acc.Jn-1) and *J. multiflorum* (Acc.Jm-1), three underutilized species namely *J. calophyllum* (Pandalmalli), *J. flexile* (Nithyamalli) and *J. rigidum* and a pure white flowering type (lacking pink tinge on flower bud) of *J. grandiflorum* termed as *J. grandiflorum* 'White'.

A scrutiny of the flowering behaviour of the jasmine types indicated that five of the six underutilized types evaluated (excepting *J. arborescens*) possessed year-round flowering potential, whereas the commercial types did not produce flowers during a few months of the year. A comparison of the flower yielding potentials of the jasmine types (based on the estimated annual yields arrived at using the data on yield/plant) revealed that Acc.Jn-1 clone of *J. nitidum* was on par with the commercial variety Ramanathapuram Gundumalli of *Jasminum sambac*. This was followed by *Jasminum grandiflorum* 'White' and Acc.Jm-1 of *Jasminum multiflorum*. The two species *J. calophyllum* and *J. flexile* also recorded considerable flower yield. Jasmine being a perennial crop with good flower yielding potentials up to around 15 years and with



a peak after 4 to 5 years after planting, there is a scope that the yield levels of these *Jasminum* species will steadily increase with progression of time. Assessment of quality parameters of the jasmine types also indicted that the underutilized types (except *J. arborescens*) possessed good quality attributes including 100 flower bud weight, corolla tube length, total flower bud length, flower bud colour, fragrance, shelf life and overall preference.

In floriculture trade, *J. sambac*, *J. grandiflorum* and *J. auriculatum* are the commercial cultivars with high market demand based on consumer preference. However, there is a market gap created during off season (from November to March) in the jasmine trade owing to very low flower yield levels or complete cessation of flowering of these three commercial species. The present study has revealed that the lesser known jasmine species are prospective species for the future, since the demand for jasmines is increasing consistently both in the domestic and the global markets. Further analysis of these species including aroma profiling will be taken up to explore the complete potentials of these promising *Jasminum* species.

Key words : *Jasminum*, underutilized, *J. nitidum*, *J. multiflorum*, *J. flexile*, *J. callophyllum*



Effect of Ethyl Methane Sulphonate on periwinkle [*Catharanthus roseus* (L.)] for determination of LD₅₀

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The main objective of the study was to determine effect of Ethyl Methane Sulphonate (EMS) on periwinkle. The treatment doses viz., 10,20,30,40, 50 and 60mM were carried out at Department of Medicinal and Aromatic Crops, Horticulture College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the year 2014-2015. The seed material of *Catharanthus roseus* cv. Rajapalayam local type, a pink variety was selected for the study. The untreated seeds are taken as the control. The effect of mutagen was observed based on the seed germination, germination speed and plant survival rate, length of seedling and vigor index. To determine the germination percentage and survival percentage of the seedlings the seeds are sown in different type of growing methods like raised bed, portrays and pots. The results revealed that the values of all parameters were decreased by increasing concentrations of Ethyl Methane Sulphonate. Based on the 50 per cent reduction of survival and germination percentage LD₅₀ values were estimated. Seed germination percentage in EMS treated as ranged from 0.0 percent to 94.1 percent in control. The seed germination decreased with increasing dose of EMS. The maximum survival was 87 percent at 10mM and minimum of 42 and 60mM. From this study it can be concluded that the LD₅₀ of EMS is 30mM was best for periwinkle.

Keywords: Mutation, LD₅₀, EMS, Survival percentage



Genetic diversity studies in *Coleus forskohlii* Briq.

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Coleus forskohlii Briq., is an ancient root drug indigenous to the Indian sub continent. In Ayurveda, the roots of *Coleus* are used as drug for heart diseases, abdominal colic, respiratory disorder, insomnia and convulsions. Forskolin increases cellular levels of cyclic Adenosine Mono Phosphate (cAMP) and thereby influences several aspects of metabolism in the human body. The exclusive presence and therapeutic properties of forskolin contributed to the emergence of *C. forskohlii* as an essential medicinal plant in modern medicine. The tuber also contains essential oil which has potential uses in food flavouring industry and also used as an antimicrobial agent. Variation in *Coleus* genotypes based on forskolin and essential oil content has been reported earlier. The presence of adequate genetic variability is an essential prerequisite for breeding programme and therefore, a thorough knowledge of existing variability within the population is very much essential as the assessment of genetic variability and identification of superior genotypes are indispensable. The D² analysis performed in 37 genotypes of *C. forskohlii* maintained at the Department of Medicinal and Aromatic Plants, TNAU, effected in the identification of a superior genotype CF 36 exhibiting high tuber yield coupled with yield component traits. The performance of genotype CF 36 for yield and yield component traits viz., high total dry matter production, harvest index, dry matter content in tubers was found to be higher. The traits viz., number of tubers, tuber length, tuber girth, total dry matter production and harvest index showed a high degree of genotypic coefficient of variations and heritability estimates were found to be higher for all these traits. The genetic gain as percentage of mean was more for tuber yield, tuber length, tuber girth, number of tubers, total dry matter production and harvest index. In addition, the genotype CF 36 accumulated higher secondary metabolites in tubers and stem bases. The particular genotype CF 36 which outperformed all other genotypes in the germplasm collection was later released as Medicinal Coleus Co.1 owing to its yield potential.



TECHNICAL SESSION

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Session II Conservation



A status on *ex-situ* conservation of medicinal and aromatic plants in India

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Recognizing the importance of conserving medicinal and aromatic species, the Department of Biotechnology (DBT) had a network of four National Gene Banks viz., Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh, Tropical Botanic Garden & Research Institute (TBGRI), Thiruvananthapuram, Kerala. National Bureau of Plant Genetic Resources (NBPGR), New Delhi and Regional Research Laboratory, Jammu. Each gene bank is equipped with the facilities of a field bank, seed bank, *in vitro* bank and cryobank. The following categories of medicinal and aromatic plants (MAPs) species are conserved in the above gene banks: (a) endangered / threatened / rare species of proven medicinal value, (b) those extensively used in traditional systems of medicine (c) taxa which are difficult to propagate and those with significant R&D leads for the future and finally (d) species which are commercially important.

More than 2,000 accessions are conserved in various forms in gene bank at CIMAP, Lucknow. Field gene bank is used on a seasonal basis to evaluate a large number of accessions of *Mentha spp*, *Catharanthus roseus*, *Papaver somniferum* and aromatic grasses. About 1,300 accession of 156 species are stored at 4°C under medium-term storage in the seed bank. A DNA Bank has been established where DNA samples of 562 accessions of 35 important MAPs are maintained. At TBGRI, Thiruvananthapuram, a field gene bank has been developed over an area of 50 acres of forest land with various vegetation types. The field gene bank has live collections of more than 2000 accessions representing 133 species of which 80 are endemic to the region. Over 250 accessions belonging to 128 species are being maintained in the seed bank. *In vitro*



bank holds 35 accessions of 30 species. The cryobank is maintaining 22 accessions of 18 species in liquid nitrogen (at 196°C) as a long-term storage. More than 2,000 accessions of 413 species of MAPs are being maintained in various forms in gene bank at the headquarters of the NBPGR and in its Regional Stations. Large number of accessions of different MAPs has been added to the National Herbarium of Cultivated Plants as reference specimens. Field gene banks have been established at Jammu (sub-tropical), Palampur (wet-temperature), Kashmir (temperate) and Leh (cold-arid) regions for conservation of the genetic resources of medicinal plants of Western Himalaya.



Strategies for *ex-situ* conservation and propagation of Rare, Endangered and threatened medicinal plants of Western Ghats

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The Western Ghats of India is among the ecologically richest regions and one of the major repositories of tropical medicinal plants that are used in traditional medicinal treatments. It is being observed that many useful medicinal plants have become either endangered or becoming extinct due to various reasons. There is an urgent need to develop efficient *ex situ* conservation strategies for these species to prevent further genetic erosion. In the present study, five endangered medicinal plants viz. *Holostemma-ada-kodien*, *Embelia ribes*, *Saraca asoka*, *Oroxylum indicum* and *Decalepis hamiltonii* were explored, collected and conserved for sustainable utilization. The species are selected considering its status in terms of threat, use in traditional medicine and demand in the pharmaceutical industry. A total of thirty one plants with a maximum of ten in *Holostemma-ada-kodien*, eight in *Embelia ribes*, five each in *Oroxylum indicum* and *Decalepis hamiltonii* and three in *Saraca asoka* were collected and their growth parameters were recorded. Flowering and fruiting were observed and the seeds were collected from different accessions. Based on the observations, data base was generated for documentation. Propagation methods by seeds, cuttings and tissue culture were standardized. The outcome of the study is useful for multiplication and conservation of these very important medicinal plants for their sustainable use

Key words: Medicinal plants, Western Ghats, Endangered, Conservation and propagation



***Ex-situ* conservation of medicinal plants**

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Ex situ conservation effort was taken up at Agricultural College and Research Institute, Kudumiyannmalai to conserve the native medicinal plants which are all in extinct stage. Among the thirty species, *Acorus calamus* (Vasambu), *Aloe vera*, (Sotru Katralai) *Coleus forskohlii* (Coleus), *Andrographis paniculata* (Nilavembu), *Adhatoda vasica* (Adhathoda), *Withania somnifera* (Ashwaganda), *Gloriosa superba* (Glory lily), *Costus igneus* (Insulin plant), *Catharanthus roseus* (Periwinkle), (Kesavarthini), *Cissus quadrangularis* (Pirandai), *Sansevieria sp* (Marugu), *Cassia angustifolia* (Senna), *Ocimum sp* (Thulasi), *Solanum trilobatum* (Thuthuvazhai), *Eclipta prostrata* (Karisalanganni), *Cardiospermum halicacabum* (Mudakathan keera), *Aristolochia india* (Peru marundhu), *Aerva lanata* (Pongal Poo), *Vitex negundo* (Notchi), *Gymnema sylvestre* (Sirukurinja), *Centella asiatica* (Vallarai), *Eryngium foetidum* (Wild Coriander), *Solanum Xanthocarpum* (Kandankathari), *Solanum nigrum* (Manathakkali), *Rosmarinus officinalis* (Rosemary), Santolina, *Piper longum* (Tippili) and *Datura* are being conserved.



***In vitro* conservation of *Holostemma ada-kodien* (Asclepiadaceae) -a rare and vulnerable medicinal plant from south India**

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Holostemma ada-kodien a species indigenous to India and popularly known as Jivanti, is a twiny, laticiferous perennial medicinal shrub. Medicinally tuberous roots are the economical part, and used in treatment of diabetes, cough, fever and tridosha. The population in wild is gradually reducing due to the destructive and ruthless collection of root tubers, as a raw material for the ayurvedic drug preparations, and fruit set is a major problem in multiplying the species in wild, which has led to the species being listed as vulnerable medicinal plant in FRLHT red list And hence there is an urgent need for its conservation. An investigation was taken up to standardized *in-vitro* conservation technique of *Holostemma ada-kodien* at Division of Plant Genetic Resources, Indian Institute of Horticultural Research (IHR), Hessarghatta, Bangaluru. Among various combinations used in tissue culture, KIN (1.50 mg/l) +NAA (0.50 mg/l) treatment significantly influenced for increase in shoot length (3.60 ± 0.10), number of shoots (3.60 ± 0.55), number of leaves (7.40 ± 0.55) and survival per cent (80%). Hence this was considered the best treatment for *in-vitro* multiplication of *H. ada-kodien*. Short term conservation of *in-vitro* raised plants of *H. ada-kodien* was attempted for six months to slow down its growth by reducing further sub-culturing and providing limited light intensity for growth. It was found that MS medium supplemented with KIN (1.50 mg/l) + NAA (0.50 mg/l) shown highest survival per cent, shoot length, number of shoots and number of leaves in both *in-vitro* conserved plantlets and tissue cultured plantlets regenerated in normal ambient conditions.

Key words: *Holostemma ada-kodien*, Medicinal uses, Endangered, *In-vitro* conservation



***Inula racemosa*: A highly valued medicinal herb needs development of efficient conservation and propagation measures**

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North West Himalayas is one of the richest pools of biological diversity in World and among them the medicinal and aromatic herbs are most valuable resource. Recently, it has been reported for ruthless extraction of medicinal and aromatic plants from their natural habitats because of ever increasing global inclination towards the use of herbal medicine. The continuous over-exploitation of these valuable herbal gems has resulted in depleting the population of many species in their natural habitats. Simultaneously, lack of reliable conservation measures also affects the survival and regeneration of this valuable resource. There are many medicinal and aromatic herbs on conservation priority and *Inula racemosa* (Pushkarmoola) in one of them. The *Inula racemosa*, belongs to family Asteraceae is a critically endangered medicinal herb found growing in temperate to alpine belts of Kashmir and Himachal Pradesh. It is perennial herb and known for its potent medicinal properties. The chemical profiling of plant roots have shown the presence of alantolactones and isoalantolactones. The roots find use in Indian System of Medicine for cardiac asthma, cough, pulmonary infection and skin disease and as adulterant for *Saussurea costus* roots. Due to the medicinal and aromatic importance and great market demand, the ruthless and destructive harvesting from its natural habitat has been increased and regularly this practice fall the species in the verge of extinction from Himalayan region. Conventionally, the *Inula racemosa* is propagated through seeds as well as vegetative means, but low germination; poor seed viability, long gestation periods and lack of agro-techniques affect large scale propagation and commercial cultivation of the species. Therefore, considering the



problems associated with conventional propagation and, development of efficient conservation and propagation measures of *Inula racemosa* has been proposed in present study on urgent basis under State Medicinal Plants Board/Herbal Research and Development Institute (HRDI) funded programme.

Key words : *Inula racemosa*, North West Himalayas, Biological diversity, Medicinal and Aromatic herbs, Ruthless extraction, Extinction, Propagation, Agro-techniques, Commercial cultivation and Conservation.



Medicinal Plants of Tripura and other North-Eastern states and their utilization by local tribes and need for conservation

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North- Eastern state is considered to be the hot-spot of medicinal plants and other high value Horticultural crops and has in abundance, diverse range of herbs, shrubs, trees and vines that have important medicinal value whose healing properties are known to the local tribes, healers and practitioner. The rural peoples are suffering from common ailments like cuts, wounds, blisters, itching, eczema, skin disease, sores, scabies, swelling, cold, fever, cough, diarrhoea, asthma, diabetes, jaundice, leprosy, hiccough, bronchitis, routine skin and eye irritations, veterinary healers etc. Tripura and other north-eastern state being one of richest centres of biodiversity of medicinal and other horticultural plants, more than thousand (1000) species medicinal are available and used by local tribes for their day to day uses. In Tripura, 270 species medicinal plants have been identified for medicinal uses, which make Tripura a unique position in traditional systems of medicine. The indiscriminate collection of medicinal plants from forest led to depletion and extinction in many valuable plants, cases making them as rare endangered and threatened species. The threats to biodiversity conservation is due to deforestation, high population growth, urbanization, shifting cultivation, grazing, illegal extraction of medicinal plants, forest fires etc. There are number of wild and traditional medicinal plant species which are yet to be identified and documented. It is highly necessary to document those medicinal plants and take efficient steps to conserve them. Therefore, adequate endeavors are needed for conservation of such invaluable medicinal plants for their sustainable uses like food security, nutritional security, health security, poverty alleviation and also provide livelihood for poor tribes.

Key word: Medicinal plants, conservation, utilization, Tripura and North-Eastern state.



Strategies for conservation of Indian Trumpet Tree (*Oroxylum indicum* (L.) Vent.): An endangered medicinal tree.

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Indian Trumpet Tree (*Oroxylum indicum* (L.) Vent.) is an important plant in Indian system of medicine, distributed throughout India. Different parts of the plant such as leaves, bark and root are used to treat various ailments. This plant is reported to contain flavonoids namely, Chrysin, oroxylin- A, scutellarin, baicalein. Roots and stem bark is widely used in Ayurvedic formulations like Chyavanprash, Dashmularistha and it is reported to have anticancer, antioxidant and hepatoprotective properties. But destructive and non-sustainable collection methods coupled with low regeneration and habitat destruction have posed serious threats to the survival and availability of this highly useful tree. So, study was undertaken at College of Horticulture, Mudigere in order to conserve and standardize the propagation techniques of Indian Trumpet Tree, by threatening seed and hard wood cuttings with different growth regulators and developing multiplication protocols using tissue culture. Seeds treated with H₂SO₄ (1%) gave maximum germination and vigor of seedling. Hard wood cuttings treated with IBA 3000ppm + NAA 200ppm showed maximum sprouting of cuttings and MS media with BAP (2mg/L) gave good shoot growth. These techniques can be used to conserve this endangered medicinal plant.



Need to conserve *Swertia speciosa* Wall D.DON : An alternate source of Xanthone and Amaroswerin compounds

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Swertia speciosa is one of the most important substitutes of *Swertia chirayita* belong to family Gentianaceae and is locally known as Bambiri. It is a perennial herb and distributed in marshy localities of timber zone in the Himalayan region to Bhutan between 2240 and 4000 msl. This species has been reported to contain bioactive compounds like xanthone, antioxidants, amaroswerin, amarogentin and ursolic acid as in *S. chirayita*. These major bioactive compounds of *S. speciosa* play significant role as hepatoprotective, anti-hepatotoxic, anti-microbial, anti-inflammatory, anti-carcinogenic, anti-leprosy, hypoglycemic, antimalarial and anti-tumor. As *S. chirayita* is critically endangered, large scale propagation of *S. speciosa* should be taken up immediately through appropriate technologies as this species is an alternate source of many valuable bioactive compounds which are found in *S. chirayita*. In this direction, we have initiated work on development of suitable agro techniques and *in vitro* culture for large scale propagation of this species.



***Ex-situ* conservation of economically important medicinal plants through demonstrative herbal garden to enhance the tribal lively hoods**

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The Nilgiris is one of the highest mountain ranges of Southern India and home for many ethnic communities i.e., Todar, Kotar, Kurumbar, Irular, Paniyar, Kattunayakar, etc. Nowadays due to over exploitation, populations of several medicinal plant species have reduced and valuable herbs are slowly disappearing from their nearby natural habitats. The Project activities envisaged in the current study mainly focuses on tribal communities namely Katunaickar, Kurumbar, Paniyar and Irular inhabiting in the villages of Nilgiri district.

Field surveys were carried out in seven tribal villages namely Anaikatti, Erumadu, Elzhumaram, Kattunaickenpadi, Kozhikandi, Pudukkadu and Thumbipettu in Nilgiris. The relative abundance of each species with their usage matrix have been prepared for selected villages. During survey, about 90 tribals of different age groups which included tribal healers, were interviewed and recorded information on traditional treatments for Fever, Boils, Cut wounds, Diabetes, Skin disease, Mouth Ulcer, Tuberculosis, Cancer, Uterus problem, Mouth odour etc. Malai Enjee and Karunochi species have been identified as depleting species.

The study revealed that the species in high demand and essential for primary



healthcare of tribes were *Ruta graveolens*, *Withania somifera*, *Decalepis hamiltonii*, *Moringa oleifera*, *Andrographis paniculata* and *Hemidesmus indicus*. It was observed that these medicinal plants are playing a major role in the primary healthcare of the selected tribes and are used commonly for anemia, boosting immune system, stomach disorders etc. Planting stock of medicinal plants was prepared both through seeds and vegetative means. Herbal gardens were established at Ezhumuram Paniyar tribal village near Gudalur and at Thumbipettu tribal village near Kotagiri in the Nilgiris in an area of 5 cents with 30 species of medicinal plants with 4 replications totaling to 120 plants.

Key words: *Ex-situ* conservation, medicinal, tribes, Nilgiris herbal garden, livelihood.



Ex-situ conservation of economically important medicinal plant through agroforestry ecosystem to enhance the rural livelihood

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Agro forestry systems can play an important role through which we can cultivate tree crops as well as medicinal plants on same piece of land and it's an additional income to farmers. During the demonstration trial conducted by us in different location in Tamil Nadu the highest growth parameters of tree species and medicinal plants were recorded in Cuddalore followed by Jayangondam, Sendurai and Sivagangai. The soil fertility was found to be improved under shaded condition. Among the three tree species, the highest macro and micronutrient were present in the soil under the tree crop *Casuarina equisetifolia*, followed by *Casuarina junghuhniana* and *Eucalyptus camandulensis*. *Gloriosa superba* produced maximum seed yield in open field compared to agroforestry system in Jayngondam location. The colchicine content of *Gloriosa superba* seed extract was high under *Casuarina junghuhniana* based agroforestry system at Sembanoor followed by under *Eucalyptus camandulensis* agroforestry system at Jeyangondam. The maximum shoot length and root length of *Decalepis hamiltonii* were produced from the *Eucalyptus camandulensis* plantation, compared to *Casuarina equisetifolia*, *Casuarina junghuhniana* and open field. The highest shoot length and root length of *Hemidesmus indicus* were produced from the *Casuarina equisetifolia*



plantation compared to *Casuarina junghuhniana*, *Eucalyptus camandulensis* and open field. The medicinal plants like *Decalepis hamiltonii*, *Gloriosa superba* and *Hemidesmus indicus* had the suitability under all the three tree species. Agroforestry has been the traditional practice of several indigenous communities and therefore has tremendous socio-economic bearing. Further agroforestry and farm forestry in the country can be an important tool for balancing biodiversity conservation with climate resistance.

Key words: Ex-situ conservation, medicinal plants, Agroforestry, tree species and livelihood.



TECHNICAL SESSION

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**Session III Production
technology and post
harvest management**



Organic production technology for industrially important medicinal crop *Coleus forskohlii*

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Coleus forskohlii is a major cultivated medicinal crop. The tuberous roots are rich source of forskolin (diterpenoid) used for treatment of glaucoma, congestive cardiomyopathy, hypertension asthma and certain type of cancers. Due to its unique properties its demand had increased tremendously from pharmaceutical industries both in National and International markets. There is a need to produce organically grown coleus free from residues to meet the National and International standards. Moreover coleus wilt and root knot nematodes are major limiting factors in its production. Hence, the present investigation was taken up to develop organic production technology for this important medicinal crop. Different treatments ranging from 0 to 22.5t/ha of enriched FYM (*Trichoderma harzianum* @ 1 kg per 1000 kg of FYM), along with recommended practice of organic manures (FYM 10 t/ha) and NPK fertilizer (50:75:60 kg/ha). The studies were conducted for two years at the experimental farm of ICAR-IIHR, Bengaluru. The results showed that the application of enriched FYM at 22.5 t / ha produced maximum dry tuberous root yield of 1851 kg /ha with a BC ratio of 2.625 over two years. Significant reduction in wilt and nematode incidence (<7%) is recorded in organically grown coleus. The standardised organic production technology consists of the following practices

- Nursery to be raised with enriched FYM.
- 40 days old rooted cuttings to be planted with a spacing of 60 x 40 cm
- Application of enriched FYM @ 22.5T/ha as basal dose for the crop
- Crop grown on raised beds with drip irrigation

Organic production of *Coleus forskohlii* is a profitable, eco friendly technology and aids in raising disease and nematode free crop.



Effect of FYM, inorganic fertilizer and bio-fertilizers on growth, herb and oil yield and oil quality of Basil (*Ocimum basilicum*)

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Field experiment was carried out at ICAR - Indian Institute of Horticultural Research, Bengaluru during kharif season of 2015 to study the effect of FYM, inorganic fertilizer and bio-fertilizers on growth, herb and oil yield and oil quality of basil var.CIM Saumya (*Ocimum basilicum* L.). Nine treatments with three replications were followed in a randomized block design to find out the effect of different levels of N through FYM (100, 75 and 50% of the recommended N along with and without bio-fertilizers), recommended dose of NPK (160:80:80 kg/ha) and recommended FYM (25 t/ha) + NPK (160:80:80 kg/ha) on the growth, yield and essential oil of *Ocimum basilicum*. Growth parameters were recorded during 30th and 60th days after planting (DAP). The results from the experiment revealed that among the nine treatments, application of recommended FYM (25 t/ha) along with NPK (160:80:80 kg /ha), followed by recommended NPK alone (160:80:80 kg /ha) recorded the maximum plant height (55.27, 54.60 cm), number of branches (15.33, 14.20) and number of leaves (206.2, 193.9) at 30th days after planting (30th DAP). At 60th DAP also, the same application resulted in maximum plant height (74.40, 72.93 cm), number of branches (28.53, 25.87) and number of leaves (352.5, 293.9) compared to other treatments. Highest fresh herb yield of 41.59 t/ha was recorded with application of recommended FYM (25 t/ha) + NPK (160:80:80 kg/ha) and it was on par with recommended NPK (160:80:80 kg/ha) alone (40.39 t/ha). Recommended FYM (25 t/ha) + NPK (160:80:80 kg/ha) recorded the highest oil yield (207.95 l/ha) and it was statistically on par with recommended NPK (189.83 l/ha). With respect to oil quality, the maximum Methyl chavicol content of 52.31% oil constitute was recorded with application of FYM (25 t/ha) + NPK (160:80:80 kg/ha), followed by 100% N through FYM + bio-fertilizer (49.39% of oil constitute). Finally, it was concluded that the application of FYM (25 t/ha) + recommended NPK (160:80:80 kg/ha) may be recommended for basil to realize maximum herb and oil yield during kharif season.



Sabujayan- A Mahatma Gandhi NREGA initiative for river embankment protection through vetiver plantation in Nadia District of West Bengal in India.

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Nadia District is a riverine district with six rivers namely Bhagirathi, Jalangi, Ichhamati, Mathabhanga, Churni and Padma passes through it. The District witnessed devastating floods very often due to vulnerable river embankments and flashes through the embankments specially in the river side of the Bhagirathi river. Mahatma Gandhi NREGA, Nadia has initiated the project “SABUJAYAN” to mitigate the perennial menace of the district through vetiver plantation along the river embankments with the support of the Department of Panchayat & Rural Development, Government of West Bengal. Nadia District comprised of six rivers with 553.31 km river length and 743.97 km river embankments considering both sides of the six rivers. Vetiver (*Chrysopogon zizanioides*) is worldwide known for its robust root structure with its long root system used for river embankment stabilization and controlling soil erosion. Vetiver System also used for absorption of heavy metals and impurities through its root network thus effectively purifying water. ‘Sabujayan’ is uniquely designed for establishment of nurseries for multiplication of vetiver from genuine sources, restoration in the river embankments for stabilization and handicrafts making from upper parts of the vetiver. The project launched on 23-11-2015 with the announcement by the Hon’ble Chief Minister, West Bengal for Nadia District. Accordingly 76 nurseries have been established with south Indian type vetiver slips from Tamilnadu. Self Help Group members associated with the nurturing and maintenance of nurseries through Mahatma Gandhi NREGA Scheme and 12 lakhs slips raised to 25 million within four to five months after establishment of nurseries. Restoration works made along the river sides with



spacing of 10-15 cm plant to plant distance and 0.30 to 1.00 metre row to row distance on the basis of slope, vulnerability and availability of land in the river sides for vetiver plantation. Over 120 km vetiver plantation for restoration work in the river sides have been done till December, 2016. The project is being used for embankment stabilization, beautification through its hedge rows and water purification as the capability of the Vetiver System Technology.

[Kew Words: Sabujayan, Vetiver, River Embankment Stabilization, Mahatma Gandhi NREGA]



Feasibility of vetiver as a bioengineering tool for river bank stabilization of Ganges basin

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Vetiver (*Chrysopogon zizanioides* L. Nash.) or khus, an indigenous Indian member of Poaceae family, is a perennial bunch grass with a strong finely structured network of deep penetrating root system that can offer both erosion prevention and control of movement of surface earth mass. Globally, Vetiver System Technology (VST) has been emerged as a novel, natural, green, simple, practicable and cost effective tool for preventing river bank erosion. This is due to its unique ability to tolerate extreme weather and soil conditions, wide range of heavy metal pollutants and agrochemicals as well as it can thrive under changed climatic conditions being a C₄ plant. The Ganges basin of West Bengal consists of a wide range of soil types; some are highly erosion-prone and increase in river siltation leads to disastrous flood and pollution load. Since the agro climatic conditions of West Bengal are favourable for Vetiver cultivation, VST may be a potential innovative approach for conserving soil and water as an alternative of hard engineering measures. Considering the facts, very recently Bidhan Chandra Krishi Viswavidyalaya and Government of West Bengal have jointly taken a massive initiative to standardize and promote different agro-techniques of Vetiver cultivation along the embankment of the river Ganges of Nadia district of West Bengal. The results so far recorded and analysed, suggest that for stabilization of river bank of the Ganges and for reducing toxic elements in irrigation water, VST may be a good means. Thus, in near future, vetiver may be a potential bio-engineering tool for stabilizing the Ganges basin.

Key words: Vetiver grass technology, soil and water conservation, roots, river Ganges.



Enhancing socio-economic status through Vetiver systems technology of small and marginal farmers of West Bengal

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In many parts of India, erosion or failure of river banks results in loss of land and it threatens dike. These problems tend to become even bigger due to lack of effective erosion controls. An economically feasible and readily available solution might be the application of vetiver or Khus grass (*Chrysopogon zizanioides* L.), a native to India. Basically, the significant role of Vetiver in the socio-economic development of rural India since ancient times is evident. Traditional use of Vetiver in making of screens, hand fans, mats, baskets, flat mattresses is a well known and till today is a pave to sustainable livelihood development of backward classes. Besides, the commercial/ industrial application of the grass, mostly related to extraction of Vetiver oil, is done worldwide extensively through the production of perfumery, soap, cosmetic and pharmaceuticals. It has also versatile uses, mainly as an effective and eco-friendly tool to combat soil erosion, water conservation and reclamation of salt affected soils along with ethno-medicinal and culinary use. As a consequence, Vetiver Systems Technology (VST) has diverse economic and ecological uses which can help for enhancement of rural livelihoods. Therefore, incorporation of VST through Self Help Groups (SHGs) can boost up farmers' interest and the socio-economic condition of small and marginal farmers. Considering these facts, MGNREGA Cell, Nadia District, Government of West Bengal has taken up a project (*Sabujayan*) for minimizing river bank erosion along with sustainable livelihood development of women SHGs in erosion-prone areas of Nadia district of West Bengal by introducing Vetiver successfully.



“Studies on standardization of rootstocks for resistance to *Phytophthora* wilt and nematode in betelvine (*Piper betle* L.)”

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Betelvine (*Piper betle*L.) is one of the important plantation as well as medicinal crop, cultivated, among small and marginal farmers in India. The recorded loss from foot rot disease is upto 80 per cent of betelvine plantations. It causes severe damage in betelvine cultivation and creates economic loss to the betelvine growers. The causal organisms reported are *Phytophthora parasitica* var. *Piperina* and root knot nematode (*Meloidogyne incognita*). The study was conducted to assess different betelvine rootstocks on incidence of *Phytophthora* wilt and to standardize the resistant rootstock for *Phytophthora* wilt and the nematode. Rootstocks viz., *P.colubrinum*, *P. hymenophyllum*, *P. longum*, *P. nigrum*, *P. attenuatum* and *P. betle* were used for the study. Screening against *Phytophthora parasitica* var. *piperina* showed that *P.colubrinum* and *P. Hymenophyllum* possess the reaction category of ‘immune’ (no lesion, grade 1, plant response), while both the scion materials exhibited ‘highly susceptible’ reaction (lesion 31 mm, grade 5). On the basis of the study, it was conducted that, the rootstock *P.colubrinum* had highest number of sprouts (1.36), sprouts length (1.42 cm) and rooting percentage (82.24%). In addition to that, two rootstocks viz., *P.colubrinum* and *P. hymenophyllum* exhibited tolerance when the rootstocks *Phytophthora parasitica* var. *piperina* than four rootstocks. Based on gall index scoring, the lowest incidence was observed in *P.colubrinum* (1), whereas the maximum infestation was noticed in Patchaikodi (4.4). Therefore, the wild rootstocks of Piper viz., *P.colubrinum* and *P.hymenophyllum* possess tolerance against the fungus *Phytophthora parasitica* var. *piperina* and pathogenic root- knot nematode (*Meloidogyneincognata*) which can be effectively utilized as potential rootstocks for commercial cultivation of betelvine.



Study of comparative performance of systems of cultivation for leafy coriander

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Since coriander is highly affected by temperature during summer season under open field condition, it is necessary to find out the suitable low cost technology for summer season cultivation of coriander. Field experiments with coriander variety CO 4 was conducted at the Tamil Nadu Agricultural University, Coimbatore during summer season 2014 under different systems of cultivation viz., 50 per cent shade net, insect proof net house and open field conditions. Growth and leaf yield of coriander were assessed under different systems of cultivation. Highest single plant weight of coriander 52.1 g was recorded under insect proof net house cultivation followed by shade net cultivation (27.3 g).with lowest weight (19.0 g) under open field cultivation. Among the systems of cultivation, coriander leaf yield was high (3.33 ton/ha) under insect proof net house followed by shade net house (2.71 ton/ha).with the lowest yield in open field (2.42 ton / ha). Highest cost benefit ratio for leaf yield (1.59) was recorded under insect proof net house followed by shade net house cultivation (1.37) with lowest benefit cost ratio of 1.31 under open field condition. Therefore it can be concluded that coriander variety Co 4 is a highly remunerative crop suitable for leaf cultivation under insect proof net house during summer season.

Key words: Coriander, Shade net, Insect proof net house, open field, system of cultivation.



Studies on the suitability of medicinal plants for growing indoors

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A study was carried out in FRLHT, Bangalore (Foundation for Revitalization in Local Health Tradition, Bangalore) to know the suitability of medicinal plants in indoor environment. The irrigation frequency, the physical appearance of the medicinal plants at weekly intervals and the medicinal plants suitable for growing in indoor environments were assessed. Eighteen medicinal herbs viz., *Kalanchoe pinnata*, *Coleus aromaticus*, *Hibiscus rosa-sinensis*, *Costus pictus*, *Ocimum teniflorum*, *Alpinia calcarata*, *Acorus calamus*, *Mentha piperata*, *Ocimum kilimandscharicum*, *Costus speciosus*, *Hedychium coronarium*, *Imperata cylindrica*, *Caladium bicolor*, *Cestrum diurnum*, *Pandanus odoratissimus*, *Mentha spicata*, *Adhatoda zeylanica*, *Euphorium triplinerve* and *Asystacia dazelliana* were studied to assess the suitability to grow under indoor conditions.

It was found that *Kalanchoe pinnata*, *Coleus aromaticus*, *Hibiscus rosa-sinensis*, *Costus pictus*, *Ocimum teniflorum*, *Alpinia calcarata*, *Acorus calamus*, *Costus speciosus*, *Hedychium coronarium*, *Imperata cylindrica*, *Cestrum diurnum*, *Pandanus odoratissimus*, *Adhatoda zeylanica*, *Euphorium triplinerve*, *Asystacia dazelliana* were found suitable for growing indoors.

Key words: Suitability of Medicinal plants-Irrigation requirement & Indoor environment



Effect of fertigation on growth, physiology, yield and quality of nutmeg (*Myristica fragrans*.Houtt)

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A field experiment was conducted to study the effect of fertigation of N, P and K fertilizers along with micronutrients on growth, physiology, yield and quality and to standardize the nutrient requirement through drip for nutmeg (*Myristica fragrans*. Houtt.) at TNAU, Coimbatore. Different fertigation levels were experimented for improving the growth, yield and quality of nutmeg and also to assess the efficiency and economics of fertigation through drip using water soluble fertilizers in comparison with conventional fertilizers.

The study revealed that application of 100 per cent Recommended Dose of Fertilizers as water soluble fertilizers along with micronutrients through fertigation increased the tree height, canopy spread and trunk girth at various stages of crop growth. The physiological parameters viz., specific leaf weight, total chlorophyll content, soluble protein content, carbohydrate content and C/N ratio were also enhanced at higher level in the same treatment. Besides this, the same treatment recorded the highest leaf nutrient status and available soil nutrients i.e. N, P, K, Fe, Zn and B analyzed at different stages of plant growth.

The days taken to flowering and from flowering to maturity were higher in 100 per cent RDF as water soluble fertilizers along with micronutrients through drip. The yield components such as number of fruits per tree, individual fruit weight, seed weight, mace weight and pericarp weight were also significantly improved by the same treatment. Fruit characters such as fruit volume and weight of the fruits were also significantly enhanced due to application of 100 per cent RDF as water soluble fertilizers through drip along with micronutrients. The quality parameters such as



nutmeg seed oil, mace oil, nutmeg seed oleoresin, mace oleoresin, protein, fat, and polyphenol content were considerably improved by 100 per cent RDF given as water soluble fertilizers along with micronutrient through drip. Economic analysis revealed that the BCR was the highest (5.98 and 6.11) in T8 (100 per cent RDF as water soluble fertilizers along with micronutrients through fertigation) by drip irrigation and followed by 75 per cent RDF as water soluble fertilizers along with micronutrients (5.83 and 5.99) RDF as WSF through drip irrigation and it was the lowest in T1 (3.26 and 3.36). It was concluded that, application of 100 per cent RDF as water soluble fertilizers along with micronutrients by drip irrigation has resulted in the improvement of all beneficial parameters leading to enhanced yield and quality in nutmeg.



Protocol for micro tuber production techniques in *Gloriosa superba* L.

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Gloriosa is one of the most preferred medicinal plant in the pharmaceutical sector owing to the widespread application as a potential drug against gout disease. More than 7000 farmers are engaged in glory lily cultivation and majority of them are small and marginal farmers (cultivation glory lily in half an acre to one acre). Due to the high cost of tubers in the last few years (Rs.100-200/kg), the threat on wild population has increased inadvertently. With the growing demand for glory lily seeds, it is anticipated that the area under this crop will increase in forthcoming years creating high demand for the planting material. Experiments were conducted at Department of Medicinal and Aromatic crops to standardize a protocol for production of micro tubers from seeds using standardized techniques.

Healthy, graded seeds of glory lily were treated with hot water (100°C) for an hour and soaked in water overnight (12hrs) and shade dried. Sowing was done in raised seed beds under shade net and observed for germination. The germination percentage observed was 74.52 with a vigour index of 542.20. The seedlings produced micro tuber weighing 1.55g at 50 days after sowing on an average. After a period of 120 days of dormancy, the second generation micro tubers exhibited enhanced sprouting (86.66%), vine length (35.69 cm), number of leaves (28.5), leaf length (1.42 cm), leaf breadth (3.18 cm), collar girth (1.8 cm), tuber length (14.2 cm), tuber girth (4.14 cm) and tuber weight (14.70 gm). None of the seedlings exhibited laterals or flowering during the second generation.

In the third generation, nearly 30-40% bulking of the tubers (42.25g) was observed at the end third year of sowing which can be used as a planting material during the ensuing season. This protocol would serve as a viable alternative for regular tubers thereby minimizing the cost incurred for procuring the tubers and reducing the pressure on wild population.



Studies on mutagenic effectiveness and efficiency in glory lily (*Gloriosasuperba* L.)

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Gloriosa superba L., is a semi-woody, herbaceous, perennial climber with tuberous roots belonging to the family Colchicaceae. Seeds and tubers contain valuable alkaloids viz., colchicine and colchicoside as the major constituents, which cures gout and rheumatism. Experiments on induced mutagenesis of tubers of glory lily using different concentrations of EMS (Ethyl Methane Sulphonate) (1%, 2%, 3% and 4%) and DES (Diethyl Sulphate) (1%, 1.25%, 1.5% and 2%) was conducted at the Department of Medicinal and Aromatic Crops, Coimbatore aimed to produce short statured mutants with high seed yield. The experiment was carried out for alterations in biological parameters (survival percentage, plant height, branching characters, flowering behavior and seed yield) in M_1 generation and spectrum and frequency of macro-mutations (chlorophyll and other morphological mutations) induced in M_2 generation. Both EMS and DES produced a high frequency as well as a wide spectrum of mutation. The frequency of mutation was more in EMS (2.58) than diethyl sulphate (1.87). The mutagenic effectiveness and efficiency was calculated based on the biological damage produced by the mutagens. In M_1 generation, based on the vine lethality (L) and injury in terms of reduced plant height (I), the M_2 generation was carefully screened for various chlorophyll and viable mutations. The mutagenic effectiveness decreased with the increase in dose/concentration of the mutagen whereas the efficiency of mutagens showed variable response depending on the criteria selected for its calculation. The lower or intermediate treatments of all the mutagens were found more efficient in causing less biological damage and inducing maximum macro-mutations. In the present study, EMS was found to be more effective and efficient than DES in causing mutations in glory lily.



Studies on standardization of *in vivo* propagation techniques in *Hybanthus enneaspermus* (L.) F. Muell.

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Oridhalthamarai (*Hybanthus enneaspermus* (L.) F. Muell.) is an important and rare medicinal plant which has been used for quite long time to restore male fertility. Seed germination in this medicinal species is erratic due to the presence of hard seed coat and hence poor germination. Propagation method and media for raising seedlings were standardised at the Department of Medicinal and Aromatic Crops, TNAU, Coimbatore. Propagation method included seed and vegetative means using two types of cutting viz., softwood cuttings and semi hardwood cuttings treated with IAA (100, 200, 300 ppm), IBA (100, 200, 300 ppm). The results indicated that pre treating of the seeds with GA₃ (25 ppm) for six hours improved the germination (53.37 per cent) and also resulted in earlier germination (16.23 days).

Softwood cuttings treated with 200 ppm IBA recorded the maximum total carbohydrates and high carbohydrate to nitrogen ratio. Among the different media, coir compost recorded better rooting (100 per cent) and was very effective for establishment of shoot and root system. At 90 days after planting, this media gave maximum number of leaves (61.66), increased fresh and dry weight of shoot (1.85g and 0.72g), fresh and dry weight of roots (0.83 and 0.08g respectively). Thus from the above study, it can be concluded that seed treatment of *Hybanthus* with GA₃ (25 ppm) can help in improving the seed germination. Alternately, soft wood cuttings treated with IBA (200 ppm) in coir compost media can be employed for successful cultivation of the species.



Organic weeding of medicinal and aromatic plants for sustainable yield

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Medicinal and aromatic plants represent part of the wild flora with a large number of species, which of secondary metabolites are commonly used in the food, pharmaceutical and cosmetic industries. These crops find an important role in organic farming systems, since organic cultivation allows to enhance their end quality, for which buyers are often willing to pay a considerably higher price. Weed management is one of the most important obstacles to adopting and prospering in organic production. Estimates of the proportion of total costs attributed with weed management range from 10-30% in broad acre organic agriculture, to 30-50% in intensive organic horticulture, and even up to 70% in some horticultural systems. Techniques for organic weed control have been developed to reduce chemical costs in conventional agriculture, in response to environmental pressures and to provide for the needs of organic food production. Organic weed management practices typically are categorized as physical, biological and cultural controls and may be preventative as well as responsive. A wide range of weed control most typically available to organic producers would include: culture (right crops and cultivars, proper seedbed preparation, right seed and seeding depth, increasing planting density and adapting planting patterns etc, adequate and localized resource (water, fertilizer) application, tillage (mechanical, hand weeding), mulches (organic, manufactured and synthetic mulches, organic herbicides (acid based, plant oils, corn gluten etc) and biological (bio control agents, allelopathy) methods to effectively controlling the weeds. Organic weed management strategies have gained renewed interest in recent years as global organic crop production acreage increases. Each sustainability or at least one less acre as a source acre converted to organic, sustainable weed control methods could be practiced which would stabilize the soil fertility and reduce the environmental pollution.

Keywords: Organic weed control, sustainable yield, Non-chemical techniques.



Studies on improvement of seed germination in aonla (*Emblica officinalis* Gaertn)

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Investigations were carried out at Forest College and Research Institute, Mettupalayam to improve the seed germination in aonla cv. BSR 1 during 2012. The treatments include soaking of seeds in water for 24 hours, cow urine for 24 hours, acid scarification for 30 seconds, acid scarification for 1 minute and a control. The design followed was completely randomized design with 4 replications. Results revealed that seeds soaked in cow urine for 24 hours recorded maximum germination percentage (79%) followed by seeds soaked in water for 24 hours (68%) and least germination percentage was observed in untreated seeds (51%). Among the various treatments, seeds soaked in cow urine for 24 hours take minimum days for attaining 50 % germination (17 days) followed by seeds treated with H_2SO_4 for 1 minute (19 days), whereas control recorded maximum of 27 days. The effect of seed treatment using cow urine recorded highest root:shoot ratio (1.03), highest root and shoot length of 26.4 cm and 25.6 cm respectively and with the vigour index of 4108. The fresh weight and dry weight of the seedlings were high in this treatment only. It was concluded that, aonla seeds soaked in cow urine for 24 hours was the best for promoting the seed germination and other traits..

Key words: Aonla, seed germination, cow urine



Effect of spacing on growth and yield characters in tulsi (*Ocimum sanctum* L.)

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An investigation was carried out to study the effect of spacing on growth and yield of tulsi (*Ocimum sanctum* L.) The study was conducted at Department of Horticulture, Agricultural College and Research Institute, Madurai, TNAU during 2013-14. The experiment consisted of five different levels of spacing viz., 30 x 45, 45 x 45, 45 x 60, 50 x 30 and 60 x 60 cm. Among these treatments, plants accommodated with 50 x 30 cm recorded the highest growth attributes such as plant spread, leaf length (cm) and leaf breadth (cm) during all the growth stages (30, 60 and 90 DAT) and higher yield (g/ plant) during the time of harvest (90 DAT). The increase in yield of 25 per cent was observed in 50 x 30 cm compared to 30 x 45 cm.



Influence of organic manures and spacing on leaf yield and essential oil content in tulsi (*Ocimum sanctum* L.)

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An experiment was conducted to study the influence of organic manures and spacing on growth, herbage yield and oil content in Tulsi (*Ocimum sanctum* L.) at College Orchard, Department of Horticulture, Agricultural College and Research Institute, Madurai, TNAU during 2013-2014. The experiment was laid out in split plot design replicated thrice with three main plot treatments (organic manures) and five subplot treatments (Spacing). The results indicated that the application of vermicompost @ 5 t ha⁻¹ along with 50 x 30 cm spacing recorded the highest leaf yield of 138.93 g plant⁻¹ followed by FYM @ 20 t ha⁻¹ (136.30 g plant ha⁻¹) and the oil recovery was more in application of vermicompost @ 5 t ha⁻¹ along with 50 x 30 cm spacing.



Effect of pre-sowing treatments on seed germination and seedling survival of *Abrus precatorius*

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Abrus Precatorius L. locally known as ratti or Gumchi belongs to the family Fabaceae is a native plants of east and west India. It is best known for its seeds and which contain toxic element abrin. Medicinally, *A. precatorius* is well reputed for antitumor properties in Ayurvedic medicine. The seeds of *A. precatorius* are potential means of propagation, but low germination is a problem requiring extensive study for inducing better germination. Seed germination with different pre-sowing treatments was taken up and the results showed that the scarification of seeds with sand paper has best performed in germination (98%) as well as survival of seedling (98%), while the use of acid found negative effect on survival of seedlings. The scarified seeds soaked in 50 and 100 ppm concentration of GA₃ also gave best/maximum germination (99%) in comparison to other treatments. This treatment also shortened the germination time and most of the seeds germinated within 6 to 8 days of seed sowing.

Key Words:- *Abrus prectorius*, bright coloration, seed, germination, pre sowing treatments, GA₃, Indian indigenous system of medicine, propagation and cultivation.



Study on juice extraction methods for Indian noni (*Morinda citrifolia* linn.) fruits

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Noni is called for Indian mulberry (*Morinda citrifolia* Linn.) and originated from Southeast Asia such as Indonesia and Australia. It has been used in folk remedies by Polynesians for over 2000 years, and is reported to have a broad range of therapeutic effects. The aim of this present study was to find out the extraction technique for the extraction of noni juice and to study its physico-chemical characteristics. The ripened fruits were subjected to hot process, where on steam blanching was done at 80°C for 2 to 10 min, and then cooled at room condition and the juice was extracted. In cold process, the ripened noni fruits were frozen (-18°C) for 6 to 30 hours, thawed and the juice was extracted. In the fermentation process, ripened fruits were kept into an airtight container at room temperature and juice was collected by seeps out from the fruits after 30, 60 and 90 days. The various parameters such as percentage of juice recovery, pH, TSS, titratable acidity, tannin, DPPH scavenging activity and total phenolic content from extracted juice were studied to find out best process for the extraction of noni juice. Among the three techniques, cold extraction process was found to be highly effective based on processing time and physico-chemical characteristics. The results showed that the samples kept for 24 hours frozen condition and the juice extracted have a highest percentage of juice yield (52.47%), DPPH scavenging activity (518.3µM of TE/100 g) and total phenolic content (335mg/100ml).

The cold extraction technique is simple and innovative extraction process with protected and higher quantity of antioxidants and phenol compounds. This extraction technique is suggested for producing a natural and multifunctional noni based dietary food additives and supplements. This simple method is suitable for both small and commercial scale food processing industries.



Standardization of post-harvest technology for *Phyllanthus amarus* L.

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Phyllanthus amarus L. is known popularly in the Indian system of medicine as “Bhumi Amalaki” has been traditionally used in the treatment of variety of ailments including Hepatic disorder. For preparation of phyto-medicines, dried raw materials prepared using standardized drying and processing methods are indispensable for market acceptability and sustained retention of alkaloids. Experiments were conducted at the Department of Medicinal and Aromatic Crops, Coimbatore to standardize the post harvest technology for *Phyllanthus amarus*. The whole plants were harvested and subjected to different drying methods viz, sun drying, shade drying, initial sun drying for 3 hrs and subsequent shade drying for 24, 48, 72, 96 and 120 hrs and initial shade drying for 24 hrs and 48 hrs followed by sun drying for 3, 6 and 9hrs respectively. Storage studies were also conducted using different storage conditions viz., jute gunny bags, polythene lined gunny bags, ventilated polythene lined gunny bags and storage at ambient conditions. The results indicated that drying under open sun light recorded the lowest time of drying ie., 14 hrs/ 250g followed by shade drying followed sun drying (20 hrs) and sun drying followed by shade drying (23 hrs). Drying of the plant material under shade required longer time than other methods. The maximum drying rate was observed in sun drying which recorded the value of 0.280 g/ min. The drying rate was found to be the lowest in shade drying with a value of 0.118 g/ min. The highest phyllanthin (0.73 per cent) and hypophyllanthin (0.26 per cent) was observed in shade dried samples. The storage studies revealed that, storing the dried samples in polythene lined gunny bags retained the alkaloids for a longer period upto 120 days with minimum deterioration as compared to other storage containers.



Effect of Ethyl Methane Sulphonate on periwinkle [*Catharanthus roseus* (L.)] for determination of LD₅₀

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Catharanthus roseus is a self pollinated species with restricted variability in population. With an objective of inducing variability in the species, Ethyl Methane Sulphonate (EMS) was used to induce mutation of seeds at 10, 20, 30, 40, 50 and 60mM concentrations. The work was carried out at Department of Medicinal and Aromatic Crops, Horticulture College and Research Institute, TNAU, Coimbatore during the year 2014-2015. *Seeds of Catharanthus roseus* local pink culture was selected for the study. The effect of mutagen was observed based on the seed germination, germination speed and plant survival rate, length of seedling and vigor index. To determine the germination percentage and survival percentage of the seedlings, the seeds were sown in nursery. Based on the 50 per cent reduction of survival and germination percentage, LD₅₀ values were estimated. Seed germination decreased with increasing dose of EMS. The maximum survival was 87 per cent at 10mM and minimum of 42 per cent at 60mM.

Keywords: Mutation, LD₅₀, EMS, Survival percentage



Seed technological approaches for enhancing seed yield and quality in glory lily (*Gloriosa superba*)

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Studies were undertaken on glory lily (*Gloriosa superba*) in the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore to elucidate information on the pattern of seed development and maturation; method of pollination on seed set and seed quality; foliar spray on pod and seed set, seed yield; and quality and standardization of suitable method to break seed dormancy.

Studies on seed development and maturation revealed that the length and girth of pod, fresh weight and dry weight pod were increased with stages of development.

The length and girth of pod and fresh weight and dry weight of pod were maximum at 63 days after anthesis and started slightly decreasing in later stages. The same trend was also noticed on fresh and dry weight of per seed. The maximum fresh weight and dry weight were recorded at 70 days after anthesis. Hence the change of colour from dark green to light green with deep yellowish orange seed could be considered as a visible index of maturity at 63 to 70 days after anthesis in glory lily. Results of the studies on different methods of pollination revealed that, dusting of foreign pollen on the stigma (pollination) one day after anthesis resulted in higher pod set 88 percentages, while pollination on the day of anthesis resulted in 80 per cent pod set and bud pollination one day before anthesis resulted in 68 per cent pod set. These results clearly revealed that the stigma of glory lily flower was receptive even before anthesis and continued to attain the maximum receptivity at one day after anthesis. Studies on



the effect of foliar spray revealed that the application of GA_3 @ 100 ppm at 10th and 20th days after anthesis recorded the increased plant growth, maximum pod yield per plant. The results of the dormancy breaking treatments revealed that the soaking of seeds in hot water (boiled to 100° C and removed from the flame) for 40 minutes effectively improved the germination and seedling length, dry matter and vigour accompanied with minimum abnormal seedling production.

Key words: seed development and maturation- pollination - foliar spray - seed dormancy



Effect of bioregulators on growth and flowering of Edward rose

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Rose is the most important flower crop all over the world. It ranks first in cut flower market. It is also used as loose flowers which have strong fragrance. They are used for making garland, gulkand, rose water, rose oil, concrete, perfumes, etc., Bulgaria and Turkey are the largest producers of rose oil from *Rosa bourboniana*. France and India also contribute significantly to the world market. In India, rose is commonly cultivated in Tamil Nadu, Karnataka and Andhra Pradesh as loose flower.

Edward rose is botanically called as *Rosa bourboniana* L. and belongs to the family Rosaceae. Petals of rose flower have the medicinal value such as cleansing the gall bladder, alleviating mild sore throat, reducing the body temperature and along with almond, it is used to treat liver, stomach & bacterial infections. A study was carried out to know the effect of bio-regulators i.e., brassinolide, salicylic acid, BAP, GA₃ and NAA on flowering characters in Edward rose.

Plants at uniform height and growth were selected for study and they are pruned uniformly in the month of October. Bio-regulators namely NAA @ 20ppm & 30ppm, brassinolide @ 0.5ppm & 1ppm, salicylic acid @ 100ppm & 150ppm, GA₃ @ 50ppm & 100ppm, BAP @ 100ppm & 150ppm were used as treatments along with control. After sprouting (20 days after pruning) first spraying was given and subsequent spraying was given at 15 days interval.

Observations were taken after bud initiation. Days taken for formation of pea size buds was less in GA₃100ppm(27.8 days) and took longer days (36.7 days) with brassinolide -1ppm. Days taken for flowering from bud formation was higher in



GA₃50ppm (17.4 days) whereas it was minimum (12.4 days) in the treatment of BAP @ 150ppm. Number of flowers per plant was high (11.7 flowers) in Salicylic acid 100ppm of and was low in NAA 30ppm. GA₃ showed earliness in flowering but the number of flowers per plant is less. Salicylic acid showed increased flower size at 100ppm.

Key words: Edward rose-bio regulators-increased flower size and yield



Studies on the physiology of petal abscission in Edouard rose (*Rosa bourboniana* desp.) and red rose (*Rosa centifolia* l.)

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Roses aptly recognized as ‘queen of flowers’ have a special place in the flower market. Edouard rose (*Rosa bourboniana* Desp.) and Red rose (*Rosa centifolia* L.) belong to the scented group of roses. They are being cultivated traditionally for use as loose flowers and in the preparation of rose oil, rose water, rose gulkhanda etc. In India, *R. bourboniana* is mainly cultivated for extraction of the aromatic essential oil. It has an oil content ranging from 0.04-0.042%. For obtaining good quality oil, flowers are to be harvested early in the morning as the essential oil content decreases with the advancing day and the petals are shed. Enzymatic changes, respiration rate and ethylene evolution associated with petal shedding in both these cultivars were studied and compared. Ethylene evolution from flowers was recorded using gas chromatography. Increased activity of enzymes such as IAA oxidase (3162.7 and 2761.7 mg of unoxidised auxin /g/h) and peroxidase (13.90 and 12.29 change in absorbance /g/h), an increased evolution of ethylene (3.14 and 1.20 ppm/kg/hr) and a decline in respiratory activity (143.62 and 185.48 ppm CO₂ /g / h) were recorded in cv. Edouard rose (*R. bourboniana*) and cv. Red rose (*R. centifolia*) respectively. Microtoming of the pedicel of the flower buds was done on the 1st and 3rd day of flower opening to observe the ultra structural changes taking place during abscission of flower petals. In the flower pedicel of the cv. Edouard rose, on the day of abscission, invagination of cell walls and cell wall break down were observed in the vascular bundles while in cv. Red rose, these changes were noticed only on the third day of flower opening. The ultra structural changes were more pronounced in Edouard rose (*R. bourboniana*) when compared to Red rose (*R. centifolia*).

Key words: Enzymatic activity, respiration rate, ethylene evolution, ultrastructural changes, Edouard rose, Red rose.



Effect of tuber size on growth and seed yield of glory lily (*Gloriosa superba* L.)

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A study on effect of tuber size on growth and seed yield of glory lily was undertaken in the Department of Medicinal and Aromatic Crops, Horticultural College and Research Institute, Coimbatore, TNAU during the year 2016-17. This study consists of planting different size of tubers viz., 30-40, 40-50, 50-60, 60-70, 80-90 and 90-100g to study their effect on growth and yield of glory lily. The result revealed that among the different tuber size, tubers weighing 50-60g recorded lesser number of days to first flowering (40.67 days), more number of flowers (19.64), more number of pods (16.07). The same treatment recorded maximum pod length (8.11 cm), pod girth (6.81 cm), pod weight (8.70 cm), number of seeds per pod (41.50) and pod setting percentage (81.82 %) indicating that the tubers weighing 50-60 g is ideal for planting in glorylily.



Enhancing the productivity of Moringa var. PKM1 through High density planting and fertigation system for exploitation of its nutraceutical properties

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Moringa tree is one of the most incredible plant to mankind, its nutritional and medicinal properties has the potential to alleviate malnutrition, as well as prevent many diseases worldwide. Moringa leaves contain 6.7 g of protein which is two times more than the protein content of milk. Several reports stated that taking 1 g of powdered moringa leaf daily is sufficient to meet 42% of dietary requirement of protein. Similarly, moringa possess many valuable phytochemicals which are useful for disease prevention. In particular, moringa is rich in simple sugar, rhamnose, glucosinolates and isothiocyanates (Bennett *et.al.*2003). It also contains antibacterial compounds viz., 4-(4'-O-acetyl- α -L-rhamnopyranosyloxy)benzyl isothiocyanate, 4-(α -L-rhamnopyranosyloxy)benzyl isothiocyanate, niazimicin, pterygospermin, benzyl isothiocyanate and 4-(α -L-rhamnopyranosyloxy) benzyl glucosinolate. It is reported that the powder and different extracts of fruits of *M. oleifera*, is obtained from a local market in India and traditionally used to treat rheumatism, liver and spleen diseases.

Tamil Nadu Agricultural University is the pioneer institute in moringa research and developed two seed propagated moringa types viz., PKM 1 and PKM 2, after the release of these two varieties the commercial cultivation has gained momentum. Experiments on high density planting and fertigation in annual moringa PKM 1 was conducted at Horticultural College and Research Institute, Periyakulam during the year 2008 – 2012. Among the twenty four treatment combinations adopting a close spacing of 1.5 X 1.0 m with two plants per hill by maintaining the plant population of 13,333/ha along with application of 135: 23:45 g of NPK/pit recorded the highest yield per plant of 8.55 kg, yield per plot of 341.86 kg and yield per hectare of 114.25 t. ha⁻¹. This is 400 % increased yield over conventional system. BC ratio (4.96) was also higher when compared to control (1.72). Hence, moringa can be cultivated under high density planting system to get more yield per unit area and the leaves and pods thus obtained may be utilized for extracting phytochemicals present in it.



Utilization of problem soils through cultivation of medicinal and aromatic plants

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A significant portion of earth surface is affected with excess salts, acidity, alkalinity and some physical soil constraints (Surface crusting, hard pan etc.,) characterized by low productivity. The reclamation of these soils is very costly requiring additional agricultural inputs such as amendments, irrigation and infrastructure for drainage. An alternate approach for utilization of the problem soils for cultivation of medicinal and aromatic crops is an attractive proposition. Available information's indicate that many high value medicinal and aromatic crops have higher tolerance to sodicity, salinity and acid soils and there is no degradation of the quality under such conditions. Under some stressed conditions the quality of the produce is even better than normal conditions. The immediate gains are quite encouraging in terms of high productivity to meet the demands of raw materials in national and international markets, high economic return, employment generation and agricultural industrial linkage. Medicinal and aromatic crops such as ashwagandha, isabgol, periwinkle, Indian Aloe, senna, tulsi, German Chamomile, vetiver, palmarosa, and lemon grass can successfully be grown with saline irrigation water and in moderate alkali soil without applying any amendments.

Keywords: Acidity, Salinity, Abiotic stress, Medicinal plants, Aromatic Plants.



Effect of treatments on seed germination in graviola (*Annona muricata* L) – the cancer killer plant

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Graviola (*Annona muricata* L) belongs to the family Annonaceae, is a widespread small tree and has its native in central America. It is a popular fruit tree that is cultivated throughout the tropical regions of the world, and it is a common plant in the house compounds of Southern Peninsular India. Intensive chemical investigation of the leaves and seeds of this species have resulted in the isolation of a great number of acetogenins. The isolated compounds display some of the interesting biological or the pharmacological activities, such as antitumor, cytotoxicity, antiparasitic and pesticidal properties. Roots of these species are used in traditional medicine due to their antiparasitical and pesticidal properties. The extract of the plant parts is effective against 12 types of cancer and it is 10,000 times powerful than chemotherapy. The greatest advantage with graviola is that it selectively hunts only the cancer cells, but not the healthy cells.

Experiments were conducted to hasten and improve the seed germination in Graviola. In the first experiment, scarification was done using sand paper. In Pre germination seed treatment sand paper was used to remove the seed coat dormancy to facilitate water absorption and gaseous exchange. The second experiment was conducted using the best treatment from the first experiment (scarification) followed by soaking with easily available materials, to observe their influence in seed germination. A significant increase in hastening seed germination was noticed in all treatments as compared to control. The maximum germination (97.2%) was recorded under boiling water treatment, whereas the seedling length was maximum in coconut water treated seeds.



TECHNICAL SESSION

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**Session IV Biotechnology, phytochemicals and
extraction**



Metabolite profiling of essential oils from cultivars and hybrids of *Betelvine (Piper betle L.)*

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Betelvine (Piper betle. L.) is a tropical, perennial, dioecious, semi woody creeper belonging to family Piperaceae. ICAR- IIHR maintains rich collection of betelvine germplasm and hybrids in this crop have been developed. An attempt has been made to evaluate essential oil composition of selected land races and hybrids to study the chemo diversity. Hydro distilled essential oil from the leaves was analysed through GC-MS and wide variation was observed for essential oil composition between and among cultivars and hybrids. In total presence of 28 compounds belonging to the class Monoterpenes (2), Oxygenated Monoterpene (1), Phenylpropanoids (8), Sesquiterpenes (14) and Oxygenated Sesquiterpenes (3) were recorded. Phenylpropanoids and sesquiterpenes were the two major group of compounds in all chemotypes with values ranging from 19.95-86.23% and 1.56- 58.69%, respectively. The mean content of phenylpropanoids was 63.76 and –67.12% in cultivars and hybrids, respectively. Among this group eugenol content (28.17%) was ~~is~~ higher in cultivars compared to hybrids. Whereas enhanced 4-allylpyrocatechol was observed in hybrids (31.92%) compared to cultivars (15.00%). All hybrids recorded very low (or) nil saffrole content and differed from land races (0.19% to 11.43% respectively). Some compounds are present uniquely in some chemotypes, which when confirmed may be useful as marker compounds i.e ., Chavicol (11.10%) present in cv. Meetha Pan, caryophyllene oxide (2.93%) in cv. Desawari and tau.-Cadinol (2.18%) observed only in hybrid HY 07-24. In this study HY 06-4 recorded highest 4-allylpyrocatechol



(76.66%) and higher chavicol (11.10%) in Meetha Pan. The findings reveal that hybridisation can create new variation and possibility to develop new chemotypes with enhanced desirable bioactive compounds. The study indicate that metabolic profiling can aid in isolating unique chemotypes of betelvine which are rich in biomolecules with identified therapeutic properties for further exploitation.

Keywords: Metabolite Profiling; Gas chromatography; Mass spectrometry; Essential oil; Phenylpropanoids and sesquiterpenes.



Modulations of Gene and Protein Expressions in COLO 320 Cell Lines by *Bauhinia variegata*, An Anticancer Medicinal Plant

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Bauhinia variegata is a medium sized deciduous tree belonging to the family *Caesalpinaceae*. Various parts of this medicinal plant have been used in Indian traditional systems of medicine for the treatment of several ailments. Preliminary studies indicated that the ethanol extract of *B.variegata* (EBV) has inhibited the growth of human colon cancer cell lines (COLO 320) by MTT assay. The aim of the present study is to identify the alterations in the genes and proteins expression induced by the treatment with ethanol extract of *B.variegata* (EBV). The effect of EBV on the expression of various genes like beta- catenin, iNOS, cox-2, k-ras, c-myc, TGF-beta, bax and caspase 9 and their corresponding protein products (after treating the cells at 7.8, 15.62, 31.25 μ M/ml for active fraction I and 15.62, 31.25, 62.5 μ M/ml for active fraction II) were studied by RT-PCR and western blotting respectively. After 48 hours treatment, there was a significant increase in the expression of apoptotic genes like bax and caspase 9 and decreased expression of genes like beta- catenin, iNOS, cox-2, k-ras, c-myc and TGF-beta. Since EBV has activated genes that enhance apoptosis and down regulated various genes that are involved in colon carcinogenesis, it may be useful in the prevention and treatment of colon cancer after further clinical trials.



***In vitro* micro propagation of fever few (*Tanacetum parthenium* (L) Schultz Bip)**

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Feverfew (*Tanacetum parthenium*: syn. *Chrysanthemum parthenium* (L) Pers.,) is a medicinal plant useful for treating headache, mainly for migraine headaches. The active ingredients in feverfew include parthenolide and tanetin both of which offer relief from migraine. The study was carried out during 2007 -2008 at Department of Bio Technology MTWU, Kodaikanal. Two different explants were used, (auxiliary bud and shoot tips). Among these, auxiliary bud performed better. The percentage of survival of explants was 91% during shoot initiation stage and 98 % at shoot proliferation stage. Whereas shoot tip recorded 66% and 65% percent during shoot initiation and shoot proliferation stage. Among the different concentration of BAP (0.5-2 mg/l), BAP 2 mg/l recorded 66 % shoot induction with time taken 6 days from shoot tip as explant whereas BAP at 1mg/l recorded (65.56%) shoot induction with time taken of 4 days from auxiliary bud explants. Highest percentage of (80.19%) shoot bud induction was observed in Kinetin at 1mg/l and time taken was 5days, from shoot tip explants and 84%) shoot bud induction with 5 days from auxiliary bud explants. Among various concentrations of BAP (0.5-3.0mg/l), 2.0mg/l recorded highest multiple shoot formation (95.00%) with the time taken for multiple shoot formation was 20 days with 13.6 shoots from auxiliary bud. Among the different concentrations of KN (1.5-3.0mg/l), 2.0 mg/l recorded highest percentage of multiple shoot formation (91.54%).The time taken was 19 days with 14 shoots per explant and the higher concentration of KN at 1.5 and 2.5 mg/l recorded less percentage (83.44% and 85.73%) and the time taken was 17 and 22 days respectively. The combination of BAP (2.0 mg/l) and NAA (1.5mg/l) recorded highest percentage of multiple shoot induction



(93.22%) which took 23 days. The combination of BAP (2.0mg/l) and GA₃ (1.0 mg/l) gave better results of shoot elongation with multiple shoots (90.39%). The time taken was 12 days and the length of shoots was 3.0 cm. Among the different concentration of IBA (0.1-1.5mg/l) supplemented with MS medium, IBA at 0.5mg/l was found to be superior in production of number of roots per explants (84.00%). Different concentration (50, 75, 100 and 200 µg/l) of different antibiotics viz., Gentamycin, Streptomycin, Penicillin, Amoxillin and Ampicillin were used in the MS medium, streptomycin (25µg/l) efficiently inhibited the growth of endophytic bacteria with zone of inhibition was 2.18 mm.



Separation, quantification and cytotoxic analysis of camptothecin from *in vitro* and *in vivo* cells of *Nothapodytes nimmoniana* (foetida) (Graham).

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Indian *Nothapodytes nimmoniana* (foetida) has been found to be an important source of camptothecin, a monoterpenoid-derived indole alkaloid regarded as one of the most promising anti cancer drug. To isolate 1kg of camptothecin, more than 1000 kg roots are required. The available destructive method led to sudden (25%) decline of the tree species. This destruction method of camptothecin isolation from the bark and roots of *N.foetida* is the biggest drawback of the existing process. There has been a tremendous opportunity to use plant cell culture as an alternative to commercial method for the industrial production of plant secondary metabolites. Exposure of the leaf bits of *Nothapodytes* in 70% ethanol for one minute and 1% mercuric chloride for one minute was good in controlling the contamination with explants survival of 93.3%. Callus initiation in leaf bits was best when cultured on half strength MS medium supplemented with 2,4-D (5mg/l) in combination with BAP (0.5mg/l) and NAA (3mg/l) in combination with BAP (0.5mg/l). Extraction and separation of secondary metabolites was carried from *in vivo* (root, stem and bark) and *in vitro* samples (callus) showed that blue fluorescent spot and green fluorescent spot when observed under UV at 254 nm and 365 nm corresponding to the samples. The Rf value of the *in vivo* root stem and bark extract for camptothecin and 9-methoxy camptothecin showed that 0.5, 0.44, 0.44 and 0.64, 0.49 and 0.49. The Rf value of the *in vitro* calli extract (T4) showed 0.50 and 0.56 indicating the presence of camptothecin and 9-methoxy camptothecin. The retention time of camptothecin was 7.5. Based on this analysis, the HPLC result of *in vivo* root (sample B) at 20µl showed 0.20% of



camptothecin and in *in vitro* callus (sample A) at 20 μ l showed 0.015% of camptothecin content. The cytotoxicity of camptothecin was analyzed through MTT assay. The absorbance was calculated at various concentrations (0, 20, 40, 80, 160 μ g). As the concentration of the camptothecin increases, the absorbance decreased indicating the cytotoxicity of the compound. Isozyme pattern of peroxidase in calli derived from young leaf segments showed more number of peroxidase bands compared to *in vivo* root and leaf samples. Rf values of 0.28 and 0.61 unique for young leaf derived calli that did not appear with other samples. A band of Rf value of 0.32 for root and Rf value of 0.24 for leaf was exhibited.



Assessment of genetic diversity in underutilized medicinal climber *Mucuna pruriens* (L.) DC. germplasm revealed by ISSR markers

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Velvet bean [*Mucuna pruriens* (L.)] is an important underutilized medicinal legume climber, whose seeds are source of L-Dopa used in the treatment of Parkinson's disease. The seed are rich source of protein, fat, carbohydrate and minerals and are used as food by many tribal communities in India. The present investigation on genetic diversity was estimated by using eleven ISSR markers in 58 germplasm of velvet bean collected from different parts of India. Out of 63 amplified products, 59 have shown polymorphism (92.53%) and 4 were monomorphic (7.47%) with an average of 5.7 bands amplified per primer. The band statistic and efficiency parameters showed that the primers UBC 827, UBC 834 and UBC 836 were more efficient in the genetic diversity studies. The least genetic similarity values (0.26) were observed between IIHR MP 89-1, IIHR MP 7 and IIHR MP 62-1 and IC 21998 and high genetic similarity values (0.90) were observed between IIHR MP 102 and IIHR MP 74-3. The dendrogram generated by ISSR markers germplasm grouped into two major clusters at 63 per cent similarity. Among the lines, IIHR Selection 4, IIHR Selection 10, IIHR MP 9, IC 33243 and IIHR MP 7 were found to be distinctly divergent, which can be used in the further breeding programme. The results revealed that ISSR markers can be an effective tool for measuring genetic diversity in velvet bean.



Production of L-DOPA from *Mucuna pruriens* through cell suspension culture

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The demand for *Mucuna pruriens* in national and international drug markets increased many folds after the discovery of the presence of L-3, 4-dihydroxy phenylalanine (L-DOPA), an anti-Parkinson's disease drug. To accommodate the large demand for L-DOPA, *in vitro* production of the drug using cell cultures is now practiced extensively. Two varieties: [IIHR Selection 3 (S3) and Arka Dhanvantari AD]] were used in this study. Murashige and Skoog (MS) medium supplemented with 2, 4-D, IAA, kinetin, NAA and BAP at different concentrations alone or in combination was employed for callus induction using the leaf and stem explants. Maximum callus induction frequency (100 ± 0.0) was recorded for the leaf derived callus of AD and S3 variety in MS + 2.5 mg/L NAA and MS + 2.0 mg/L 2, 4-D respectively. Amongst the treatment with combinations of auxins and cytokinin, maximum callus induction frequency (100 ± 0.0) was obtained in MS + NAA (3.0 mg/L) + BAP (0.5 mg/L) and MS + 2, 4-D (2.0 mg/L) + BAP (0.5 mg/L) for leaf and stem derived callus respectively in both varieties. Growth rate of calli was studied by recording the callus fresh weight and dry weight. Using the leaf and stem calli derived, cell suspension cultures were established to analyze the production of L-DOPA. The effect of plant growth regulators, elicitor and precursor treatments in cell suspension culture for production and enhancement of L-DOPA was evaluated *via* packed cell volume (PCV) during each passage and HPLC after three passages (21 days). In leaf derived callus cell suspension, the highest percentage of PCV (42.4 ± 0.1) was observed in treatment L4: MS + NAA (1.5 mg/



L) + Pectin (100 mg/L) + ascorbic acid (250 mg/L) in AD variety while in S3 variety the highest percentage of PCV (55.1 ± 0.1) was recorded in treatment L9: IAA (1.0 mg/L) + L-tyrosine (15 mg/L) + ascorbic acid (250 mg/L). In the HPLC analysis of cell suspension culture, treatment T3c: MS + IAA (1.0 mg/L) + L-tyrosine (15 mg/L) + ascorbic acid (250 mg/L) showed the highest peak area percentage of 31.19 at retention time (RT) of 2.36 (same RT with standard L-DOPA at 50 ppm) against control which had peak area percentage of 1.39 at 2.35 RT. L-DOPA content was observed to increase with increase in concentration of the elicitors.



Efficient protocol for conservation and DNA barcoding of *Andrographis* species to develop sustainable utilization and validation

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Andrographis (Family: Acanthaceae) species is widely distributed and a high value medicinal plant in India. The present study aimed to carry out plant tissue culture and DNA barcoding of *Andrographis* species, such as *A. alata*, *A. affinis*, *A. lawsonii* and *A. lobeloides* from Nilgiri's Biosphere Reserve (NBR). The MS medium supplemented with various concentration and combination of plant growth regulators used for mass multiplication and standardization. The mass cultivation of *in vitro* cultured *Andrographis* species were validated phytochemically for sustainable utilization. DNA barcoding analysis of *Andrographis* species used for increasing demand of herbal medicine in the global market and for authentication of the source material. DNA barcoding technology provide a single database containing information about authentic plant materials and their adulterants. The database should provide DNA barcodes for data retrieval and similarity of the species and chemical constituents. This study concluded that conservation and DNA barcoding should be used in a complementary manner for species identification with chemical analyses to detect and quantify the required chemical compounds, thus improving the quality and authentication of the plant species.

Keywords: Conservation, *Andrographis alata*, DNA barcoding and authentication.



Variability in antioxidant activity among genotypes of Kalmegh (*Andrographis paniculata* Nees.)

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Andrographis paniculata (Kalmegh) is an important medicinal plant popularly used for the treatment of an array of ailments such as leprosy, cancer, influenza, diabetes, high blood pressure, bronchitis, skin diseases, colic, dysentery, dyspepsia, malaria and ulcer. Present study was aimed at estimating the antioxidant properties of in nine different genotypes of *A. paniculata* grown in the experimental farm of IIHR, Bangalore. Freshly harvested leaves were collected during the flowering stage and extractions were performed from using 80% methanol as solvent. The extracts were analysed for their free radical scavenging activity using 2, 2-diphenyl- 1-picrylhydrazyl (DPPH) assay and ascorbic acid as standard. Antioxidant activity recorded among the selected lines varied from 72.11 – 84.54 %. IIHR AP 25-4 showed the highest percentage antioxidant activity (84.54%) followed by IIHR AP 18-4 (82.01%) and IIHR AP 32-1 (80.94%). The least antioxidant activity recorded among the nine lines was about 72.11% in IC111291. The result showed that Kalmegh has the potential to be used as a source of natural antioxidants and variation exists among genotypes for antioxidant capacities which provide an opportunity for selecting potential lines which are rich in antioxidants.



***In vitro* anti oxidant property of siddha formulation, Irunelli karpam.**

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Siddha system of medicine is a renowned holistic system of traditional medicine emphasizing curative and preventive measures. The medicines used in siddha are of plant origin, metals, minerals and animal products. *Kaya-karpam* (Elixir science) is a treasure for the siddha system as they improvise the longevity of life through their anti-oxidant activities. *Irunelli karpam* is one of the karpa medicine, is a herbo-mineral drug, widely used in siddha for the treatment of inflammatory skin diseases like psoriasis, eczema, urticaria, etc. The aim of the present study was to evaluate the *in vitro* free radical scavenging activity of Irunelli karpam. DPPH radical scavenging activity, hydroxyl radical scavenging activity, superoxide radical scavenging activity, nitric oxide radical scavenging activity and total reducing power assay was determined as per standard procedures. From the results of the present study, it was observed that the IC 50 of the tested drug was found to be 29.73 ± 0.87 $\mu\text{g/ml}$ for DPPH, 61.22 ± 6.75 $\mu\text{g/ml}$ for hydroxyl radical, 51.22 ± 4.75 $\mu\text{g/ml}$ for superoxide radical and 37.94 ± 3.44 for nitric oxide radical respectively. Hence it may be concluded that Irunelli karpam is a potent antioxidant candidate which can be used for the treatment of various non communicable diseases like Cancer, Diabetes, Arthritis and other inflammatory diseases which involve oxidative stress in its pathogenesis. This result is for the world at large from Siddha system of medicine.

Key Words: Siddha system, Irunelli karpam, Antioxidant



GC-MS analysis of ethanolic extracts of leaf and fruit of *Trichosanthes dioica* ROXB.

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The medicinal plants are considered to be most important in primary health care system of the developing countries and herbal drugs in the industrialized countries. The therapeutic property of a plant depends upon the physiologically active chemical compounds present in the plant parts employed in preparation of a medicine. In the present study, the ethanolic extracts of leaf and fruit of *Trichosanthes dioica* were subjected to GC-MS analysis for determination of phytochemical composition and qualitative and quantitative identification of the many structurally complex components. The GC-MS analysis showed that the extracts contain different bioactive compounds, which might be a perfect product for any kind of pharmaceutical applications.



An Ultrasound assisted Extraction Technology

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Ultrasound-assisted extraction has not only been used to extract bioactive compounds such as antioxidants and tocopherols, but also essential oils, steroids, and lipids from plants. Sound waves (frequencies higher than 20 kHz) travel in matter and involve expansion and compression cycles. Expansion pulls molecules apart while compression pushes them together. In a liquid, the expansion can create bubbles that grow and then collapse. Close to a solid boundary, cavity collapse is asymmetric and involves high-speed jets of liquid, which have strong impact on the solid surface. Ultrasound induces a greater penetration of solvent into cellular materials, thus improving mass transfer, and also disrupts biological cell walls, thus facilitating the release of contents. Ultrasound frequency can have great effects on extraction yield and kinetics, depending on the nature of the plant material to be extracted. In any case, the use of ultrasound allows a decrease in the temperature and pressure with respect to the extraction without ultrasound and the apparatus is cheaper than that of microwave-assisted extraction. Ultrasound-assisted extraction is not an off-the-shelf technology. This means that it must be developed and scaled up for each application. Nevertheless, ultrasonic processing has the capability for molecules large commercial scale-up and good payback on capital investment (generally less than 1 year) due to the availability of high amplitude/power units for large commercial operations; improved energy efficiency of the equipment, ease of installation and/or of retrofitting, competitive energy costs and low maintenance costs.



Studies on phyto-chemicals, antioxidant activity and *in-vitro* anticancer activity of different bamboo species leaves

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Bamboo is the fastest growing woody plant of this planet. In ancient medicine, the shoots and the leaves of the bamboo has been used for treating various diseases and ailments, particularly in Ayurveda and Chinese. In view of this, a study was undertaken to study the phyto-chemicals, antioxidant activity and anticancer activity of the selected bamboo species. Leaves viz., *Bambusa vulgaris* (green & golden), *Bambusa balcooa*, *Bambusa bamboos*, *Bambusa polymorpha*, *Dendrocalamus gigantea*, *Dendrocalamus strictus*, *Dendrocalamus asper* and *Dendrocalamus hamiltonii* were used for screening of various activity. Preliminary screening of phyto-chemical examination showed the presence of alkaloids in ethanol extracts of *B. vulgaris* (golden), *B. balcooa*, *B. bamboos* and *D. hamiltonii*; and ethyl acetate extracts of *B. polymorpha*, *D. strictus* and *D. hamiltonii*. The species *D. hamiltonii* showed the presence of tannin and phenols compounds in ethyl acetate extract. The methanol extracts showed the presence of tannin and phenolic compounds in *B. bamboos*, *B. polymorpha*, *D. gigantea* and *D. strictus*. In the ethanol extracts, the presence of tannin/phenolic compounds was observed in *B. vulgaris* golden, *B. balcooa*, *B. polymorpha*, *D. gigantea*, *D. strictus*, *D. asper* and *D. hamiltonii*. Glycosides were present in the leaves of *B. vulgaris* green and golden in petroleum ether extract. The ethyl acetate extracts of all the selected species showed the presence of flavonoids except in *B. vulgaris*. The presence of saponins was observed in species of *B. balcooa*, *B. bamboos*, *B. polymorpha* and *D. gigantea*.



in ethanol extract and aqueous extracts of all the selected samples. The antioxidant analysis exhibited that the leaves namely *B. vulgaris* (golden), *B. balcooa*, *B. polymorpha* and *D. gigantea* showed 69.30, 65.89, 58.91, 64.34 per cent inhibition rate in ethanol extract; *B. balcooa* (47.28%), *B. bamboos* (65.25%), *B. polymorpha* (50.38%) and *D. gigantea* (62.01%) in methanol extracts; and *B. bamboos* (69.76%) in aqueous extract. The results of *in-vitro* anticancer activity (cell line) of different bamboo species showed that the species such as *B. vulgaris* (green), *B. balcooa*, *B. bamboos*, and *B. polymorpha* have the activity against colon cancer at the inhibition rate of 67, 41, 67 and 47 per cent respectively.



Antimicrobial and phytochemical characteristic of *Zanthoxylum armatum* DC.

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Plants produce a diverse range of bioactive molecules, making them rich source of different types of medicines. Most of the drugs today are obtained from natural sources or semi synthetic derivatives of natural products and used in the traditional systems of medicine. The aim of present study is to know the antimicrobial and phytochemical characteristic of *Zanthoxylum armatum* DC plant. *Zanthoxylum armatum* DC is a glandular aromatic shrub belonging to family Rutaceae widely distributed in the subtropical Central Himalaya between 1000- 2200 m asl.

In the present study, antifungal extract *Zanthoxylem armatum* diffused from the cup through an agar layer in a Petri dish or plate to an extent such that the growth of added fungus is restricted entirely in circular area or zone around the cavity containing the solution of an antifungal substances. The antifungal activity was expressed as zone diameter in millimeters, which was measured with a measuring scale. Different concentrations of the test solution inhibited all the fungal species with varying degree of sensitivity. Among these, high percentage inhibition was observed in *Penicillium canadense* (66.66 %) and high radial growth in *A.ochraceus* 30mm. Methanol extract of *Z. armatum* was screened against the 3 fungal species, *Rhizoctonia solani*, *Penillium canadense*, *Aspergillus ochraceus* and the result was evaluated at 72 hrs. Methanol extract of *Z. armatum* did not inhibit *A. ochraceus* at 500 ppm, inhibition was highest at 2000 ppm [17mm, PI 43.33%]. Inhibition was dose dependent and *R. solani* showed lowest growth (DM 17mm) at 250ppm (PI 15 %). Inhibition by *Z. armatum* extract was highest at 2000 pmm [DM 9mm,PI 55]. Methanol extract of *Z. armatum* inhibited *P. canadense* at all concentrations

Key words: *Zanthoxylem armatum*, antimicrobial, phytochemical, *Rhizoctonia solani*, *Penillium canadense*, *Aspergillus ochraceus*.



Physiochemical and antioxidant analysis of *Bauhinia tomentosa* leaves-An invitro study

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Chemistry of natural products has endless potential. Most important of such molecules are flavonoids, alkaloids, tannins, terpenoids, saponins and other phenolic compounds. These compounds have been reported to quench or decompose free radicals and its products. *Bauhinia tomentosa* is one such medicinal plant belonging to *Caesalpinaceae* family. Various parts of this medicinal plant have been used to treat various ailments in traditional systems of medicine. The preliminary phytochemical studies indicated that the ethanol extract contains much phytochemicals than the others and hence, the ethanol extract of the *B.tomentosa* leaves (EBT) was selected for further studies. The present study is aimed at to investigate the physiochemical analysis and free radical scavenging potential of the ethanol extract of *B.tomentosa* leaves. The collected leaf samples were subjected to physiochemical studies and safety studies like total microbial load assay, aflatoxins assay, pesticides analysis and heavy metal analysis as per WHO guidelines. Ethanol extract of *B. tomentosa* (EBT) was then subjected to DPPH, nitric oxide, superoxide radical scavenging assays and FRAP assay. From the results, it was observed that the collected leaf sample was found to be free from pesticides, aflatoxins, heavy metals and microbial contamination. The water and alcohol extractive values of *B.tomentosa* leaves were $9.1 \pm 0.9\%$ and $8.1 \pm 0.4\%$ respectively. The total ash value, water soluble ash and acid insoluble ash were found to be $12.19 \pm 1.1\%$, $3.1 \pm 0.4\%$ and $8.5 \pm 0.9\%$ respectively. The moisture content was found to be $10.13 \pm 1.3\%$. The IC_{50} value of EBT for DPPH radical was found to be $59.54 \mu\text{g/ml}$ and it also exhibited appreciable activity towards other radicals as compared with the standards like BHA and curcumin. Hence, it may be concluded that *B.tomentosa* has appreciable antioxidant activity and the present study justifies the traditional usage of *B. tomentosa* for the treatment of various ailments.



Variation in total diterpenoid content at different stages of harvest in genotypes of Kalmegh (*Andrographis paniculata* Nees.)

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Kalmegh (*Andrographis paniculata* Nees.) is an indigenous medicinal plant belonging to the family Acanthaceae. It is one of the highly traded Indian medicinal plants and has been positioned 17th among the 32 prioritized medicinal plants of India by National Medicinal Plant Board (NMPB). The plant has been reported to possess antipyretic, antihepatotoxic, antihistamic, analgesic, antibacterial and anti fertility properties. The therapeutic properties of kalmegh are attributed to four major active diterpenoids like, andrographolide (AP₁), neoandrographolide (AP₂), 14-deoxy-11, 12-didehydroandrographolide (AP₃) and andrograpanin (AP₄). Twenty genotypes with two checks *ie.*, CIM-Megha and Anand kalmegh were studied to know the variation in different andrographolide content in two stages of harvest at 90 and 120 DAP. The different andrographolide contents were analysed through Ultra High Performance Liquid Chromatography (UHPLC) with Photo Diode Array Detector (PDA). There was a wide variation in contents of AP₁, AP₂, AP₃ and AP₄ in leaf and stem powder of 22 genotypes. The AP₁ content of leaf and stem at 90 DAP were maximum (2.127 and 1.911%) respectively in IIHR Kalmegh 6. At 120 DAP the highest levels of leaf AP₁ was recorded in IC342137 (2.695%) and in stem of IIHR Kalmegh 13 (1.861%). The AP₃ content at 90 DAP was higher in IIHR Kalmegh 6 (0.330 and 0.313%) both in leaf and stem respectively. Whereas, the lowest amount of AP₃ 0.185 (IC111291) and 0.179% was recorded in IIHR Kalmegh15 at 120 DAP. At 90 DAP the total diterpenoid content of the herb varied from 5.057% (IIHR Kalmegh 6) to 1.534 % (Anand



Kalmegh). The genotypes IIHR Kalmegh6 (5.057%) and IIHR Kalmegh10 (4.192%) recorded higher diterpenoid content at 90 DAP suggesting that they may be suitable for early harvest. At 120 DAP IIHR Kalmegh 3 (5.65 %) recorded highest diterpenoid content. Greater variation among the genotypes at different stages of harvest was observed for total and different andrographolide contents. Hence selection of genotypes with higher chemical constituents both in leaves and stems based on stage of harvest should be considered for obtaining higher active ingredient yields.



Isolation of bio-active flavonoids from *Hybanthus enneaspermus* by HPLC analysis

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Hybanthus enneaspermus is used as an aphrodisiac, demulcent, tonic, diuretic, in urinary infections, diarrhea, leucorrhoea, dysuria, and sterility. The plant is also attributed to its antimicrobial and anti-plasmodial action. In some part of India, the plant is used to treat diabetes and is also having anti-oxidant property and free radical scavenging activity. HPLC is a chromatographic technique that can separate a mixture of compounds and is used in phytochemical and analytical chemistry to identify, quantify and purify the individual components of the mixture. The present study was carried out to identify the flavonoids present in whole plant of *Hybanthus enneaspermus* using five standard phenolic compounds namely, Gallic acid, caffeic acid, Rutin, Quercetin, Ferulic acid.

Extraction was carried out using 2 ml of fermented broth with 50 mL of 95% ethanol under 80 KHz, 45°C in ultrasonic extraction device for 30 min, repeated twice. The extract was collected and filtered; the filtrate was dried at 50°C under reduced pressure in a rotary evaporator. The dried crude extract was dissolved in the 100 ml mobile phase. After filtering through a filter paper and a 0.45 mm membrane filter (Millipore), the extract was injected into HPLC. Phenolic-flavonoids found in plants exhibit antipyretic, analgesic, anti-inflammatory & antioxidant properties. As the result of the experiment, four compounds Caffeic acid (0.111µg/ml), Rutin (0.002 111µg/ml), Quercetin (0.011 µg/ml) and Ferulic acid (0.005 µg/ml) were quantified.



Novel techniques for extraction of essential oil

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Essential oil's are chemical compounds with an odoriferous nature obtained from herbs, flowers, woods by steam distillation, expression, fat absorption and solvent extraction. Extraction of essential oil is one of the most time consuming and tedious process. However, now a days novel techniques are used for extraction of essential oil like Headspace trapping techniques, Solid Phase Micro Extraction (SPME), Super Critical Fluid Extraction (SCFE), Protoplast technique, Simultaneous Distillation Extraction (SDE), Microwave distillation, Controlled Instantaneous Decomposition (CID), Thermo micro distillation, Molecular spinning band distillation and Membrane extraction. These techniques are more efficient than conventional methods, as they are solvent free extraction techniques , the essential oil produced is lighter in colour, higher yield, contains cleaner, distinguishable peaks ,fragrance and flavour ingredients resemble their source. In the present context, these are time and energy saving techniques and also have several industrial importance.



Green synthesis of silver nanoparticles using neem extract (*Azadirachta indica*) and its role in antimicrobial activity

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Nanotechnology is emerging as a rapidly growing field with its wide application in science and technology for manufacturing of new materials at nanoscale level. Nanoparticles are synthesised by using green synthesis and it is one of the promising branches of nanoscience for applications in different fields includes biomedical and food safety. It makes more attractive potential option due to non toxic and very low cost of synthesis. The neem tree (*Azadirachta indica*) is a tropical evergreen tree native to India and is also found in other southeast countries. The seeds, leaves and bark contain compounds with proven antiseptic, antiviral, antipyretic, anti-inflammatory, anti-ulcer and antifungal uses. Leaf extract of *Azadirachta indica* was used for bioconversion of silver ions to nanoparticles by Green techniques. The plant extract acts both as reducing agent as well as capping agent. The silver nanoparticles showed antibacterial activities against both gram positive (*Staphylococcus aureus*) and gram negative (*Escherichia coli*) microorganisms. With respect to the microbes, the silver nanoparticles get attached to the cell wall, thereby disturbing the permeability of cell wall and cellular respiration. The nanoparticles may also penetrate deep inside the cell wall, thus causing cellular damage by interacting with phosphorus and sulfur containing compounds, such as DNA and protein, present inside the cell. The bactericidal properties of silver nanoparticles are due to the release of silver ions from the particles, which confers the antimicrobial activity. Neem extract based synthesis of silver nanoparticles used in variety of application includes food industry and medical field. In our world facing major problem concerning the food industry is microbial spoilage of food and



severe economic losses are incurred as result of microbial spoilage and/or contamination of food items with pathogens. During food processing, nanoparticles have been applied to improve nutritional quality, flow properties, flavor, color and stability or to increase shelf life. Silver coated ceramics and package are used as antimicrobial agent in many products e.g. food preservation, disinfection of medical products and decontamination of materials.



Biosynthesis and structural characterization of silver nanoparticles and its *in vivo* study using leaf extract of *G. polycaulon*, Indian folkloric medicinal plant in The Nilgiri, Tamil Nadu

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The present study aims to analyse the bioreduction of silver ions by using methanolic leaf extract of *G. polycaulon*. The further characterization methods of UV-Vis Spectroscopy, Scanning Electron Microscope, EDX, and Fourier transform infrared spectroscopy were performed to examine the formation of environmentally benign silver nanoparticles. The results were observed strong plasmon resonance around 360 nm and predominantly spherical and slightly oval shape in the presence of many active functional group (aromatics, alkenes, amines, alkyl halides and aromatics groups) and elements (K, C, Cl, Mg, Ag and O) of the synthesised silver nanoparticles of *G. polycaulon*. Silver nanoparticles were observed to have effective antimicrobial properties against all the tested microorganisms, wound healing activity, even at low concentration which was confirmed by histopathological examinations. The bioactive constituents was structurally evaluated by GCMS analysis. The present work concluded that the methanolic dried leaf extract of *G. polycaulon* is more effective for the synthesis of silver nanoparticles. The resultant silver nanoparticles are highly stable and reproducible. This preparation can be further exploited to rapidly screening the plants can be used for various biotechnological and traditional medicinal applications for various ailments and could be used in future therapeutics.

Key words: *G. polycaulon* leaves, silver nanoparticles, UV-vis spectroscopy, FTIR, antimicrobial, wound healing, GCMS.



Determination of polyphenol oxidase activity in petals and leaves of graviola (*Annona muricata*)

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Poly phenol oxidase is a group of copper containing enzymes and is widely distributed in plant parts. Different parts of graviola constitutes a rich source of PPO and the enzyme is responsible for them turning brown, when the tissue is damaged. The rupture of leaves leads to the rupture of plastids where PPO is located and ultimately results in contact of PPO with the phenolic compounds released from the vacuole. This enzyme PPO catalyzes the ortho-hydroxylation of phenols and the oxidation of catechols to orthoquinone in the presence of oxygen. High correlation can be found between PPO activity and phenolic compounds. It is the rapid polymerization of O-quinones that is the cause of enzymic browning of sour sop. PPO is also responsible for the development of Off-flavors which repels the insects and cattle from feeding the plant parts and they are generally believed to play important roles in plant defense responses.

The use of plant based remedies and their derived substances has been integral part of traditional medicine. Bioactive principle present in medicinal plants attribute to therapeutic efficacy and it can be incorporated into modern system. Enzymic antioxidants play an important role in cellular defense against reactive oxygen species [ROS]. The determination of PPO in petals and leaves of graviola reveals that the activity was maximum in petals 2600 units/min/g weight [FW] while it was 762 units/min/g weight [FW] in leaves. It implies that the higher level of PPO in petals is responsible for its antioxidant property in scavenging free radicals in the human body.



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TECHNICAL SESSION

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Session V Biological management of pest & diseases



Nematode diseases of tropical MAPs: A major hurdle in the advancement of agrotechnology and marketing

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The trade and industrial advancement of a nation relies on the development of profitable agrotechnologies, an enhancement in the export and limitation on avoidable imports. This is only possible when there is plentiful availability of highly productive and disease free planting materials of commercially important tropical medicinal and aromatic plants (TMAPs). The advancement of agrotechnologies, processing and trade through value addition of materials from MAPs are providing much needed avenues of self employment in country like India. With the increasing interest in natural products of plant origin for nutraceutical, health and cosmeceutical benefits, there is an added emphasis on the quality of the source raw materials of TMAPs. In most cases, the vegetative tissues and organs are the source of the required raw material. However, such tissues/organs may become infested / susceptible to many diseases causing deterioration of the quality of the desired economic product and loss of genetic resources. Considerable progress has been made with respect to the identification of disease causing organisms, and their pathogenic impact at organ, cellular and biochemical level. In this lecture focus will be made on nematode diseases threatening the yield, biomass, bioactive potential of TMAPs.

Plant parasitic nematodes are considered a major constraint for the future prospects of tropical medicinal and aromatic plants. It constitutes one of the most important groups of pathogenic organisms prevalent in and around the root system thus, playing a significant role in the plant growth and yield reduction. The damage caused by these phytonematodes to a particular plant depends on crop and cultivars, nematode species,



level of inoculums in soil and the environment. Various plant parasitic nematodes have been found to limit the yield and productivity of numerous TMAPs. The most severe damage generally occurs in the field with high level of nematode inoculums are planted with susceptible host plants. Their deleterious effect on plant growth results in low crop / oil yield and poor quality. Primarily, three species of plant parasitic nematodes i.e. root-knot nematodes (*Meloidogyne incognita* & *M. javanica*), root lesion nematode (*Pratylenchus thornei*) and stunt nematode (*Tylenchorhynchus vulgaris*) affect various TMAPs. The major crops which suffer root-knot nematode infestation are: Menthol mint (*Mentha arvensis*), Davana (*Artemisia pallens*), Geranium (*Pelargonium graveolens*), Patchouli (*Pogostemon patchouli* syn *P. cablin*) Henbanes (*Hyoscyamus* spp.), Basil (*Ocimum* spp.), Opium poppy (*Papaver somniferum*), Ashwagandha (*Withania somnifera*.), Serpagandha (*Rauvolfia serpentina*) Coleus (*Coleus forskohlii*), Qinghao (*Artemisia annua*), Brahmi (*Bacopa monnieri*) and Safed musli (*Chlorophytum borivillianum*), whereas the root lesion nematode is a major problem on Peppermint (*Mentha piperita*), Spearmint (*Mentha spicata*) and Citronella (*Cymbopogon winterianus*). Likewise, stunt nematode mainly affects aromatic grasses i.e. Palmarosa (*Cymbopogon martinii*) and Lemon grass (*Cymbopogon flexuosus*). Thus, exact diagnosis and effective management is the need of the hour for better utilization and exploitation of TMAPs.



***Muntingia calabura* – A Medicinal plant with fungicidal activity and its characterization of antimicrobial properties**

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Plant diseases are the major biotic constraints to crop growth and cause variety of damage and significant yield loss. The disease management requires effective integration of approaches to reduce the crop loss effectively. The present study is successful in demonstrating the inhibitory activity of the medicinal plant *Muntingia calabura* against *Alternaria solani* that causes early blight of tomato and proposes the development of a new botanical formulation (Muntingin 5EC) and its use in plant disease management after package and practice. This ecofriendly botanical formulation was developed from the purified antimicrobial metabolite (Stigmasterol) isolated from the methanol extract of *M. calabura* root. Different concentrations of Muntingin 5EC was examined on seed infection, germination and seedling vigour of tomato and it was found that two per cent Muntingin 5EC increased the germination and vigour and reduced the disease infection in tomato seed to a significant extent. Application of Muntingin 5EC increased the enzyme activity such as peroxidase (PO), polyphenol oxidase (PPO), phenylalanine ammonia lyase (PAL) and phenol content of tomato. Muntingin 5EC (2%) was found to be the optimum concentration for control of early blight of tomato under pot culture conditions. Application of this botanical in plant disease management assumes special significance by being an ecofriendly and cost effective strategy, which can be used in integration with other strategies for a greater levels of protection with sustained crop yields after sufficient evaluation.

Key words: *Alternaria solani*, Botanical fungicide, Muntingin 5EC, Plant diseases management.



Exploitation of antimicrobial properties in *Pseudomonas* spp. for the biological management of root rot caused by *Macrophomina phaseolina* (Tassi.) Goid in medicinal Coleus

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Coleus (*Coleus forskohlii* Briq.) is cultivated mainly for its medicinal principle 'forskolin', a labdane diterpene, reported with pharmacological activities namely antidiabetic, antiplatelet aggregation, anti-inflammatory, antithrombotic and a biochemical activity of adenylate cyclase stimulant increasing intracellular cyclic AMP. It is widely cultivated in Salem, Villupuram, Namakkal, Erode and Dindigul districts of Tamil Nadu. Among the several production constraints, losses due to diseases are much concerned. Among the various diseases, root rot disease caused by *Macrophomina phaseolina* (Tassi.) Goid. is the most devastating disease, which causes reduction in the tuber yield, forskolin content and complete death of the plant. Rhizobacteria live in the plant rhizosphere and colonize the root system and they have been studied as plant growth promoters for increasing agricultural production and produce antimicrobial compounds as biocontrol agents against many plant diseases. *Pseudomonas* spp. has been considered to be most promising biocontrol agents against *M. phaseolina*. Twenty two isolates of *Pseudomonas* spp. were collected and isolated from *coleus* rhizosphere soils of Tamil Nadu and evaluated for their ability to inhibit *M. phaseolina in vitro* by dual culture technique. Among the 22 isolates of *Pseudomonas* spp. screened for antibiosis against *M. phaseolina*, maximum inhibition of the pathogen was shown by the isolate MPf7 (53.05%) which was on par with MPf8 (48.33%), MPf1 (47.50%) and MPf3 (46.11%). Out of 22 *Pseudomonas* isolates tested, 8 isolates showed more than 35 per cent inhibition over control. The result of GC-MS analysis of *Pseudomonas*



sp. MPf7 revealed the presence of antifungal compounds viz., Butanoic acid, 2-Decanoic acid, Oxacyclododecan-2-one, Pyrrolo[1,2-a]pyrazine-1,4-dione, 1,2-Benzenedicarboxylic acid, 9-Octadecenoic acid and Cyclo hexane propanoic acid. *Pseudomonas* sp. MPf7 showed the highest antagonistic activity against *M. phaseolina* evaluated through the antimicrobial screening techniques and this isolate can be explored for the formulation development for the effective management of root rot in coleus.



Effect of selected medicinal plants and marine seaweeds against Nuclear Polyhedrosis Virus (BMNPV) infection in silkworm, *Bombyx mori*

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Grasserie in the larvae of silkworm, *Bombyx mori* is the most harmful disease caused by nuclear polyhedrosis virus (NPV) with enormous economic loss in the sericulture industry. In the present investigation, an effort was made for the screening of antiviral activity against *BmNPV* using medicinal plants namely *Lantana camara* and *Phyllanthus amarus* and seaweeds such as *Sargassum wightii* and *Turbinaria ornata*. Different solvents as hexane, ethyl acetate, methanol and water were used to prepare the crude extracts for insect bioassay study to investigate their efficacy for antiviral activity. Each extract was tested for their antiviral activity with different concentrations using the grasserie infected fifth instar larvae of silkworm, *B. mori*. The methanol extract of *P. amarus* showed significant antiviral activity in the infected larvae of silkworm with a 90 % reduction in NPV infection. In addition, the infected larvae treated with this extract enhanced the economic parameters, viz., larval mortality, cocoon weight, shell weight and shell ratio as observed in control larvae.

Keywords: Botanicals, seaweeds, Anti-*BmNPV*, Grasserie, Silkworm



Management of root rot disease in *Gloriosa superba*

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Glory lily (*Gloriosa superba* L.) is an important medicinal plant grown commercially for a chemical compound, colchicine. Seeds and tubers contain valuable alkaloids viz., colchicine and colchicoside and used to treat gout and rheumatism. Root rot disease caused by *Macrophomina phaseolina* is the destructive disease in *Gloriosa superba*. Yellowing of leaves, discolouration and rotting of roots and dark brown lesions on the stem are the prominent symptoms of root rot disease. Rotting of tubers also occur. Sclerotial bodies as small, black dot like structures are seen in the stem portion and the pathogen survives in the soil for several years. The yield loss ranges up to 50 to 60 per cent due to this disease. Management of disease through fungicides alone leads to soil residual problem and health hazards, besides involving higher input cost. The use of microbial agents can be an attractive option for control of soil-borne plant diseases. Field experiment was conducted in the farmer's field at Dharapuram, Tiruppur district for the management of root rot disease using biocontrol agents. The tubers were dipped in bioagent *Bacillus subtilis* talc formulation at the rate of 2 g per litre of water for 15 minutes. Drenching was also done with bioagent *B. subtilis* talc formulation at the rate of 2 g per litre of water on 30 and 60 days after planting. The results revealed that dipping the tubers in *B. subtilis* talc formulation at the rate of 2 g per litre of water for 15 minutes followed by drenching with *Bacillus subtilis* talc formulation at the rate of 2 g per litre twice on 30 and 60 days after planting was highly effective in managing the root rot disease and increasing the seed yield under field conditions.



Evaluation of microbes against whitefly, *Bemisia tobaci* on Jasmine (*Jasminum sambac* L.)

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Jasmine (*Jasminum sambac* L.) called in Persian as yasmin *ie.* 'Gift of God' is one of the oldest aromatic flowers of India. The production of jasmine is affected by various factors, among these insect pests are the most devastating factor, of which sucking pests, especially whiteflies are taking lead in stunting the plant growth, thereby reducing flower production. Using chemical/synthetic pesticides as a single tactic in controlling this pest have been proved as dangerous as their indiscriminate use have often resulted in problems such as pesticide resistance, pest resurgence, residual toxicity, imbalance in ecological equilibrium, etc. and hence the efficacy of microbes was evaluated to control whiteflies. The field experiment laid out in randomized complete block design with three replications for each treatment was carried out at a farmers holding. The crop was raised with recommended management practices except plant protection measures. The treatments tried were *Metarhizium anisopilae*@ 1x10⁸ spores/g, *Beauveria bassiana*@ 1x10⁸ spores/g, *Paecilomyces lilacinus*@ 1x10⁸ spores/g, *Lecanicillium lecani*@ 1x10⁸ spores/g, *Hirsutella thompsonii*@ 1x10⁸ spores/ml, *Bacillus thuriangiensis var kurstaki* @ 0.5 %W.P along with a standard insecticide, Thiomethoxam 45 WG @0.6 g/l for comparison. Three rounds of foliar application were given at fortnight interval. The post treatment counts of the budworm infestation were recorded on 1, 3, 7 and 14 days interval after each spray, besides pre-treatment count. The experimental results revealed that *L. lecani* treated plots recorded maximum per cent reduction over control of 73.95, 73.72 and 77.36 per cent, followed by *B. bassiana* treated plots recording 66.39, 66.34 and 65.96 per cent after the first, second and third sprays. *M. anisopilae*, *P. lilacinus* and *Bt* falls next in the order of efficacy. However, the standard chemical Thiomethoxam 45 WG @0.6 g/l recorded maximum efficacy of 80.71, 81.20 and 81.62 after the three sprays.



Method of extraction of insecticidal properties from medicinal and aromatic plants

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Many medicinal and aromatic plants produce biologically active secondary metabolites which are isolated using various extraction techniques. The obtained products are used in food, cosmetic, perfume and detergent industries, as well as pharmacology for their antibacterial, antifungal, antioxidant and anti carcinogenic properties and also in agriculture in plant protection area for their pesticidal activity. In recent times, a global concern has been raised against the utility of synthetic insecticides in fields and households. Many of such synthetic insecticides were banned in due course of time because of their toxicity to the non target flora and fauna. In the quest of developing sustainable and environment-friendly commercial products, different plant components have been studied extensively. Although there are many reports on the insecticidal potential of plant-based compounds, very few reports describe the actual active component responsible for such efficacy. Lack of adequate information on the bioactive compounds creates major challenges for the commercialization of plant-derived products for pest control. This paper describes the different methods of extraction of plant-derived insecticidal compounds such as alkaloids, flavonoids and terpenoids. The qualitative and quantitative studies of plant compounds need vast expertise in isolation and characterization methods. The development of chromatographic and spectrometric tools eased the extraction of plant active components. The different techniques involved in the extraction, purification and characterization of insecticidal compounds extracted from plants along with some salient examples available in the literature are discussed. This paper may be helpful to construct a bridge between the biologists and chemists to work together in collaboration for elucidating the different methods of extraction of plant-based insecticidal compounds, which have very significant insecticidal property. This paper is the outcome of collective work from different secondary sources.



***Acorus calamus* L.- A medicinal plant with potential anti-insect activities**

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Acorus calamus L. (sweet flag) is an indigenous herbaceous perennial plant with erect aromatic leaves ascending from a branched rhizome, amenable to cultivation in low-lying wetland areas prone to water stagnation and rice can be cultivated as an intercrop in sweetflag field. The rhizome of *A. calamus* is used in Ayurveda, Siddha and Unani medicines. Many medicines with sweetflag as one of the ingredients are available in the market for the treatment of different ailments. Moreover, it has got antifungal, antibacterial and antiinsect activities. The use of botanical bio- pesticides has gained greater attention since, it is known to be benign to environment and safe to humans. Among the botanicals, *A. calamus* emerged as a potential plant source for the management of insect pests next to *Azadirachta indica*. *A. calamus* has been tested against more than sixty insects in the different parts of the world. Sweetflag dust formulation developed for managing the rice bug has been released by the Tamil Nadu Agricultural University in 2004 and it is being used by the farmers. A new EC formulation developed in TNAU was found to be effective for a range of insect pests viz., *Callosobruchus maculatus*, *Sitophilus oryzae*, *Plutella xylostella*, *Bactrocera cucurbitae* and *Bactrocera dorsalis*. The new product has insecticidal, repellent, oviposition deterrent and growth inhibiting activities on crop and storage insect pests.



Evaluation of efficacy of bio-pesticides in the management of defoliator complex of glory lily, *Gloriosa superba*

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Gloriosa superba (Linnaeus), an important medicinal crop in which lily caterpillar, *Polytela gloriosae*, semilooper, *Plusia signata* and tobacco cutworm, *Spodoptera litura* were recorded apart from the natural enemies viz., spiders, *Oxyopus sp* and ladybird beetle, *Chilomenes sexmaculatus* (Fabricius). Limited and scattered reports are available on the management of insect pests attacking *G. superba*. Hence, field experiments were carried out in the Department of Medicinal and Aromatic Crops, Tamil Nadu Agricultural University, Coimbatore and in the farmer's holdings at Vellipalayam from August, 2011 to December, 2011 with seven treatments and three replications to study the field efficacy of bio-pesticides against *Polytela gloriosae*, *Plusia signata* and *Spodoptera litura* infesting *G. superba*. When the pest population crossed the economic threshold level (ETL), two rounds of sprays were given at 15 days interval. Pre-treatment count on pest population was taken before spraying. Results of the field experiments revealed that among the treatments, flavonoids recorded superiority in the management of *P. gloriosae*, *P. signata* from 3rd day after treatment and it was statistically on par with the standard chemical check, quinalphos. Pungam oil 3 per cent was next in the order of efficacy, followed by neem oil 3 per cent and NSKE 5 per cent. Efficacy of *Bt* (2 ml/lit) was observed only at seven days after treatment and persisted even after 14 days of second spray. At 14 days after treatment, *Bt* was second in the order of efficacy next to chemical pesticides and flavonoids. Similar trend was recorded on *Spodoptera litura* also. From the findings of both the field trials, it was concluded that flavonoids are highly comparable with chemical pesticides



in the management of defoliators infesting *G. superba*. Thus, flavonoids were adjudged as the best alternative to chemical pesticides in gloriosa eco-system and are recommended as one of the components in organic pest management against defoliator complex of *G. superba*.

Key words: *Gloriosa superba*, *Polytela gloriosae*, *Plusia signata*, *Spodoptera litura*, biopesticides



Studies on the management of thrips and necrosis in glory lily, *Gloriosa superba*

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Gloriosa superba, the state flower of Tamil Nadu is an important medicinal crop cultivated for its seeds. Results of field survey revealed that the crop suffers due to thrips, which not only damages the crop by feeding, but also acts as a vector of gloriosa necrosis, a viral disease. Thrips infesting *G. superba* was identified as *Thrips tabaci*. Virus infected plants develop a bronze or purple discoloration. Leaves curl downwards and are distorted. Numerous small, dark spots develop on leaves and leaf stalks. Affected leaves wilt and die. Dark streaks often appear on stems near the growing point, leads to death of the plant. Transmission occurred when the viruses were acquired from infected plants by first or early second instar thrips. Thrips remained infective for life-time but did not pass the virus to their off-springs through the egg. Five days were required from the time the virus is acquired by the thrips from an infected plant until it was able to transmit the virus to another plant. Thrips act as a vector of gloriosa necrosis, even a single thrips could effectively transmit the disease from infected source to healthy plants. Results of field trial revealed that maximum reduction in thrips population was observed in fipronil (0.1 thrips/plant), spinosad (0.6 thrips/plant) followed by natural lactones (3.1 thrips/plant) treated plots at one day after treatment (DAT). Similar trend was observed at 3, 5, 7 and 14 DAT. Because of the reduction in the population of *T. tabaci*, spread of gloriosa necrosis was totally reduced in fipronil and spinosad treated plots followed by the plots treated with natural lactones. Regarding the seed yield, maximum seed yield of 516 kg per ha was recorded in spinosad treated plots, which was found to be on par with fipronil treated plots with the seed yield of 508 kg per ha as against the minimum seed yield



of 328 kg per ha in untreated control. Hence, foliar applications of fipronil, new phenylpyrazole group of insecticide @ 750 ml/hectare twice at fifteen days interval was found to be effective in reducing the population of *Thrips tabaci* and completely suppressed the spread of gloriosa necrosis.

Key words: *Thrips tabaci*, *Gloriosa superba*, necrosis, fipronil, spinosad



Occurrence of *Cochlochila bullita* Stal. in Tulsi, *Ocimum basilicum* Linn.

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Ocimum sanctum, commonly known as Indian basil is a traditional medicinal herb, consumed as herbal tea and has been used for treating ailments, such as cold, kidney stones, urinary tract infections, liver and bladder problems. Since its establishment as an important cash crop, the herb has been notably free of serious insect problems until recently. The occurrence of a lace wing bug, identified as *Cochlochila bullita* Stal was recorded in Indian Tulsi, *Ocimum sanctum* for the first time in the Botanical Garden, TamilNadu Agricultural University, Coimbatore. Damage on *Ocimum sanctum* caused by *Cochliochila bullata* was investigated and symptoms of infested plants were described. Description of this species was also made. *Cochlochila bullita* commonly known as *Ocimum* Tingid, belongs to the family Tingidae of the order Heteroptera. The lace bug damages the host plant by piercing and sucking young leaves and shoots, resulting in the curling and drying of the leaves and shoots. The eggs were inserted into the branches in clusters or singly into the veins of the leaf, leaving the operculum exposed. The egg, 0.04 mm long, is oblong and dark brown. Eggs hatched in 5- 7 days and nymphal stages (instars I-V) lasted for about 10 days. The adults lived for about 40 days. The adult male and female are morphologically similar, except that the female is significantly larger with respect to the body length. The female, however, can be differentiated from the male by the presence of an ovipositor whereas the male has a distinct genital capsule with hidden structures (parameres). *Cochlochila bullita*'s piercing-sucking mouthparts damage the host by removing nitrogen-rich plant fluids. This results in curling and drying of leaf tips, leaf dehiscence and lowering the



inflorescence production. The adult lace bugs usually feed on tender shoots of the herb causing them to wilt and eventually die and in many instances, nymphs and adults feed gregariously on the leaves, leaving tiny black spots of excrement on the upper surface of the leaves. The infestation pattern and survival of *C. bullita* on *O. sanctum* indicates that this bug has the potential to be a serious pest on the medicinal plant, *O. sanctum*.



Biology of Common Rose Butterfly, *Papilio aristolochiae* Fabricius (Lepidoptera: Papilionidae) on *Aristolochia bracheata* L. (Aristolochiaceae)

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Butterflies are the most beautiful and colourful creatures on the earth and have a great aesthetic value. These precious creatures are declining day by day due to several reasons. All butterflies are herbivores in their larval stages, majority of them are host specific and have close relationship with their host plants. The common rose butterfly, *Pachliopta aristolochiae* (Lepidoptera: Papilionidae) is a swallow tail butterfly. It feeds on *Aristolochia bracheata*, commonly known as the Indian Birthwort. Butterflies select host plants for oviposition using chemical cues. A lab study was carried out on the biology of common rose butterfly, emphasizing on the larval activities with the change of time, with a view to analyze the association between butterfly and plant that could be utilized as a tool for the effective biodiversity conservation management through butterfly colonization process. To study the biology of *Pachliopta aristolochiae* on its host plant, *A. bracheata*, singly laid eggs on the host plant were collected from the field and reared in the laboratory under optimum conditions of temperature ($28 \pm 3^{\circ}\text{C}$) and relative humidity ($70 \pm 5\% \text{ RH}$). Ten field collected freshly laid eggs were reared in the laboratory to study the biology of the pest. Incubation period of the egg was 5 ± 0.66 days, larval developmental period was 11.7 ± 0.46 days, prepupal period was 1 ± 0.34 day, and the pupation took 13.2 ± 1.16 days. To conserve the common rose butterfly, the host plants and nectar plants of this species must be protected and conserved in nature. Hence, the genus *Aristolochia*, mostly seen in wild areas need to be conserved. Effective conservation strategy through creation of local awareness, among local villagers living near protected and unprotected forests, can prove to be the most effective method for conservation of butterflies.



Testing the efficacy of talc based botanical formulation of *Coleus forskohlii* against white muscardine disease in silkworm

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White muscardine disease is a serious fungal disease caused by *Beauveria bassiana* L. resulting considerable cocoon yield loss ranging from 30-40 percent. Currently the disease is managed through chemical disinfectants but higher dosage leads to destroy the health of silkworms. Hence, attempts were made to manage the disease through medicinal plant extracts. The experimental results showed that among twelve medicinal plants fresh leaf extracts screened against *B.bassiana*, leaf extracts of *Coleus forskohlii* (10%) recorded the lowest mycelial growth (16.1mm). *In vitro* studies on antifungal activity of *C.forskohlii* against *B. bassiana* showed that the chloroform extract of *C. forskohlii* were found to have maximum inhibition zone of 25mm at 2000ppm concentrations. The talc based botanical formulations of *C.forskohlii* (2000ppm) recorded the minimum larval mortality (10%) and highest silkworm growth parameters viz., larval weight (3.4g), cocoon weight (2.0g), pupal weight (1.4g) and shell weight (0.6g) and highest post cocoon parameters viz., filament length (1013.33m), filament weight (0.32g) and filament denier (2.90).

The TLC, HPLC, GC-MS analysis revealed that the chloroform extract of *C.forskohlii* indicated the presence of 27 active phytochemical compounds. Among the 27 compounds, Butaric acid, 2-Methyl pivalic acid, 1,2-Benzene dicarboxylic acid, Butyl cyclohexyl ester, 1a - Cedrene butyl- 2-ethyl hexy ether, a -Chloroethyl trimethyl silane, Morpholine, Propane, 2-ethoxy group of functional compounds having antifungal activity against white muscardine fungi.



Efficacy of antibacterial activity of Glory lily, *Gloriosa superba* against bacterial wilt pathogen, *Ralstonia solanacearum*

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The antibacterial activity of methanol extracts of different plant parts of *Gloriosa superba* viz., rind, rhizomes, leaves flowers and seeds was tested against growth inhibition of bacterial wilt pathogen, *Ralstonia solanacearum* *in vitro*. Among the different extracts tested, seed and rhizome extracts were found effective in inhibiting the growth of *R.solanacearum* followed by leaves, flowers and rind. The seed and rhizome extracts recorded highest growth inhibition of bacterial colonies (1.93 mm and 1.93 mm) at 100 per cent concentration followed by leaves (1.70 mm), flowers (1.66 mm) and rind (1.63mm). The leaves extract inhibited the growth of 1.70, 1.46, 1.33 and 1.20 mm at 100, 75, 50 and 25 per cent concentrations. Flower extract at 100, 75, 50 and 25 per cent concentrations recorded the growth inhibition of 1.66, 1.50, 1.36 and 1.13 mm. The minimum inhibition was recorded in rind extract at 100 per cent concentration with 1.63 mm where 1.43, 1.26, 1.10 mm growth inhibition in 75, 50, 25 per cent concentrations. In *G.superba*, different extracts inhibited the growth of bacterial wilt pathogen, *R. solanacearum* with highest inhibition was observed by seed and rhizome extracts at 100 per cent concentration.

Key words: Glory lily, antibacterial, growth inhibition, *Ralstonia solanacearum*.



Identification of nematicidal compound of Glory lily, *Gloriosa superba* and its efficacy against root knot nematode, *Meloidogyne incognita*

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Studies were carried out to identify a nematicidal compound from different plant parts of *Gloriosa superba* viz., rind, rhizomes, leaves, flowers and seeds by using HPLC (High Performance Liquid Chromatography) analysis and the efficacy of nematicidal activity was also tested against root knot nematode, *Meloidogyne incognita* *in vitro*. The nematicidal compound has been identified as colchicine by subjecting the methanol extract of *G. superba* rind, rhizome, seed, leaves and flowers to HPLC based on the Retention Time (RT). The methanol extract of rind, rhizome, leaves, flowers and seeds of *G. superba* inhibited egg hatching and caused juvenile mortality of *M. incognita*. Its effect on inhibition of hatching and causing mortality showed directly proportional relationship to their concentrations and time of exposure. Among the different plant parts tested, rhizome extract was found effective followed by seeds in inhibition of egg hatching and caused juvenile mortality of *M. incognita* at 25, 50, 75 and 100 per cent concentrations and different time of exposure. Total inhibition was noticed at higher concentrations of 75 and 100 per cent after 48h of exposure and at 72h total inhibition was noticed in all the concentrations. The rhizome extract significantly caused mortality of juveniles (J_2) of *M. incognita* even at 12h of exposure with 75 and 100 per cent concentrations and total mortality was resulted after 24h of exposure at 100 per cent concentrations and in all the concentrations after 48h of exposure. The rind was slightly less effective as compared to rhizome and seed extracts. The per cent inhibition in hatching was less than 50 per cent after 12h and its efficacy increased after 48 and 72h of exposure. The leaves and flower extracts were found less effective in inhibition of hatching and caused juvenile mortality at different concentrations and time of exposure.

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Key words: Glory lily, colchicine, egg hatching , juvenile mortality, nematicidal compound, inhibition.



TECHNICAL SESSION

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General papers



HIBISCUS – An ornamental plant with immense medicinal properties

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Hibiscus is a perennial shrub that is found in each and every home gardens of India. It is a vigorous shrub that flowers throughout the year. A wide range of flower colour starting from red to violet and varied growth habit like tall and dwarf types are there in hibiscus. Flower forms like single, double, multi-petaled and with modified styles are present in hibiscus flowers. Traditionally these hibiscus flowers are used for treating a wide range of diseases. Mostly the single types are used for medicinal purpose. The ethanol extract of *Hibiscus rosasinensis* flower is found to increase the rate of wound healing in rats. It was found that the ethanol extract of Hibiscus increased the hydroxyproline content of the granulation tissue in the wounded area which is needed for the activation of collagen which plays a role in healing of wounds. It is found that crude extract of Hibiscus contain two compounds like cholinomimetic and calcium antagonist. Cholinomimetic is likely to play as aperient (mild laxative) which make it possible to be used for curing constipation. Calcium antagonistic activity provides pharmacological rationale for its use in diarrhoea. The extract of petals and leaves have the property of enhancing the hair growth in rats. This property could be either due to decreased 5 alpha dihydrotestosterone or increased subcutaneous blood flow in rats. The crude extract of petals of *Hibiscus rosasinensis* possess a good anti-oxidant activity which paves way for the extract of the petals being used in various pharmacological industries. The presence of anti-oxidant potential in hibiscus petals, is the reason why they were used in curing various ailments in human systems. Apart from this it also possess anti-diabetic property and also can be used to treat hypertension and hypercholesterolemia. These properties are mainly due to the presence of compounds



like anthocyanin and flavonoids which includes cyanidin 3,5-diglucoside, quercetin-3,7-diglucoside, quercetin-3-glucoside and cyaniding-3-sophorosode-5-glucoside. These areas are not well studied in plants like hibiscus. Hence a diverse research in hibiscus under these fields will aid in wonderful findings which will be in favour of the betterment of the people.



Heavy metals toxicity in medicinal and aromatic crops- a problem concern

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Quantitative determination of the composition & properties of food products is important from the view point of quality and safety of the food. Pollution of general environment has increasingly gathered a global interest since the beginning of this century. In this respect, contamination of agricultural soils with heavy metals has always been considered a critical challenge in scientific community. Heavy metals are generally present in agricultural soils at certain levels. Medicinal plants have a long history of use in therapy throughout the world. Herbal formulations are getting popularity throughout the world and commercialized extensively for various medicinal properties. WHO has emphasized the need for quality assurance of herbal products, including testing of heavy metals and pesticides residues. WHO recommends that medicinal plants which form the raw materials for the finished products may be checked for the presence of heavy metals, further it regulates maximum permissible limits of toxic metals like arsenic, cadmium and lead, which amount to 1.0, 0.3 and 10 ppm, respectively. Medicinal herbs are easily contaminated during growth, development and processing. Toxic level of heavy metal will adversely affect the absorption and transport of nutrient, disturb the metabolism and have impact on growth and reproduction in plants. heavy metal decreases yield and affect the quality of the herbal product. It is essential to have quality control of medicinal plant raw materials. Use of analytical methods (AAS, GC, ICP) help to determine the presence of contaminants and toxic elements like heavy metals, pesticide residues, aflatoxins can be highly beneficial in order to avoid over consumption and their cumulative



toxicities on long-term use. It has caused a great concern in crops such as *Ocimum tenuiflorum* L. in *Ocimum* excess of Cr affects the production of eugenol *Dioscorea bulbifera* L. *Hypericum perforatum* L, *Phyllanthus amarus*, *Rosmarinus officinalis* A broad set of metals need to be pondered namely; lead (Pb), cadmium (Cd), aluminum (Al), mercury (Hg), and arsenic (As) so that timely management can be done to produce a quality product.



Bioactive compounds from tropical ornamental plants of medicinal value

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Bioactive compounds in plants can be defined as secondary plant metabolites eliciting pharmacological or toxicological effects in man and animals. Secondary metabolites are produced within the plants besides the primary biosynthetic and metabolic routes for compounds associated with plant growth and development, and are regarded as products of biochemical “side tracks” in the plant cells and not needed for the daily functioning of the plant. Several of them are found to hold various types of important functions in the living plants such as protection, attraction or signalling.

Many of the major human diseases like Alzheimer's, Cancer, Diabetes, Sclerosis, Parkinson's etc are due to the presence or generation of free radicals resulting in oxidative stress. Thus the maintenance of oxidative stress in balance is necessary and intake of antioxidant rich nutrition is important.

In countries like India, flowers are always used in all its cultural activities (Jeeva et al 2011). Flowers are widely used for their beauty and color they radiate. Flowers which serve their purpose usually wilt and thrown as trash. However, due to the possession of phytoconstituents they can be potentially considered as a major source of phytocompounds in pharma and nutraceutical industries. Antioxidants potency and bioactivities of metabolites from flowers have been reported. (Ebrahimzadeh et al., 2009).



***Euphorbia hirta* Linn. A weed of wonders for therapeutic applications: An overveiw**

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Euphorbia hirta Linn.(Asthama plant in Hindi), a pantropical weed, a native of India is one of the most extensively researched plant in recent times by professions due to its uses in folk remedies which has many activities including thermogenic, depurative, rubefacient, tonic, aphrodisiac, abortive, ophthalmic, diuretic, contraceptive etc., and some of the recent findings viz., chemopreventive effects against the development and proliferation of cancers, in treating dengue's, prophylaxis against malaria, tumours, curing allergy which includes allergic rhinitis, anaphylaxis, purities and asthma-the disease associated with inflammatory conditions. Plant extract exhibited coagulation and hemagglutination properties. It also showed the health promoting properties due to presence of proteins, carbohydrates, steroids etc. In conclusion, the present review will provide some of the recent experimental evidence of therapeutic applications of *Euphorbia hirta* L.



Indigenous knowledge and medicinal plants used by Fisher folks in Tranquebar region, Tamil Nadu

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India is rich in medicinal plant diversity which is distributed in different geographical, environmental conditions and associated tribal and folk knowledge systems. The fisher people mostly depend on coastal for their livelihood and up to 70% of the rural population still depends on traditional medicine as a primary healthcare source. The present study is concentrated on various indigenous phytotherapies used by the fisher folks of Tranquebar regions. Interviews and semi –structured questionnaire survey were conducted among native communities and 60 taxa of angiosperms belonging to 32 families were recorded from the study area. The present investigation brought out some popular medicinal plants frequently used in the treatment of various diseases like Psoriasis, Poisonous-bites, stomach-ache, nervous disorders, cough, fever, body pain, jaundice, rheumatism, mums, dysentery, head-ache., etc. Some noteworthy medicinal plants such as *Sphaeranthus indicus* L., *Hybanthus ennaespermus* (L.) F.Muell, *Sesuvium portulacastrum* L., *Heliotropium curassavicum* L., *Pandanus odoratissimus* L.F. , *Cressa cretica* L., *Catharanthus roseus* (L.) G. Don, *Justicia tranquebarensis* Roxb., *Vitex negundo* L., are depended by the fishermen for their livelihood, as it is increasing dramatically due to poor economic condition and absence of awareness about the importance of medicinal biodiversity. Unplanned and over exploitation of the bio-resources for medicines by the inhabitants are endangering the biodiversity of medicinal plants. It is recommended that a harmonious of indigenous knowledge with modern science is essential to promote sustainable and sustained utilization of these uncultivated sources of plants.



Medicinal Plants: Power of Planet (Withspecific reference to Medicinal, Health and conservation of Biodiversity, Biodiversity)

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Plant wealth is super natural power for the biological system on this planet i.e. they govern all biofunctions, distribution and climatic link of different habitat of this world. **Biofunctional plants (BPs)** are live telecast of our mother planet growing naturally and cultivated in different geographical regions of the world since ancient times. Plants are major component of our biological and Ecological system which deals direct relationship with Biodiversity of plants and Biological system. Plants have specific biofunctional role and growing in different Biospecific **Regions (BRs)** of the world, commonly known as **Biospecific Region Plants (BRPs)**. In real sense Plants are the super natural wealth and power of our mother earth Planet.

Medicinal plants have been playing pivotal role in providing medical aid and **promote positive health** in mankind. In recent years there has been a tremendous expansion in the number of the institutions with provision for research and development of various branches of medical systems. The drug plants are collected and prepared in crude indigenous way. The medicinal value of drug plants is due to the presence of some chemical substances in the plant tissues which produce a definite physiological action on the human body. There are about more than 9000 thousand plants are known as medicinal plants but only a few are utilized on large scale by civil society. Health is a comprehensive term used for physical, biological and mental fitness on whole of humans and environmental system, directly or indirectly govern by plants. Considering all benefits derived by plants for human and ecological security, there is an urgent



need of Conservation plants in natural state which is done either by ex-situ or in-situ methods. **Fomeag (Food + Medicine+ Agricultural/Arboretum/Aquatic Garden) cafeteria** would be a new mile-stone and vision to the nature's health, biodiversity-climate links, utilization and conservation of biodiversity especially for food , medicine and health plants which provides a new impetus in revolutionizing the sustainable and economically feasible development of the country and the whole world.



Medicinal orchids in India and strategy for their conservation

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Orchids belong to the family *Orchidaceae*, comprises one of the largest families of flowers in the plant kingdom with over 30,000 different species. They are ultimate in rarity, beauty and allure. Apart from their ornamental value, orchids evoke a special interest in us because of their distinctive uses in traditional medicines. Ancient history indicates that roots of orchids were dried and chopped and were used in the traditional pharmacopoeia of Greece and neighbouring Asia Minor as antidepressants and stimulants. Even today in some rural areas of these countries “salep”, a nutritious drink prepared from the dried tubers of certain orchids is common. Interesting uses of orchids as medicines include the use of bulbs of the species *Diuris maculata* for emergency food, their dry tuber roots as an anti-aphrodisiac and their petals as skin allergy soothers. In another species, *Cyrtorchis arcuata*, the whole orchid is dried and powdered to treat diabetes; while leaves of the species *Bulbophyllum maximum* and *Tridactyle tricuspidata* are used by the Malawi peoples in Southeast Africa to treat against sorcery and madness. Out of the 1220 species of orchids reported from India, nearly 300 species are rare, and about 150 are endangered and ornamental whereas very few i.e., about 37 are of medicinal importance. Among the endangered ones, 6 species viz., *Paphiopedilum fairieanum*, *P. venustum*, *P. wardii*, *Vanda coerulea* and *Renanthena imschootiana* belong to the Appendix-I list of CITES and IUCN. Research reports indicate the role of *Vanda tessellata* as a potential aphrodisiac and fertility booster. Conventionally, there are three prominent methods of conservation of genetic resources of orchid species, namely, legislative measures, *in situ* conservation in sanctuaries/reserves, *ex situ* conservation in orchidaria/botanic gardens by cultivation. India has 17 biosphere reserves, 98 national parks, 13 botanical for conservation of endemic, endangered and vulnerable orchid species. Propagation of plants through *in vivo/in vitro* and their re-introduce into well protected habitat are among other measures suggested for orchid conservation.



Medicinal plants as a bioactive source: A review

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Medicinal plants are known to endowed richly with bioactive compounds like glycosides, flavonoids, proanthocyanidins, tannins, mono- and sesquiterpenoids, phenylpropanoids, diterpenoids, resins and alkaloids are the compounds produced by plants possess pharmacological or toxicological effects on human being and also in veterinary field. Plants like *Digitalis purpurea*, *Senecio jacobaea*, *Cicuta virosa*, *Nartheicum ossifragum*, *Quercus spp.* Nuts, *Taxus baccata* and *Aconitum septentrionale* are the few sources for bioactive compounds. If bioactive compounds are at high doses may elicit the pharmacological or toxicological effect when ingested by the humans or animals. Typically bioactive compound are produced as secondary metabolites. Thus bioactive compounds in broad term are secondary metabolites eliciting the pharmacological or toxicological effect in human beings as well in animals. Secondary metabolites are synthesized within the plant system besides the biosynthetic and metabolic routes of compounds aimed at plant growth and development such as carbohydrates, proteins, amino acids and lipids. The bioactive compounds synthesized from the plants seem to be rule than exception. Even common plants are capable of producing such compounds. However, higher concentrations of potent bioactive compounds are known to be found in most of the medicinal plants and poisonous plants than food and feed plants. So intake of plants containing less bioactive compounds are considered to be more worthwhile.

Key words: medicinal plants, Bioactivecompounds, secondary metabolites.



Minor salubrious solanaceous vegetables as a source of bioactive molecules

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Solanaceae is a family of flowering plants in the Solanales order, characterized by five petaled flowers, typically conical or funnel form, and alternate or alternate to opposite leaves, and including some of the more important food and drug-producing plants. This family is known as the potato or nightshade family. Family Solanaceae includes about 75 genera and over 2000 species of herbs, shrubs and small trees, distributed in the temperate and tropical regions of the world. The Solanaceae family is characteristically ethnobotanical, that is, extensively utilized by humans. It is an important source of food, spice, and medicine, and many plants are used as ornamentals, including the petunia and butterfly flower. Some of the Solanaceous plant that has to be given importance for cultivation and extraction of bioactive molecules are African Eggplant (*Solanum macrocarpon* L.), Jilo (*Solanum gilo*) and Pepino (*Solanum muricatum* Aiton).

African Eggplant (*Solanum macrocarpon* L.) is commercially grown in Ivory coast countries of Africa. It is also grown in Madagascar and West Indies (Yamaguchi, 1983; Messiaen, 1992). Fruit used as a laxative (to treat cardiac diseases), flowers are chewed to clean teeth. Leaves are heated and then are chewed to ease throat pain. In Kenya the roots are boiled and the juice is then consumed to kill any hookworms in the stomach. The root is also used for bronchitis, body aches, asthma, and speed up the process of healing wounds and the seeds are crushed to treat toothaches.

Jilo (*Solanum gilo*) is considered as an important crop in Nigeria while in Central and Southern Brazil, it is a minor crop. It possess low calorific value, vitamin A, B, C and minerals such as Ca, Mg, Fe, P and K. Anticancer properties; prevent colorectal,



cancer and constipation; regulates blood pressure; promotes oral hygiene and a healthy breath; good for diarrhea and anaemia, burns and dermatitis.

Pepino (*Solanum muricatum* Aiton) a nutritious vegetable-cum-fruit crop is highly juicy and moderately sweet. The fruits are rich in minerals and vitamin C, low in starch and soluble sugars. The fruit is almost devoid of oxalate, which is another striking feature. Pepinoes offer multiple choices for consumption like green and cooked vegetable, fresh fruit (dessert), fruit salad, delicious fruit juice, squash etc. Pepino is well known in South American countries, New Zealand and Australia. Recently, it has been introduced to the Nilgiris in Tamil Nadu first time in India from the Northern Andes, South America. Vitamin A, C and K and also B, protein, Fe, Cu and K. Essential for a healthy immune system; Ca for bones; K which is needed for relaxing and lowering blood pressure and a good diuretic too; helps with liver disease, lowers blood pressure, helps those that suffer from strokes to heal faster, and promotes cardiovascular health; helps in losing weight; slows digestion; prevents oral thrush and maintain healthy gums. Thus these plants cultivation has to be expanded and its bioactive molecules can be used effectively for a healthy living.



Repository of novel bioactive molecules from underutilized Cucurbits

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Indian sub-continent is well known as an important center of origin and diversity of large number of agri-horticultural crops. Cucurbits are the popular name of the family Cucurbitaceae, commonly known as the gourd family. They are widely distributed in the tropics and warm temperate regions of south, southeast and East Asia, Africa including Madagascar, central and south America. The family is represented by about 120 genera and 800 species. Cucurbits are mostly climbers and trailers, are rarely woody and arborescent. They are characterized by inferior ovary and parietal placentation. The most common uses of cucurbits are as vegetables and fruits. They are valuable sources of vitamins and minerals. There are many underutilized cucurbits with high nutritional value, preventing the current health problems like diabetes, cancer and hypertension and so on. Ivy gourds (*Coccinia grandis*), Spine gourds (*Momordica dioica*) and Buffalo gourds (*Cucurbita foetidissima*) are among them which serve as an important source in treating various diseases.

Ivy gourd is native to India. The plants are distributed in Myanmar, Pakistan and whole of the South-East Asia. It is also distributed in Tropical Africa. Fresh juice of roots is used to treat diabetes; tincture of leaves is used to treat gonorrhea, paste of leaves is applied to the skin diseases. Dried bark is a good cathartic. Leaves and stem are antispasmodic and expectorant. The fleshy green fruit is very bitter. Green fruit is chewed to cure sores on the tongue. It is famous for its hypoglycemic and antidiabetic properties in Ayurvedic system of medicine.

Buffalo gourd is a native of semi-arid regions of North America and Mexico. Native America and Mexican tribes have used buffalo various ways as food, cosmetic,



detergent, insecticides etc. Its underground tuber has medicinal properties. Along with fruits, its seeds are very useful. They are roasted, boiled or ground and cooked to make edible mash. The seeds can be ground into powder and used as a thickener in soups. Buffalo gourd is employed medicinally by many native of North American tribes who use in the treatment of skin complaints (Moerman, 1998). It is still employed in the modern herbalism as a safe and effective vermicide (Bown, 1995). The leaves, stems and roots are laxative and poultice (Balls, 1975). Zhong and Halaweish (2003) isolated foetidissimin from the roots of buffalo gourd which possesses anti cancerous and antiviral properties.

Spine gourd is distributed from Himalayas to Sri Lanka; up to an altitude of 1500 m. Plants of spine gourd are found naturally growing in hilly tracts of Rajmahal, Hazaribagh and Rajgir of Jharkhand and in wet hills of Maharashtra, Assam and West Bengal (Rathi *et al.*, 2002). Fruit are diuretic, alexiteric stomachic laxative, hepatoprotective, and have antivenom property. It is also used to cure asthma, leprosy, excessive salivation, prevent the inflammation caused by lizard, snake bite, elephantiasis, fever, mental disorders, digestive disorders and troubles of heart and to treat discharge from mucous membrane. Fresh fruit juice is prescribed for hypertension. The fruit is cooked in a small amount of oil and consumed for treating diabetes. The alkaloid present in seed called momordicin and present in root called momordicafoetida. Most of the bioactive molecules that have the curing property are found in the nature but are yet to be exploited. Among them are the ivy gourds, spine gourds and buffalo gourds from which the bioactive molecules can be extracted and used effectively.



Potential medicinal properties of Nerium- *Nerium oleander* L.

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Nerium oleander L. is an evergreen shrub under Apocynaceae family. It is native Northern Africa and the Mediterranean region. Globally it is well acclaimed as an ornamental due to its abundant and long lasting flowering habit its heat, salinity and drought tolerance. Nerium flowers are commonly used for worship in home and temples. Several varieties have become very popular as cultivated shrubs because of their fragrant showy blooms in spite of the poisonous nature of the sap. The flowering is throughout the year, but are at their best during rains.

The nerium leaves contain neriin and oleandrin. Oleandrin is 3-glucoside-16-acyle derivative of gitoxigenin. They are poisonous to mammals. All parts of the plant either fresh or dried are toxic and contain cardiac glycosides, where the roots and seeds having the highest concentrations. The most prominent of those glycosides are oleandrin and neriin.

Antioxidants are substances that protect cells from the damage caused by unstable molecules known as free radicals. Free radicals constantly seek out healthy cells and attack their vulnerable outer membranes eventually causing cellular degeneration and death. Antioxidants interact with these free radicals and prevent any damage ought to happen. Examples of antioxidants include α -carotene, lycopene, vitamins C, E, A and other plant derived metabolites. Antioxidants are widely used as ingredients in dietary supplements in the hope of maintaining health and preventing diseases such as cancer and coronary heart disease. In addition to these uses of natural antioxidants in medicine, these compounds have many industrial uses, such as preservatives in food and cosmetics and preventing the degradation of rubber and gasoline. In traditional Chinese medicine, the flowers and leaves of *Nerium oleander* (Kaner) have been used to stimulate cardiac muscles, relieve pain and eliminate blood stasis. Immunological active pectin polysaccharides have been isolated from *Nerium oleander*.



PHARMACEUTICAL SIGNIFICANCE OF ORNAMENTAL PLANTS

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The world is running towards urbanization, modernization, industrialization etc. and the population is increasing day by day. These issues are resulting in pollution, change in food habits, global warming, malnutrition etc. All these factors are increasing problems to human health there by demand for new and effective drugs. Plants produce various secondary metabolites as the part of their normal metabolic activities among which several metabolites have healing properties.

India has been considered as treasure house of a large number of valuable medicinal plant species. Ministry of Environment and Forests has identified and documented over 9500 plant species considering their importance in the pharmaceutical industry. The use of plants as complementary and alternative medicine is increasing. Various plants which have the ornamental importance are capable of producing chemical compounds of medicinal value and have the ability to be exploited in pharmaceutical industry on which very less attempts have been taken up. Some of the ornamental plants which can act on the different body parts of human are: Head:Honey suckle (*Lonicera japonica*), *Ixora coccinea*, *Tabernaemontana divaricata*; skin: *Tabernaemontana elegans*, *Hibiscus rosa-sinensis*, *Mirabilis jalapa*, *Plumeria rubra*, *Rosa indica*, *Thespesia populnea*, *Cassia occidentalis*; throat: *Cassia fistula*, *Jasminum officinale*; heart: *Cassia fistula*, lotus (*Nelumbo nucifera*); lungs: Bamboo, *Terminalia arjuna*; stomach: *Tabernaemontana divaricata*, *Quisqualis indica*, *Andrographis paniculata*; joints: *Cassia fistula*. Even our national flower, lotus (*Nelumbo nucifera*) has been the subject of a number of *in vitro* and animal studies, exploring its pharmacologic effects, including anti-ischaemic, antioxidant, hepatoprotective, antiproliferative, anti-inflammatory and antiviral activities, although clinical trials are lacking. Research into the quality, safety, molecular effects, and clinical efficacy and identifying the active compounds of these plants is needed.



Sarpagandha -World's first Antihypertensive drug

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Hypertension is one of disastrous disease resulting of various physiological and psychological causes. Though knowledge of disease is widespread but incidence and prevalence of disease is increasing at alarming rate. *Rauvolfia serpentina* is a medicinally famous herb in ayurvedic and western system of medicine. About 55 alkaloids are isolated from dried roots of Rauvolfia species among them reserpine, serpentine, Ajmalicine is most important principle constituent. Reserpine is a specific remedy in hypertension and certain neuropsychiatric disorder. It is first herbal antipsychiatric drug. By its action on vasomotor center, it leads to generalized vasodilation with a lowering of blood pressure and by its depressant action on cerebral centers, it soothes general nervous system. Apart from this drugs from sarpagandha is used in vertigo, insomnia, cardio depressant, sexual aggression, migraines. Hence patients with excessive hypertension can be managed better with ayurvedic antihypertensive drugs like Sarpagandha.