सीएसआईआर
CSIR
भारत का नवाचार इंजन
The Innovation Engine of India

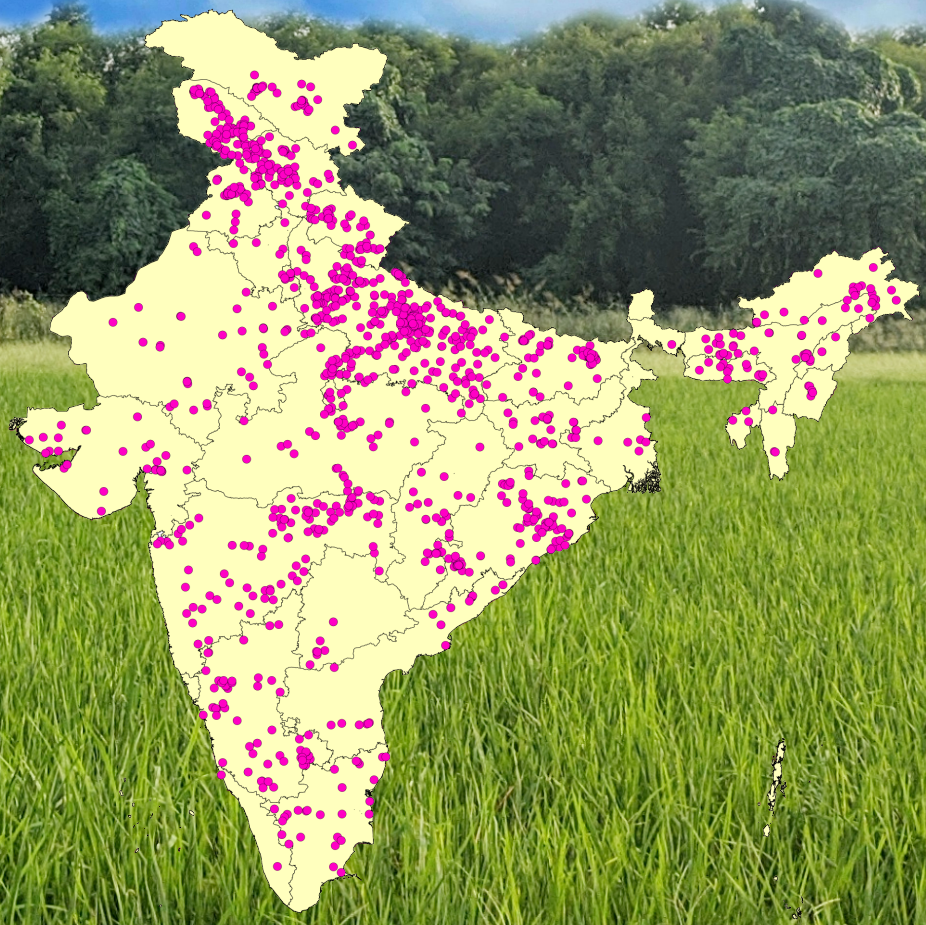
वार्षिक प्रतिवेदन

२०२३-२०२४

Annual Report

2023-2024





सीएसआईआर-केन्द्रीय औषधीय एवं सगंध पौधा संस्थान, लखनऊ

CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow

सीएसआईआर–सीमैप के प्रमुख योगदान

- 3,00,000 हेक्टेयर से अधिक क्षेत्र में मेन्था की खेती का विस्तार, लघु अवधि और उच्च पैदावार वाली किस्मों और बेहतर कृषि और प्रसंस्करण प्रौद्योगिकियों को विकसित किया, जिससे लगभग 6,00,000 किसानो की आय में वृद्धि हुई और भारत को एक मेन्थॉल आयात करने वाले देश से मेन्थॉल मिंट तेल के सबसे बड़े वैश्विक उत्पादक और निर्यातक देश बनाने में मदद मिली।

- आर्टीमिसिया एनुआ की उच्च पैदावार वाली किस्में, निष्कर्षण और आर्टिमिसनिन के व्युत्पन्नकरण के लिए रासायनिक प्रक्रिया के विकास और किसानों में सुधारित किस्मों की खेती को बढ़ावा देकर मलेरिया रोधी दवा आर्टिमिसनिन के 'मेक इन इंडिया' को सुनिश्चित किया।

- वेटिवर (खस) की कम अवधि और उच्च पैदावार वाली किस्मों को विकसित और प्रसारित करके नमक प्रभावित और बाढ़ ग्रस्त तटीय और नदी के किनारे वाले क्षेत्रों में उनका लाभकारी उपयोग।

- बुंदेलखंड, विदर्भ, कच्छ और मराठवाड़ा जैसे कम वर्षा वाले क्षेत्रों में नींबू घास, पामारोजा, अश्वगंधा और तुलसी की खेती की बेहतर किस्मों का विकास और प्रसार।

- आयुर्वेद में वर्णित औषधीय पौधों का उपयोग करके मधुमेह टाइप 2 के प्रबंधन के लिए सफल हर्बल फॉर्मूलेशन (सीएसआईआर– एनबीआरआई के साथ) का विकास।

- किसानों और उद्योगों को सुगंधित फसलों की खेती, प्रसंस्करण, मूल्यवर्धन और विपणन द्वारा सशक्त बनाने के लिए सीएसआईआर एरोमा मिशन में अग्रणी भूमिका।

- भारतीय–महासागर रिम एसोसिएशन (IORA) के सदस्य देशों के बीच औषधीय पौधों के ज्ञान और व्यापार के आदान–प्रदान को बढ़ावा देने हेतु सीमैप में समन्वय केन्द्र की स्थापना।

वार्षिक प्रतिवेदन

२०२३–२०२४

Annual Report

2023-2024

CSIR-Central Institute of Medicinal and Aromatic Plants
(Council of Scientific and Industrial Research)
Lucknow | Bengaluru | Hyderabad | Pantnagar | Purara

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Special Thanks
Dr. Manoj Semwal for providing cover page photographs.

Cover page
The cover page illustrates the drone-assisted precision agricultural techniques being developed by CSIR-CIMAP in alignment with programmes promoted by Government of India. The map depicts aromatic crops clusters developed under CSIR-Aroma Mission for which CSIR-CIMAP is the Nodal Institute.

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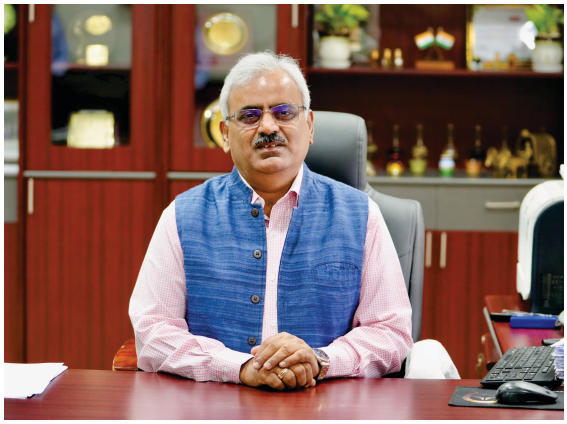
From The Director's Desk....



I am delighted to present the annual progress report of the CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) for the year 2023-24. The institute is engaged in breeding improved varieties of medicinal and aromatic plants (MAPs) through conventional and advanced-molecular technologies including genome editing, developing better agricultural practices, synthesizing high-on-demand active compounds through synthetic biology, characterization, extraction, and bioprospection of bioactive phytomolecules/extracts, formulating innovative herbal products, value addition and business models to improve socio-economic status of the farmers and entrepreneurs.

As the nodal laboratory, CSIR-CIMAP has made significant progress under CSIR Aroma Mission. To raise awareness among farmers about the potential economic benefits of growing aromatic crops, lower input costs and reduced environmental impact, this year the institute promoted the cultivation of aromatic plants in about 1100 hectares of agricultural land and conducted more than130 awareness-cum-training programs which benefitted around 7800 farmers/entrepreneurs. Additionally, 20 sustainable clusters of tribal farmers were developed in different parts of the country like Anamalai Tiger Reserve (Tamilnadu), Dudhwa Tiger Reserve (Uttar Pradesh), Malgaon (Chhattisgarh) and Majuli (Assam) etc. The life of these tribal communities has been improving significantly through cultivation of high valued aromatic crops using agricultural practices developed by CSIR-CIMAP.

CSIR-CIMAP also participated in CSIR-Floriculture Mission and played an important role in developing a successful national and international market related to floriculture business. The institute significantly contributed in enhancement of area under cultivation of floriculture crops. During this period, about 101 hectares of agricultural land has been covered with floral crops benefitting more than 500 farmers. The net income of these farmers has increased many folds.

CSIR-CIMAP also made strong progress in R & D areas. Under one of the CSIR-FTT projects, we are raising nicotine-less commercial varieties of tobacco plants through genome-editing for human welfare. Under another CSIR project, the institute has developed region specific smart agro-technologies for enhancing soil and plant health. In addition, the institute has conducted many other important R&D studies through various projects, of which 27 (GAP, CNP, and CSIR projects) were sanctioned during FY 2023-24.

In a recent research work from Plant Biotechnology Group published in "Journal of Hazardous Materials", it has been shown that nicotine production in tobacco roots is regulated by shoot-to-root mobile transcription factor NtHY5, the mutation in which through CRISPR technology decrease the level of nicotine biosynthesis. This presents a possibility of producing nicotine-less commercial variety of tobacco to lower the life risk of smokers around the globe. Another work published in the same journal reports an interesting role of miR397b-LAC2 module in regulating cadmium stress response in model plant *Arabidopsis thaliana.* This work provides a clue to improve cadmium tolerance in various plants including MAPs. In yet another significant study published in "Plant Physiology", a mechanism for modulation of monoterpene indole alkaloids biosynthesis by ROP GTPase with geranyl geranylation motiff was deciphered which contributed in advancing our understanding about alkaloid biosynthesis in *Catharanthus roseus*.

The scientists from Phytochemistry Division published a study in "Journal of Ethnopharmacology" which reports the isolation of 2-phenyl ethyl alcohol (PEA) from the spent floral distillate of damask rose. This is a significant study related to value addition as the isolated compound showed vasorelaxation in both aorta and mesenteric artery. The division also developed a tool involving Radiocarbon (^{14}C) accelerator mass spectrometry which can differentiate flavor chemicals of synthetic origin from biobased sources. This study, published in "Science of the Total Environment", was able to distinct natural and fossil-derived citral and its blends in Cymbopogon essential oils.

In a couple of studies from Bioprospection and Product Development Group, published in "International Journal of Biological Macromolecules" and "Phytotherapy Research", the role of aescin was established against lung cancer proliferation and mobility. This phytomolecule also enhanced the efficacy of sorafenib synergistically in lung cancer cells. In another study addressing psoriasis that was published in "Life Sciences", the anti-inflammatory, anti-proliferative and anti-psoriatic properties of a plant molecule apigenin was demonstrated using *in-vitro* and *in-vivo* models.

A group of scientists from Plant Breeding and Genetic Resource Conservation Division explored the genetic variability of opium poppy and conducted character association studies for further genetic improvement of the plant. In addition, they also studied the genetic diversity and chemical profiling of natural populations of Indian Cannabis for devising effective breeding strategies. Both the studies have been published in "Industrial Crops and Products".

The scientists from Bioinformatics group published a potent methodology to predict the inhibitory concentration (IC_{50}) of terpene derivatives against human breast cancer in "Journal of Molecular Structure" which is based on machine learning mediated QSAR modeling, molecular docking and dynamic simulation. The group also developed similar methodology to predict the anti-cancer potency of curcumin and other novel analogs and published the work in "Current Medicinal Report".

During FY 2023-24, the institute published more than 116 research papers in high-impact journals with an average impact factor more than 4, transferred seven technologies to different industries and filed four patents. CSIR-CIMAP has signed 19 MoUs with various NGOs, Universities, State Government/ Corporate Sector, FPOs and others. During this period, about 8800 farmers/entrepreneurs/students/faculties visited our institute. A new herbal product viz. Aloe Roma Gel (skin soothing Aloe vera gel free from chemical preservatives) was also developed. The strength of our institute lies in our students and during this tenure, 25 students were awarded Ph.D. through AcSIR and JNU Ph.D. programs, and 34 new students enrolled for the Ph.D. program in various disciplines.

CSIR-CIMAP is continuously upgrading and improving facilities to conduct rigorous research as per global standard and society requirement. This year, a new plant growth facility having two walk-in plant growth chambers for growing plants and conducting experiments under completely controlled conditions has been developed. In addition, a new greenhouse and a net-house to perform studies related to genetically modified plants under natural soil condition has been constructed. Furthermore, to understand the functions of various molecules and proteins at the 3-D structural level, a single-crystal X-ray diffractometer (XRD) facility was established. This would help in acquiring more detailed knowledge to develop effective drugs and other important molecules. CSIR-CIMAP also developed an Android mobile app, 'CSIR-Aroma', to provide information and advisories on aromatic crops to farmers and entrepreneurs.

The Institute regularly celebrate Kisan Mela in the month of January, which benefits thousands of farmers across the country. This year, the CIMAP Kisan Mela obtained special grace by the presence of Shri Adityanath Yogi Ji, Chief Minister Uttar Pradesh and CSIR Director General Dr. N. Kalaiselvi. It was really motivating to get praise from honorable Chief Minister for our continuous efforts to address various societal problems, especially related to farmers.

In addition, our continuous efforts and work have earned accolades from other agencies and bodies. CSIR-CIMAP's rajbhasha patrika "Aus Vigyan" was conferred first prize by Nagar Rajbhasha Karyanvayan Samiti (Zone-3), Lucknow. The scientists of the institute have received various prestigious awards during FY 2023-24, including Fellow of Indian Academy of Horticulture Sciences and Indian Botanical Society (Dr Birendra Kumar), Fellow of National Academy of Agricultural Sciences (FNAAS), Fellow of International Society of Environmental Botanists (FISEB) and Fellow of the Royal Society of Chemistry (FRSC) (Dr. Puja Khare), Fellow of National Academy of Sciences, India (Dr. Sumit Ghosh) and SERB Women Excellence Award (Dr. Akansha Singh).

CSIR-CIMAP is thankful to the Director General, CSIR, the chairperson and members of the Research and Management Councils for their valuable suggestions and help in shaping the R & D, social activities and overall management of the institute. The institute is also thankful to all the well-wishers, who have played a role in bringing the institute to its present stature and hope to get their support in the coming days.



(Prabodh Kumar Trivedi)



CSIR-CENTRAL INSTITUTE OF MEDICINAL AND AROMATIC PLANTS

TOWARDS BETTER HEALTH AND LIFE

Estd.-1959

Research & Development

PHYTOCHEMISTRY

HIGHLIGHTS

During the year 2023-24, Phytochemistry Division has been involved in various R & D activities of Medicinal and Aromatic Plants (MAPs) including phytochemical investigation, bioactivity guided isolation, structure elucidation, process chemistry, new chemical processes of high value aroma molecules, down-stream processing, metabolic profiling, nano-formulations, target based synthesis of designer molecules, quality control, Chemical ecology and Supercritical Fluid Extraction Technology etc.

Some of the research activities of Phytochemistry Division are in collaboration with other Divisions of the institute and also with other research organisations. The Division has sophisticated instrumentation facility i.e. Chemical Central Facility (CCF) hosting advanced instruments like GC-MS, LC-MS, LC-MS/MS, 500 MHz NMR, UPLC, Raman spectrometer etc. to serve analytical support to internal projects and also external samples from farmers, academics and industry. Division has significantly come up with high priority Mission projects.

The Division has been contributing in CSIR Aroma Mission Phase-III significantly. It is providing support for efficient distillation processing *via* procurement and functioning at farmers' site. Division is remarkably contributing in the development of efficient process technologies for high value aroma molecules desired by industry namely vanillin, cis-3-hexenol, menthone, isomenthone, citronellyl nitrile, ambrox etc.










Scientists of Phytochemistry Divisional Unit

Upper Panel (L to R) : Dr. Ratnasekhar CH, Dr. Atul Gupta, Dr. Karuna Shanker, Dr. Kapil Dev, Dr. A. S. Negi, Dr. Sudeep Tandon, Dr. PK Rout, Dr. Ram Swaroop Verma, Dr. CS Chanotiya and Er. Ashween D Nannaware

Lower Panel (L to R) : Er. G. D. Kiran Babu, Dr. J. Kotesh Kumar, Dr. RC Padalia, K.V.N. Satya Srinivas, Dr. Hariom Gupta and Dr. V S Pragadheesh

In Phytochemical investigation several phytomolecules have been isolated; thirty-one withanolides and one flavonoid from *Withania somenifera*, gymnemagenin, a sapogenin from *Gymnema sylvestre*, a spiroketal enol ether poly-yne from root oil of *Artemisia pallens*, twenty six compounds including two lignan glycosides and one monoterpene glycoside from *Cupressus torulosa* leaves, four alkaloids from *Alstonia scholaris* leaves, nineteen compounds from *Psidium guajava* leaves, endo-fenchyl acetate from essential oil of *Strobilanthes sessilis*, alpha-bourbonene from *Garcinia pushpagadaniana*, Chemical compositions and constituents variability was done in essential oils of γ-irradiated German Chamomile (*Matricaria recutita* L.) mutants. A process has been developed for the simultaneous production of four withanolides namely, withaferin-A, withanolide-A, withanoside-IV, and withanone from Ashwagandha (*Withania somnifera*). Some other plants under investigation are *Zanthoxylum armatum* leaves, *Artemesia annua* stem, *Glycyrrhiza glabra* and other spent biomass.

Under Process Technology of MAPs, a pilot scale processing technology of fresh tuberose flowers has been developed for concrete and absolute preparation. Optimization of essential oil yield and quality aspects of *Pimenta dioica* leaf was done on modulating salt, pH and some other parameters. Several studies on essential oil yield and quality assessment for sequential evolution and impact of deep eutectic solvents (DES) along with distillation kinetics of Vetiver roots have been conducted. Further, effect of post-harvest drying period on chemical composition of *Zingiber zerumbet* and phenological effect on essential oil yield and composition in *Ocimum gratissimum* were also studied. In another study, effect of harvesting time, drying process and sequential separation on essential oil yield and composition in Citronella (*Cymbopogon winterianus*) has been conducted. Division has been developing advanced Solar Distillation units. Its energy, environment and economic evaluation has been compared with wood based distillation for extraction of organoleptically superior essential oils. Further, centralised hybrid solar distillation units (500 kg capacity) are also being installed at farmers' fields after developing prototype.

The Division is engaged in developing efficient process technologies of high value industrial aroma molecules. A novel process for the synthesis of vanillin at 100g batch has been developed. Several other processes under development are; preparation of (+) p-menthane-3,8-diol from lemongrass, cis-3-hexenol, citronellyl nitrile, nerol, geraniol and (+) citronellal etc. Nano-structures of bimetallic oxide and bioengineered zinc oxide have been prepared as nano-sorbents to substitute hazardous dyes in use for multiple applications. Silver nano-particles of gymnemic acids exhibited anti-hyperglycemic effects. Dual targeted 2-benzylideneindanone pendant hydroxamate exhibited selective histone deacetylase 6 and antitubulin effects as potential anticancer agents. Gallic acid based nitrogenous chalcone showed synergistic antibacterial effect by inhibiting efflux pump transporters. Anti-typhoidal activity has been identified in water soluble essential oil fraction of inter-specific basil (*Ocimum basilicum* L.).

In quality assurance several analytical techniques have been applied. A High Resolution Mass Spectrometry based complete metabolic profiling of *Withania somnifera* has been done for tissue specific and also for variety specific authenticity. An analytical method has been developed to differentiate between natural and synthetic menthol. An HPTLC based method has been developed to distinguish among the different Sida spp. This method also identifies the adulteration in this plant material. In another HPTLC-densitometric method estimation of six alkamides *viz*. pellitorine **(1)**, piperanine **(2)**, piperine **(3)**, piperdardine **(4)**, piplartine **(5)**, and piperlonguminine **(6)** in *Piper longum* Linn. has been done.

In another application, the geographical origin of turmeric has been established by rapid metabolic fingerprinting. High volatile adulterants have been identified in various essential oils by Thermo Gravimetric Analysis (TGA). This TGA technique has also been applied in identifying different volatiles and

ash contents in agarbattis. Fourier Transform-Near Infrared (FT-NIR) based non-invasive fingerprinting can be used for the authenticity assessment of essential oils with the help of machine learning models.

In this period several externally funding (GAP) projects and consultancy projects (CNP) were successfully executed in the Division. Four new projects were granted. Seven research students were PhD degree awarded. The Division organised seven training programmes and participated in other such programs to upgrade the skills of the students, entrepreneurs and other beneficiaries.

The faculties of the Division delivered several invited talks at the dignified forums. In analytical support, more than twenty-eight thousand samples in Chemical Central Facility were served. Dr. Kapil Dev received 'ACD Labs Research award in Natural Product Chemistry' and Dr. Ratnasekhar CH received 'SFE-Best Publication award-2024', both the awards in the 11th International Conference on Traditional Medicine & Phytopharmaceuticals (SFE). During this period the division has transferred knowhow of designing of improved distillation units. Further, one product, 'Aloeroma gel', UV protecting, nourishing and skin soothing *Aloe vera* gel free from chemical preservatives was released by Honourable CM of Uttar Pradesh on the occasion of CIMAP Kisan Mela on 31st January 2024. Another technology, Ocimmune (Tulsi drop) was transferred to BigM Pharmaceuticals, Puri. Phytochemistry Division earned forty-three research publications in SCI journals and three new patents filed from the division.

Dr. Arvind Singh Negi डॉ अरविंद सिंह नेगी

Dual targeted 2-Benzylideneindanone pendant hydroxamic acid group exhibits selective HDAC6 inhibition along with tubulin stabilization effect



Cancer is a complex multifactorial disease having high morbidity and mortality in addition to immense economic impact. Abnormal epigenetics has been recognised as an early event in tumour progression and aberrant acetylation of lysine in particular has been understood in tumorigenesis. Consequently, over-expression of histone deacetylases (HDACs) has been observed in various malignant tumours. It has become an attractive target for cancer epoigenetics. Vorinostat and panobinostat are among the few successful HDAC inhibitors (Fig.). Earlier, single drug single target has been an approach to devlop chemotherapeutics, however, single drug multiple target is a recent approach. Dual targeted HDAC inhibitors are being developed for cancer chemotherapeutics.

In our study, we included histone deaectylase 6 inhibitory fragment on to our basic antitubulin indanone core to have a dual targeted pharmacophore for simulataneous antitubulin and HDAC inhibition activity (Fig.).

In the series of 2- Benzylideneindaone core possessing a pandent chain with hydroxamic acid terminal as zinc binding group, we got two potent representative anticancer compounds (Fig.), **KK22A2** with IC_{50} at 0.36µM against triple negative breast cancer cells (MDA-MB-231) and 3.27µM against leukemic cell (K562). Another compound **KK-97B** exhibiting antiproliferative effect with IC_{50} at 3.25 µM against triple negative breast cancer cells (MDA-MB-231) and 1.66 µM against leukemic cells (K562). Overall, **KK22A2** was more effective against MDA-MB-231 cells while **KK-97B** was more effective against leukemia. Both the compounds i.e. **KK22A2** and **KK-97B** exhibited mainly S-phase arrest in MDA-MB-231 and K-562 cells respectively.

In tubulin kinetics, both the compounds exhibited microtubule stabilization effects which was further confirmed by confocal microscopy. In histone enzyme inhibitory effect, compound **KK22A2** showed high potency but low selectivity while **KK-97B** showed high potency and high selectivity when compared with HDAC6 Vs Pan-HDAC enzymes in HDAC6 selectivity assay. Both the compounds possessed low antiinflammatory effects too. The best representative **KK-97B** was well tolerated and safe up to 1000 mg/kg oral dose in Acute oral toxicity assay. Dual targeted anticancer agents with concomitant anti-inflammatory effects will be more attractive clinical candidates in future.

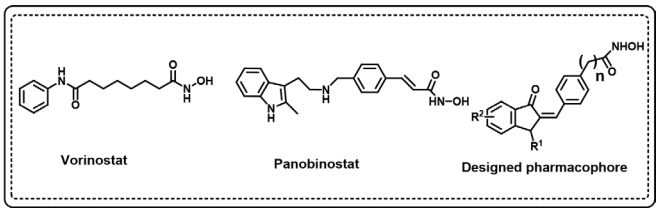


Fig.: Structure of HDAC6 inhibitory clinical drugs and planned pharmacophore

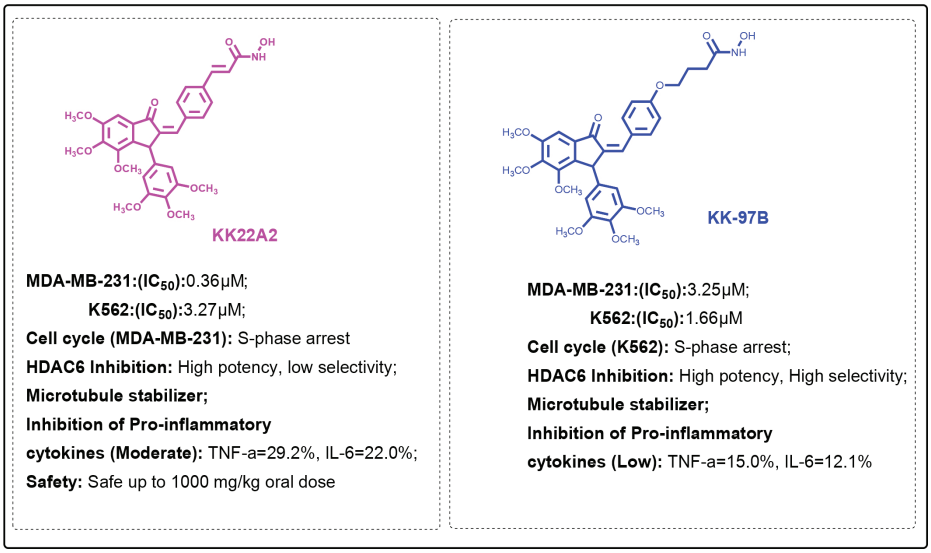


Fig.: Detailed pharmacological profile of KK-22A2 and KK-97B

Synergistic antibacterial activity of gallic acid based chalcone Indl 2 with tetracycline by inhibiting efflux pump transporters

The antibacterial potential of gallic acid based nitrogenous chalcones **Indl-2** i.e.1-(3', 4,'5'-trimethoxyphenyl)-3-(3-Indyl)-prop-2-enone and **Indl-3** i.e. 1-(3', 4,'5'-trimethoxyphenyl)-3-[4-(N,N-dimethylaminophenyl)]-prop-2-enone was evaluated alone and in combination with different group of antibiotics Fig. Minimum Inhibitory Concentration (MIC) of antibiotics was reduced up to eight folds against the different cultures of *E. coli* by both the chalcones.

Indl2 reduced MIC of Tetracycline *via* numerous mechanisms such as efflux pump inhibition, modulation of drug transporter/porin making genes. It significantly suppressed the expression of these pro-inflammatory cytokines specifically TNF-α and IL-6. In safety studies in Swiss albino mice, **Indl-2** exhibited no significant adversative outcome with reference to illness or death and biochemical constraints were within the tolerable limits upon oral administration of **Indl2**. Overall, **Indl2** may be useful in managing the MDR *via*; (i) lowering the dosage of antibacterial; (ii) reducing the progress of drug resistance; and (iii) augmentation of effectiveness of antibiotics. This study shows that gallic acid derived nitrogenous chalcone as synergistic antibacterial agent with tetracycline acting *via* inhibiting the primary efflux pumps.

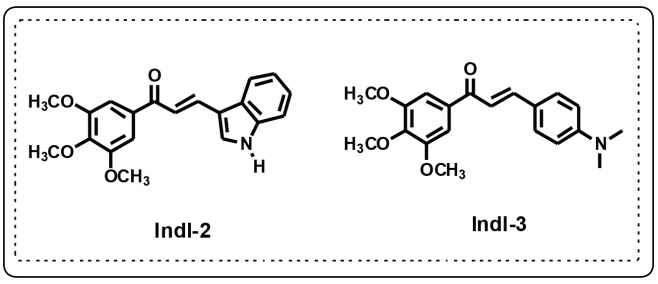
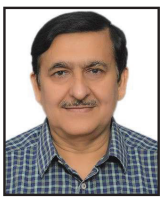


Fig.: Chemical structure of gallic acid derived nitrogenous chalcones



Dr A S Negi & his team

Dr. Sudeep Tandon डॉ. सुदीप टंडन

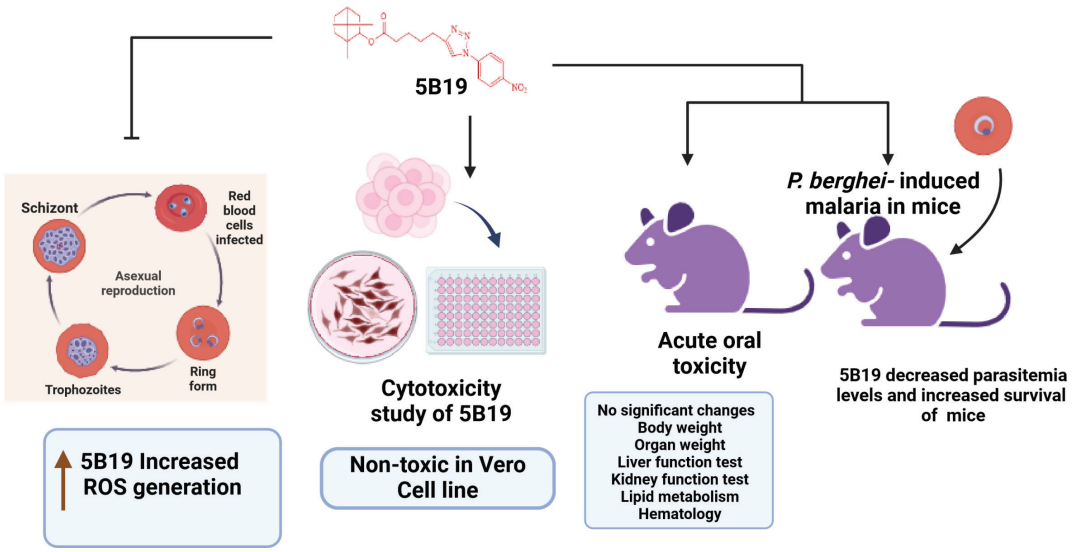


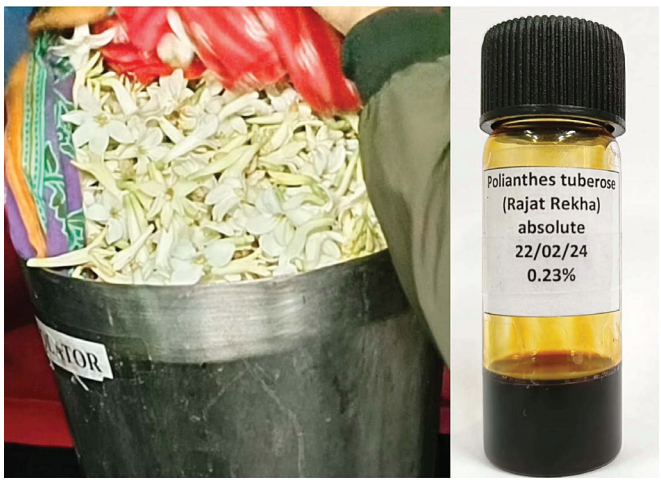
Extraction, isolation and synthesis of Borneol-triazole derivatives

Extraction, isolation and synthesis of Borneol-triazole derivatives induced oxidative stress-mediated antimalarial activity. Drug-resistant *Plasmodium falciparum* infections pose a considerable challenge to the healthcare system. The emergence of resistance to commonly used antimalarial therapies malaria parasites have further complicated the situation, with the added risk of resistance to Artemisinin derivatives. In the present study, a click chemistry approach was used to design and synthesize borneol-triazole derivatives and determine their anti-plasmodial activity against a chloroquine-sensitive (NF-54) strain of *P. falciparum*. Among 31 borneol derivatives, compound-**23** was found to be the most active against the chloroquine-sensitive (NF-54) strain of *P. falciparum* with an C_{50} of 1.64±0.47μM.

Development of pilot scale processing technology for Concrete and absolute of Tuberose flowers

Experimental trials for developing an improved processing technology for Concrete and absolute of Tuberose flowers has been carried out at Pilot scale of 4.5 kg / batch capacity. Fresh semi opened tuberose flowers were plucked early morning and were spread





evenly in a shaded room. In evening hours when the flowers emitted maximum aroma & fragrance, the extraction was carried out. The flowers were dipped in a hydrocarbon solvent in ratio of 1:3 to 1:4 for single wash of 45-50 mins in a stainless steel percolator at room temperature. The solvent was then concentrated under reduced temperature and vacuum to remove the solvent. The extract was treated with anhydrous sodium sulfate to remove traces of moisture to finally obtain approx. 0.5% of concrete. The concrete was further dissolved in absolute alcohol in 1: 10 ratios and vigorously agitated for 4-6 h. The mixture was then kept at (-) 20-25 °C for 10-12 hrs to allow the waxes to freeze which was filtered out. Rewashing of the waxes with alcohol was carried out in 1: 5 ratios. The alcohol fractions were pooled and concentrated under vacuum to obtain approx. 0.25% of absolute.



Dr. Sudeep Tandon & his team

Er. G.D. Kiran Babu इंजी. जी. डी. किरण बाबू

Kinetic studies on Vetiver oil hydro-distillation



South Indian vetiver oil has a strong, long-lasting fragrance that is similar in quality to the best Indonesian oils. It has a rich, complex scent with earthy, sweet, woody, and smoky notes that are highly valued in the perfumery industry. Experiments were conducted to study the sequential evolution of the Vetiver oil chemical constituents to optimize the conventional hydrodistillation process being followed by the farmers/distillers. Four hundred grams of CIM-Vridhi dry roots which was cultivated by one of CIMAP beneficiaries from Tamil Nadu were hydrodistilled in a Clevenger-type apparatus. Essential oil samples collected at random during the process were weighed, dried over anhydrous sodium sulphate and used for the GC-FID analysis. The kinetic data of the vetiver oil distilled during the experiment is furnished in the following (Fig.).

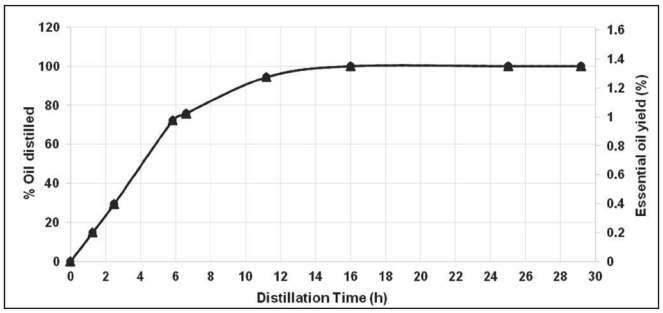


Fig.: Kinetics of Vetiver oil distillation

The kinetic data suggested that about 95% of oil is distilled in about 11 h 12 min. The first 72% of the oil is distilled at the highest distillation rate (@0.167%

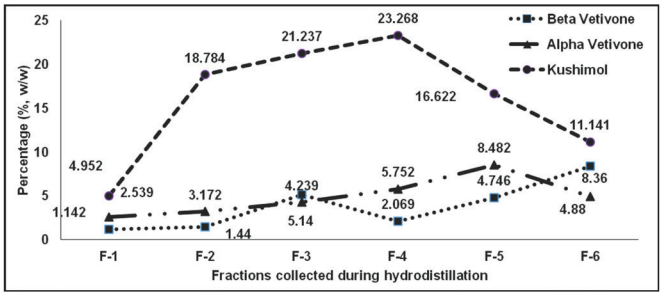


Fig.: Variation in the content of major constituents of oil during hydrodistillation

oil per hour), almost linearly, during the first 5h 50 min but then reduced to 0.035% per hour up to 16 h, where complete distillable oil was extracted. This long duration required for the complete extraction of Vetiver roots by hydro-distillation process may be attributed to the high boiling volatile components of the oil and/or the low diffusion rate of oil components due to the complex and hard oil sacks of the roots. The reduction in distillation time will greatly help the farmers to minimise the production cost and thereby increase in the net profits.

Sequential evolution studies revealed that the first fraction (F-1) collected within 1 h 15 min contained 4.95% Khusimol, one of the major chemical constituents, and thereafter it increased gradually to 18.78% (F-2) and then further increased to 23.27% (F-4), the highest concentration among all the fractions. On continuing distillation, the Khusimol content

Table: GC Analysis Report of Vetiver Essential Oil Fractions

Fraction No.	Distillation time (h)	Oil Yield (%, w/w)	Chemical Composition (%)		
			Kushimol	*â*-Vetivone	*á*-Vetivone
F-1	0 to 1 h 15 min	0.20	4.952	1.142	2.539
F-2	1 h 15 min to 2 h 30 min	0.20	18.784	1.440	3.172
F-3	2 h 30 min to 5 h 50 min	0.575	21.237	5.140	4.239
F-4	5 h 50 min to 6 h 35 min	0.050	23.268	2.069	5.752
F-5	6 h 36 min to 11 h 10 min	0.250	16.622	4.746	8.482
F-6	11 h 11 min to 16 h	0.075	11.141	8.360	4.880
		1.35%			

started declining to 16.62% (F-5) and further reduced to 11.14% (F-6). α-Vetivone gradually increased from 2.54% (in F-1) to 8.48% (in F-5) and then decreased in the last fraction (F-6) to 4.9%. β-Vetivone also gradually increased from F-1 (1.14%) to F-6 (8.36%) except at F-3 (5.14%) wherein the fraction (F-3) was collected after soaking the roots overnight. From the above quantitative and qualitative studies, it is recommended that the hydrodistillation process be continued for 16 hours to recover most of the oil with optimum oil quality.

Process improvement studies for enhancing the yields of Vetiver oil using Deep Eutectic Solvents (DES)

A study on the effect of the ratio of hydrogen bond acceptor (HBA) to hydrogen bond donor (HBD), used for the preparation of Deep Eutectic Solvents (DES) and the concentration of DES in the water during hydrodistillation, on extraction efficiency of essential oil from vetiver roots (*Vetiveria zizanioides*) was carried out. The DES prepared with choline chloride (as HBA) and ethylene glycol (as HBD) in four different ratios (i.e., 1:2, 1:3, 1:4 and 1:5) were used to extract the essential oil from vetiver roots. Further, the effect of four different ratios of plant raw material to DES to water (i.e., 1:0.5:12, 1:1:11.5, 1:1.5:11 and 1:2:10.5) on essential oils yields and chemical composition were also studied.

A comparative oil yield data as shown in Fig. revealed that the choline chloride and ethylene glycol in a 1:3 molar ratio produced the highest essential oil yields

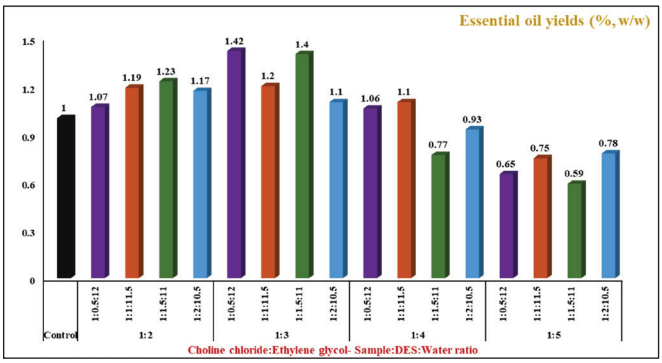


Fig.: Impact of the composition of DES on Vetiver oil yields

followed by a 1:2 molar ratio for a given vetiver root: DES: water ratio as compared to the control (1.0% w/w); and that the vetiver root: DES: water in 1:0.5:12 ratio produced the highest oil yields (1.42% w/w). Lower oil yields (0.59 to 0.78% w/w) were recorded when the vetiver roots were distilled using DES prepared in a 1:5 ratio of HBA and HBD when compared to the control.

In the present study, it is observed that the extraction effect of DES is better than other extraction methods like normal hydro-distillation, which reflects the advantages of high yield and high speed of DES extraction. The extraction effect of DES formed by choline chloride and ethylene glycol in a 1:3 molar ratio and with a root: DES: water ratio of 1:0.5:12 was the best. While extraction with DES, 80% essential oil was obtained within 4 h of hydro-distillation; whereas, the control yielded nearly 40% only. This study not only provides some data support for the green extraction of natural plant active components but also provides a new idea for the further development of terpenoids in Vetiver essential oils.



Er. G.D. Kiran Babu & his team

Dr. J Kotesh Kumar डॉ. जे. कोटेश कुमार

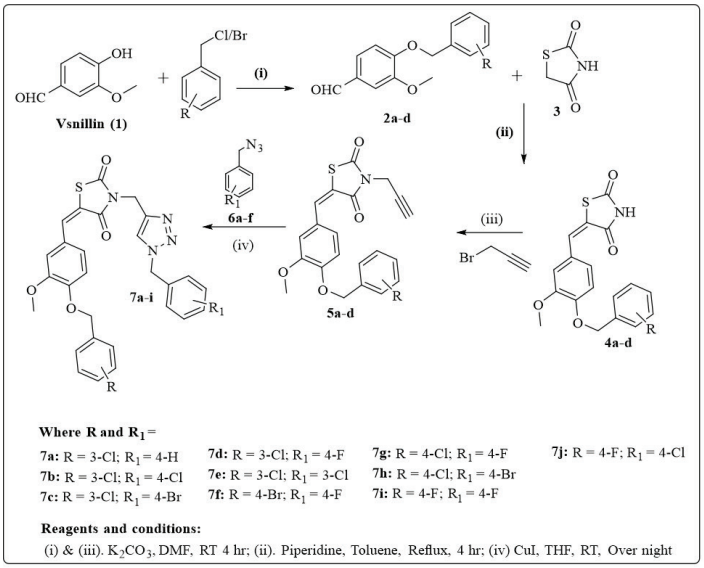
Synthesis of Novel Anti-cancer Vanillin-Thiazolidinedione-Triazole Hybrids as Potential ADMET Inhibitor

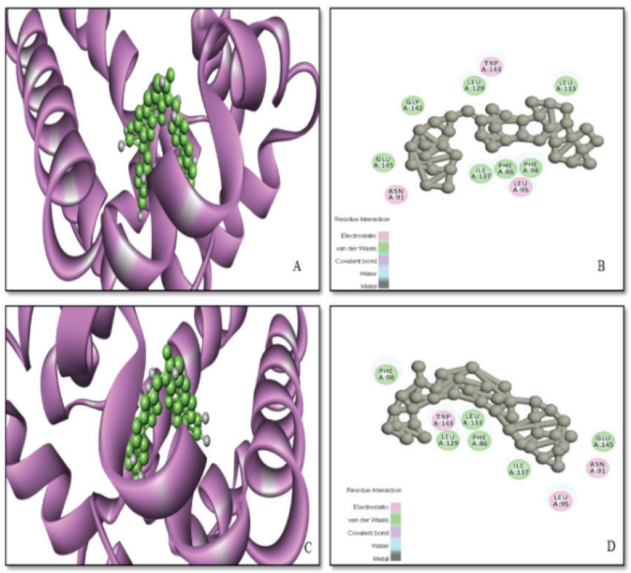


Novel hybrid analogues (10 Nos) of Vanillin-2,4-thiazolidinedione-triazoles were synthesized and evaluated for anticancer activity. Among the analogues, compound 7f with fluoro & bromo substituion (**7f**) demonstrated significant inhibition (50.61%; IC_{30}: 21.98 µm) against MDA-MB 231 cell line when compared to standard Doxorubicin (73.88%). Compound 7i with di-fluoro substitution also showed notable inhibition (52.08%; IC_{30}: 23.57 µm) against FaDU cell line when compared to Doxorubicin-74.6%). Wound healing assay highlighted the efficacy of **7i** compared to the standard. Western blot analysis indicated significant effects of compound **7i** treatment on MDA-MB-231 cell lines compared to the internal standard β-actin. Docking studies showed that compound **7f** had a good binding affinity with SDH (-16.7), BCL-2 (-13.7), BCL-XL (-16.2) and BCL-W (-17.8). Similarly, another active molecule **7i** also had a good binding affinity with SDH (-16.5), BCL-2 (-13.7), BCL-XL (-16.9) and BCL-W (-17.7). Importantly, none of the compounds displayed hERG blocker capability, skin sensitization, or AMES toxicity, suggesting the potential of hybrid heterocyclic systems in developing new anticancer therapies with unique mechanisms of action.

Synthesis and Biological Evaluation of Iso-vanillin-2,4-Thiazolidinedione-Triazoles

Isovanillin is a phenolic aldehyde, an organic component and isomer of vanillin, and one of the primary elements of vanilla extract. Isovanillin is either obtained from various plant extracts (*Pluchea sagittalis*, *Pycnocycla spinose*, *Mondia whitei*, *Benincasa hispida*, *Arum Palaestinum*, *Thalictrum przewalskii etc.*) or is chemically synthesized. Isovanillin was primarily utilized as a precursor in the chemical total synthesis of morphine. We synthesized a series (21 Nos) of novel heterocylic molecules composed of Isovanillin connected with 2,4-Thiazolidinedione moieties having substituted 1,2,3 triazole moieties through knoevenagel condensation and click chemistry. All the compounds evaluated for *in vitro* cytotoxic activities against four cancer cell lines like MDA-MB 231 (Model late-stage breast cancer), MCF-7 (Breast cancer), A549 (lung cancer) and FaDU (Hypopharyngeal carcinoma) using MTT assay. Doxorubicin was used as a standard, floro and chloro benzyl substituted compound **7e** showed better inhibition against MCF-7, A549 and FaDU cell lines



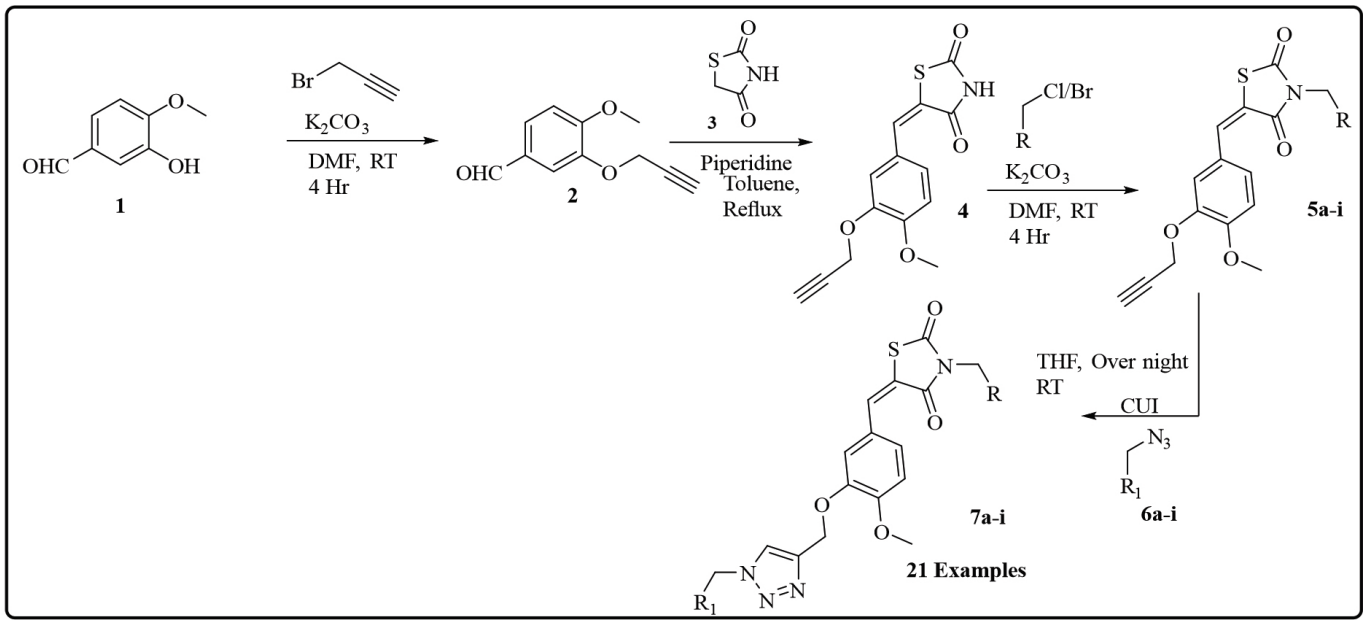


(28.63%, 26.49% & 30.11% respectively) compare to standard Doxorubicin (69.07%, 59.97%, and 64.23%) and hexane and benzyl substituted compound **7r** & hexane and 4-chloro benzyl substituted compound **7t** significantly inhibited against MDAMB 231 cell line (31.68% & 31.42%; Doxorubicin-73.88%).

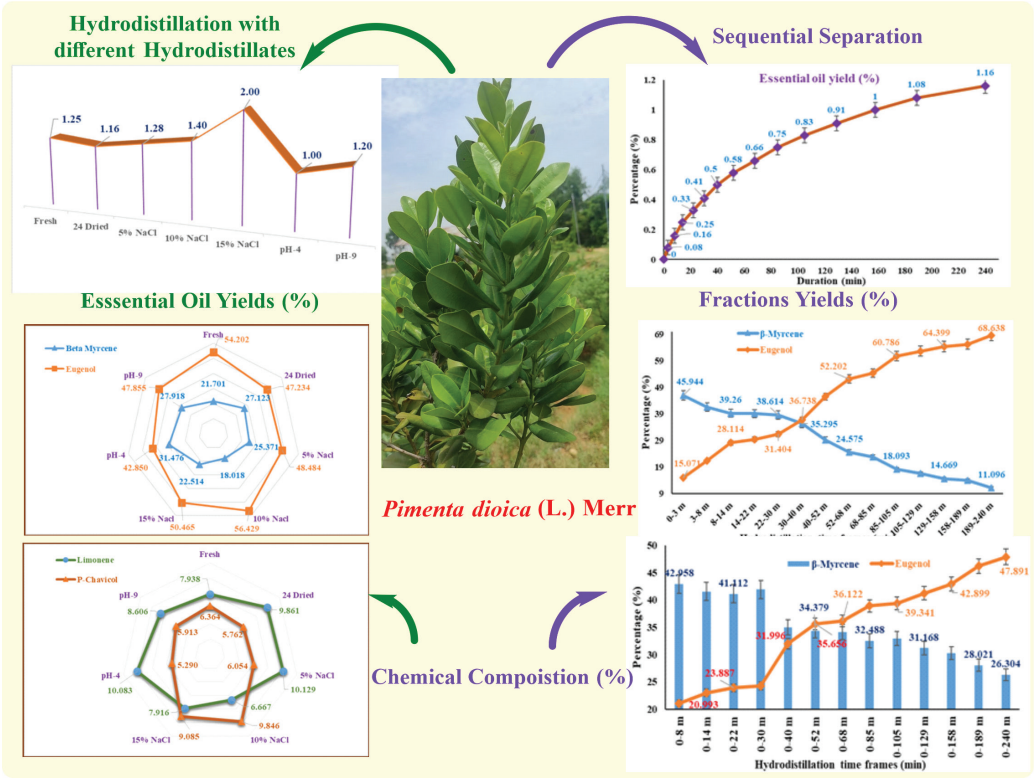
Analogue	R & R_1 =	Analogue	R & R_1 =
7a	R=4-F C_6H_5, R_1=H C_6H_5	**7l**	R=4-Br C_6H_5, R_1=4-Br C_6H_5
7b	R=4-F C_6H_5, R_1=4-Cl C_6H_5	**7m**	R=4-H C_6H_5, R_1=4-H C_6H_5
7c	R=4-F C_6H_5, R_1=4-F C_6H_5	**7n**	R=4-H C_6H_5, R_1=4-Cl C_6H_5
7d	R=4-F C_6H_5, R_1=4-Br C_6H_5	**7o**	R=4-H C_6H_5, R_1=4-F C_6H_5
7e	R=4-Cl C_6H_5, R_1=4-H C_6H_5	**7p**	R=4-H C_6H_5, R_1=4-Br C_6H_5
7f	R=4-Cl C_6H_5, R_1=4-F C_6H_5	**7q**	R=$(CH_2)_5CH_3$, R_1=$(CH_2)_5CH_3$
7g	R=4-Cl C_6H_5, R_1=4-Cl C_6H_5	**7r**	R=$(CH_2)_5CH_3$, R_1=4-H C_6H_5
7h	R=4-Cl C_6H_5, R_1=4-Br C_6H_5	**7s**	R=$(CH_2)_5CH_3$, R_1=4-Br C_6H_5
7i	R=4-Br C_6H_5, R_1=4-H C_6H_5	**7t**	R=$(CH_2)_5CH_3$, R_1=4-Cl C_6H_5
7j	R=4-Br C_6H_5, R_1=4-F C_6H_5	**7u**	R=$(CH_2)_5CH_3$, R_1=4-F C_6H_5
7k	R=4-Br C_6H_5, R_1=4-Cl C_6H_5		

Optimizing Essential Oil Yields and Quality from *Pimenta dioica* (L.) Merr. Leaf: Impact of NaCl Concentrations, pH Media and Sequential Separation of Essential Oil Components during Hydrodistillation

The present study aimed to explore the impact of herb drying, salt concentration, pH of the media and systematic sampling approach on essential oil yield and composition in *Pimenta dioica* (L.) Merr. Key findings highlighted that fresh samples exhibited a notably higher essential oil yield (1.25%) compared to shade dried samples. Moreover, increasing sodium chloride (NaCl) concentration in water correlated with elevated volatile oil yields. Additionally, variations in water pH levels indicated that a basic environment resulted in superior yields. Gas Chromatography analysis identified Eugenol and β-myrcene as primary constituents alongside five other compounds. Eugenol content peaked in the 10% NaCl sample (56.429%) and was lowest in the



pH-4 sample (42.850%). Similarly, β-myrcene content was notably higher in the pH-4 sample (31.476). Conversely, chavicol remained largely unaffected by pH, salt concentration, and drying techniques. The hydrodistillation (HD) process with systematic sampling approach of 1ml each over a period was aimed to evaluate, for the first time, the effects of 14 fractions in different HD time frames (HDTs) on the yield, and chemical profile of *P. dioica* (L.) Merr EO. The EO fraction yield revealed *Phenylpropanoids* (*PPs;* 17.303% to 79.403% mainly eugenol*) and* acyclic monoterpene (ACMs; 45.944% to 11.096% mainly β-myrcene) dominated in all fractions while Cyclic Monoterpene (CMs) enriched in first four fractions (< 15%, mainly limonene). Furthermore, Fractions 10 to 14 were the major constituents where eugenol showed a significant increment comparee to control (47.372%) (F-10: < 13.414%; F-11: < 15.277%; F-12: < 17.027%; F-13: < 17.884% and F-14: < 21.266% respectively). Due to the variable composition of the resulting EO fractions, these findings can be valuable in meeting specific market demands, thereby enhancing the commercial potential of *P. dioica* EO.



Natural Product Research. 2024 (Accepted)



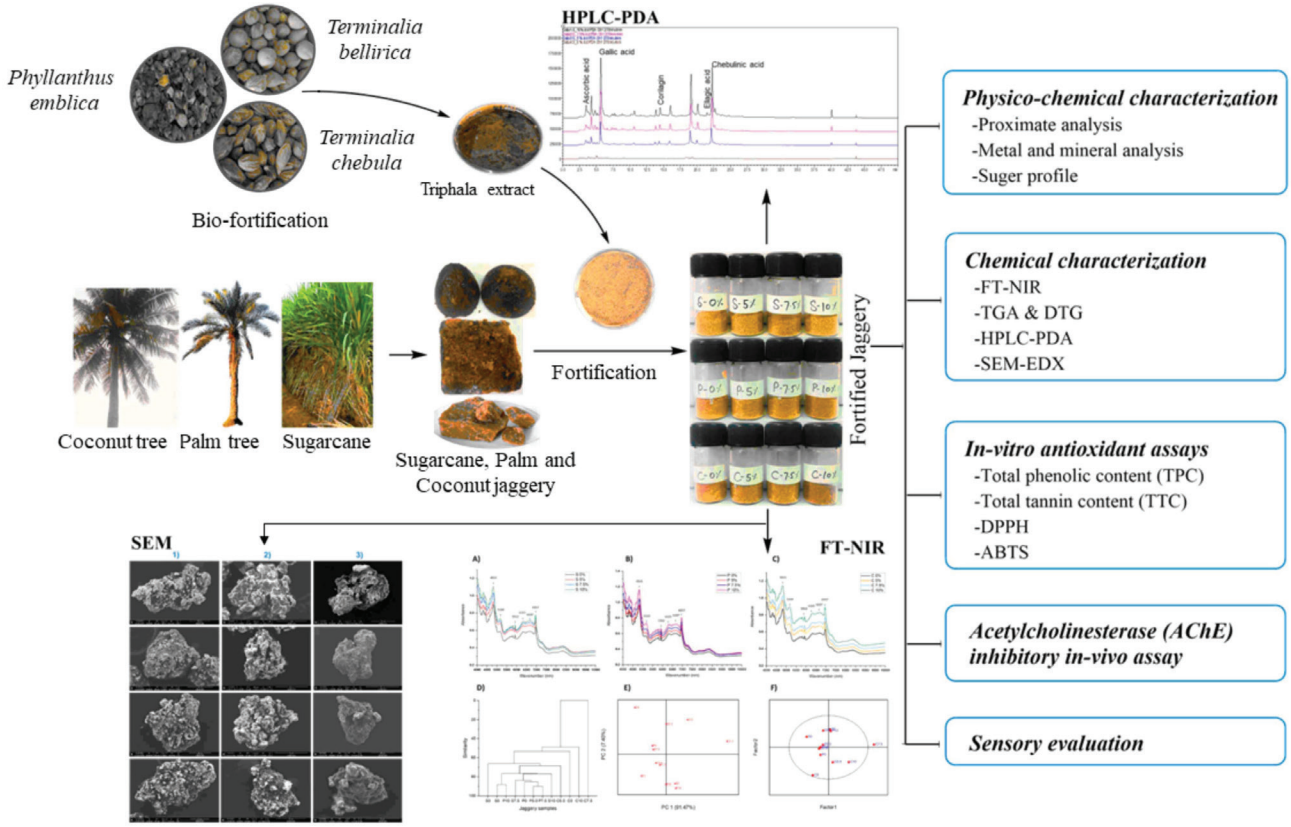
Dr. J. Kotesh Kumar & his team

Dr. Karuna Shanker डॉ. करूणा शंकर

Fortification of Triphala in Jaggery for health benefits: Chemico-biological Standardization, sensory evaluation

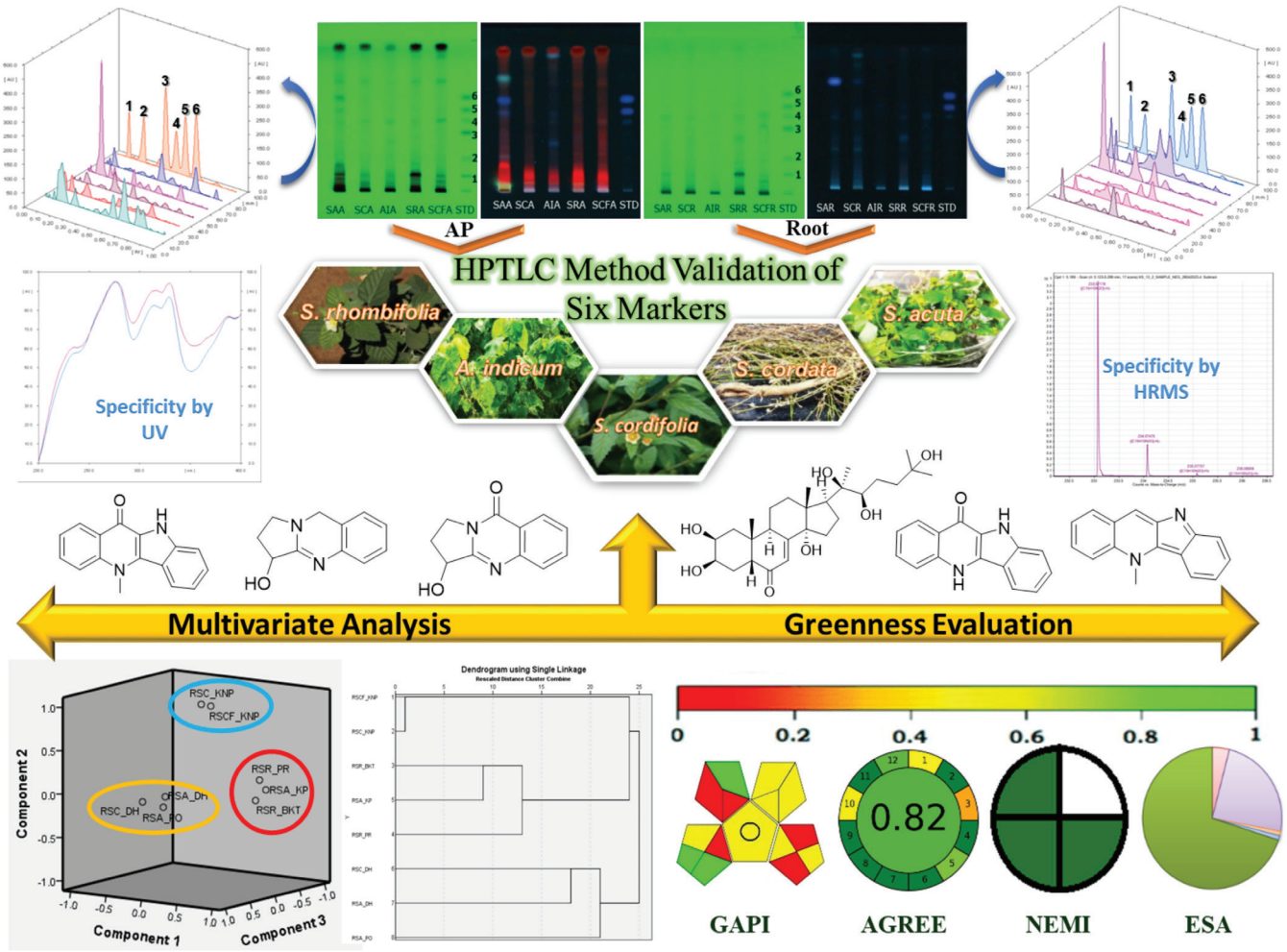


Triphala, a blend of three fruits - Amalaki (*Phyllanthus emblica*), Bhibhitaki (*Terminalia bellirica*), and Haritaki (*Terminalia chebula*), is an Ayurvedic remedy best enjoyed as a hot tea to enhance digestion and immunity. It is commonly available over the counter as a pre-mixed fine powder. The population in Asia Pacific and the Middle East favors Triphala as a natural remedy for hyperacidity and appetite enhancement, leading to a high export volume to these regions. Renowned for its antioxidant and immunomodulatory properties, Triphala contains valuable phytochemicals like corilagin, chebulagic acid, and vitamin C, which aids in collagen formation. Jaggery made from sugarcane, palm, and coconut was fortified with varying amounts of Triphala extract. Triphala is a popular and well-known Indian medicinal botanical. The concentration-dependent effect of Triphala fortification on nutritional value, buffering capacity, physicochemical characterization, marker-based standardization antioxidant, acetylcholinesterase inhibition capacity, and sensory preference were investigated. To maximize the benefits of Triphala-fortified jaggery (TFJ), various analytical techniques and chemometric approaches were used to achieve standardization and quality. Scanning electron microscopy reveals the heterogeneous microstructure of the TFJ sample, including particle formation, size, texture, and distribution. Palm jaggery has the highest organic content. Triphala fortification increased the calcium and magnesium content of the respective jaggery, which affected the total carbohydrate. TFJ was characterized using spectroscopic, thermogravimetric, and chromatographic methods. Chemometric analyses classify TFJ.



Six marker based HPTLC method development and validation for quality assessment of Sida spp and its probable adulterant Abutilon indicum

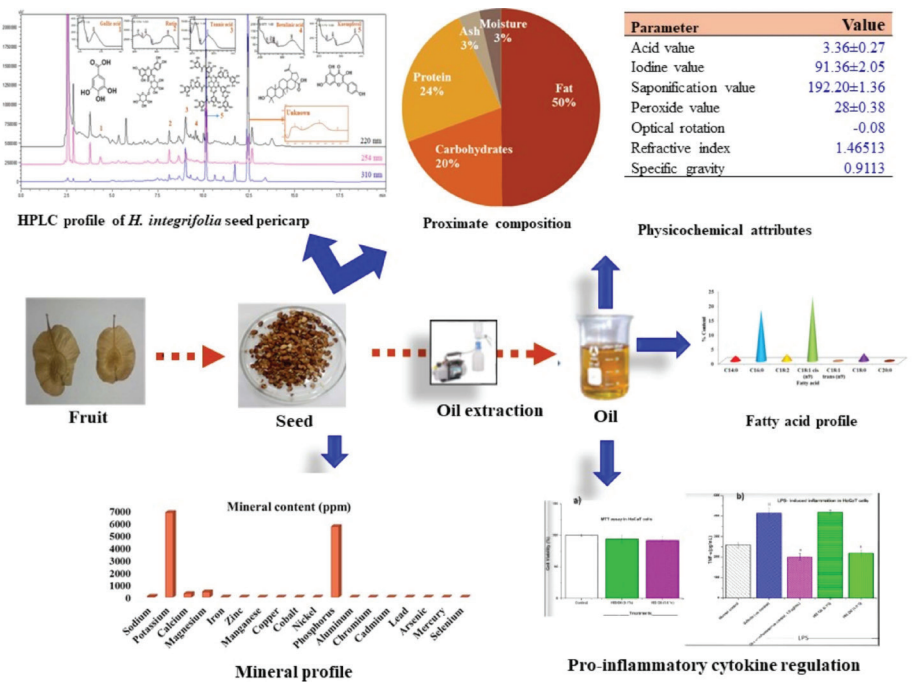
Different Ayurvedic drug manufacturing industries in India consume about 5000-10000 MT of Sida roots per year. The burgeoning demand of *Bala*, *Mahabala*, and *Atibala* predisposes these botanicals to adulteration. Sida is one of the most diverse genera, with about 200 species distributed in tropical and subtropical regions of the world. Among 18 species distributed in India, *Sida acuta*, *Sida cordifolia*, *Sida rhombifolia*, and *Sida cordata* are used in traditional medicines along with its possible adulterant *Abutilon indicum* for several therapeutic uses. Different species in the genera are many times challenging to distinguish particularly in powder form and used as a substitute or an adulterant to each other. In India, Sida species and *A. indicum* are used as '*Bala*' without discrimination. Due to the complexity of Sida taxonomy, many commercially available Bala materials are often mislabeled since raw materials of different species are sold with the same common name, *Bala*. The non-availability of marker-based validated methods for the identification and classification of these species leads to adulteration. Indoloquinoline and quinazoline are the major bioactive alkaloids distributed in Sida spp. First time, a simple, economical and high throughput method was developed and validated for the simultaneous determination of 20-hydroxyecdysone (**1**), vasicine (**2**), vasicinone (**3**), cryptolepine (**4**), quindolinone (**5**), and cryptolepinone (**6**) using HPTLC-UV densitometry. The method was validated to meet



globally accepted ICH guidelines. The method was sensitive with LOD and LOQ ranging from 0.38-0.63 and 1.57-2.12 µg/band. The samples were spiked at 3 different concentrations, the recovery values were 93.49-98.88%. In addition, the greenness index of the HPTLC method was estimated using four different greenness assessment techniques. Targeted HPTLC analysis indicated the distribution of specialized metabolites in Sida spp. and *A. indicum*. However, the occurrence of cryptolepine in *A. indicum* was not reported in the literature, so this was further confirmed by liquid chromatographic studies of the samples from different locations. The chromatographic data was statistically evaluated by principal component analysis (PCA) and hierarchical clustering (HCA). HPTLC-based targeted metabolite quantitation explains the adulteration/substitution in *Sida* raw material and derived herbal preparations.

Search of an alternate source of protein supplement and fatty acids with health benefits: Chirabilva (*Holoptelea integrifolia* Roxb.) seed

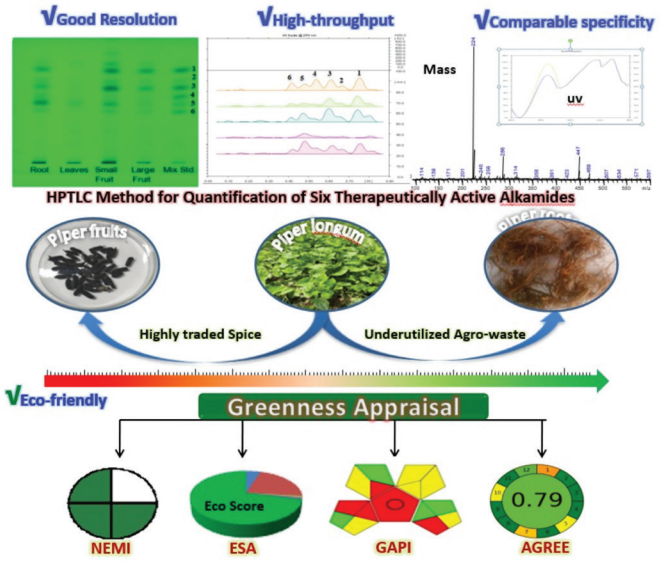
Indian elm (*Holoptelea integrifolia* Roxb.) is locally known as 'Chirabilva.' It is dispersed up to 2,000 feet altitude. It is predominantly found in all parts of India and tropical regions of the northern hemisphere. Indian elm is drought-resistant, effortlessly grows on sandy and loam to gravelly subsoil, and its resilient climate nature makes it a preferential choice for agro-forestry. The seeds are consumed raw by ethnic minorities and remain underutilized by most people. However, there is documented evidence of the use of *H. integrifolia* in traditional Indian medicine and ethnic groups. The seeds of *H. integrifolia* have about 50% fixed oil content and a reasonable amount of saturated and unsaturated fatty acids, protein, fiber, energy, and mineral content. Vegetable oils play an important role in food, a healthy diet, and nutrition as a source of vitamins and essential unsaturated fatty acids. Therefore, exploring the possibility of unconventional edible food sources of vegetable oils has been carried out. The present research investigation unfolds insights into the chemical, nutritional, and biological potential of the seeds (HIS) and pericarp (HISP) of *H. integrifolia*. The seeds contain mainly fixed and very few essential oils. The fixed oil of HIS is composed primarily of unsaturated oleic (47%) and saturated palmitic (37%) acids. The HIS are exceptional due to a high content of lipid (50%), protein (24%), carbohydrates (19%), fiber (4%), and anti-nutritional components within permissible limits. The high content (in mg/Kg) of phosphorus (6000), magnesium (422), Calcium (279), and essential nutrients (Ni, Co, Zn, Fe, Cu, Mn, and Cr) in the range of (0.04-6.69) were observed. The moderate anti-oxidant potential of HISP was evident in single electron transfer *in-vitro* assays. Moreover, HISP extract and HIS solvent-extracted fixed oil showed anti-inflammatory action in lipopolysaccharide-induced HaCaT cells by significantly attenuating pro-inflammatory cytokines (TNF-α) without causing cytotoxicity. Results



support de-oiled HIS cake as an alternative source of a high-protein diet and its oil with anti-inflammatory attributes for topical applications.

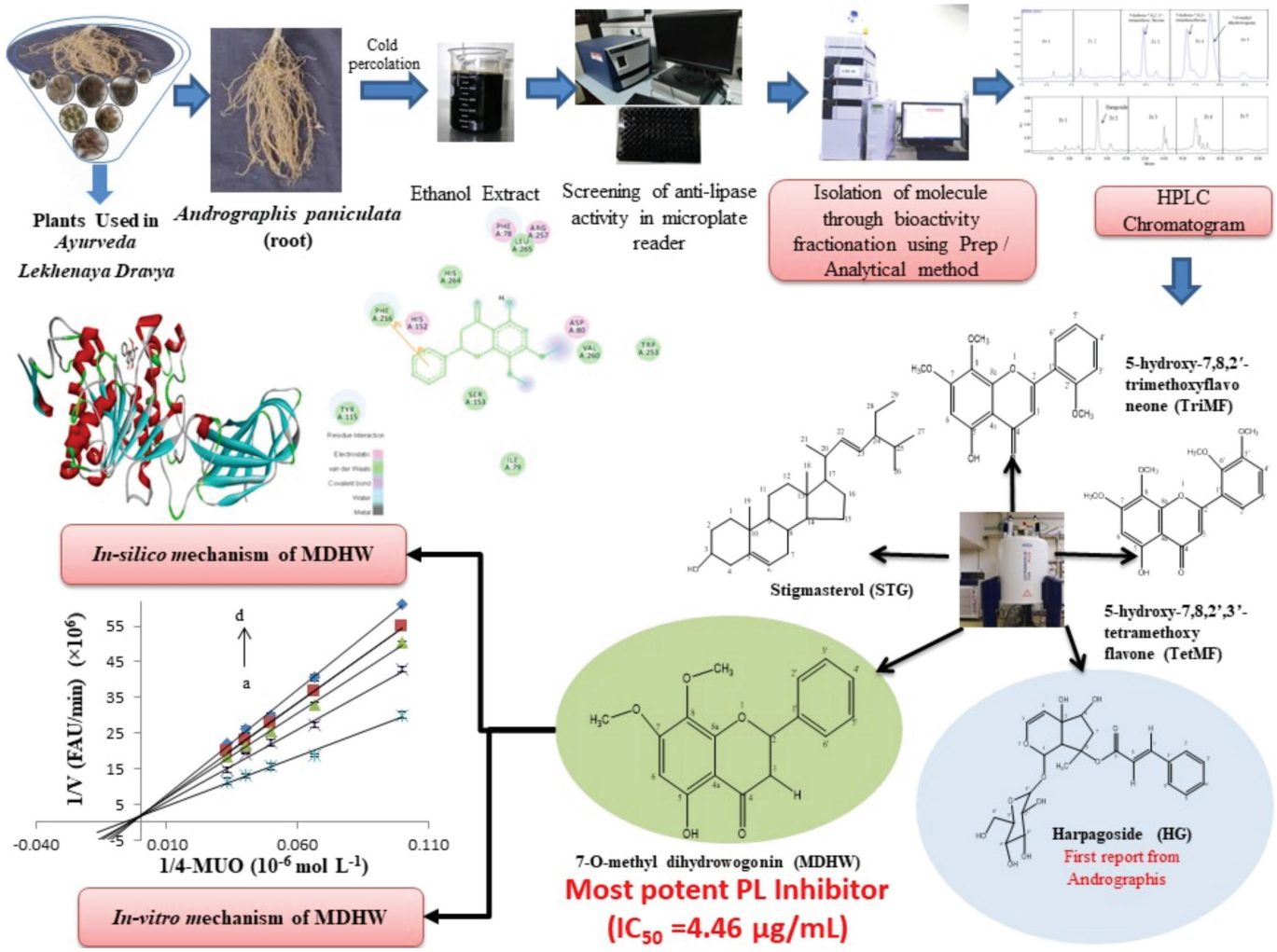
HPTLC-densitometric method development for simultaneous determination of six bioactive markers in Piper longum Linn. root

Piper longum L. (family-Piperaceae), known as '*Pippali*', is a native of the Indo-Malaya region, wide spread in tropical and subtropical parts of Asia and the Pacific islands. The fruits of *P. longum* are one of the highly traded botanicals worldwide. The root part of the *Pippali* is also used *Ayurveda* and known as '*Pipermoola*'. Recent reports have confirmed that the alkamides are the major phytochemicals responsible for the different therapeutic purposes of *Pipermoola.* The substantial structural similarity of alkamides poses a challenge in the chromatographic separation for simultaneous quantification of bioactive alkaloids in agrowaste of Piper longum. Here, we report a novel HPTLC method for the simultaneous quantitation of six alkamides, viz., pellitorine, piperanine, piperine, piperdardine, piplartine, piperlonguminine in Piper longum. PRISMA approach was applied for optimum separation on silica gel 60F254 plates using n-hexane-dichloroethanediethylamine (7.8:1.2:0.5, v/v/v) as the solvent system. In addition to Rf and colour visualization, the specificity of determination was demonstrated by UV, and mass spectral matching. The method was consistent with the Beer's law over the 1–5 µg/band range. The detection limits and the limits of quantification are in the range of 0.073- 0.531, and 0.243- 0.769 µg for pellitorine, piperanine, piperine, piperdardine, piplartine, and piperlonguminine; respectively. The proposed method was successfully applied to determine the six cited alkamides with mean recoveries ranging from 98.81 to 100.05%, and intra- and inter-day precisions with relative standard deviations below 2%. Moreover, the greenness was investigated using National Environmental Methods Index (NEMI), Eco-scale Assessment (ESA), Green Analytical Procedure Index (GAPI), and Analytical GREEness metric (AGREE) metrics revealing the current HPTLC method environmentally benign and energy efficient. It is the first report of an analytical method that supports precise, highthroughput, and simultaneous quantification of six alkamides (1-6) in Piper longum roots with application in food and pharmaceutical.



Activity guided isolation of lipase inhibitor from *Andrographis paniculata* root: Mechanism of inhibition

In the present study, firstly, highly efficient for rapid de-replication HPLC-based activity profiling was developed to evaluate the lipase inhibitory activity of *A. paniculata* root phytochemicals. Secondly, the PL inhibitory mechanism of interaction of most active compounds were determined by fluorescence spectroscopic, UV–Vis, FTIR, thermodynamics, and *in-silico* methodology of molecular docking and dynamics. . The HPLC-based micro-fractionation and offline *in-vitro* pancreatic lipase inhibition assay has resulted in potential phytochemicals with IC_{50} value 4.46-21.76 µg/mL. 7-O-methyl-dihydro wogonin **(MDHW)** was the most potent with IC_{50}=4.46 µg/mL than reported flavones to date. The **MDHW** has also exhibited a synergistic effect with orlistat at a concentration lower than 14.86 µM. **MDHW** acts as a competitive inhibitor via energy transfer from PL. The binding interaction of **MDHW** with



PL was hydrophobic (Ka=1.40×10^3 L/mol). FT-IR studies showed the stable and compact **MDHW**-PL complex as the percentage of β -turn, β-antiparallel and random coil increased, while the portion of the α-helix, β-sheet decreased. Molecular docking and simulation results directed towards the non-polar interaction of **MDHW** with protein's active site (PBD:1ETH) by spontaneous H-bonds. We conclude that disregarded part of *Andrographis* i.e. root could be used as a source of **MDHW** a pancreatic lipase natural inhibor for the obesity treatment.



Dr. Karuna Shanker & his team

K.V.N. Satya Srinivas के.वी.एन. सत्या श्रीनिवास

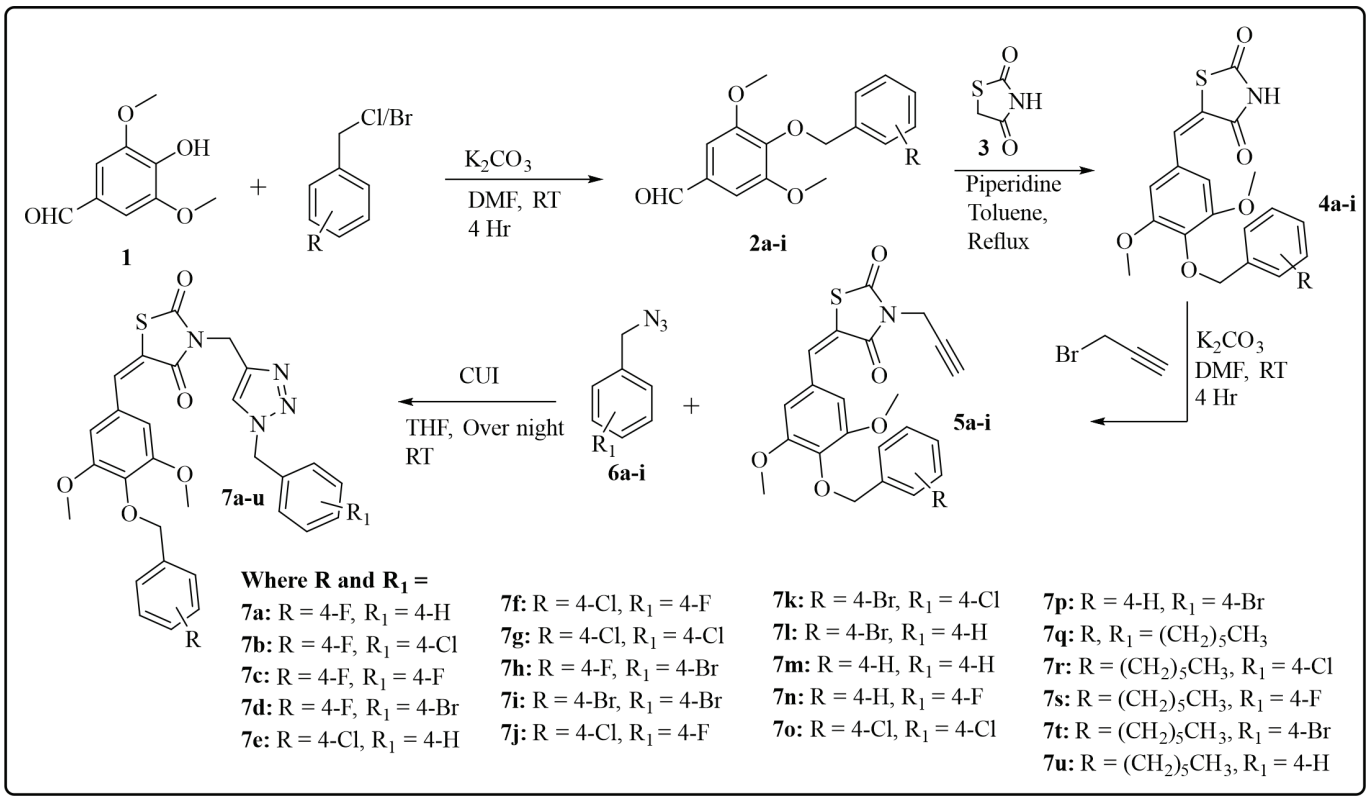
Design and synthesis of novel Syringaldehyde -2,4-Thiazolidinedi-one-Triazoles



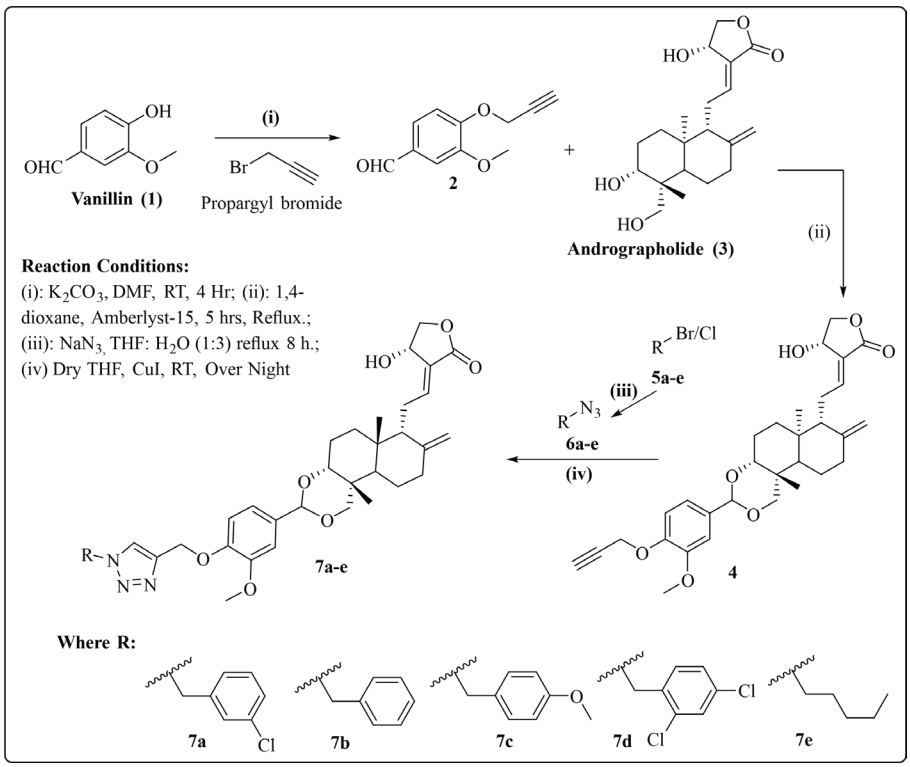
Syringaldehyde has a variety of bioactive properties that can be found in plants' cell walls. Some insect species employ syringaldehyde in their chemical communication systems. During oviposition, the *Scolytus multistriatus* insect uses syringaldehyde as a signal to locate a host tree. Syringaldehyde is a crucial intermediate in the production of the antibacterial drugs Trimethoprim, Bactrim, and Biseptol. Thiazolidinediones (TZDs) and 1,2,3-triazoles have occupied an important role in medicinal chemistry due to their attractive features as well as numerous biological activities. 1,2,3-triazole is one of the key structural units found in a large variety of bioactive molecules as antifungal, antibacterial, antiallergic, anti-HIV, antitubercular and anti-inflammatory agents. Based on the importance of Syringaldehyde, 2,4 thiazolidinedione and 1,2,3 triazoles, synthesized a series (21 analogues) of different substituted Syringaldehyde 1,2,3 triazoles linked with 2,4 thiazolidinedione molecules.

Synthesis of novel bioactive Angro-grapholide-Vanillin-1,2,3-triazoles

Andrographolide is a marker compound of *Andrographis paniculata* and has multiple pharmacological properties, such as anticancer, antimalarial, anti-HIV, anti-hyperglycaemic, antihepatotoxic, immunostimulant, anti-inflammatory, antibacterial and antimicrobial activities. Based on the importance of Andrographolide (3) and 1,2,3 triazoles, synthesized novel Andrographolide-Vanillin-1,2,3-triazole hybrid molecules composed of an Andrographolide attached to Vanillin having various benzylic and aliphatic substitutions via 1,3-dipolar cycloaddition between azide and alkyne. Among all the derivatives tested



Scheme: Synthesis of novel Syringaldehyde -2,4-Thiazolidinedione-Triazole analogues



Scheme: Synthesis of Angrographolide-Vanillin-1,2,3-triazole analogues

for anticancer activity, 3-chloro benzyl substituted analogue (**7a)** demonstrated significant inhibition against HepG2 cell line at 0.75 mg/ml (IC_{30}: 8.223 µm) and pentane substituted analogue (**7e)** significantly inhibited at 0.25 mg/ml (IC_{30}: 9.590 µm) compare to control (0.985 and 2.85 µm respectively).

Studies on effect of harvesting time, drying and sequential separation on Essential Oil yield and composition of Citronella (*Cymbopogon winteri-anus* Jowitt) by Hydro distillation

The aerial parts of the plant "Bio-13" were harvested from the field of CIMAP, Research Centre, Hyderabad in regular time intervals of 2 hr during day and night (2nd and 3rd of June-2023; 12 harvesting times in 24 hr day) and Essential Oil (EO) was extracted by hydro-distillation. The samples harvested at 2.00 PM yielded highest percentage of EO (1.75%) whereas samples harvested at 6.00 AM yielded minimum (1.13%).

The composition of major chemical constituents observed in the essential oil with respect to harvesting time is Citronellal (27.182-31.412%), Geraniol (16.745-21.857%), Citronellol (8.566-11.235%) and Elemol (13.011-19.460%). In the samples harvested at 6.00 AM shown highest composition of Citronellol 11.235% & Citronellal 31.412% and samples harvested at 8.00 PM shown lowest content of Citronellol 8.566% & Citronellal 27.182%. Similarly, Geraniol is in highest percentage (21.857%) in the samples harvested at 2.00 PM and lowest (16.745%) at 8.00 PM. Whereas, Elemol was observed in highest percentage (19.460%) in the samples harvested at 8.00 PM and lowest composition (13.001%) at 6 AM.

In shade drying, the 27-hr shade dried material yielded the highest essential oil yield (2.48%) compare to fresh material (1.72%). In 27-hr shade dried material, there is no significant change in the chemical composition of major constituents except elemol.

While fractionation, 85% of oil was recovered within 102 min of distillation time from fresh material. Whereas, 92% of oil was recovered in 27 hr dried material. In sequentially separated individual fractions, citronellal composition (Fresh: 54.590-0.259% & 27 hr shade dried material: 57.327-0.814%) was recorded in decreasing pattern from first collected faction to last collected fraction. Whereas, elemol composition (Fresh: 1.698-40.557% & 27 hr shade dried material: 1.941-30.552%) is increased from first collected faction to last collected fraction. Similar pattern was also noticed in the cumulative fractions. Asper literature survey, this is the first study of essential oil quality and quantity with respect to harvesting time.

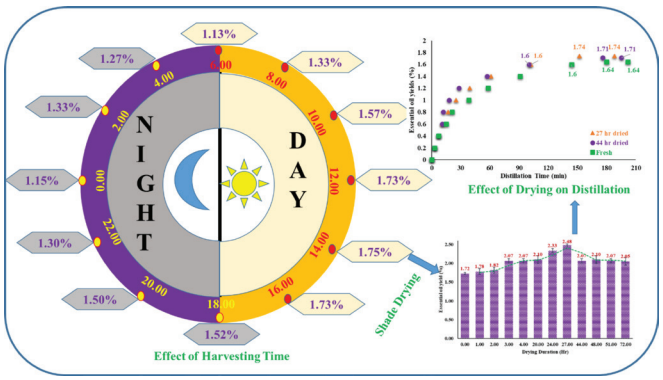


Fig.: Effect of harvesting time on essential oil yield of Citronella

Dr. R.C. Padalia डॉ. आर.सी. पडालिया



Effect of Post-Harvest Drying Period on the Chemical Composition of *Zingiber zerumbet* Sm. Rhizomes Essential Oil and its Biological Activities

Zingiber zerumbet Sm. (Family: Zingiberaceae) is an important perennial medicinal oil-bearing herb that is native to the Southeast Asia. This study examines the impact of different durations of post-harvest shade drying (ranging from one to twelve months) on essential oil yield and chemical composition of *Z. zerumbet*, in comparison to the freshly collected sample. The oils were analysed for their chemical composition by GC and GC-MS. The primary constituent, Zerumbone, was detected in concentrations ranging from 69.38±5.63 % to a maximum of 80.19±1.53 % as the drying duration of the rhizome was extended. The output of the essential oil was not significantly affected by drying times; however, it did have a noticeable impact on the proportions of monoterpenes. Both disc diffusion and broth microdilution assay were used in freshly collected *Z. zerumbet* oil for its antimicrobial potential against *S. aureus*, *L. monocytogens*, *S. hominis*, *Salmonella enterica* serovar Typhimurium, *P. aeruginosa*, *S. intermedius*, *E. coli*, and *C. albicans*. For the first time, the oil reported to exhibit antibiofilm activity against *S. aureus* which was validated using fluorescence microscopy, and effectively disrupts the biofilm by 47.38% revealing that essential oil was able to disintegrate the clusters of the pathogen. *Z. zerumbet* rhizome oil is effective to reduce food-borne microorganisms. Therefore, its essential oil, a natural source of bioactive zerumbone, may improve flavour, aroma, and preservation.

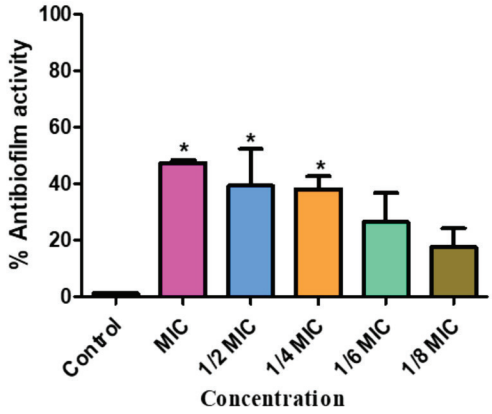


Fig.: Graphical representation of the antibiofilm activity of the *Z. zerumbet* rhizome EO against *S. aureus*

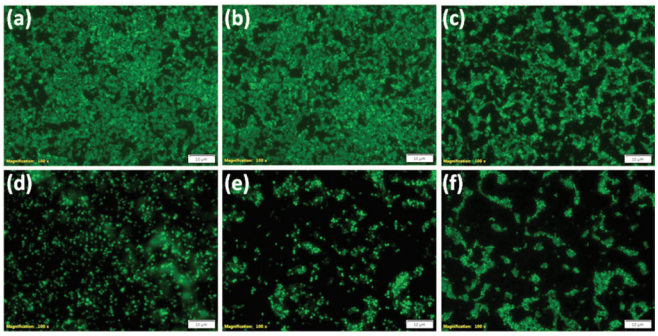


Fig.: Fluorescence microscopic analysis of the *Z. zerumbet* rhizome EO against *S. aureus* at: (a) Control, (b) 1/8 MIC, (c) 1/6 MIC, (d) ¼ MIC, (e) ½ MIC, (f) MIC

Phenological Influence on Essential Oil Yield and Chemical Composition of *Ocimum gratissimum* and it's Antimicrobial Potential

The study was made to evaluate the influence of phenological stages on the yield and chemical profile of the essential oil of *Ocimum gratissimum* var. CIM-Akshay grown under the agro-climatic conditions of the Tarai region of Pantnagar, Uttarakhand,

India. The essential oil yield was higher in the full flowering stage (0.55 %) than in the other stages (0.50 %). In addition, GC/MS analyses resulted in the identification of about 16 compounds containing thymol (46.65-49.93%), γ-terpinene (17.67-19.78%), p-cymene (6.22-6.91%), α-thujene (4.29-6.04%), β-pinene (3.58-4.60%) and α-terpinene (2.91-3.81%), the proportions of these compounds varying according to the phenological period. Oxygenated monoterpenes (49.99-52.08%) were the most represented compound class in the oils collected

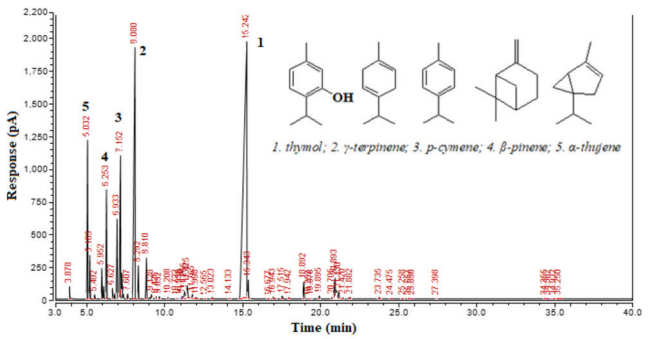


Fig.: Gas chromatogram of *O. gratissimum* var. CIM-Akshay essential oil collected at the full flowering stage

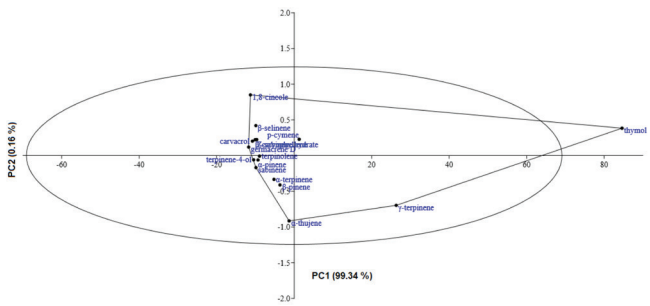


Fig.: Biplot (PCA) resulting from the analysis of essential oils' composition collected in different phenological stages of *O. gratissimum* var. CIM-Akshay

during all phenological periods. The yield of essential oil and volatiles of *O. gratissimum* was significantly ($p < 0.05$) affected by the phenological studies. It was observed that the content of γ-terpinene decreased significantly in the transition from the vegetative stage to the seed formation stage. The antimicrobial potential of the essential oil of *O. gratissimum* against different bacterial strain viz. *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* and fungal strains viz. *Candida albicans* and *Candida kefyr* was investigated using the disc diffusion method. The zones of inhibition and minimum inhibitory concentration were calculated by comparing them with standard drugs; penicillin-G and amphotericin-B.



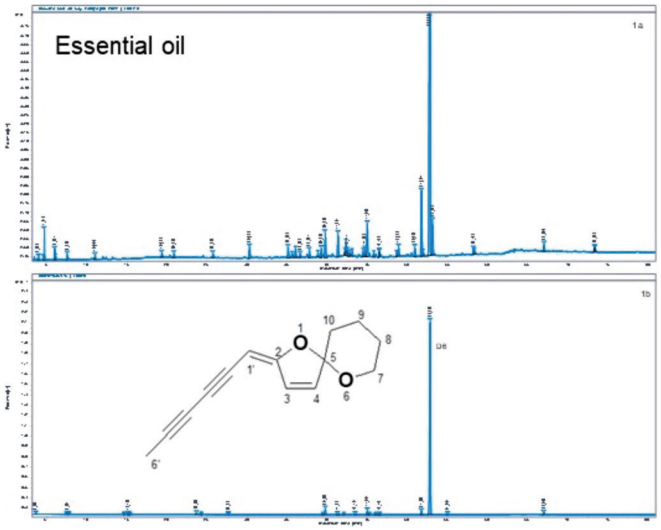
Dr. R.C. Padalia & his team

Dr. Ram Swaroop Verma डॉ. राम स्वरूप वर्मा

Neuroinflammation and Acetylcholinesterase Inhibitory Potentials of a Spiroketal-Enol Ether Polyyne Isolated from the Root Essential Oil of *Artemisia pallens* Wall. ex DC.



Artemisia pallens Wall. ex DC (Asteraceae) is cultivated for the extraction of high-value essential oil from its aerial biomass. In this study, the chemical composition of the root (crop-residue) essential oil was investigated, which led to the identification of twenty constituents, with isolation of (*E*)-2-(2', 4'-hexadiynylidene) -1,6-dioxaspiro [4.5] dec-3-ene (D6). The oil was mainly represented by D6 (62.6%), neryl isovalerate (7.7%), bicyclogermacrene (4.4%), *β*-elemene (3.9%), germacrene A (3.2%), (*Z*)-2-(2',4'-hexadiynylidene)-1,6-dioxaspiro[4.5] dec-3-ene (2.5%), and spathulenol (1.0%). The D6 was evaluated in vitro for neuroinflammation and acetylcholinesterase inhibitory potential. It showed inhibition of neuroinflammation in a concentration-



dependent manner with significant inhibition of pro-inflammatory cytokines (TNF-α and IL-6) in LPS-stimulated BV2 microglial cells. D6 did not have any significant effect on the viability of the cells at the therapeutic concentrations. D6 also has shown acetylcholinesterase inhibitory potential (51.90±1.19%) at the concentration of log 10^6 nM. The results showed that D6 has a potential role in the resolution of neuroinflammation, and its acetylcholinesterase inhibitory potential directs further investigation of its role in the management of Alzheimer's disease-related pathogenesis.

Neuroinflammation and Acetylcholinesterase Inhibition Potentials of Acyclic Monoterpenoids Isolated from *Cymbopogon distans* (Nees ex Steud.) Will.Watson:

Cymbopogon distans (Nees ex Steud.) Will. Watson (Poaceae) is a promising aromatic plant distributed in the Himalayas. In this study, five acyclic monoterpenoids, namely geranyl acetate (RS1), neral (RS2), geranial (RS3), citral (RS4), and geraniol (RS5) were isolated from the essential oil of *C. distans*. The isolated compounds were tested for *in-vitro* neuroinflammation inhibitory potential in LPS-stimulated BV2 microglial cells. RS1-RS4 exhibited significant neuroinflammation inhibition without any cytotoxic effect at the dose of 10 µM. RS4, the most active anti-neuroinflammatory compound (TNF-α 31.48±1.00%; IL-6 24.02±0.63%; IL-1β 42.15±1.76%) was also able to inhibit acetylcholinesterase(AChE) in a dose-dependent manner. The results showed that RS4 (an isomeric mixture of neral and geranial) has the potential to inhibit neuroinflammation and acetylcholinesterase, which are the biomarkers of neurodegenerative disorders.



Dr. Ram Swaroop Verma & his team

Dr. CS Chanotiya डॉ. सी.एस. चनौटिया



Chemical compositions and constituents variability in essential oils of γ-irradiated German Chamomile (*Matricaria recutita* L.) mutants and their Acetylcholinesterase Inhibitory activities

Silent features of this study are :

a. We studied around 22 γ-irradiated German chamomile accessions and found significant changes in their chemical composition and antimicrobial activity.

b. Some accessions with high α-bisabolol oxide B were identified while other accessions showed

larger concentrations of α-bisabolol oxide B, α-bisabolone, and α-bisabolol oxide A.

c. All studied accessions showed high inhibition against *S. aureus* and *C. albicans*.

d. The study revealed that it inhibited the production of pro-inflammatory cytokines (TNF-α and IL-6) in LPS-stimulated BV2 microglial cells and RAW264.7 macrophages in a concentration-dependent manner.

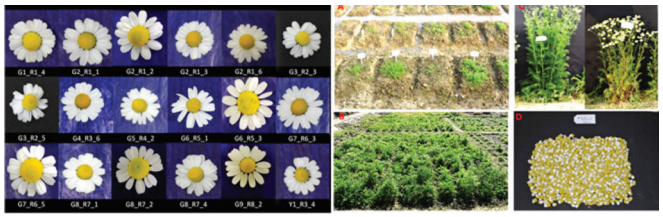


Fig.: Morphological Diversity at different developmental stages in selected German Chamomile accessions

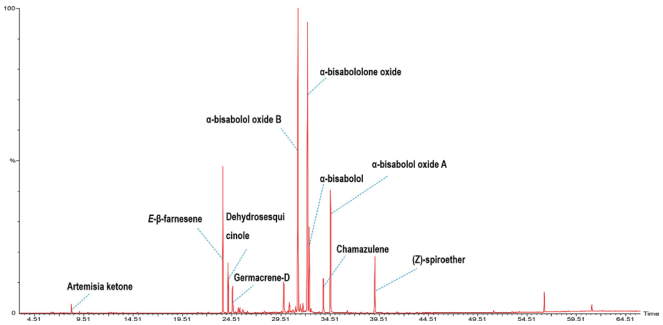


Fig.: Representative fingerprints of volatiles in a selected Chamomile accession

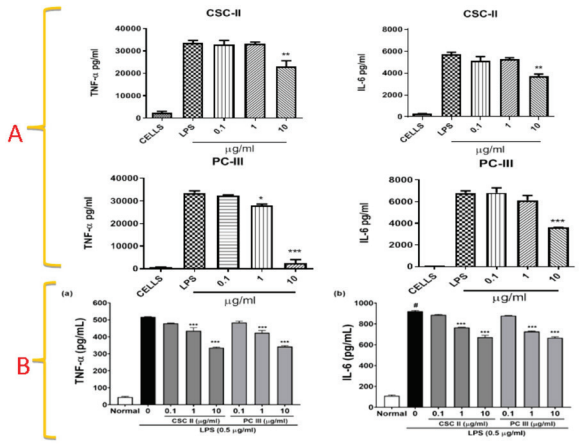


Fig.: A; Effect of oil CSC II (0.1, 1 and 10 µg/ml) and its potent compound PC III (0.1, 1 and 10 µg/ml) in RAW264.7 macrophage cells. B; Effect of oil CSC II (0.1, 1 and 10 µg/ml) and its potent compound PC III (0.1,1 and 10 µg/ml) on LPS-induced IL-6 and TNF-α production in BV2 microglial cells

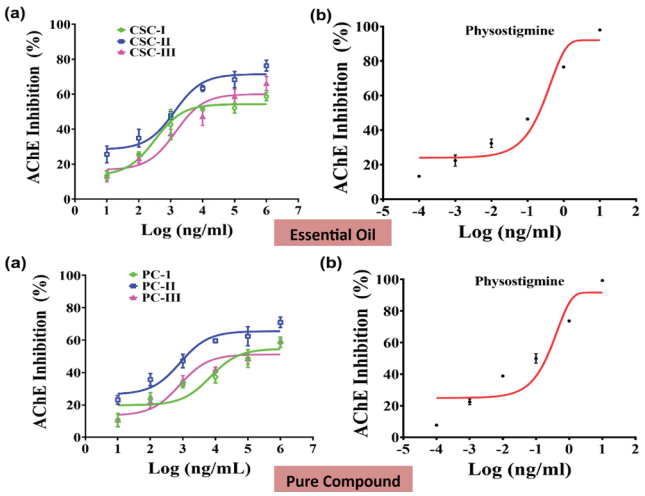


Fig.: Dose-dependent AChE inhibition potential of essential oils from selected chamomile accessions and their isolated compounds against the Physostigmine, CSC I; Y1R3-5, CSC II; G2R1-3, CSC III; G8R7-1, γ-irradiated chamomile accessions, and PC I; Chamazulene, PC II; α-Bisabolone, and PC III; α-Bisabolol pure isolates

Unraveling composition, toxicity and anti-typhoidal activity of water soluble essential oil fraction (WSF) of inter-specific basil (*Ocimum basilicum* L.)

Silent features of this study are :

a. Water soluble basil fraction (WSF) was investigated using GC and GC-MS

b. meta-eugenol was the most exclusive constituent of water soluble fraction

c. Water soluble basil fraction does not reveal any sub-acute oral toxicity effects

d. Besides, WSF exhibited maximum reduction in bacterial load of *S.* Typhimurium.

e. We have shown biological potential of basil water soluble fraction as an effective bacterial load suppressing agent for prevention of Salmonella infections in an animal model.

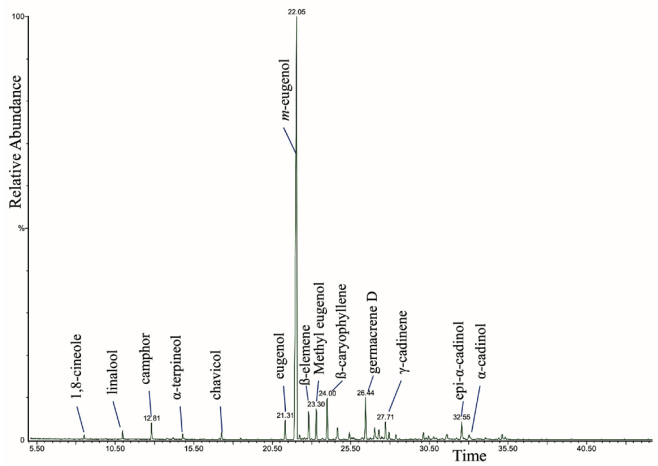


Fig.: Developed chemical fingerprint of WSF of *O. basilicum* L.

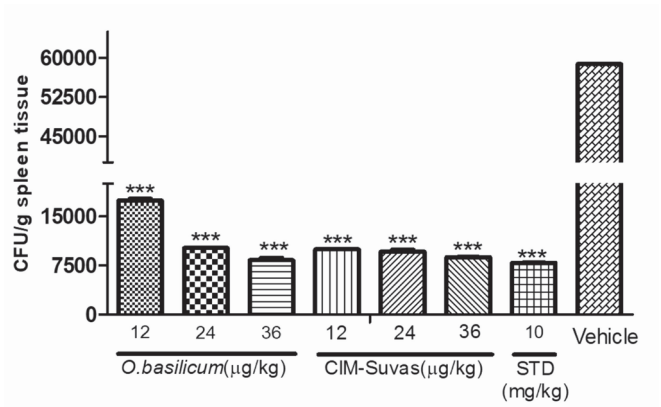


Fig.: Effect of WSF on the *S.* Typhimurium bacterial load. The results are presented as Mean ± SEM (n=6).

*p<0.05, **p<0.01, ***p<0.001 (significant compared to Vehicle vs Treatment). Vehicle- Salmonella infected.

Development of Radiocarbon (^{14}C) signatures of Indian lemongrass essential oils and its marker compound for authentication of their naturalness

The accelerator mass spectrometer (AMS) analysis revealed a distinction between natural and fossil-derived citral and its blends in Cymbopogon essential oils. The plant-derived citral contained a percent modern carbon (pMC) value in the range of 99-100%. In contrast, the fossil fuel-derived citral showed zero pMC. Similarly, blends of Cymbopogon oils with 30-50% (w/w) of fossil origin citral contained pMC equivalent to the proportions of modern carbon. These results showed the usefulness of AMS in quantifying the amount of ^{14}C associated with flavor ingredients. Further, it may be possible to synthesize chemical precursors isobutene or formaldehyde with artificially produced 14C to match biogenic levels in $^{14}C/^{12}C$ ratios, which cannot be differentiated with AMS. Since artificial production of ^{14}C involved high input cost as it requires spallation reaction with neutrons (from nuclear reactor) on ^{14}N, thus, it is unlikely a preferred route due to the high cost economics involved in manufacturing process.

Determination of volatile matters and ash (residue) content in agarbatti using simultaneous thermogravimetric analyzer (STA)

The worldwide demand for agarbattis is growing at a fast pace. In India, the demand and volume of production of agarbattis is increasing. The industry is well established with many firms completing over a 100 years in existence. With the invention of the mechanized process agarbatti can now be produced in any part of India and many individuals who are traditionally not a part of this fraternity originally are now running successful agarbatti industries. Agarbattis are used in homes, offices, places of worship and all other venues. The industry would like to come together to create a standard for agarbattis in association with BIS in order to provide a safe and consumer friendly product.

About 20 mg of agarbatti sample was subjected to constant weight loss under thermogravimetric analyzer as per the developed programme. For the quality control comparison, total volatile matters, high boiler and ash content in agarbatti sample can be calculated quantitatively as shown in thermograms (Fig).

The weight loss measurement can provide vital clues about the total volatiles and ash content at the end of

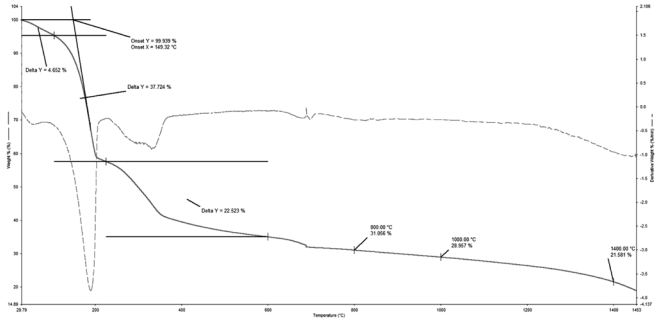


Fig.: Total volatiles and ash content in agarbatti samples

Note: *The above method and results were submitted to PCD 18 of BIS, New Delhi for inclusion in a new draft proposal on* **PCD 18 (14870) P Incense Sticks Agarbatti – Specification** *(ICS 71.100.70).*

the analysis. The results obtained were interpreted as a function of Delta Y, which determines the percent weight loss between two temperatures on a TGA curve.

A careful observation depicts the agarbatti constitution as per mentioned below:

- Agarbatti revealed multi-stage decomposition pattern.
- Agarbatti (average weight from taken from three different sticks) with fragrance and DEP showed mass loss value (Delta Y=42.9%) at 200°C when subjected to SGA analysis.
- A high boiler remained thermally stable up to 600°C, but only showed complete weight loss (Delta Y=22.5%).
- The amount of residue or ash present above 800 °C was (Delta Y=31.0%).



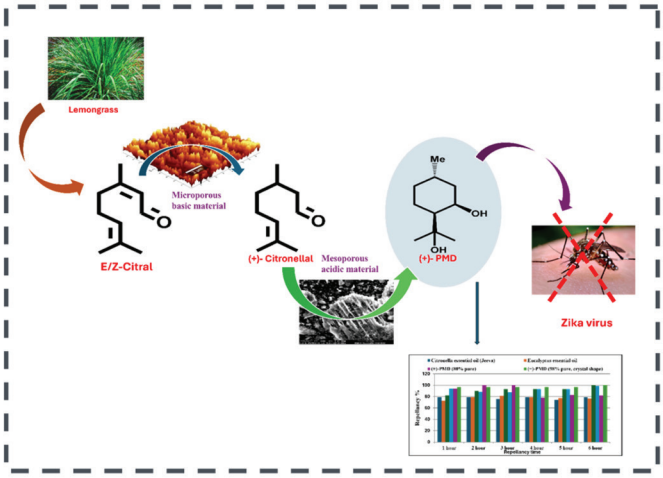
Dr C. S. Chanotiya & his team

Dr. PK Rout डॉ. पीके राउत

Catalytic transformation of Citral to *p*-Menthane-3,8-diol (PMD) via citronellal using novel heterogeneous materials



p-Menthane-3,8-diol (PMD), plays a crucial role in addressing the threat of vector-borne illnesses, including malaria, dengue, chikungunya, Zika, tick-borne disease, and scrub typhus. Mosquitoes, particularly those belonging to the Aedes, Anopheles, and Culex genera, are the most common vectors. Effectively managing these diseases necessitates vigilant surveillance and control of the vector population. PMD may be made through acid-catalysed cyclization-hydration of citronellal. Under CSIR-Aroma mission, India produces more than 2000 ton of lemongrass essential oil. Lemongrass essential oil contains citral (~70%) as major components. This (*E*/*Z*)-citral is transformed to (*Z*)-PMD via two step procedure. First step involves the hydrogenation of citral to citronellal using novel Ni-HT-530 catalyst and the second step involves the selective cyclic hydration of citronellal to (*Z*)-PMD using novel Cr-SBA-SBC catalyst. Both the synthesized materials were thoroughly characterized using various analytical techniques. Finally, the obtained product is tested for its ant mosquito repellent study against aedes mosquitoes.



The Ni-HT-530 catalyst is synthesized via co-precipitation method followed by hydrothermal method as listed in Fig.

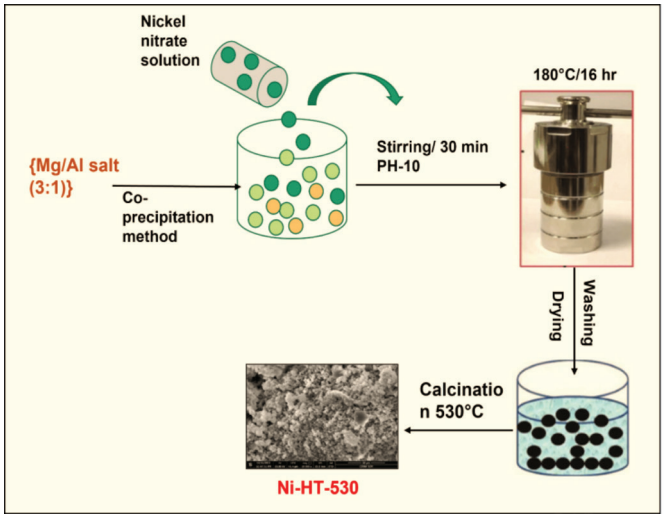


Fig.: Schematic representation of Ni-HT-530 catalyst synthesis.

The catalyst (Cr-SBA-SBC) has been synthesized by hydrothermal method which involves the sulfonation of biochar followed by metal doping via wet impregnation method as listed in Fig.

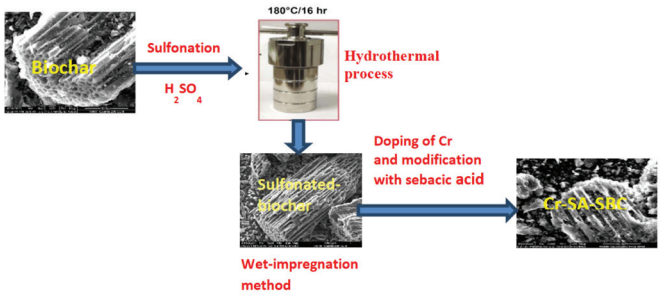


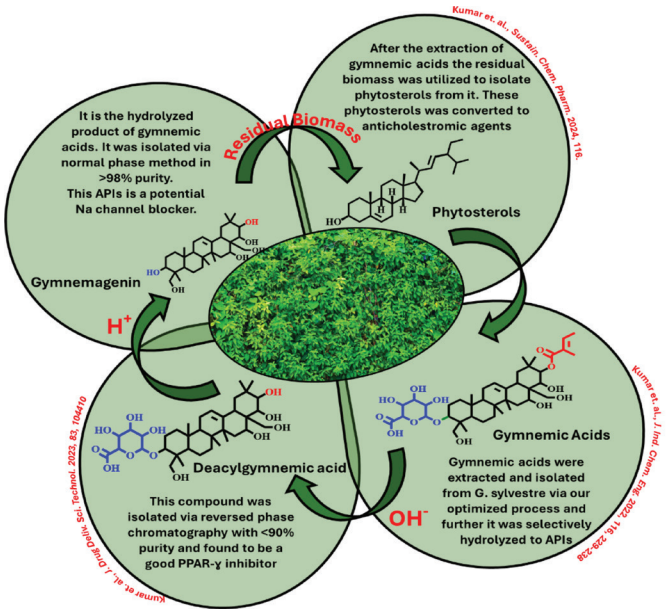
Fig.: Schematic representation of synthesis of Cr-SBA-SBC catalyst

The reaction parameters were optimized using single factorial and multifactorial design method to find the optimum reaction condition. Firstly, the synthesis of citronellal from citral is investigated using different loaded Ni-HT-530 catalyst. Among these catalysts, the 12wt%Ni-HT-530 catalyst demonstrates superior activity and selectivity toward citronellal. Under optimized conditions, this catalyst achieves a remarkable 99% conversion of citral to citronellal, with 95% selectivity, indicating its effectiveness in promoting the desired reaction while minimizing undesirable by-products. Furthermore, the catalytic performance of the 12wt%Ni-HT-530 is evaluated across multiple reaction runs, demonstrating its stability and longevity. In addition, the selective modification of citral in lemongrass essential oil is produced (+)-citronellal rich oil. This value-added process enhances the commercial appeal of lemongrass essential oil by enriching it with citronellal, a compound widely used in fragrances, cosmetics, and insect repellents.

Moreover, the study presents a novel method for the semi-synthesis of (*Z*)-PMD in citronellal-rich essential oil using 5%Cr-SA-SBC. Through the optimization of reaction conditions using response surface methodology (RSM) combined with a Box-Behnken design (BBD), optimal parameters are identified, including temperature, reaction time, and catalyst dosage. Under these optimized conditions, the conversion rate and selectivity for (*Z*)-PMD synthesis reach impressive levels, highlighting the efficiency and efficacy of this green and sustainable process. Importantly, the synthesized (*Z*)-PMD demonstrates superior efficacy as a mosquito repellent as compared to (*E*)-PMD and the commercial DEET (*N*,*N*-Diethyl-meta-Toluamide) compound. This nature-identical (Z)-PMD exhibits excellent repellence against *Aedes albopictus* mosquitoes for up to 6 hours, emphasizing its potential as an alternative to conventional insect repellents. This underscores the significance of utilizing citronellal and essential oils (citronella essential oil, lemongrass essential oil and eucalyptus essential oil) as ideal substrates for enantioselective (Z)-PMD synthesis, with implications for public health and environmental sustainability.

Complete utilization strategy and development of anti-hypertensive, anti-hyperglycaemic and anti-hypercholesteraemic products from *Gymnema sylvestre*

Gymnema sylvestre is a plant that is well known for its antihyperglycemic actions due to the presence



of gymnemic acids in its leaves. However limited quantity of gymnemic acids (~1% w/w) is a major concern of its selective extraction from the leafy biomass, which translates into lower biological potency. In the present study, addressed the complete package of pharmacology of leafy biomass, scale-up preparation of standardized extract, quantitative estimation of four APIs in the standardized extract, isolation of APIs, preparation of standardized extract through greener approach along with its bioactivity. The hydro-ethanolic (7:3) extract was prepared from *G. sylvestre* known as Gym-Crude. A novel greener process has been developed for preparation of GAs enriched extract (Gym-CA) from Gym-Crude using citric acid (0.5 M). Gym-CA (75 mg/g) was enriched with GAs (17.7%) including 1.6% of deacylgymnemic acid (DAG) and 8.2% gymnemic acid IV (GA-IV). The Gym-CA was modified to lipid soluble derivatives (Gym-Ace) and also its Ag-nanoparticle (Gym-Ag-NPs) formation. Gym-Ag-NPs hydrodynamic size 216.3 nm, inorganic core size 15 nm, polydispersity index 0.263, and surface plasmon resonance peak at 434 nm. The insulin resistance reversal potential (IRRP) of gymnemagenin, DAG, GA-IV, Gym-CA, Gym-Ace, and Gym-Ag-NPs were evaluated. Highest IRRP (99.88%) was observed in Gym-Ag-NPs at 10 ìg/mL concentration due to increased bioavailability of Ag-nano formulation. On the other hand, Gym-Ace was least potent with 37.20% IRRP at same concentration. Among isolated GAs, DAG was most potent due to medium molecular mass, enhanced polarity and better bioavailability. Gym-Ace has displayed reduce bioavailability; hence esterified form is least potent. The preparation of Gym-Ag-NPs and its thorough characterization is a novel approach for enhancing IRRP activities. In another study, the antihypertensive activity from this plant was not yet discovered. In our study it was discovered that gymnemagenin is a potent Na/K channel blocker.

The partial utilization of waste for isolation of biomolecules and its extraction process optimization, logistic modification to enhance bioactivity. Phytosterol waste (PW) was generated as spent in commercial-scale extraction unit, while preparing Gym-CA extract. PW_{in} (4.63±0.04% (w/w)) was recovered during initial defatting step in hexane and after the extraction of Gym-Crude PW_{ex} (4.49±0.13 % (w/w)) was recovered by extracting the solid herb waste in ethyl acetate. Stigmasterol (I) is isolated on an industrial scale and subjected modification to stigmasteryl acetates (Fig.). The synthesized stigmasteryl acetates (II-VI) was performed better with respect to Stigmasterol (I) in *In-silico* docking analysis and among them compound VI was found to most affinitive with HMGCoAR. Furthermore, compound VI was found to attenuate hypercholesterolemia and improve blood cholesterol profile of experimental animals when tested *In-vivo* study.

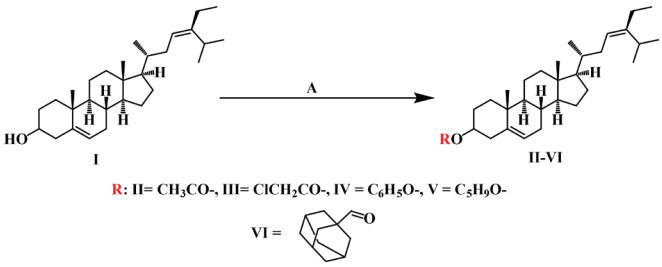


Fig.: Scheme of modification of stigmasterol to stigmasteryl acetates

Similarly, the bioactivity of standardized extract, isolated GAs, modified standardized extracts and Ag-nanoform, and modified stigmasterol have been thoroughly studied through *In-vitro*, *In-vivo*, *In-silico* models for hyperglycemia and hypertension activities with well complied to the safety aspects. The phytochemical investigation of leafy biomass of *G. sylvestre* and its bioactivities potential have been fully addressed.



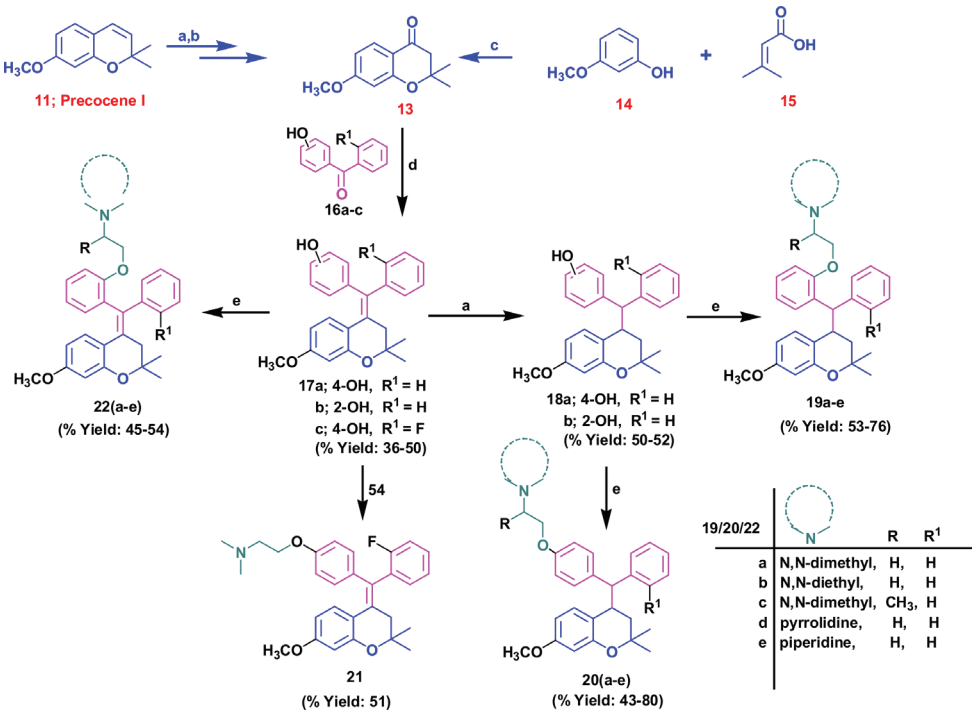
Dr. Prasanta Kumar Rout & his team

Dr. Atul Gupta डॉ. अतुल गुप्ता



Synthesis of 2,2-Dimethyl-chroman based stereochemically felxible and constrained anti-breast cancer agents

Receptors are proteinous macromolecules in the *apo* form under normal/ unliganded conditions. As the ligand approaches, there are specific stereochemical changes in the *apo* form of the receptor as per the stereochemistry of a ligand. Accordingly, a series of substituted dimethyl-chroman-based stereochemically flexible and constrained Tamoxifen analogs were synthesized as anti-breast cancer agents. The synthesis of designed prototypes I, II, and III (8, 9, and 10) was started using 7-methoxy-2,2-dimethylbenzopyran-4-one (13), which was obtained by reduction followed by oxidation of naturally occurring chromene, i.e., Precocene-I (11) isolated from *Ageratum conyzoides* (Scheme). The synthesized compounds **19a-e, 20a-e, 21,** and **22a-e,** showed significant anticancer activity against estrogen receptor-positive (ER^+, MCF-7) and negative (ER^-, MDA MB-231) cells within IC_{50} value 8.0-25.0 µM. Amongst all, four potential molecules viz **19b**, **19e**, **22a**, and **22c**, were evaluated for their effect on the cell division cycle and apoptosis of ER^+ and ER^- cancer cells (MCF-7 & MDA MB-231cells), which showed that these compounds possessed anticancer activity through triggering apoptosis. *In-silico* docking experiments elucidated the possible affinity of compounds with estrogen receptors-α and -β.



Reagents and reaction conditions: (a) H_2, 5% Pd/C in dry THF; (b) CrO_3, dry DCM, pyridine in 0°-35°C; (c) polyphosphoric acid (PPA) at 100 °C; (d) Zn, $TiCl_4$, dry THF, reflux under inert condition; (e) 2-chloroethyl alkylamine hydrochloride, anhydrous K_2CO_3, dry acetone, reflux.

Isolation of phytomolecules from *Zanthoxylum armatum DC* leaves and their osteogenic activity

Zanthoxylum armatum DC belongs to Rutaceae family. It is commonly known as timur or prickly ash. It is mainly distributed in tropical and sub tropical parts of India and also found in China, Nepal, Taiwan, Japan, Phillippines, Malaysia and Pakistan. It is a small aromatic plant or a type of a large shrub upto 6 m high. It is generally propogated through seeds, but also from vegetative parts through soft wood cuttings. A variety of Phytochemical constituents like terpenoids, flavonoids, alkaloids, phenolics, lignans, coumarins, glycosides, steriods, fatty acids are extracted from this plant. Traditionally, *Z. armatum* herbal tooth powder has been used in varoius oral disease like gum disease, tooth erosion etc. It is reported for many health benefits.

The present study was focused on isolation of phyto-constituents from leaf extract of plant, which can be useful candidates for the treatment of osteoporosis. The leaves of *Zanthoxylum armatum DC* were collected from different locations of Uttarakhand, India and were authenticated from CSIR-CIMAP, Pantagar. The plant material was shade dried and coarsely powdered.The powdered leaf material (2.6 kg) was extracted by continuous hot extraction process using percolation method and methanol as a solvent. The extract was concentrated under reduced pressure to obtain a green semi-solid residue (332 grams), which was screened for osteogenic activity by ALP method. Extract showed promising enhancement in osteoblast cells. Having these results in our hand, we started isolation of the different phytochemicals from the extract to know their individual role against osteoporosis and target oriented structural modifications which is in progress.

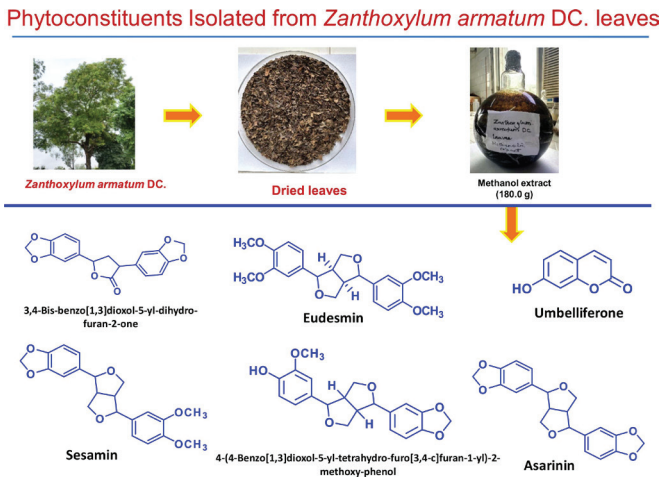


Fig.: Structures of phytoconstituents isolated from *Zanthoxylum armatum DC* leaves



Dr. Atul Gupta & his team

Er. Ashween D Nannaware इंजी अश्विन डी. नन्नावरे



Installation and commissioning of centralized hybrid solar distillation unit (500kg capacity) at farmers field in Vidarbha region for essential oil extraction

Boiler-operated solar hybrid distillation technology (BO-SHDT) has been designed and developed to extract valuable essential oils from aromatic plants. The BO-SHDT is embedded with a centralized solar distillation, a multi-layered self-power operated hydraulic foldable solar structure for easy system



Fig.: Installation of new design centralized solar hybrid distillation unit (500 kg) at farmers field in Nagpur region

transport, 35 solar panels, and a solar hybrid boiler-based distillation assembly with a capacity for 500 kg of planting material. The new designed solar hybrid boiler has a 150L water capacity and is properly designed with pressure safety features. Solar tracking module for solar energy transport and uniform steam generation has been designed and developed. This BO-SHDT has been installed and commissioned at farmers field in Village Ramagaon (Nagpur region) for the extraction of valuable essential oils. Initial trails was successful in producing better oil yield with good organoleptic qualities tested through GC/MS analysis. Using the BO-SHDT, the lifetime return of solar setup is very profitable with reduce CO2 emissions. This solar hybrid distillation technology also highlights the impact of BO-SHDT on the upliftment of farmer's income through a green circular LCA (Cradle to grave) approach. Initial studies on environmental sustainability and cost-effectiveness have shown that this technology is green, portable, energy-efficient, and has a payback period of ~2-3 years with a 20-25-year service life.



Fig.: Field study of new design decentralized solar aroma distillation unit at different geographical famers location in India

Energy, environmental and economic evaluation of Decentralized Solar Distillation and Wood based distillation for extraction of organoleptically superior essential oils

A novel environmentally-friendly decentralized Solar Distillation Unit (DSDU) has been designed and developed for the extraction of organoleptically superior essential oil from different valuable aromatic crops. It comprises of multi-functional hydraulic trolley with a drawbar body, a foldable hydraulic solar structure with a tilting gear that captures solar energy by lowering and raising the solar panel structure operated by lever, hydraulic arm jack at four sides of hydraulic trolley, and new solar distillation apparatus. This DSDU effectively traps the solar energy at different angles during the daytime (maximum at 24° angle). The results of extraction studies of citronella, lemongrass and ocimum by DSDU revealed improved oil yield, i.e.,0.53%, 0.33%, and 0.20% respectively as compared to wood-fired distillation unit (WDU). The oil composition analysis was also performed using GC/MS which showed variation in composition of major and minor chemical constituents. A cradle-to-grave life cycle approach for greenhouse gas emission showed that WDU has higher emissions (45.3 tonnes of CO_2 equivalents) in comparison to DSDU. System efficiency, performance, environmental and cost-economic impact of DSDU were also studied and found superior over WDU. In addition, DSDU is an easy-to-move green sustainable technology which may empower rural India and meet increasing energy demands.



Dr. Ashween D Nanaware & his team

Dr. Hariom Gupta डॉ. हरीओम गुप्ता

Bio-synthesis of bimetallic oxide and its functionalized nanostructures using distillation waste for the mitigation of dye hazard or carcinogenic dye contaminant



Triphenylmethane dyes are widely used in various industries, including textiles, paper, leather, and plastics. Its presence in water sources poses significant health risks, as it is classified as a carcinogen and has been linked to serious health issues such as cancer and reproductive disorders. The contamination of drinking and irrigation water with triphenylmethane dyes can adversely affect both human health and the food chain, particularly through food and medicinal crops irrigated with polluted water. Therefore, environmentally benign bimetallic oxide nanostructured adsorbents are prepared using distillation waste of medicinal plants for the mitigation of hazardous crystal violet contaminants. The prepared bimetallic oxide nanostructures (Nano-BMO and f-Nano-BMO) are characterized using appropriate analytical tools and techniques. The dye sequestration efficacy, kinetics, pH, and concentration dependence analysis are performed and examined with various obtained kinetic and adsorption isotherm models to determine the followed mechanism. Nanostructures prepared using distillation waste of medicinal plants have shown significant benign potential to mitigate the toxic dye contaminant (more than 90 % efficiency) that can be used to control and management of the quality of water and herbal extracts.

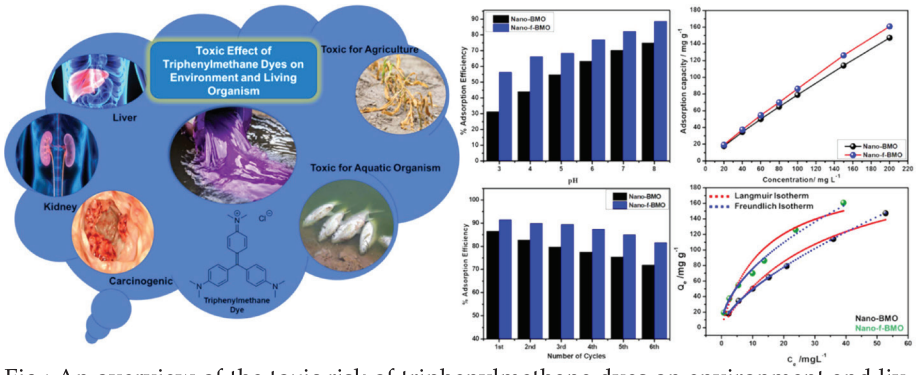


Fig.: An overview of the toxic risk of triphenylmethane dyes on environment and living organisms, and mitigation characteristics of nano-bimetallic oxide.

Mechanistic Insight into Binding of Graphene Towards Multiple Therapeutic Target of SARS-CoV-2 by Molecular Docking and Dynamics Studies

Although a few years have passed since the emergence of COVID-19, the disease remains challenging to cure, despite the availability of emergency-approved vaccines. The effectiveness of these vaccines in combating the virus is still somewhat uncertain. The impact of the emergency-approved vaccines against it is not highly certain. The entire world may face surge of new wave of the infection, and therefore, its reoccurrence cannot be denied. Causalities and economic losses may happen in the future. In this situation, it is need of the hour to explore some suitable therapeutic agents against this highly infectious and challenging disease. Organic molecules, inactivated virus etc were largely focused to derive the vaccines, however, nanomaterials still remain untested for it. Interaction of nanomaterials like graphene against proteins of the coronavirus to inhibit its activity is yet to be tested computationally.

In this computational research work, SARS-CoV-2 proteins, including spike proteins (both open and closed form), Main Protease (MPRO), receptor-binding domain (RBD), RNA dependent RNA polymerase (RdRp), Angiotensin Converting enzyme 2 (ACE2) have been individually evaluated for their docking with graphene. It is observed that all of these proteins were found interactive through their amino acid residues with graphene. A number of interacting amino acid residues is considerable

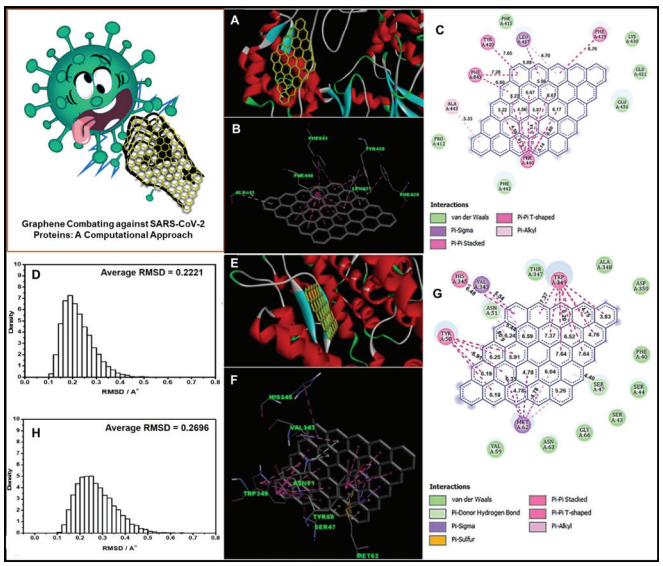


Fig.: Molecular docking and dynamics results for graphene complex with RdRp (A-D) and ACE-2 (E-H) protein of SARS-Cov-2

enough to collectively acquire high binding energy in each case. It can be envisaged that cumulative perturbations of all the interactions of each protein caused by graphene can lower or inactivate the virus. Molecular dynamics simulation clearly suggests the formation of stable graphene-protein complexes. The feasibility of graphene-based disinfectant spray, personal protective cloths, and sensors can be suggested. Further, in-vitro virucidal/virustatic studies can be envisaged



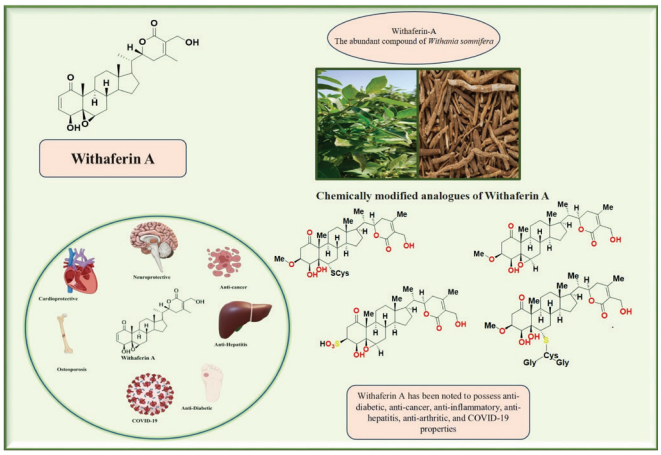
Dr. Hariom Gupta & his team

Dr. Kapil Dev डॉ. कपिल देव

Review on Chemistry, Pharmacology, Toxicity, and Future Prospective of Withaferin A

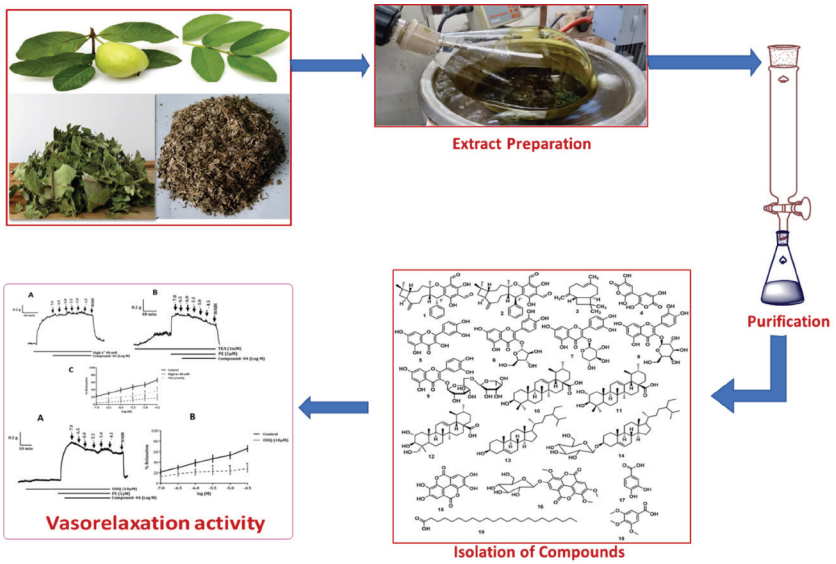


Withania somnifera (L.) Dunal is an important Indian medicinal plant. It is a highly reputed Ayurveda herb with diverse biological activities like aphrodisiac, immunomodulatory, anti-inflammatory, cardioprotective, anti-cancer, etc. The bioactive compounds isolated from *W. somnifera* are categorized as withanolides. Withaferin A, a major bioactive constituent of *W. somnifera* which possess a steroidal lactone ring in its skeleton. Numerous studies have shown that withaferin A exhibits various pharmacological properties. Its structural modification targets several signal transduction pathways and improves the effectiveness of treatment for a range of illnesses. We comprehensively reviewed the pharmacological properties of withaferin A against various diseases. Among the most well-studied effects of withaferin A are anti-cancer properties, including those from multiple myeloma, neuroblastoma, leukemia, glioblastoma, ovarian, breast, colon, head, and neck cancers, which have shown evidence of WA's anticancer activity.



Phytochemical investigation of *Psidium guajava* L. leaves in search of vasorelaxant bioactives

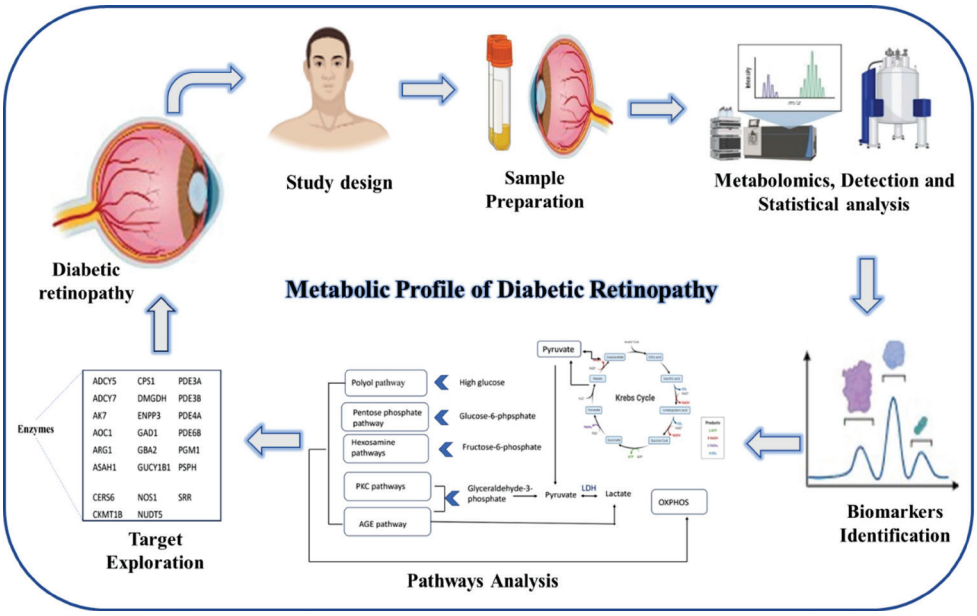
Psidium guajava L. (commonly known as guava), belongs to family Myrtaceaea and cultivated for its fruits in tropical and subtropical regions of the world. In Ayurveda, it is considered as tridosh nashak *i.e.* Vata, Pitta, and Kapha. Previous preclinical studies found that *guava* leaves and their isolates have the potential for anti-cancer, antioxidant, anti-inflammatory, antibacterial, antidiabetic, and hypolipidemic activities, etc.



The phytochemical investigation of *Psidium guajava* leaves led to the isolation of nineteen compounds belonging to meroterpenoids, flavonoids, phenolics, and triterpenoids. The compounds were isolated using extensive chromatography techniques and identified as psiguanol (**4**), as new compound along with guajadial (**1**), psidial A (**2**), β-caryophyllene (**3**), quercetin (**5**), avicularin (**6**), guaijaverin (**7**), hyperin (**8**), rutin (**9**), ursolic acid (**10**), corosolic acid (**11**), asiatic acid (**12**), β-sitosterol (**13**), β-sitosterol-D-glucoside (**14**), ellagic acid (**15**), 3,3',4'-trimethylellagic acid 4-O-glucoside (**16**), protocatechuic acid (**17**), gallic acid (**18**), and tricosanoic acid (**19**) as known molecules. The compound **16** was isolated for the first time from this plant. The isolated compounds were evaluated for vasorelaxation activity in rat aorta cells and it was observed that compound **4** exhibited the most potent vasorelaxation response in the *ex-vivo* model in isolated rat aorta cells. Mechanistically, the vasorelaxation activity of **4** was mediated through the cGMP-dependent opening of calcium-activated potassium channels.

Metabolomics of Diabetic Retinopathy

A frequent side effect of diabetes mellitus and the main global cause of visual loss is diabetic retinopathy (DR). The retinal vasculature and neuronal tissues experience gradual deterioration, which ultimately impairs vision. The onset and progression of DR are significantly influenced by metabolic dysregulation, although the pathophysiology of DR is complex.



A potent omics method called metabolomics has become an invaluable tool for understanding the intricate metabolic alterations connected to DR. The methods used in metabolomics studies of DR are compiled here. As principal analytical methods, liquid chromatography-mass spectrometry (LC-MS) and gas chromatography-mass spectrometry (GC-MS) and their extent of use in metabolomics of DR. In the current chapter, we focused on the key metabolic pathways connected to DR as revealed by metabolomics research. Biomarkers may help with risk stratification and early illness detection, which could lead to better clinical DR management.



Dr. Kapil Dev & his team

Dr. V S Pragadheesh डॉ. वी एस प्रगधीश

Endo-Fenchyl Acetate Rich Essential Oil of *Strobilanthes sessilis* Nees Inflorescence and its Characterisation using GC, GC-MS and NMR Techniques



Strobilanthes Blume is a genus in the family Acanthaceae, with many species endemic to the Indian subcontinent. *Strobilanthes sessilis* Nees is endemic to the southern Western Ghats of India. The essential oil of dried inflorescence of *S. sessilis* was extracted using hydrodistillation method and the chemical composition was determined using GC and GC-MS techniques, which revealed the major compound to be *endo*-fenchyl acetate (89.33%). Other minor compounds like *endo*-fenchol (3.74%), (*E*)-caryophyllene (1.07%), and limonene and β-phellandrene (0.55%) were also observed. The major diastereomer of fenchyl acetate was determined using 2D-NMR techniques like HSQC, HMBC, and ROESY to confirm the *endo* configuration. The optical rotation of the oil in different solvents deduced that the laevorotatory enantiomer of *endo*-fenchyl acetate as the major or single compound. *S. sessilis* could be further explored as a major source of *endo*-fenchyl acetate, which has high importance in flavouring and other biological applications.

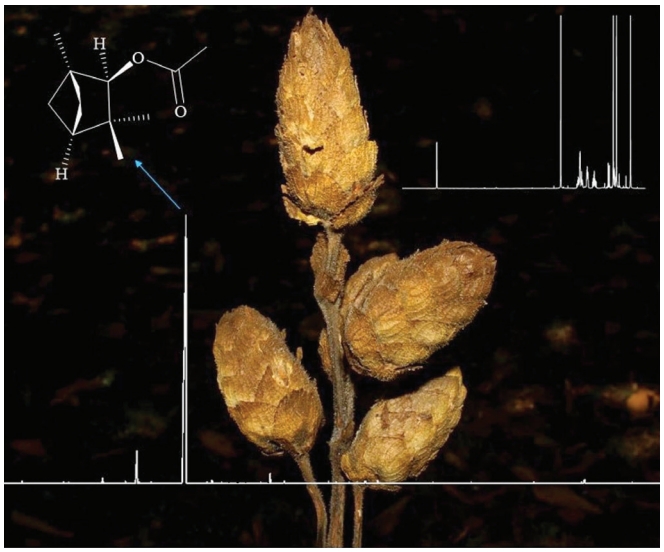


Fig.: GC chromatogram of *S. sessilis* inflorescence essential oil rich in *endo*-fenchyl acetate

Essential Oil Profile of *Garcinia pushpangadaniana*, a Recently Described Species from the Western Ghats of India

The medicinally important genus *Garcinia* is widespread in the Western Ghats and the Northeast Regions of India. Three accessions of *Garcinia pushpangadaniana* from two populations were studied during pre-monsoon and monsoon seasons. Dried leaves were subjected to hydro-distillation to extract essential oil and chemical composition of the essential

oils were determined using gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) techniques. (*E*)-Caryophyllene was the major compound with 14.05%, 18.96%, and 15.60% in all three accessions respectively. Sesquiterpene compounds with cadinene-type skeleton were found to be the key compounds in *G. pushpangadaniana,* making up 47.65 – 49.67% of the EO. These include δ-cadinene (12.79 – 14.38%), γ-muurolene (9.56 – 9.87%) and γ-cadinene (5.93 – 6.94%). The compounds such as spirolepechinene, α-calacorene, α-corocalene, caryophylla-4(12),8(13)-dien-5-ol and cadalene are identified as unique compounds in *G. pushpangadaniana* essential oil, and these marker compounds can be used for the authentication of this species.

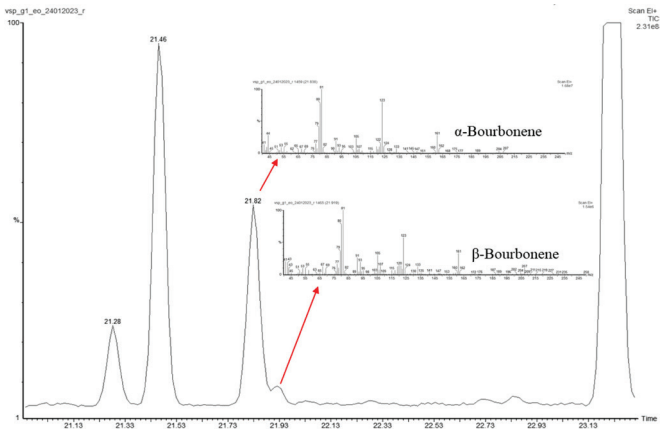


Fig.: GC-MS chromatogram of *G. pushpangadaniana* essential oil showing both α-bourbonene and β-bourbonene with their mass spectra (inlaid)



Dr. V S Pragadheesh & his team

Dr. Ratnasekhar CH डॉ. रत्नशेखर सीएच

Mass spectrometry based untargeted metabolomics combined with machine learning models for the authenticity of natural medicines



Herbal medicines are popular natural medicines that have been used for decades. The use of alternative medicines continues to expand rapidly across the world. The World Health Organization suggests that quality assessment of natural medicines is essential for any therapeutic or health care applications, as their therapeutic potential varies between different geographic origins, plant species, and varieties. Classification of herbal medicines based on a limited number of secondary metabolites is not an ideal approach. Their quality should be considered based on a complete metabolic profile, as their pharmacological activity is not due to a few specific secondary metabolites but rather a larger group of bioactive compounds. A holistic and integrative approach using rapid analytical strategies for the screening of herbal medicines is required for robust characterization. In this study, a rapid and effective quality assessment system for geographical traceability, species, and variety-specific authenticity of the widely used natural medicines turmeric, and *Withania somnifera* was investigated using high resolution accurate mass spectrometry. Extremely good discrimination (R^2 >0.99, Q^2 >0.98, and accuracy= 1.0) with sensitivity and specificity of 100% was achieved using this metabolic fingerprinting combined with machine learning models strategy.

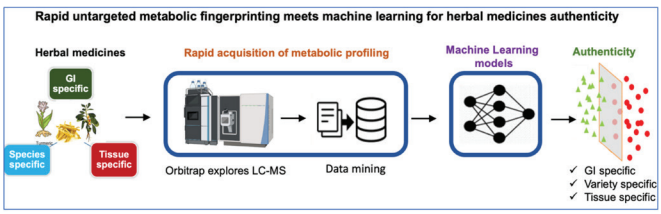


Fig.: Schematic of the Metabolic fingerprinting of natural medicines using chemometric models

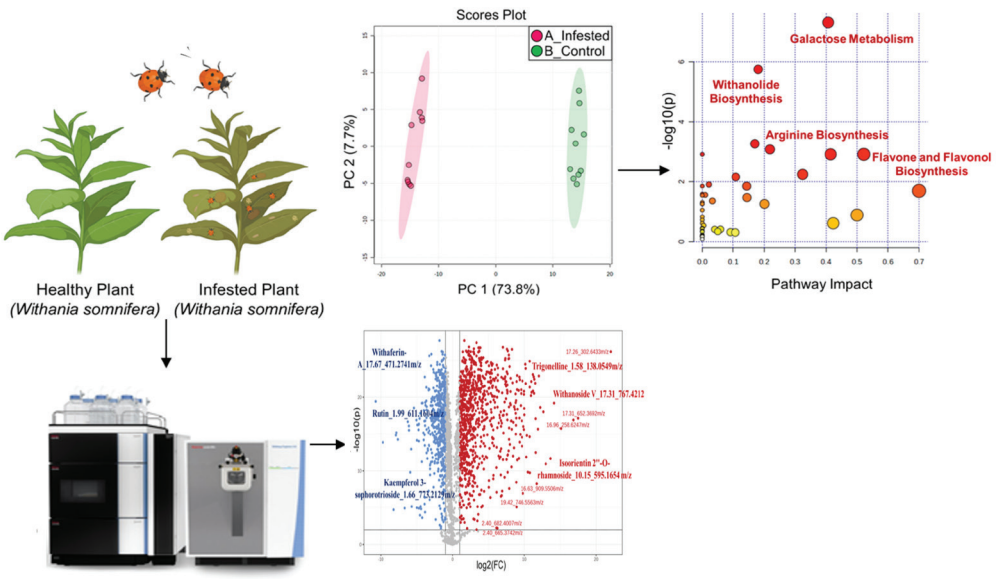


Fig.: Schematic of the Metabolic perturbations occurred in *Withania somnifera* in response to infestation

Our study demonstrated that rapid untargeted metabolic fingerprinting can be used as a robust analytical method to authenticate several important medicinal herbs.

Metabolomics based approach to investigate the biotic stress on *Withania somnifera*

Withania somnifera is a traditional herbal medicine that has been using since 3000 years in the Indian ayurvedic systems for treating a number of disorders and is well known as a general health tonic having analgesic, antiepileptic, and sedative properties due to the presence of bioactive metabolites such as alkaloids, withanolides. In India, *W. somnifera* plant is known to grow in semi-arid places as this plant is drought resistant having a hardy stem and root. However, the plant is prone to various distempers including depredation by the insect pests. *Henosepilachna vigintioctopunctata* is one of the major pests of ashwagandha that causes severe damage to yield of the crop. The extent of herbivorous pathogenic attack of *H. vigintioctopunctata* to the *W. somnifera* varies from place to place with variation in the temperature and other environmental conditions. The pest is distributed widely in Southeast Asian countries along with Korea and Australia. The pest *H. vigintioctopunctata* was being noticed since many decades in different parts of India. The pest commonly known as 28-spotted lady bird beetle have also- been found on the leaves of *Withania somnifera* plants in the Northern regions of India. The insect completes its life cycle on the leaves of *W. somnifera*. The larvae voraciously feed the leaves causing skeletonization of leaves resulting in the reduced commercial value of plants. In the present study, for better understanding of the plant-insect interaction and its effect on the plant metabolism, we utilized comprehensive metabolomics guided approach for understanding the metabolic response of *W. somnifera* plant in response to insect pathogen *H. vigintioctopunctata*. Along with this ICP-OES based elemental analysis was performed to identify the accumulation of different nutrients in response to pest interaction in plants.



Dr. Ratnasekhar CH & his team

Bio-Prospection & Product Development

HIGHLIGHTS

The major research area of the division is development and standardization of herbal formulations for human health in AYUSH and PHYTOPHARMACEUTICAL mode. Focus areas are Antimicrobial, Malaria, Psoriasis, Inflammation, Diabetes, Liver, Wound healing, Hepatoprotection, Immuno-Pharmacology, Cancer, Safety studies, Nanomedicine and drug delivery of plant drugs.

Important Division R&D activities:

- The immuno-pharmacological potential of Medicinal and Aromatic Plants (MAPs) leads with special reference to the involvement of inflammatory mediators in non-infectious (Metabolic disorders, Skin Inflammation), and infectious (Immune-Pathogenesis of Malaria).
- Antimicrobial and anti-biofilm activities of enriched hydrosol from *Trachyspermum ammi* against two prominent foodborne pathogens: *Listeria monocytogenes* and *Staphylococcus aureus*..
- Reported first time anti-psoriatic and anti-proliferative potential of apigenin in HaCaT cells and psoriasis like dermatitis in BALB/c mice.
- Developed QbD-based mupirocin-β-cyclodextrin complex loaded thermosensitive in-situ gel for wound healing.
- Developed nano-liposomes mediated delivery system for enhanced therapeutic efficacy of Piperlongumine for cancer treatment.
- Narirutin, a flavonoid discovered in citrus fruits, regulates cell cycle stages and suppresses the growth of hormone-resistant prostate cancer cells through hyaluronidase targeting. It also delayed the growth of cancer cell lines by suppressing lipoxygenase-5 expression and prompting G0/G1 arrest in triple-negative breast carcinoma



Scientists of Bio-prospection and Product Development Divisional Unit

(L to R) : Dr. Suaib Luqman, Dr. D. Chanda, Dr. D Saikia, Dr. Abha Meena, Dr. DN Mani, Dr. Anirban Pal, Dr. N. P. Yadav, Dr. DU Bawankule

cells. Therefore, it may act as an active and safe compound for reproductive cancer prevention/ treatment.

- Myricetin 3-rhamnoside targets hyaluronidase, an enzyme that breaks down hyaluronic acid to slow down the proliferation of hormone-independent breast cancer cells.
- Myricitrin, a phytochemical derived from the bayberry act as a potential blocker of cathepsin-D, an enzyme overexpressed and hyper secreted in cancer. The findings pave the way for prevention of squamous lung carcinoma**.**
- Reported antifungal and synergistic activity of an indole derivative 1-(4-((5-methoxy-2-(3,4,5-trimethoxyphenyl) - 1*H*-indol-1-yl) methyl) phenoxy)-N, N-dimethylethan-1-amine (**100DL-6**) by using *in-vitro* anti-candidal activity against two Candida strains; *Candida kefyr* and *Candida albicans*.
- Dose dependent screening and optimization of medicinal plants on *in-vivo* model of ulcerative colitis and rheumatoid arthritis.
- Model development of rheumatoid arthritis using type-II collagen and ulcerative colitis using DSS.

Other important activities:

Bio-Prospection & Product Development Division has published 23 articles, filed 01 patent and working under 05 different mission projects. The division has 03 on-going GAP/CNP/SSP projects. Total number of Ph. D. students in the division are 28 and 09 students have been awarded Ph. D. in the year 2023-24.

Dr. Abha Meena, Principal Scientist received ICMR-DHR International Fellowship for Young Scientists 2023-24 for 12 months to work at King's College London UK. Dr. Suaib Luqman, Senior Principal Scientist featured in the list of top 2% Most Influential Scientists (Single Year) in 2023 by Stanford University.

Three herbal formulations viz. CIMAP Phal Se (fruit-based granules), Cough Syrup and Tulsi Drops as immune booster developed under divisional contribution have been transferred to Industry. Divisional scientists also contributed for the development of preservative free Aloe vera gel (Aloe Roma) formulation released in the year 2023-24.

Bio-Prospection & Product Development Division has conducted various training programs for skill developments namely (1) Residential training on “Pre-Clinical Development of Medicinal and Aromatic Plant-based Leads” (2) 5-days training program (online) on Herbal Drug Development Technologies (3) 5-days training program (offline) on “Entrepreneurship Development Hands on Training Program” under CSIR-Skill Initiative Program.

The division also provides the Services for testing of bioactives for anti-microbial, immune modulatory activity, besides microbial load and test for specific pathogens under ISO:17025.

Dr. D. Saikia डॉ. डी. सैकिया

Synergistic potential of plant-derived compound as antifungal agent against Candida strain



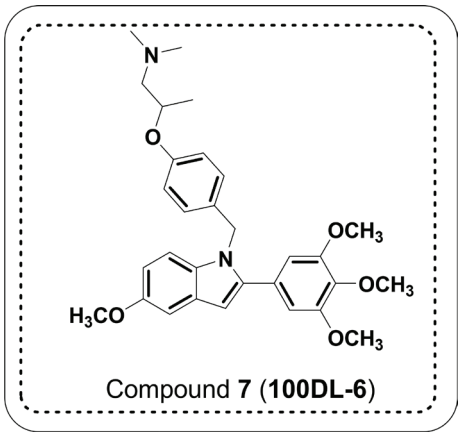
Fungal infections have fewer therapeutic options than bacterial infections because of the similarity between fungal and mammalian cells. The arsenal used to treat Candida infections is made up of various chemical types e.g. polyenes, azoles, echinocandins, nucleoside analogues, and allylamines are employed with various success rate depending on the type and location of infection, as well as pathogen's sensitivity to available drugs. Generally, four unique fungal metabolic pathways are targeted by commonly used antifungal drugs. Glucan synthesis is inhibited by echinocandins, macromolecule synthesis is inhibited by fluorinated pyrimidine analogues, and interaction with microtubules by griseofulvin. Ergosterol biosynthesis is inhibited by azole derivatives and allylamines, which also alter membrane function through ergosterol complex-cell lysis.

There are over 150 species of Candida, of which more than 17 are known to cause candidiasis in humans. The most common species causing infections are *C. albicans, C. glabrata, C. tropicalis, C. parapsilosis, C. krusei* etc.

Fluconazole, an azole antifungal, interacts with lanosterol 14-α-demethylase (LDM) a key enzyme in ergosterol biosynthesis pathway involved in fungal membrane synthesis. Lanosterol 14-α-demethylase (CYP51) is a member of the cytochrome P450 family and responsible for catalyzing the conversion of lanosterol to ergosterol. As ergosterol forms a critical part of the fungal cell membrane, fluconazole inhibits the synthesis of ergosterol to increase cellular permeability. Plant derived natural moieties such as the indole moiety represents an important structural component associated with a variety of alkaloids and wide-ranging biological activities, such as antitumor activities, antiviral activities, antimicrobial activities, anti-tubercular activities, and antifungal activities. Previously, our group synthesized several indole derivatives as potent anti-tubulin anticancer agents using Fischer Indole synthesis.

Antifungal activity of an indole derivative 1-(4-((5-methoxy-2-(3,4,5-trimethoxyphenyl)-1*H*-indol-1-yl) methyl) phenoxy)-N,N-dimethylethan-1-amine (**100DL-6**) was done by using *in-vitro* anti-candidal activity against two Candida strains; *Candida kefyr*-(ATCC-204093) and *Candida albicans* (AI-clinical isolate, AIIMS-Delhi).

Indole derivative **100DL-6** was active against the tested fungal pathogens and the total zone of inhibition was measured between 13-14 mm in diameter and at MIC values between 31.25 µg/mL to 250 µg/mL and at MFC values between 62.5 µg/mL to 500 µg/mL. In checkerboard assay synergistic mode of interaction of **100DL-6** with known antifungal drugs was observed. Compound **100DL-6** considered to be less-cytotoxic to the cells as determined by MTT assay. Lead compound **100DL-6** was found to be non-mutagenic.



Compound **7** (**100DL-6**)

Combination study by Checkerboard Method: The combined activity of compound 100DL-6 with fluconazole through the *in-vitro* checkerboard interactions against the *Candida albicans* (Clinical Isolate, AIIMS- Delhi) *and Candida kefyr* (ATCC 204093) are summarized.

Table : Combination synergistic study of compound 100DL-6 with Fluconazole:

Fungal strains	Compound / Drug	MIC µg/mL		FIC	FICI	Mode of Interaction
		Alone	Combination			
C. albicans	**100 D-L 6**	250	25	0.1	0.29	**Synergistic**
	Fluconazole	1.56	0.31	0.19		
C. kefyr	**100 D-L 6**	31.25	6.25	0.20	0.30	**Synergistic**
	Fluconazole	0.78	0.07	0.10		

Combination MIC Concentration started for drug Fluconazole- 5 µg/mL and for compound **100DL-6**- 100 µg/mL

Table: Mutagenicity assay of 100DL-6 using Salmonella strains TA 1535 and TA 1538 with S9 activation.

Sample (µg/plate)	No of Revertants per plate (Mean ± SD)	
	TA 1535	TA 1538
Vehicle control	2.5 ± 0.707	3.5 ± 0.707
100DL-6 (10 ug)	5.5 ± 0.707	5.5 ± 3.535
100DL-6 (50 ug)	6 ± 2.828	5 ± 2.828
100DL-6 (100 ug)	3.5 ± 2.121	5.5 ± 3.535
100DL-6 (200 ug)	5 ± 4.242	8.5 ± 2.121
STD mutagen	341.5 ± 4.949	150 ± 18.38

Results are expressed as mean ± SD, Standard mutagen for TA1535= Sodium azide (20 µg/plate), and for TA1538=2-Nitrofluorene (40 µg/plate).

Dr. Anirban Pal डा. अर्निबन पाल

Increasing Demand for Natural Antimicrobials: Exploring the Antimicrobial and Anti-Biofilm Properties of Enriched *Trachyspermum ammi* Hydrosol Against Foodborne Pathogens



The increasing demand for new antimicrobials to combat foodborne pathogens has driven interest in natural compounds, with hydrosols gaining recognition as promising alternatives. Hydrosols, which are by-products of plant hydro-distillation, consist of condensed vapors that contain trace amounts of essential oil components. Despite being rich in water-soluble biologically active compounds, hydrosols are often discarded. This study investigates the antimicrobial and anti-biofilm activities of enriched hydrosol from *Trachyspermum ammi* (T. ammi) against two prominent foodborne pathogens: *Listeria monocytogenes* and *Staphylococcus aureus*. Gas Chromatography (GC) analysis identified thymol and carvacrol as the major constituents of the enriched hydrosol. The hydrosol concentrate demonstrated a Minimum Inhibitory Concentration (MIC) of 0.625 mg/mL against both pathogens. Moreover, it exhibited notable anti-biofilm activity, effectively reducing biofilm formation in *L. monocytogenes* at concentrations as low as 0.078 mg/mL (1/8 MIC) and in *S. aureus* at 0.156 mg/mL (1/4 MIC). The hydrosol also disrupted pre-existing biofilms of both pathogens, as evidenced by Scanning Electron Microscopy (SEM) and Fluorescence Microscopy assays. Mechanistic studies, including bacteriolysis and protein leakage assays, suggested that the hydrosol compromises the integrity of the bacterial cell wall.



Dr. Anirban Pal & his team

Dr. Daya Nandan Mani डॉ. दया नन्दन मणि

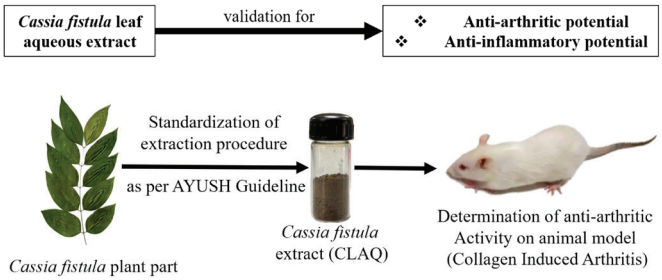
Aragwadh Aqueous Extract Against Rheumatoid Arthritis



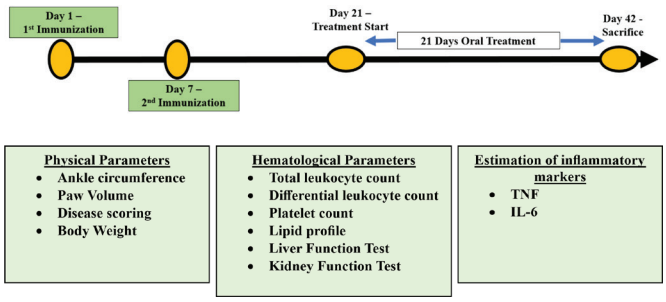
Rheumatoid arthritis (RA) is a chronic autoimmune disease which affects joints of feet and hands symmetrically. Cytokines like (T-cell derived IL-2, IL-17, and IFN-γ and others like IL-6, IL-4, IL-23), and high levels of metalloproteinase activity are thought to contribute to inflammation and cartilage, bone degradation in RA. The prevalence of RA in women and developed countries is on a higher notch with data varying between 0.3% and 1% of prevalence. In developed countries, within ten years of RA onset, up to 50% of patients cannot work full-time jobs. Global and Indian prevalence of RA is 1% and 0.5%-0.75% respectively.

Disorder with RA like symptoms is known as *Amavata Roga* in *Ayurveda*. Disease is not fatal but is very painful throughout its course. The symptoms specifying *Amavata Roga* (RA) are body ache, loss of appetite, thirst, lethargy, heaviness of body parts, mild fever, indigestion, and numbness of joints. Presently, the primarily used treatments in RA are allopathic drugs, surgical procedures, and psychotherapy. Non-steroidal anti-inflammatory drugs ([g]NSAIDs) like dexamethasone, Indomethacin, diclofenac, and others are used as the primary line of treatment for patients diagnosed with RA. Other treatments include glucocorticoids and Disease-modifying anti-rheumatic drugs ([h]DMARDs). Allopathic drugs are palliative and relieve pain related to RA. It can only control the disease progression in RA rather than completely curing it and are often associated with many adverse effects. Complementary and alternative medicine has now become an area of the patient's choice.

Cassia fistula also known as *Aragwadh,* has been mentioned in classic *Ayurveda* texts for the management of *Amavata Roga* (RA). Classical formulations like *Aragwadhadi Kwath (Cassia fistula* + 20 other ingredients*)*, and *Rasnasaptak Kwath* (*Pluchea lanceolata* + 6 ingredients), that include *C. fistula*, have been mentioned for managing RA and related symptoms.

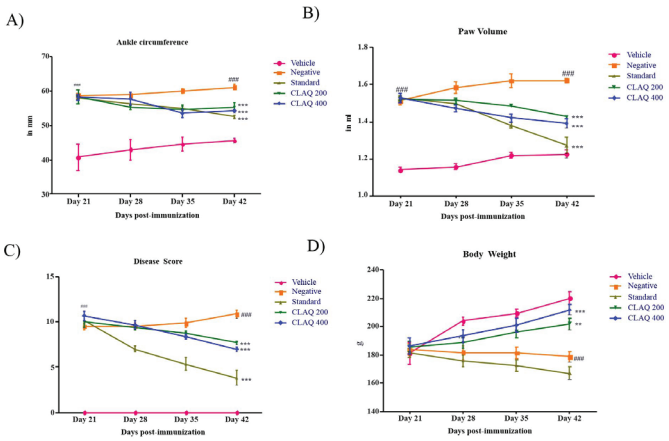


Induction of arthritis using collagen



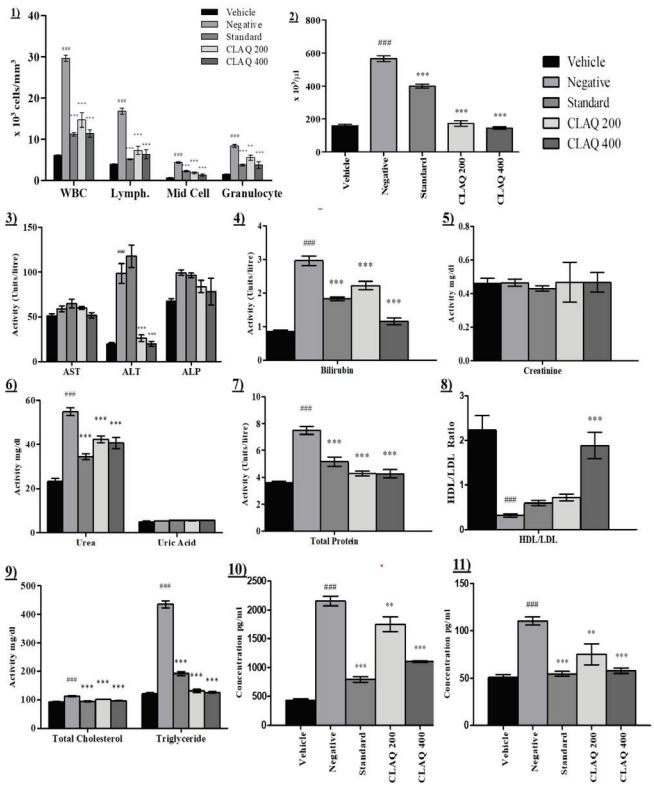
Effect of CLAQ on morphological changes in arthritis model

Effect of 21-day repeated dosing of CLAQ on the physical parameters of animal A) Ankle circumference B) Paw Volume C) Disease Score and D) Body Weight. Values are represented as Mean ± SEM. One way ANOVA followed by Tukey's multiple comparison test. Significant difference at #p<0.05, ##p<0.01, ###p<0.001 compared with the Control (HC). *p<0.05, **p<0.01, ***p<0.001 when compared with the Negative Control (DC).



Effect of CLAQ on haematological parameters in arthritis model

Effect of 21-day repeated dosing of CLAQ on the hematological parameters of animal 1) Total Leukocyte count and Differential Leukocyte count 2) Platelet count, 3) AST, ALT, and ALP, 4) Bilirubin, 5) Creatinine, 6) Urea and Uric Acid, 7) Total Protein, 8) HDL/LDL ratio, 9) Total Cholesterol and triglyceride, and serum inflammatory markers 10) IL-6 and 11) TNF-α. Values are represented as Mean ± SEM. One way ANOVA followed by Tukey's multiple comparison test. Significant difference at #p<0.05, ##p<0.01, ###p<0.001 compared with the Control (HC). *p<0.05, **p<0.01, ***p<0.001 when compared with the Negative Control (DC).



Effect of CLAQ on the redness and swelling of hind paw of rats

Effect of 21-day repeated oral dosing of CLAQ on the redness and swelling of hind paw of rats, where a) Vehicle, b) Negative control, c) Standard control, d) CLAQ 200, e) CLAQ 400.



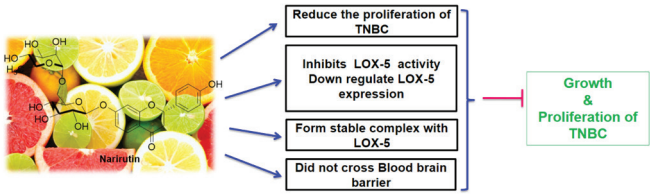


Dr. D. N. Mani & his team

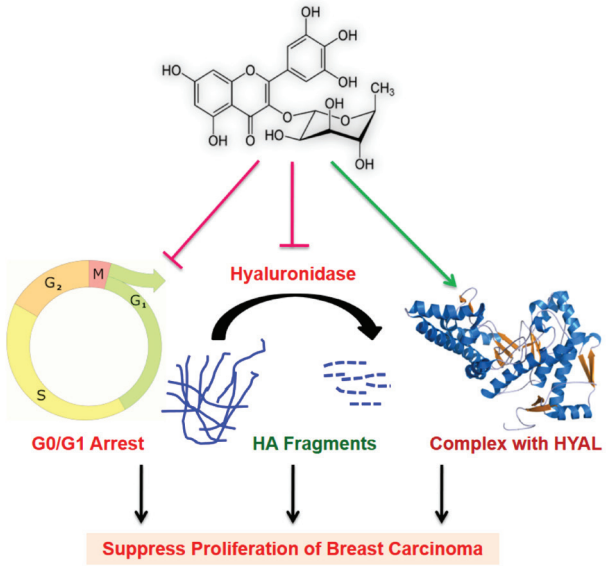
Dr. Suaib Luqman डॉ. शोएब लुकमान



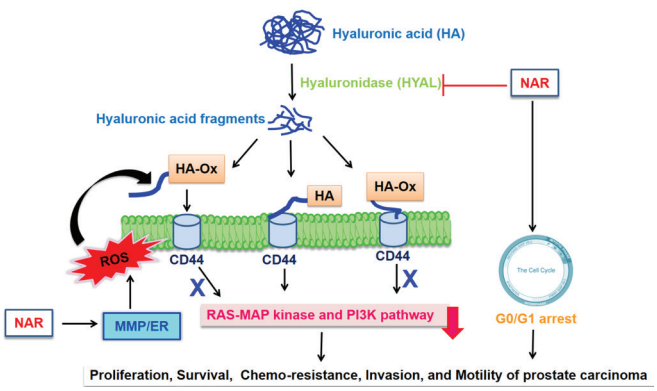
Narirutin suppresses lipoxygenase-5 expression and prompts G0/G1 arrest in triple-negative breast carcinoma cells (Biochimica et Biophysica Acta, 2023)



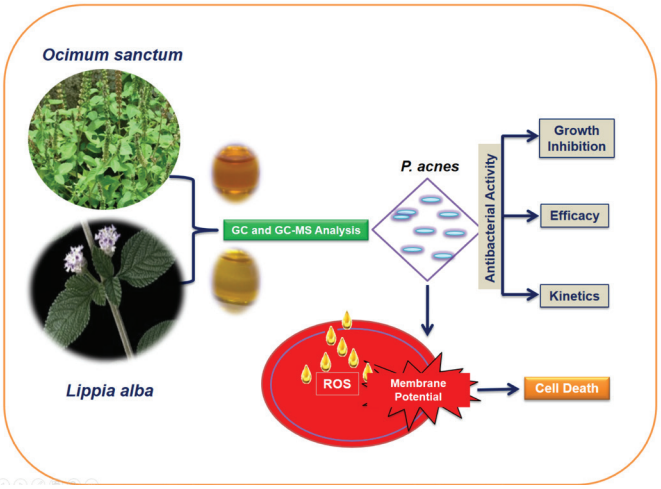
Hyaluronidase is targeted by myricetin 3-rhamnoside to slow the proliferation of hormone-independent breast cancer cells (Journal of Biomolecular Structure and Dynamics 2023)



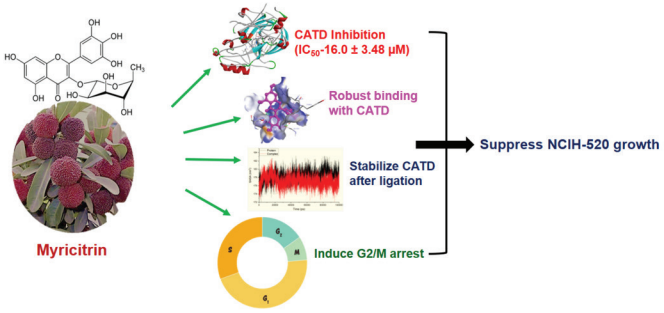
Narirutin, a flavonoid discovered in citrus fruits, regulates cell cycle stages and suppresses the growth of hormone-resistant prostate cancer cells through hyaluronidase targeting (Food and Chemical Toxicology, 2023)



The growth of *Propionibacterium* acnes is impeded by *Lippia alba* essential oil through modulation of membrane potential and ROS levels (Journal of Herbal Medicine 2023)



Exploring myricitrin derived from bayberry as a potential blocker of cathepsin-D: Implications for the prevention of squamous lung carcinoma (Food and Chemical Toxicology, 2023)





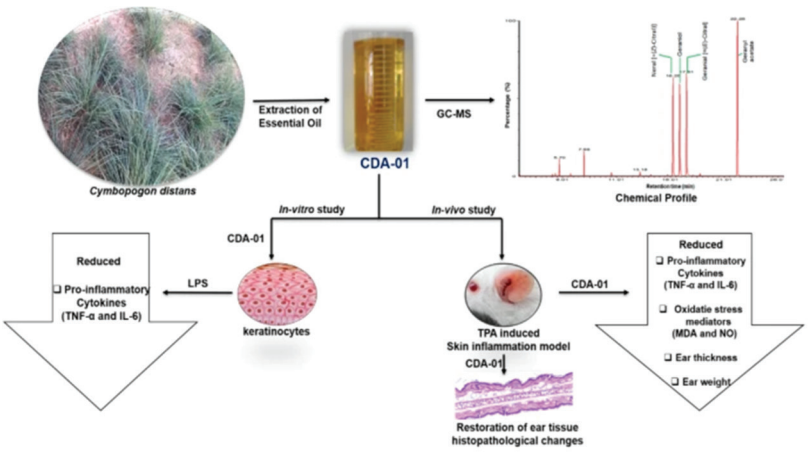
Dr. Suaib Luqman & his team

Dr. DU Bawankule डॉ. डी.यू. बावनकुले

Acyclic monoterpenoid-rich essential oil of Cymbopogon distans mitigates skin inflammation: a chemico-pharmacological study



The topical application of essential oils is considered an effective treatment for skin diseases. *Cymbopogon distans* (Nees ex Steud.) Wats (Poaceae) is a promising aromatic grass widespread in the Himalayan temperate zone. Therefore, using in-vitro and in-vivo bioassays, we examined the chemical and pharmacological characteristics of essential oil hydro-distilled from *C. distans* coded as CDA-01, specifically concerning skin inflammation. Characterization using GC-FID and GC–MS provided a chemical fingerprint for CDA-01, enabling the identification of 54 compounds; amongst them, citral (34.3%), geranyl acetate (21.2%), and geraniol (16.4%) were the most abundant. To examine the anti-inflammatory potential, CDA-01 treatment on LPS-stimulated macrophage cells in addition to 12-O-tetradecanoylphorbol-13-acetate (TPA) generated cutaneous inflammatory reaction in the mouse ear was assessed through quantification of the inflammatory markers. Consequently, CDA-01 demonstrated protection against inflammation caused by LPS by lowering the pro-inflammatory cytokines (IL-6 and TNF-α) level in HaCaT cells with negligible cytotoxicity. Consistent with the in-vitro findings, CDA-01 treatment reduced pro-inflammatory mediators (TNF-, IL-6, and NO) and lipid peroxidation in an in-vivo investigation. Subcutaneous inflammation in TPA-treated mice ears was similarly decreased, as evidenced by the histological and morphological studies. As a result of our findings, it is possible that CDA-01 could be an effective treatment for skin inflammation disorders.





Dr. DU Bawankule & his team

Dr. NP Yadav डॉ. एन.पी. यादव

Development of QbD-based Mupirocin-β-cyclodextrin complex loaded thermosensitive *in-situ* gel for wound healing



The wound is considered one of the complex processes in which the function and integrity of skin and deep underlying tissue are affected, resulting infection and inflammation. Infection of the wound by microbes may frequently occur due to poor hygienic conditions. Therefore, substantial use of antimicrobial agents in wound dressing is required to prevent possible bacterial infection. Mupirocin is a potent antibacterial drug used topically in different dosage forms. However, it has a limitation of low aqueous solubility. Therefore, the purpose of this study was to prepare a complex of mupirocin (MUP) with β-cyclodextrin (β-CD) to enhance the solubility and develop a thermosensitive *in-situ* gel for improved patient compliance. Mupirocin-β-cyclodextrin (MUP-β-CD) complex was prepared, and the formation of the inclusion complex was confirmed by Nuclear magnetic resonance spectroscopy (NMR), Fourier transform infrared spectroscopy (FT-IR), Thermogravimetric analysis (TGA), X-ray diffractometry (XRD) and Scanning Electron Microscope (SEM). The thermosensitive *in-situ* gel was optimized by response surface methodology (central composite design). The formulation was prepared by the cold method using pluronic F-407 and pluronic F-68, and 2% w/v mupirocin and characterized for gelation temperature (32±0.5°C), pH (5.35±0.2), viscosity (9970±31.75 cps at 50 rpm), *in-vitro* drug release (94.81±1.38%), drug content (96.05 ±1.24%) and texture parameters. It showed a broader zone of inhibition against *Staphylococcus aureus* (26±0.8 mm) and *Staphylococcus epidermis* (6±1.36 mm). The excisional-wound model in mice showed a remarkable wound contraction (99.9±0.22%), epithelialization period (13.5±0.5 days), and hydroxyproline content (36.10±4.05 mg/gm skin tissue). In conclusion, a thermosensitive mupirocin-β-cyclodextrin complex *in-situ* gel was prepared successfully, which exhibited improved antibacterial and wound-healing properties (***Journal of Drug Delivery Science and Technology***, 2023, 86:104585)

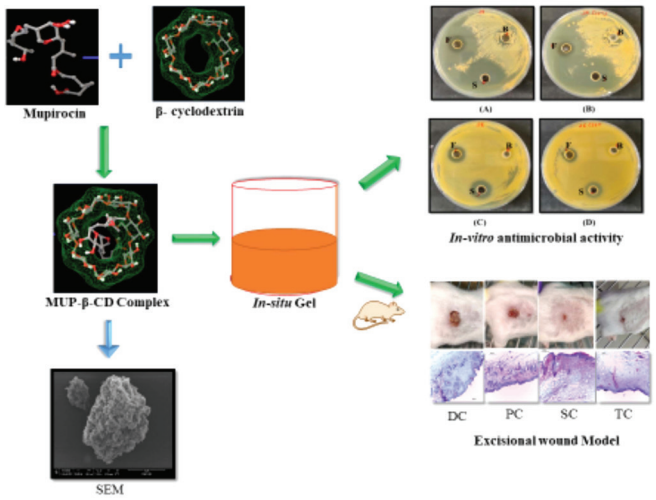


Fig.: Mupirocin-β-cyclodextrin complex loaded thermosensitive *in-situ* gel and its biological evaluation

Apigenin attenuates imiquimod–induced psoriasis-like skin inflammation in Balb/c mice via suppression of inflammatory response

Psoriasis is an immune-mediated skin disease characterized by keratinocytes hyperproliferation, abnormal differentiation and inflammation. Apigenin (APG) has extensive range of pharmacological effects and numerous studies have shown anti-oxidant, anti-inflammatory, anti-proliferation, anti-cancer, anti-bacterial, and immunostimulant property of APG in different *in-vitro* and *in-vivo* model. Therefore, this study was aimed to investigate *in-vitro* and *in-vivo* anti-inflammatory and anti-proliferative activity to evaluate anti-psoriatic potential of apigenin. For *in-vivo* study, imiquimod cream was used to induce psoriasis-like skin inflammation in BALB/c mice to mimic human psoriatic conditions. For *in-vitro* studies, LPS-induced inflammation in RAW264.7 was done, and qRT-PCR, ELISA, and immunofluorescence were conducted to evaluate

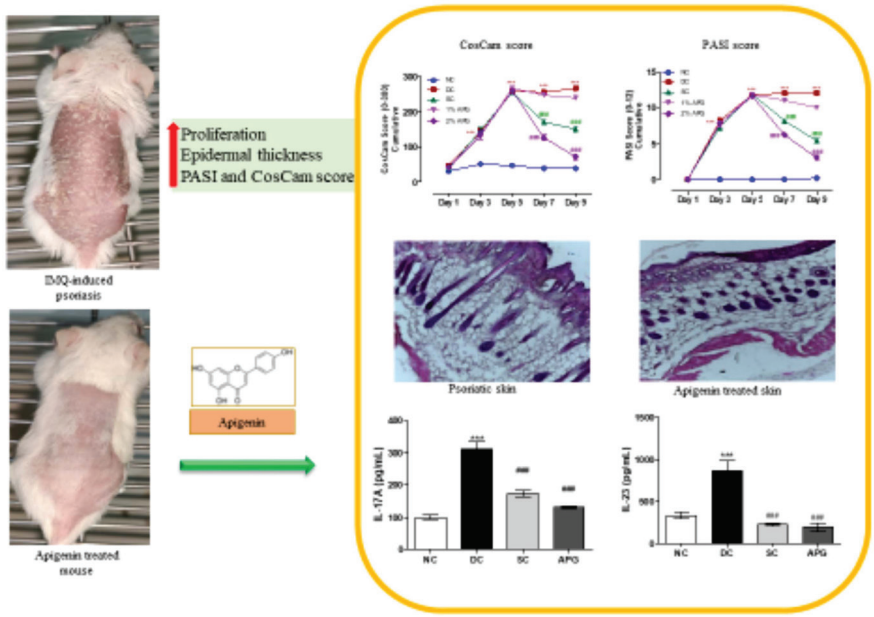
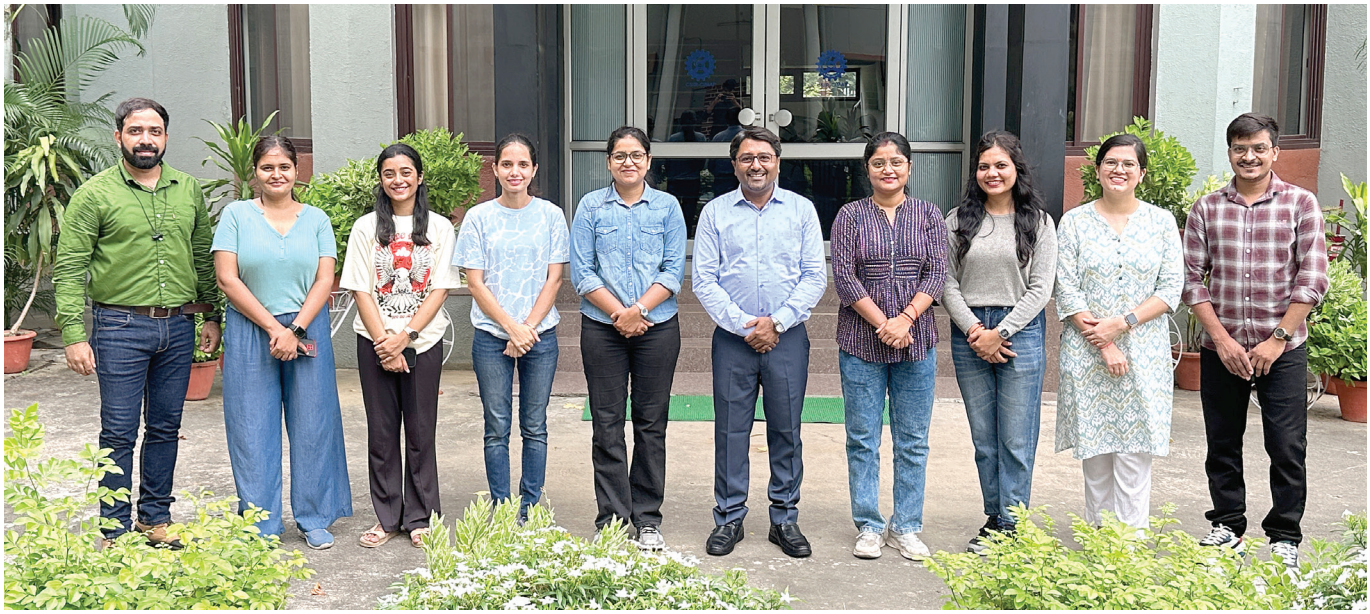


Fig.: Apigenin mitigates imiquimod–induced psoriasis in Balb/c mice

the anti-inflammatory activity of apigenin. Results showed that apigenin significantly reduce the PASI and CosCam scores, ameliorate the deteriorating histopathology, and effectively downregulated the expression of CCR 6, IL-17A, and NF-κB. Apigenin effectively downregulated the expression and secretion of pro-inflammatory cytokines through IL-23/IL-17/IL-22 axis. Apigenin suppressed nuclear translocation of NF-κB in LPS-induced RAW 264.7 cells. Cell migration and cell doubling assay in HaCaT cells showing the anti-proliferative potential of apigenin. Apigenin was found safe in acute dermal toxicity study.



Dr. NP Yadav & his team

Dr. Debabrata Chanda डॉ. देबब्रत चंदा

Novel bioactive hydroxamate indanones elicit potent vaso-relaxation response in rodent conduit and resistance arteries



The study envisaged vaso-relaxation potential of novel indanones molecules in isolated rat resistance and conduit arteries for possible antihypertensive activity. Indanone is one of the privileged structures in medicinal chemistry associated with various pharmacological activities having wide spectrum of biological activities. Inspired by the success of donepezil, several academic and industrial laboratories commenced the active research to develop novel indone analogs as antihypertensive agent. *Ex-vivo* vasorelaxation potential of novel indanone molecules were explored in isolated rat

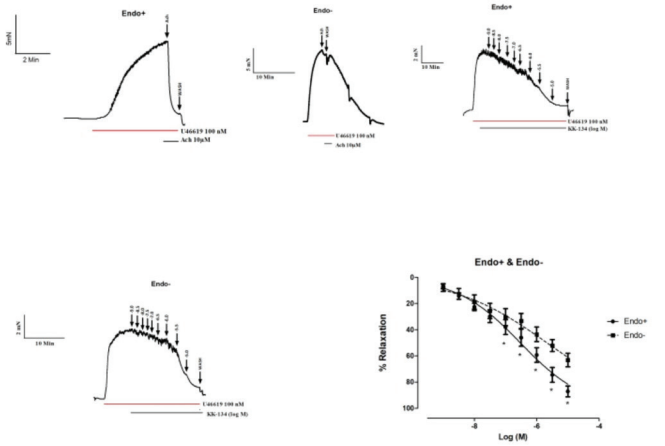


Fig.: Role of endothelium in KK134-induced vasorelaxation in isolated rat arterial tissue.

aorta and mesenteric artery considering them as conduit and resistance arteries using standard methodologies. The mechanism of action of the best molecule was also studied. Out of the series of the molecules studied, KK134 showed the best vasorelaxation both in aorta and mesenteric artery. The relaxation response of KK134 is endothelium dependent. Further, the present study suggests that

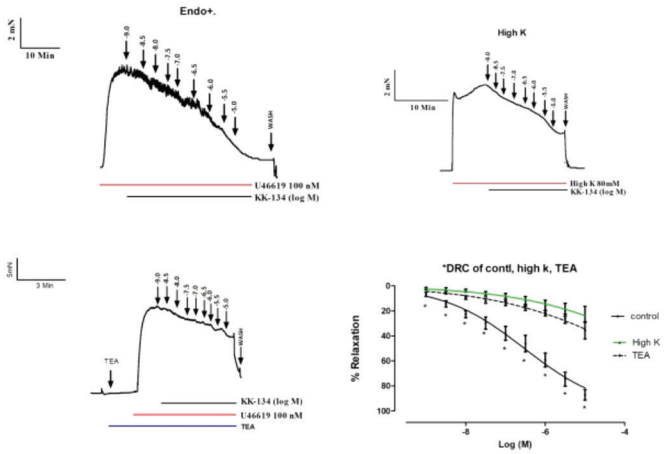


Fig.: Role of potassium channels in KK134-induced vasorelaxation in isolated rat arterial tissue.

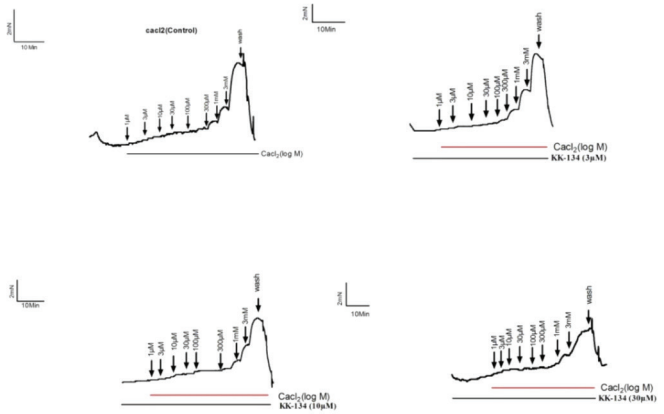


Fig.: Role voltage dependent calcium channel in KK134-induced vasorelaxation in isolated rat arterial tissue.

KK134 produces relaxation via activation of BKca channel and blockade of VDCC in endothelium dependent manner and is currently under evaluation for efficacy in rodent model of hypertension.

Acute dermal toxicity of plant based natural dye NBRI-RE in New Zealand White Rabbit and Charles Foster rats

The experiment was carried out following the methodology very recently published by our group with minor modification (Life Sci. 2023 Sep 1;328:121909) and in accordance with the protocol approved by IAEC for dermal toxicity (CIMAP/IAEC/2023-26/25). Briefly healthy male and female

rats and rabbits were taken, furs were removed and skin surface were cleaned of fur. After 24 hours, the test items were suspended in sesame oil at 10, 20 and 50 (w/v) and were applied to an area of 1 sq inch. The animals were then observed for behavioural changes, dermal irritation, erythema and any other changes. Control area received only application with sesame oil. The skin area s were then scored for erythema and oedema at different time intervals upto 48 hours following the guidelines recommended by Federal Hazardous Substance Act (FHSA) 2011 and thus irritation index and primary irritation index were calculated for the different levels of the samples applied to animals in rats and rabbits. As per the recommendation of the guidelines, PII value more than 2 is considered as irritant.

In the present study with NBRI-TE and NBRI-RE didn't produce any irritation, erythema, oedema or behavioral changes in both the species of the experimental animals studied. Hence, the samples can be considered non irritant to CF rats and New Zealand white rabbit upto 50% level (w/v) when applied once to skin of the animals.

In addition, we have also carried out oral toxicity at 2000 mg/kg in Swiss albino mice of the test items and observed no mortality or morbidity or any behavioural changes in the tested animalsupto observation period of 7 days.



Dr. D. Chanda & his team

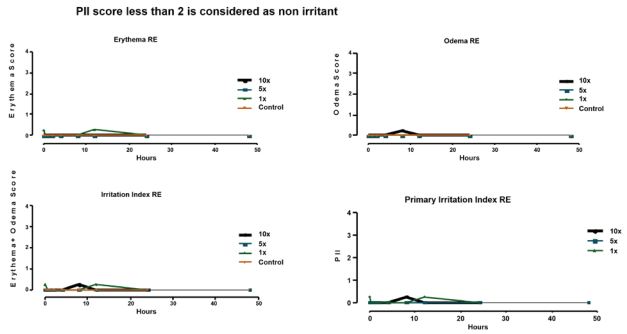


Fig. 1: Irritation scores of NBRI-RE in CF rats after acute dermal toxicity

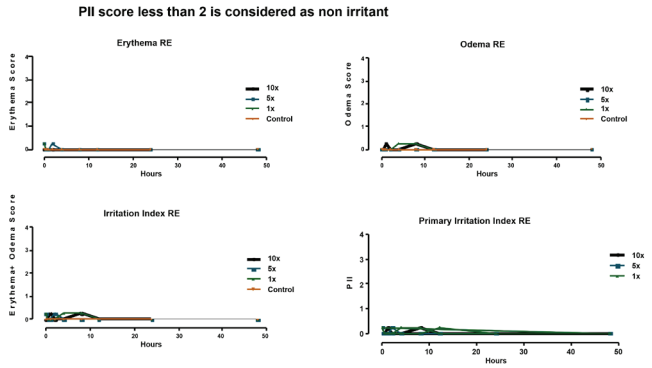


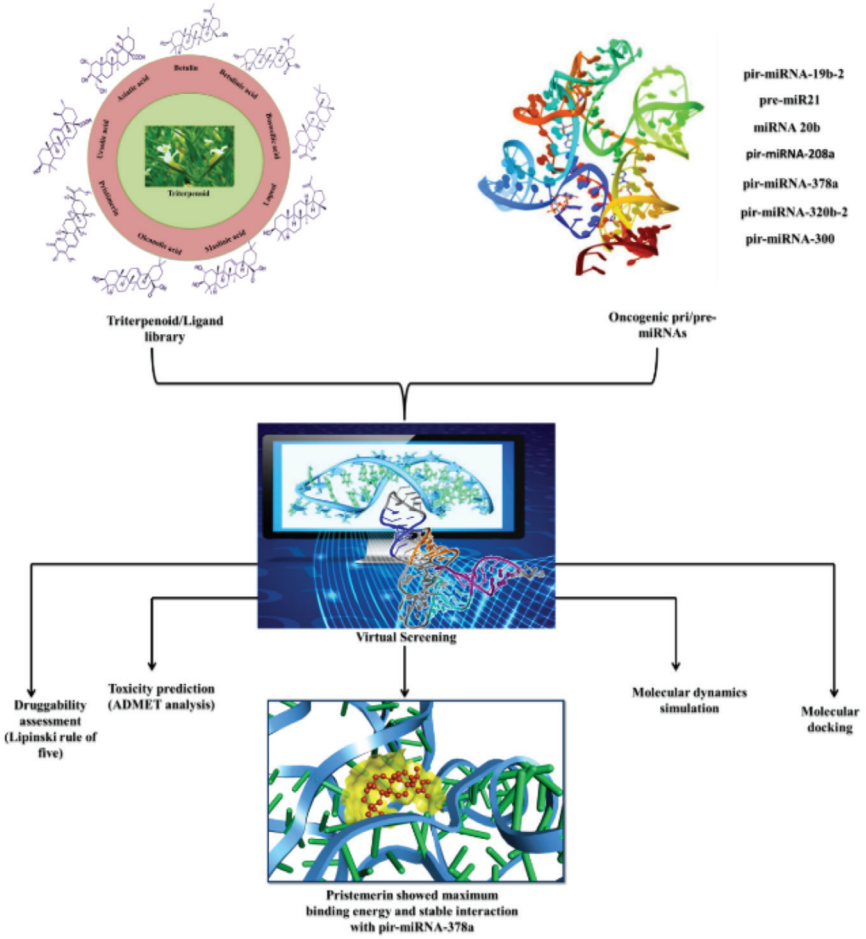
Fig. 2: Irritation scores of NBRI-RE in New Zealand white rabbit after acute dermal toxicity:

Dr. Abha Meena डॉ. आभा मीणा



Regulating pri/pre-miRNA up/down expressed in cancer proliferation, angiogenesis and metastasis using selected potent triterpenoids

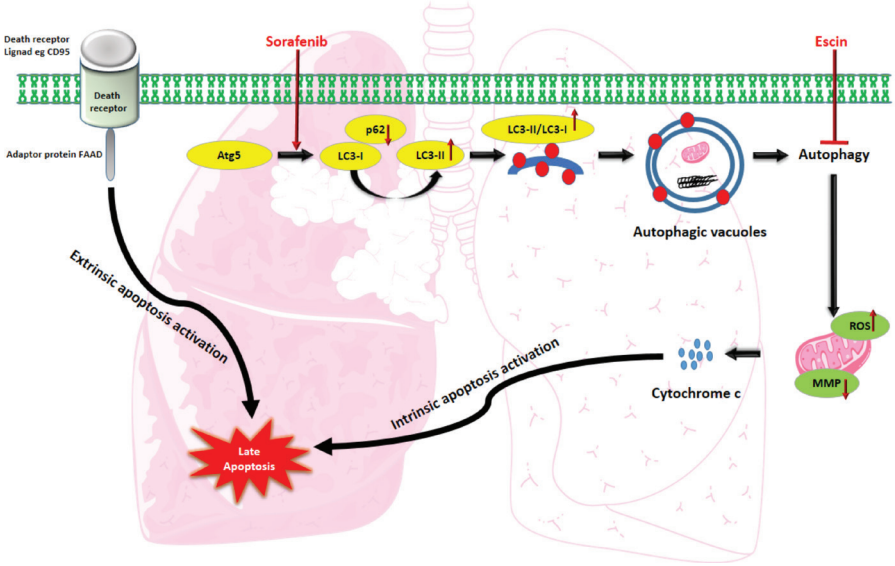
MicroRNAs (miRNAs) play a crucial role in cancer progression by selectively inducing translational degradation of messenger RNA (mRNA) via sequence -specific interactions with the 3′-untranslated region (3′-UTR). The potential targeting of miRNA has been recognized as a significant avenue for investigating the biological progression of diverse cancer types. Consequently, targeting of pri-miRNA and pre-miRNA by phytochemicals emerges as a viable strategy in the realm of anticancer therapies. Among phytochemicals, triterpenoids have garnered significant recognition for their chemotherapeutic and



chemopreventive capabilities in combating multiple cancers. To date, there is a dearth of literature about the molecular interactions between triterpenoids and miRNAs. The primary objective of this investigation is to discern the potential triterpenoids that can function as modulators for specific miRNAs, namely pri-miRNA-19b-2, pre-miR21, microRNA 20b, pri-miRNA-208a, pri-miRNA-378a, pri-miRNA-320b-2, and pri-miRNA-300, achieved through the use of in silico investigations. The study primarily focused on performing drug-likeness, computer-aided toxicity, and pharmacokinetic prediction studies for triterpenoids. Furthermore, molecular docking and simulation techniques were employed to investigate these compounds. The triterpenoids studied were shown to have drug-likeness characteristics, although asiatic acid, lupeol, and pristimerin were able to pass all toxicity tests. Among the triterpenoids that underwent docking, pristimerin had a significant binding energy of −10.9 kcal/mol during its interaction with pri-miR-378a. The stable interaction between the pristimerin and miRNA complex was demonstrated by molecular dynamics simulation. As a result, pristimerin has the potential to act as a modulator of carcinogenic miRNAs, making it a promising candidate for cancer prevention and treatment due to its tailored modulation of miRNA activity (*International Journal of Biological Macromolecules*, 2023)

Escin enhanced the efficacy of sorafenib by autophagy-mediated apoptosis in lung cancer cells

Combining anti-cancer drugs has been exploited as promising treatment strategy to target lung cancer. Synergistic chemotherapies increase anti-cancer effect and reduce effective drug doses and side effects. In this study, therapeutic potential of escin in combination with sorafenib has been explored. 3-(4,5-Dimethylthiazol-2-yl)-2 5-diphenyltetrazolium bromide assay was used to calculate IC_{50} values. The synergy was evaluated using Chou–Talaly algorithm. Cellular reactive oxygen species, mitochondrial membrane potential, annexin V, and cell-cycle studies were done by flow-cytometer, and autophagy biomarkers expression were determined using western blotting. Moreover, autophagy was knocked down using ATG5 siRNA to confirm its role, diethylnitrosamine-induced lung cancer model was used to check the synergy of sorafenib/escin. Escin significantly reduced the IC_{50} of sorafenib in A549 and NCIH460 cells. The combination of sorafenib/escin produced a 2.95 and 5.45 dose reduction index for sorafenib in A549 and NCI-H460 cells. The combination of over-expressed p62 and LC3-II reflects autophagy block-mediated late apoptosis. This phenomenon was reconfirmed



by ATG5 knockdown. This combination also selectively targeted G0/G1 phase of cancer cells. In in vivo study, the combination reduced tumour load and lower elevated serum biochemical parameters. The combination of sorafenib/escin synergistically inhibits autophagy to induce late apoptosis in lung cancer cells' G0/G1 phase. (*Phytotherapy Research.* 37(10):4819-4837).



Dr. Abha Meena & her team

Plant Biotechnology

HIGHLIGHTS

The Plant Biotechnology Divisional Unit (DU) is a team of twelve Scientist of which three are stationed in Bengaluru Research Centre of the Institute. The group is engaged in Genomics, molecular biology, biochemistry, synthetic biology, *in silico* biology and tissue culture-related research in medicinal and aromatic plants (MAPs) like *Withania somnifera*, *Andrographis paniculata*, *Bacopa monnieri*, *Cathranthus roseus*, *Mucuna puriens*, *Gymnema sylvestre*, *Ocimum sp.*, rose-scented geranium, *Artimisia annua*, cannabis, Coleus sp. and few others. The R&D activities are aimed at understanding the biosynthesis of









Scientists of Plant Biotechnology Divisional Unit

Upper Panel (L to R) : Dr. Sunita Singh Dhawan, Dr. Rakesh Kumar Shukla, Dr. Vikarant Gupta, Dr. Sumit Ghosh, Dr. Ashish Sharma, Dr. Laiq Ur Rahman, Dr. Prabodh Kumar Trivedi, Dr. Neelam Prabha Negi, Dr. Pradipto Mukhopadhyay, Dr. Ashutosh Kumar Shukla, Dr. Prema G. Vasudev

Lower Panel (L to R) : Dr. Dinesh A Nagegowda, Dr. Venkata Rao, D.K and Dr. Mukti Nath Mishra

active metabolites and development of important plant parts, improving the MAP varieties through biotechnological interventions and engineering pathways for production of high-on-demand phytomolecules from heterologous system.

Earlier, we reported developing a low nicotine containing tobacco plants by CRISPR-mediated mutation of *HY5* gene which will cause less health hazards to smokers. The group has further identified the role of *COP1*gene in regulating the nicotine level by modulating the activity of HY5. Using model plants, a role of HY5, miR397b and auxin-associated factors in root hair development has been established. This might prove useful in improving water use efficiency of many MAPs. In a recent breakthrough, germacrene D biosynthesis was successfully engineered in yeast, which opens up possibilities for scalable production of this compound with potential pharmaceutical and biofuel applications. In another key study, the role of ApCPS2 in diterpenoid biosynthesis and defense against insect herbivores has been elucidated in *Andrographis paniculata*. Our work also depicted role of CfADH1 and CfAKR2b in biosynthesis of citral in Lemongrass. Metabolic engineering strategies are also being employed to enhance the production of secondary metabolites in medicinal and aromatic plants (MAPs), aiming to increase the yield of valuable compounds for various industries. Additionally, the characterization of a pectin methylesterase (CrPME) in *Catharanthus roseus* indicated its potential role in vindoline accumulation, an alkaloid with therapeutic applications. Further, Investigations into low-temperature perception and response mechanisms in *Ocimum basilicum* has been done, particularly in the CIM-Shishir cultivar and is aimed to develop varieties with improved cold tolerance. Concurrently, exploration of endophytic bacteria in stress-resilient plants is underway, assessing abiotic stress tolerance and plant growth-promoting traits to identify strains that could improve crop performance under challenging conditions. Furthermore, transgene technology has been used to develop fungal-resistant lines of geranium, which are expected to have enhanced resistance to fungal pathogens, reducing reliance on chemical fungicides. Many genes from *W. somnifera* has been tested for their role in tuberous root development (like GRAS, MYB and NAC domain protein encoding genes) and for improvement of withanolide biosynthesis (like *24ISO* and *ACO*). Further, work towards improvement of root quality in *W. somnifera* by employing transgenic and genome-editing technologies are under process. These advancements represent significant strides towards sustainable agriculture and the enhanced production of valuable plant-derived compounds. In the field of structural biology, a state-of-the-art Single Crystal X-ray Diffractometer facility has been installed, significantly enhancing research capabilities. This facility has been instrumental in the 3-D structure elucidation of plant secondary metabolites, peptides, and proteins, as well as in peptidomics studies on medicinal plants to identify microproteins.

The R&D activities have been supported by 06 CSIR and 06 GAP projects of which 02 CSIR and 01 GAP project has been received this year. The R&D achievement could not have been accomplished without the participation of our 31 PhD student and many other project fellows. Seven Students were awarded PhD degree this year. The studies mentioned above yielded 24 publication in various journals with average impact factor of 5.2 which includes highly reputed journals like “Journal of Hazardous Material”, “Plant Physiology” and “The Plant Journal”. We also contributed with our work in filing a patent. The contributions from the scientists of the DU have been recognized by different academia and other sectors. Dr. Sumit Ghosh has been elected as a Fellow of the National Academy of Sciences, India (NASI), Allahabad. He also received a Fellowship from the International Cooperation and Development Fund (ICDF), Taiwan for participation in a two-week workshop on Agrotechnology held in Taipei, Taiwan. Dr. Sunita Singh Dhawan has been appointed as academic council member of NIPER and FFDC. The ongoing activities in the DU are expected to bring more accolades from the scientific world.

Dr. Prabodh K. Trivedi डॉ. प्रबोध कु. त्रिवेदी

A network comprising HY5, microRNA397b, and auxin-associated factors regulates root hair growth in Arabidopsis



ELONGATED HYPOCOTYL 5 (HY5) is a major light-associated transcription factor involved in plant growth and development. In Arabidopsis, the role of HY5 is very well-defined in regulating primary root growth and lateral root formation; however, information regarding its role in root hair development is still lacking. Very little information is known about the genetic pathways regulating this process. In this study, we have investigated the role of HY5 and its associated components in root hair development. The detailed analysis of root hair phenotype in wild-type (WT) and light signaling mutants in light and dark conditions revealed the importance of light-dependent HY5-mediated root hair initiation. The altered auxin levels in the root apex of *hy5* mutant and the interaction of HY5 at promoters of root hair developmental genes are responsible for the differential expression of root hair developmental genes and phenotype in *hy5* mutant. The partial complementation of root hair in the *hy5* mutant even after external supplementation of auxin and regaining of root hair in *pin2,* and *pin3* mutant after grafting suggested that auxin-mediated root hair development pathway requires HY5 transcription factor. Furthermore, both *miR397b* overexpression (*miR397bOX*) and CRISPR/Cas9-based mutants ($miR397b^{CR}$) indicate the targeting of Reduced Residual Arabinose (RRA1/RRA2) genes, which in turn regulate root hair growth. The regulation of the *miR397b-* (*RRA1/RRA2*) module by HY5 demonstrated its indirect role by targeting root hair cell wall genes. Together, this study demonstrated that HY5 controls root hair development by integrating auxin signalling and other miRNA-mediated pathways (Fig.).

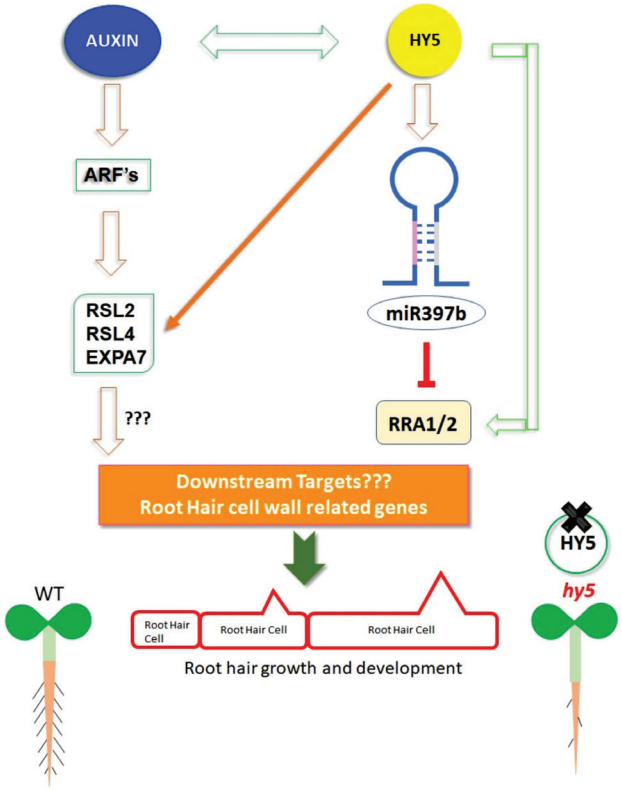


Fig. : Proposed model of HY5-dependent regulation of auxin/root hair development-associated genes and miRNA-Mediated Pathways. The activation and inactivation of transcription are depicted by arrows and blunt ends, respectively. The inclusion of (?) indicates that detailed mechanisms of this regulation have yet to be elucidated.

Light-dependent regulation of secondary plant product biosynthesis

Nicotine constitutes approximately 90% of the total alkaloid content in leaves within the *Nicotiana* species, rendering it the most prevalent alkaloid. While the majority of genes responsible for nicotine biosynthesis express in root tissue, the influence of light on this process through shoot-to-root mobile ELONGATED HYPOCOTYL 5 (HY5) has been recognized. CONSTITUTIVE PHOTOMORPHOGENIC1 (COP1), a key regulator of light-associated responses, known for its role in modulating HY5 accumulation, remains largely unexplored in its relationship to light-dependent nicotine accumulation. Here, we identified NtCOP1, a COP1 homolog in *Nicotiana tabacum*, and demonstrated its ability to complement the *cop1-4* mutant in *Arabidopsis thaliana* at molecular, morphological, and biochemical levels. Through the development of

NtCOP1 overexpression (*NtCOP1OX*) plants, we observed a significant reduction in nicotine and flavonol content, inversely correlated with the down-regulation of nicotine and phenylpropanoid pathway. Conversely, CRISPR/Cas9-based knockout mutant plants (*NtCOP1*^{CR}) exhibited an increase in nicotine levels. Further investigations, including yeast-two hybrid assays, grafting experiments, and western blot analyses, revealed that NtCOP1 modulates nicotine biosynthesis by targeting NtHY5, thereby impeding its transport from shoot-to-root. We conclude that the interplay between HY5 and COP1 functions antagonistically in the light-dependent regulation of nicotine biosynthesis in tobacco (Fig.).

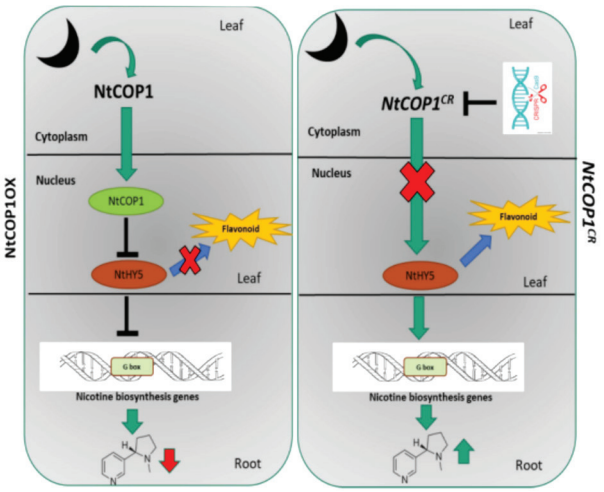


Fig.: Proposed working model illustrating the involvement of NtCOP1 in nicotine and flavonol accumulation in tobacco. Arrowheads and tees represent positive and negative regulation, respectively.

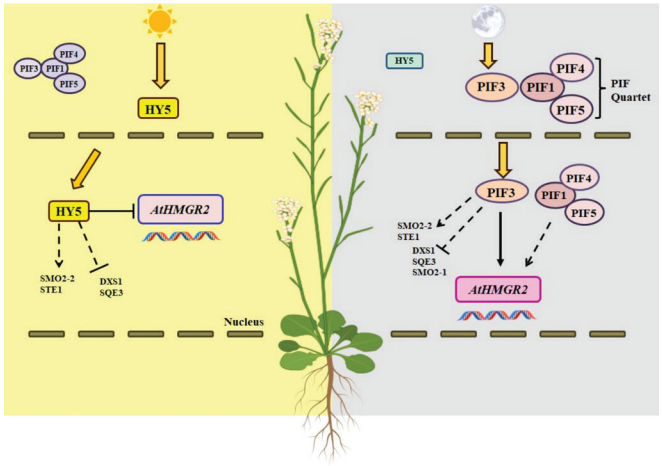


Fig.: Model representing transcriptional regulation of MVA and downstream pathway genes by light signalling components HY5 and PIF factors.

To uncover light-dependent regulation of the mevalonic acid (MVA) pathway, mutants of light signalling components, *hy5-215* and *pifq* quadruple mutant (*pif 1,3,4* and *5*), were analysed in *Arabidopsis thaliana*. The gene expression analysis in wild-type (WT) and mutant backgrounds indicated the involvement of HY5 and PIFs in the transcriptional regulation of genes related to sterol biosynthesis in Arabidopsis. DNA-protein interaction analysis confirmed their interactions with promoters of the rate-limiting pathway gene *AtHMGR2*. Results suggest that HY5 and PIFs regulate light-dependent MVA pathway, including sterol biosynthetic branch, in Arabidopsis (Fig.). These findings demonstrate the diversity of light signalling components that optimize key pathways essential for plant growth.



Dr. Prabodh K. Trivedi & his team

Dr. Laiq-ur Rahman डॉ. लईक–उर–रहमान

Bridging fungal resistance and plant growth through constitutive overexpression of Thchit42 gene in *Pelargonium graveolens*



Pelargonium graveolens essential oil possesses significant attributes, known for perfumery and aromatherapy. However, optimal yield and propagation are predominantly hindered by biotic stress. All biotechnological approaches have yet to prove effective in addressing fungal resistance. The current study developed transgenic geranium bridging molecular mechanism of fungal resistance and plant growth by introducing cassette 35S::Thchit42. Furthermore, 120 independently putative transformed explants were regenerated on kanamycin fortified medium. Primarily transgenic lines demonstrated peak pathogenicity and antifungal activity against formidable *Colletotrichum gloeosporioides* and *Fusarium oxysporum*. Additionally, phenotypic analysis revealed ~ 2-fold increase in leaf size and ~ 2.1-fold enhanced oil content. To elucidate the molecular mechanisms for genotypic cause, de novo transcriptional profiles were analyzed which indicated that the auxin-regulated longifolia gene is accountable for augmentation in leaf size, and zinc finger (ZF) RICESLEEPER attributes growth enhancement. Collectively, the data provides valuable insights into unravelling the mechanism of Thchit42-mediated crosstalk between morphological and chemical alteration in transgenic plants. This knowledge might create novel opportunities to cultivate fungal-resistant geranium throughout all seasons to fulfil the demand.

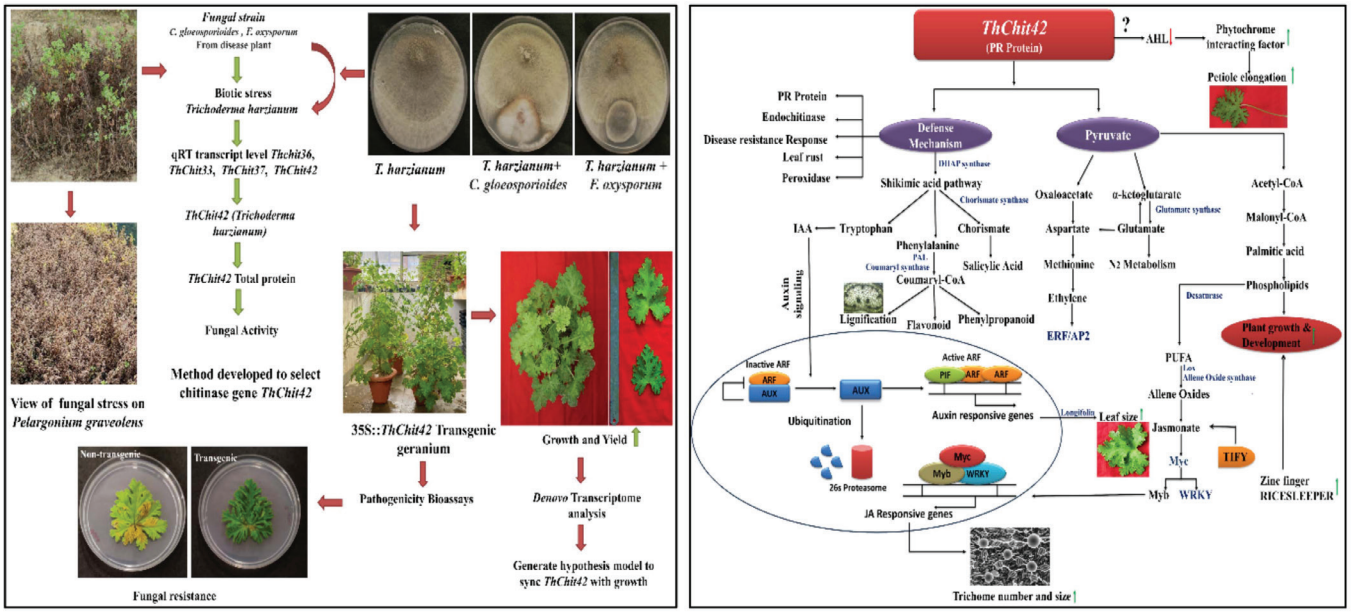


Fig.: Overexpression of *ThChi42* in *Pelargonium graveolens*



Dr. Laiq-ur-Rahman and his team

Dr. Dinesh A Nagegowda डॉ. दिनेश ए नागेगौड़ा

Biosynthesis of citral, the major essential oil component of lemongrass (*Cymbopogon flexuosus*)



The ability to produce citral is widespread in dicots, but among monocots only a few species, including aromatic grasses of the *Cymbopogon* genus, have evolved this ability. Lemongrass (*Cymbopogon flexuosus*), is a perennial herb and one of the most cultivated aromatic crops and commercially important aromatic grasses belonging to Poaceae family, due to its citral-rich (around 70-80%) essential oil, making it the primary source of citral (Kumar *et al.*, 2023). Our previous study involving transcriptomics, gene expression analyses, and molecular modelling, showed evidence for the presence of ADH and AKR encoding genes, indicating the potential involvement of any of these enzymes in citral biosynthesis (Meena *et al.*, 2016). Here, using a combination of biochemical, reverse and forward genetics, and molecular approaches, we have elucidated the functions of an ADH (CfADH1) and an aldoketo-reductase (CfAKR2b) in citral biosynthesis in lemongrass. Expression of both *CfADH1* and *CfAKR2b* showed correlation with citral accumulation in different developmental stages. Recombinant CfADH1 and CfAKR2b, despite their sequence unrelatedness, exhibited similar kinetic properties and formed citral from geraniol with NADP cofactor. Virus-induced gene silencing in lemongrass, and transient expression in lemon balm (*Melissa officinalis*), demonstrated the *in-planta* involvement of *CfADH1* and *CfAKR2b* in citral biosynthesis. While CfADH1 exhibited a dual cytosolic/plastidial localization, CfAKR2b was localized to cytosol. Moreover, feeding lemongrass seedlings with mevalonate- and methylerythritol-phosphate-pathway specific inhibitors combined with volatile profiling supported the role of both pathways in citral formation. Our results demonstrate phylogenetically distant enzymes localized in cytosol and plastids drive citral biosynthesis in lemongrass,

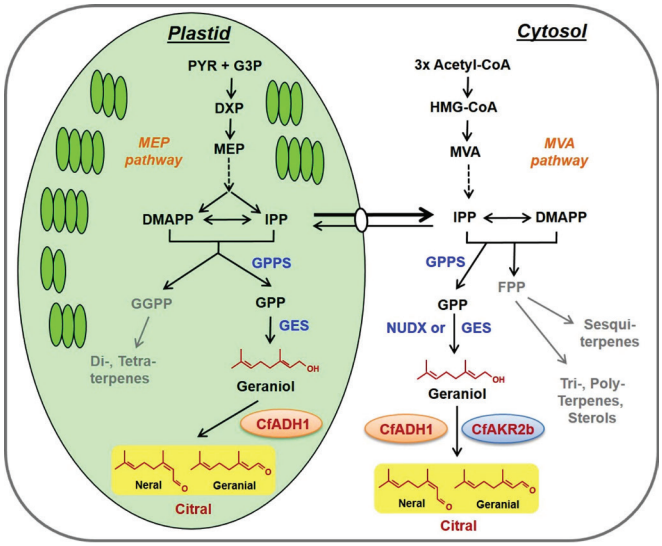


Fig.: Overview of citral biosynthesis in lemongrass.

indicating an evolutionary scenario aimed at maximizing the utilization of precursor pools from both cytosolic and plastidial pathways for high citral production.

The dual cytosol/plastid localized CfADH1 and cytosolic CfAKR2b form citral by utilizing geraniol made either by plastidialgeraniol synthase (GES) or cytosolic NUDX or GES. Abbreviations: DMAPP, dimethylallydiphosphate; DXP, 1-Deoxy-D-xylulose 5-phosphate; FPP, farnesyldiphosphate; G3P, glyceraldehyde 3-phosphate; GES; geraniol synthase; GPP, geranyldiphosphate; GPPS, GPP synthase; GGPP, geranylgeranyldiphosphate; HMG-CoA, 3-hydroxy-3-methylglutaryl coenzyme A; IPP, isopentenyldiphosphate; MEP, methylerythritol phosphate; MVA, mevalonic acid; PYR, pyruvate.



Dr. Dinesh A Nagegowda and his team

Dr. Vikrant Gupta डॉ. विक्रांत गुप्ता

Artemisinin biosynthesis modulation by Genome Editing



For manipulating the secondary metabolic pathways operating in *Artemisia annua* for enhanced artemisinin biosynthesis, few candidate pathway genes (*RED1,* dihydroartemisinic aldehyde reductase; *QHS1,* â-caryophyllene synthase; and *LS*,lupeol synthase) were previously identified that have common precursors or diverging points for synthesis of diverse/different compounds, and selected for knocking out through CRISPR-Cas9. Silencing of these genes would lead the metabolic flux to divert towards the artemisinin biosynthesis as more of the precursor compound would be available to the artemisinin pathway. The CRISPR/Cas9 constructs (in pKSE401 vector) containing specific sgRNAs for all these target genes (*AaQHS1, AaRED1* and*AaLS*) were prepared and introduced into *Agrobacterium tumefaciens* (strain AGLI). *A. annua* plants were then transformed with these constructs independently by using the regeneration procedure standardized and established in the laboratory. The putatively transformed/regenerated plantlets are being generated which would be maintained in containment glass house (HARITI). Subsequently, the lines which are modified by the CRISPR-Cas9 complex at the desired specific sites would be screened by using the Guide-it™ sgRNA *In Vitro* Transcription and Screening System.

Previously, an efficient regeneration procedure for *A. annua* was developed by studying the effects of various plant growth regulators (PGRs) on different explants like leaf, petiole and callus. The outcomes of the study were published, and the optimized method was used for the genetic modification using the sgRNA constructs *[Plant Biosystems, 158 (1): 59-69, 2023].*

Root/leaf biomass development-related gene homolog(s) in *Withania somnifera*

Withania somnifera, known to produce withanolides (triterpenoid steroidal lactones), have immense economic and medicinal value. Withanolides including withanolide-A and withaferin-A, are major bioactive molecules biosynthesized through MEP and MVA pathway in the root and shoot, respectively. Previously, homologs of root/leaf biomass development-related genes, i.e. *WsBIG-BROTHER*, *WsDWF4* and *WsSHR*, were successfully cloned and transformed into tobacco model plant for functional characterization. In the case of *WsSHR*,transgenic linesof tobacco were generated and confirmed by PCR. Further analyses were carried out in subsequent generations of the transgenic lines. The transgenic tobacco lines ectopically expressing *WsSHR* showed morphological differences in their root and leaf biomass as compared to wild-type tobacco plants. Stably transformed tobacco plants with an ectopically introduced construct of *WsSHR* in T_2 generation showed tap root systems, whereas, wild-type plants of *N. tabacum* showed a fibrous root

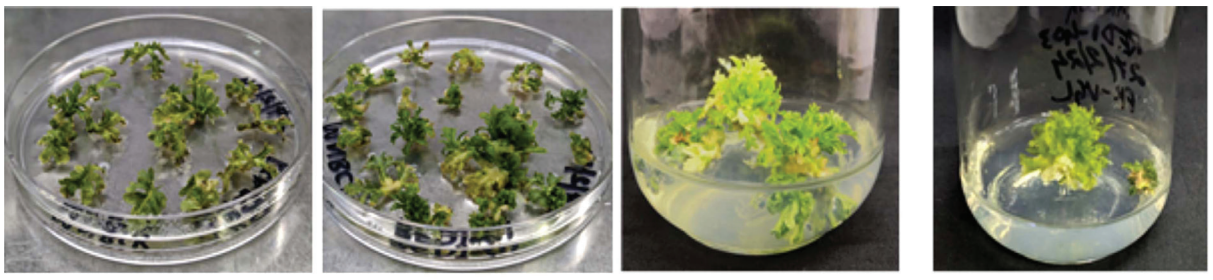


Fig.: Raising CRISPR-edited plant of *Artemisia annua* targeting *AaQHS1, AaRED1, AaLS*

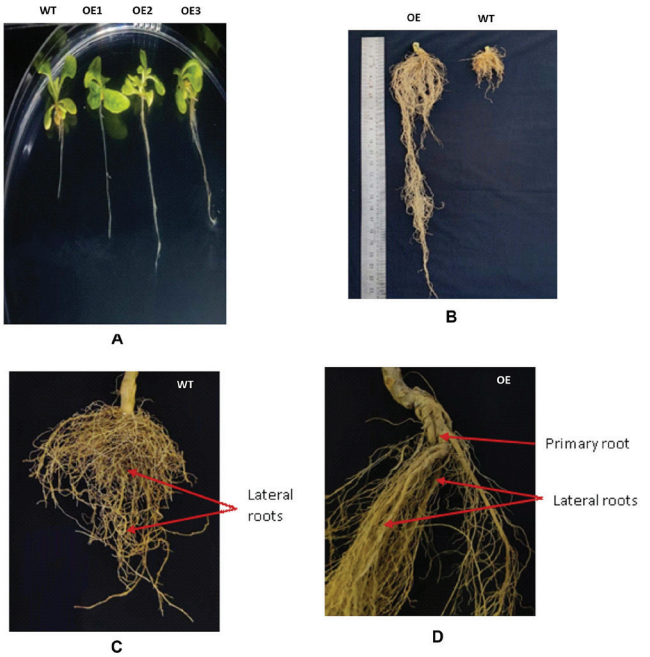


Fig.: Transformed tobacco plants ectopically expressing *WsSHR* of *W. somnifera*. **(A-D)** morphological differences in root architecture observed inwild type (WT) and overexpression (OE) lines of the model plant.

system.Transverse section (TS) of the ectopically over-expressed *WsSHR* transgenic tobacco lines showed more lignin accumulation in the stem than wild-type tobacco plants.In order to study the effect of *WsSHR* in secondary metabolites biosynthesis, transient expression analysis in homologous system (i.e.*W. somnifera* seedlings) were also carried out.Upon transient overexpression of *WsSHR*enhancement in major bioactive molecules in *W. somnifera* seedlings were observed.Specifically, the leaves of the W. somnifera plant showed an increase in withaferin-A and withanone, while, the roots showed an increase in withanolide-A and withanone.



Dr. Vikrant Gupta and his team

Dr. Sunita Singh Dhawan



Low-temperature perception and modulations in *Ocimum basilicum* commercial cultivar CIM-Shishir

The need for climate-smart, resilient high-yielding genotype is of high importance due to varied climatic conditions as this will hit the yield drastically and further to the economic sectors including farmers and industries. The expression analysis of key genes associated with cold tolerance in two plant groups: the newly developed hybrid variety known as CIM-Shishir Ocimum, which exhibits cold tolerance, and the control plants susceptible to cold climate that include *WRKY53, ICE1, HOS1, COR47, LOS15, DREB5, CBF4, LTI6, KIN*, and *ERD2*. These genes exhibited significantly higher expression levels in the CIM-Shishir variety compared to the control, shedding light on the genetic basis of its cold tolerance.

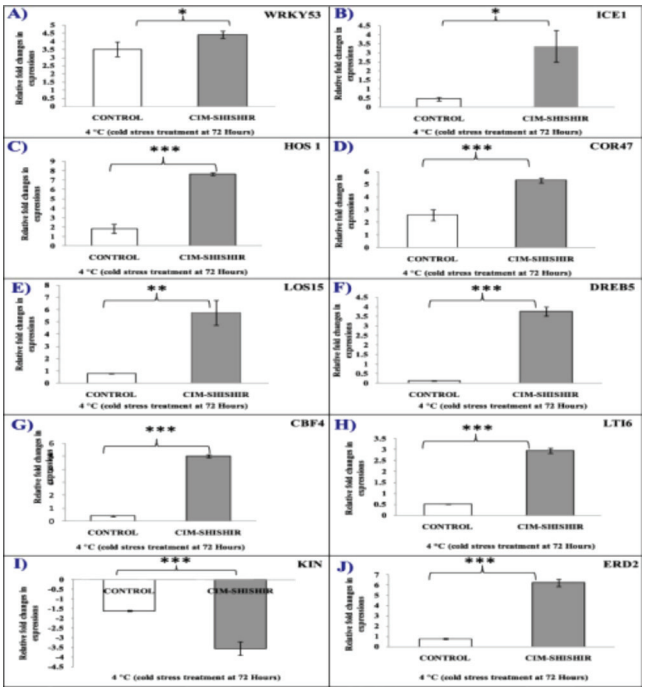


Fig.: Relative fold induction of genes associated with cold stress. (A) WRKY53, (B) ICE1, (C) HOS1, (D) COR47, (E) LOS15, (F) DREB5, (G) CBF4, (H) LTI6, (I) KIN and (J) ERD2 control and Ocimum hybrid CIM Shishir during cold treatment at 4 °C for 72 h.

Exploration of endophytic bacteria in stress-resilient plants: assessing abiotic stress tolerance and plant growth-promoting traits to uncover promising strains for crop improvement

M. pruriens (*L.*) DC. (Fabaceae) is globally recognized for its various therapeutic values, but it is mainly known for its abundant reservoir of natural L-DOPA. L-DOPA holds dual importance, serving as a therapeutic agent for Parkinson's disease (PD) treatment and contributing to enhanced brain health. However, abiotic stress prevalent in tropical regions poses a severe threat to plant growth and L-DOPA biosynthesis. The study conducted at CSIR-CIMAP Lucknow, India, six endophytic bacteria were isolated from different parts of healthy *M. pruriens* (*L.*) DC. plants. Among these, *Enterobacter roggenkampii, Enterobacter mori,* and *Enterobacter ludwigii* exhibited superior performance in conferring salinity stress tolerance in the range of 100 mM to 800 mM. Inoculation with these bacteria resulted in higher growth, yield, and physiological parameters, highlighting their potential as endophytes to enhance salinity stress tolerance in *M. pruriens* (*L.*) DC. and improve L-DOPA yield.

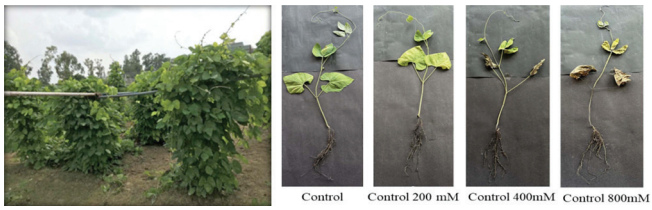


Fig.: Effect of different concentrations of salt on *Mucuna pruriens*

Development of High-yielding/ resource-efficient and climate-resilient varieties in Spearmint: Comparative analysis of yield potential in *Mentha spicata* varieties/accessions

Mentha spicata varieties viz Arka, Neera, Neerkalka,

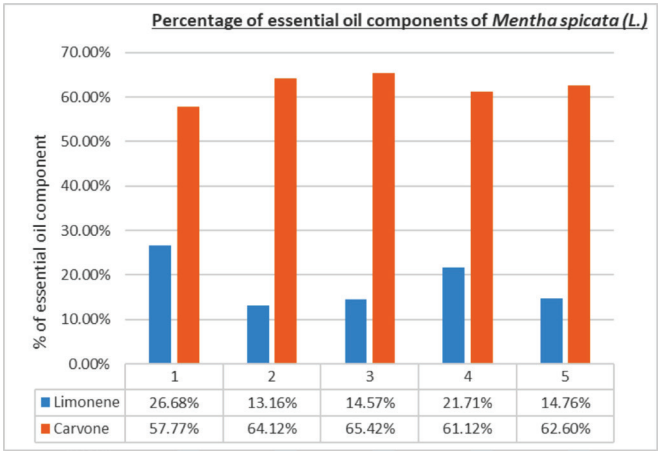


Fig.: Analysis of constituents in Mentha spicata essential oil

CIM-Mohak, and MSS5 plants were established in glass house and under *in vitro* conditions for developing regeneration protocols. Trichomes were analyzed during the dormant phase and transferred to experimental fields for the analysis of essential oil yield, constitutional analysis and herbage yield. Key factors were under nalysis for yield variations. Selections were in process under in vitro conditions.



Dr. Sunita Singh Dhawan and her team

Dr. Sumit Ghosh डॉ. सुमित घोष

The role of *Andrographis paniculata* ApCPS2 in diterpenoid biosynthesis and defense against insect herbivore



Kalmegh (*Andrographis paniculata*) in a source of medicinal diterpenoids (*ent*-LRDs) such as andrographolide (AD), 14-deoxy-11,12-didehydroandrographolide (DDAD), neoandrographolide (NAD). These specialized metabolites are formed in a spatio-temporal manner in kalmegh. *Ent*-copalyl pyrophosphate (*ent*-CPP) is the proposed precursor of kalmegh *ent*-LRDs. However, the involvement of *ent*-copalyl pyrophosphate (*ent*-CPP)-producing class II diterpene synthases (diTPSs) in the supply of *ent*-CPP precursor for diterpenoid biosynthesis was not understood well. We elucidated *in planta* roles of three *ent*-CPP-producing diTPSs (ApCPS1,2,4) by integrating transcript-metabolite co-profiles, biochemical analysis and gene functional characterization. ApCPS1,2,4 localized to the plastids, which are the sites of diterpenoid biosynthesis in plants. However, *ApCPS1,2,4* transcript expression patterns and *ent*-LRD contents in various tissues of kalmegh found a strong correlation of *ApCPS2* expression and *ent*-LRD accumulation. Moreover, *ApCPS1,2,4* upstream sequences differentially activated the reporter gene *β-glucuronidase* (*GUS*) in Arabidopsis and transiently-transformed kalmegh. Considering higher expression of *ApCPS1* transcript in kalmegh stem, *ApCPS1* upstream sequence activated *GUS* in stem/hypocotyl of Arabidopsis and kalmegh. However, *ApCPS2,4* upstream sequences weakly activated *GUS* expression in Arabidopsis, which was not well correlated with *ApCPS2,4* transcript expression in kalmegh tissues. Whereas, *ApCPS2,4* upstream sequences could activate *GUS* expression at a considerable level in kalmegh leaf and roots/calyx, respectively, suggesting the involvement of transcriptional regulator(s) of *ApCPS2,4* that might participate in kalmegh-specific diterpenoid pathway.

Interestingly, *ApCPS2*-silenced kalmegh showed a drastic reduction in AD, DDAD and NAD contents and compromised defense against insect herbivore

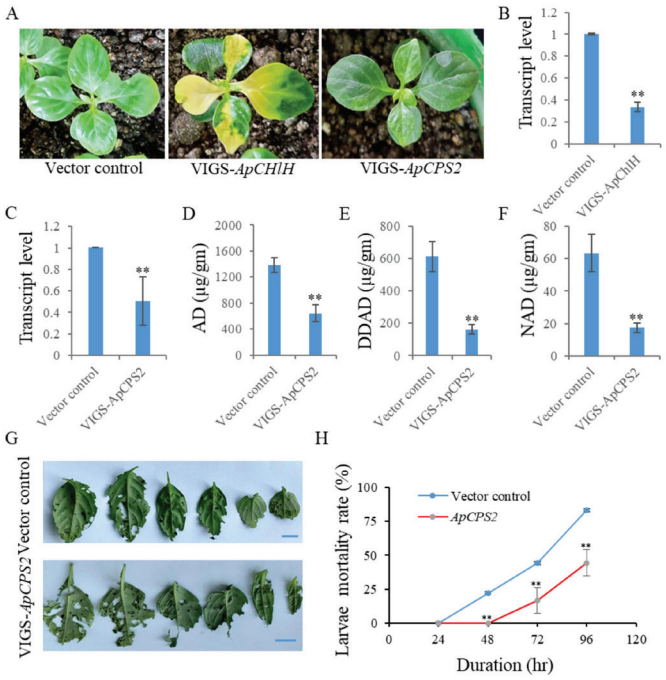


Fig.: Virus-induced gene silencing (VIGS) of *ApCPS2*. (A) Kalmegh seedlings at 3-week post-vacuum infiltration with a 1:1 mixture of *Agrobacterium* containing pTRV1 and pTRV2-*ApCPS1*, pTRV2-*ApCPS2*, pTRV2-*ApCPS4* or pTRV2-*ApChlH*. A characteristic leaf-yellowing phenotype resulted due to silencing of *ApChlH*. Kalmegh seedlings infiltrated with *Agrobacterium* suspension with pTRV1 and pTRV2 empty vectors were used as the vector control. (B-C) Relative transcript level of *ApChlH* (B) and *ApCPS2* (C) in the leaves of VIGS plants was determined by qRT-PCR analysis. Data are means ± SD of four biological replicates. (D-F) Andrographolide (AD), neoandrographolide (NAD) and 14,11-dideoxydehydroandrographolide (DDAD) contents in VIGS plants were determined by HPLC analysis. Data are means ± SD of four biological replicates. Each biological replicates in B-F comprising of seven seedlings. (G-H) Insect feeding bioassays in *ApCPS2*-silenced plants. (G) Photographs of leaves taken at 48 h post insect infestation in detached leaves of kalmegh plants. (H) Larval mortality rate was estimated at regular intervals post-insect feeding on detached leaves. For insect bioassay using detached leaf, six leaves of VIGS-*ApCPS2* and vector control were detached for each replicate and placed on 1% agar plates. Subsequently, six second instar larvae per plate were released on to the leaf surface. Larvae mortality rate was recorded periodically. Data are means ± SD of three biological replicates. The scale bar in the figure represents a length of 1 cm. **P≤0.01 compared with control samples as determined by Student's t-test.

Spodoptera litura. However, *ent*-LRD contents and herbivore defense in *ApCPS1* or *ApCPS4*-silenced plants remained largely unaltered. In previous studies, kalmegh extract and the bitter compound AD showed insecticidal activities. However, the role of *ent*-LRDs in plant defense to insect herbivores was not analyzed before. Overall, these results suggested an important role of ApCPS2 in producing *ent*-CPP for medicinal *ent*-LRD biosynthesis and defense against insect herbivore (Fig.). Therefore, *ApCPS2* could be a useful bait to develop gene co-expression network and library of promoter-interacting proteins unraveling the unknown enzymes and transcriptional regulator(s) of the kalmegh *ent*-LRD pathway *[Plant Science (2024) 342:112046]*.

Metabolic engineering in yeast for the high-level biosynthesis of enantiopure germacrene D

Germacrene D is a sesquiterpenoid compound found mainly in plant essential oils at a low level as (+) and/or (-) enantiomeric forms. It is an ingredient for the fragrance industry; but a process for the sustainable supply of enantiopure germacrene D was not well established. We carried out metabolic engineering in yeast (*Saccharomyces cerevisiae*) to achieve biosynthesis of enantiopure germacrene D at a high titer. To boost farnesyl pyrophosphate (FPP) flux for high-level germacrene D biosynthesis, a background yeast chassis (CENses5C) was developed by genomic integration of the expression of cassettes for eight ergosterol pathway enzymes that sequentially converted acetyl-CoA to FPP, and by replacing squalene synthase promoter with a copper-repressible promoter, which restricted FPP flux to the competing pathway (Fig.). Galactose-induced expression of codon-optimized plant germacrene D synthases led to 13-30 fold higher titers of (+) or (-)-germacrene D in CENses5C than the parent strain CEN.PK2.1C. Further, genomic integration of germacrene D synthases in *GAL80, LPP1* and *rDNA* loci generated CENses8(+D) and CENses8(-D) strains, which produced 41.36 µg/ml and 728.87 µg/ml of (+) and (-)-germacrene D,

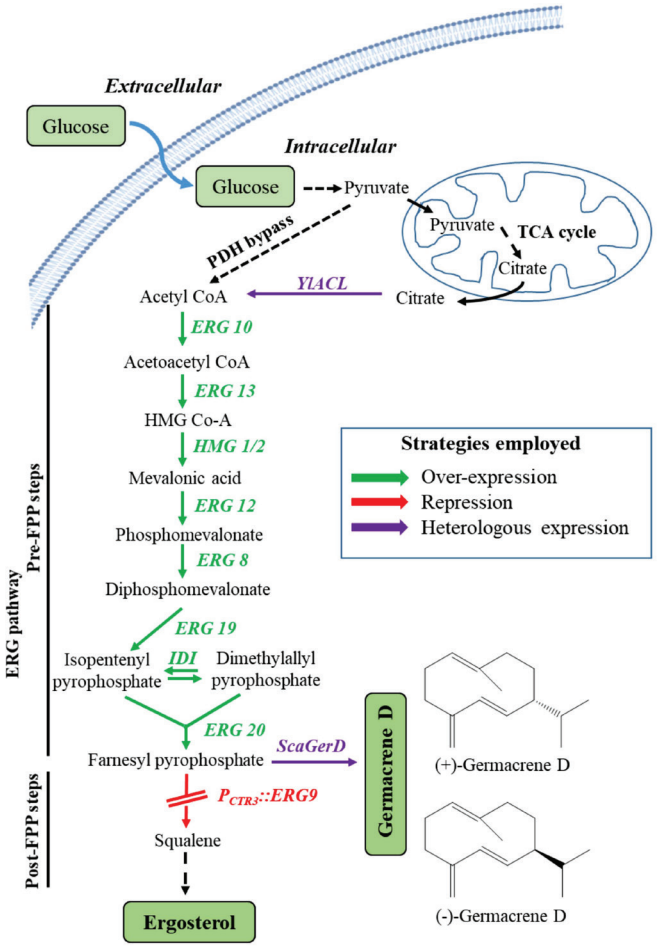


Fig.: A schematic biosynthetic pathway displaying the strategies employed to produce enantiopure germacrene D in the engineered *Saccharomyces cerevisiae*. To increase terpenoid precursor flux towards farnesyl pyrophosphate (FPP), eight ERG genes (*ERG10, ERG13, tHMG1, ERG12, ERG8, ERG19, IDI, ERG20*) and codon optimized *Yarrowia lipolytica* ATP-citrate lyase (*YlACL*) were overexpressed while *ERG9* promoter was replaced with a copper-repressible promoter P_{CTR3}. Codon optimized germacrene D synthase (*ScaGerD*) of *Solidago canadensis* was over-expressed to convert FPP to (+) or (-) germacrene D.

respectively, without galactose supplementation. Moreover, coupling of mitochondrial citrate pool to the cytosolic acetyl-CoA, by expressing a codon-optimized ATP-citrate lyase of oleaginous yeast, resulted in 137.71 µg/ml and 815.81 µg/ml of (+) or (-)-germacrene D in CENses8(+D)* and CENses8(-D)* strains, which were 67-120 fold higher titers than in CEN.PK2.1C. In fed-batch fermentation, CENses8(+)* and CENses8(-)* produced 290.28 µg/ml and 2519.46

µg/ml (+) and (-)-germacrene D, respectively. This work was recently published in the journal Applied Microbiology and Biotechnology (2024) 108(1):50.



Dr. Sumit Ghosh & his team

Dr. Ashutosh K Shukla डॉ. आशुतोष कु. शुक्ला



Characterization of a *CrPME* indicates its possible role in determining vindoline accumulation in *Catharanthus roseus* leaves

The leaf-specific *Catharanthus roseus* alkaloid, vindoline, is the major bottleneck precursor in the production of scarce and costly anticancer bisindoles (vincristine and vinblastine). The final steps of its biosynthesis and storage occur in the laticifers. Earlier, we have shown that vindoline content is directly related to laticifer number. Pectin remodeling enzymes, like pectin methylesterase (PME), are known to be involved in laticifer development. A search in the croFGD yielded a leaf-abundant *CrPME* isoform that co-expressed with a few vindoline biosynthetic genes. Full-length cloning, tissue-specific expression profiling, and in silico analysis of *CrPME* were carried out. It was found to possess all the specific characteristics of a typical plant PME. Transient silencing (through VIGS) and overexpression of *CrPME* in *C. roseus* indicated a direct relationship between its expression and vindoline content. Comparative analysis of transcript abundance and enzyme activity in three familial *C. roseus* genotypes differing significantly in their vindoline

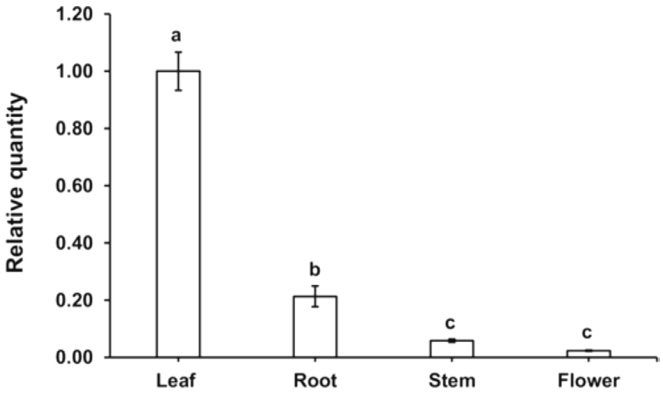


Fig.: qRT-PCR based analysis of transcript abundance of *CrPME* in various tissues of *Catharanthus roseus* (cv. Dhawal). The leaf sample was taken as the calibrator and *C. roseus* cyclophilin was used as the endogenous gene.

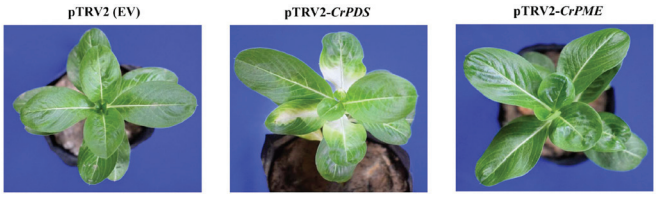


Fig.: Representative *Catharanthus roseus* (cv. Dhawal) plants infiltrated with pTRV1 and pTRV2 [empty vector, pTRV2 (EV); control] or its derivatives (pTRV2-*CrPDS* or pTRV2-*CrPME*). After ~21 days (post-infiltration) plants transformed with pTRV2-*CrPDS* showed photobleaching due to TRV-mediated silencing of *CrPDS*.

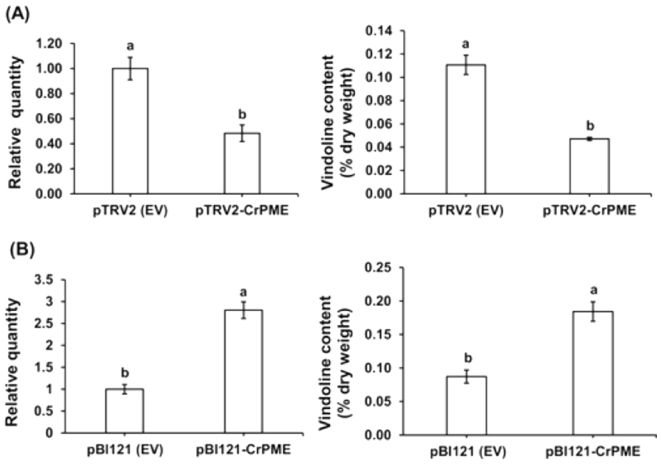


Fig.: Analysis of agro-infiltrated *Catharanthus roseus* (cv. Dhawal) plants for transcript abundance of *CrPME* and vindoline content (% dry weight basis) in leaves. (A) With pTRV2-*CrPME* (VIGS construct). (B) With pBI121-*CrPME* (overexpression construct). For qRT-PCR, in each case, the empty vector control sample was taken as calibrator and *C. roseus* cyclophilin was used as the endogenous gene.

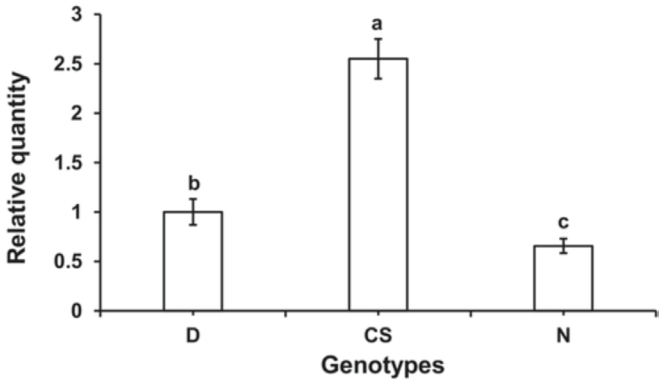


Fig 4: qRT-PCR based analysis of transcript abundance of *CrPME* in various *Catharanthus roseus* genotypes - Dhawal (D), CIM-Sushil (CS) and Nirmal (N). The Dhawal sample was taken as calibrator and the *C. roseus* cyclophilin gene was used as the endogenous gene.

Genotype	Specific activity (μmoles min^{-1} mg^{-1} protein) (x 10^{-4})
Dhawal	21.35 ± 0.69^{b}
CIM-Sushil	27.33 ± 0.71^{a}
Nirmal	18.76 ± 0.20^{c}

Fig 5: Total PME specific activity in different *Catharanthus roseus* genotypes.

content and laticifer count (CIM-Sushil > Dhawal > Nirmal) also corroborated the positive relationship of CrPME expression with vindoline content. This study highlights the possible role of CrPME, a cell wall remodeling enzyme, in modulating laticifer-associated secondary metabolism. [Singh *et al.*, 2024 *Physiologia Plantarum*].



Dr. Ashutosh K Shukla & his team

Dr. Prema G. Vasudev डॉ. प्रेमा जी. वासुदेव

Crystallization and structure analysis of peptides containing homologs of phenyl alanine



In collaborative research with Dr. Ramesh Ramapanicker, Professor, Indian Institute of Technology, Kanpur, the effect of inserting side chain-homologated Phenylalanine residues in short peptide helices has been investigated. The π… and C-H…π interactions between aromatic side chains of amino acids are known to stabilize the fold and assembly of short peptides. In the present study, we investigated the effect of homologated phenylalanine sidechains on the conformation and assembly of peptide helices through X-ray crystallographic structure determination and analysis of five pentapeptides. The parent peptide Boc-Phe-Aib-Aib-Leu-Phe-NHiPr (Fig.) and its three variations were synthesized, in which either one or both of the Phe side chains have been modified by inserting one (homophenylalanine, hPhe; $-CH_2-CH_2-C_6H_5$) or two (h^2Phe; $-CH_2-CH_2-CH_2-C_6H_5$) additional CH_2 groups in the side chain. Single crystal X-ray diffraction and analysis were accomplished for the parent peptide and four of its variants, namely, Boc-hPhe-Aib-Aib-Leu-Phe-NHiPr (Fig.), Boc-hPhe-Aib-Aib-Leu-hPhe-NHiPr (Fig.), Boc-h^2Phe-Aib-Aib-Leu-Phe-NHiPr (Fig.) Boc-h^2Phe-Aib-Aib-Leu-h^2Phe-NHiPr (Fig.). The results show that the backbone conformations of helical peptides are largely unaffected by the homologated Phe residues, while formation of intramolecular interactions between the aromatic rings were facilitated by the lengthening of the Phe side chain. This analysis confirms that by increasing the length of aromatic side chains at i^{th} and $i+4^{th}$ positions of the peptide helices, intramolecular aromatic interactions can be induced in short helical peptides, providing additional stability to the helical structure in solution. The observation of longer interaction distances in peptide 5 (Fig.) for intermolecular aromatic interaction as compared to

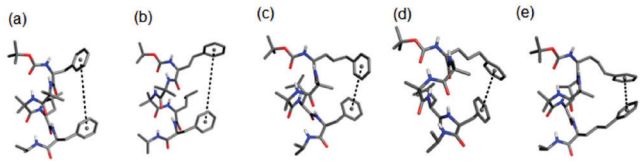


Fig.: Distance between the centroids of the aromatic rings in side chains of Res1 and Res5 of peptide structures: (a) peptide 1, (8.0 Å) (b) peptide 2 (8.7 Å), (c) peptide 4 (5.1 Å) and (e) peptide 5 (5.01 Å).

other peptides is suggestive that with the increased propensity for intramolecular interaction, there is a decrease in the propensity for aromatic interactions in helix aggregation. The results may prove useful in designing helical peptides with specific aggregation pattern by modulating the length of aromatic side chains.

Crystallographic structural studies of Precocene derivatives and *in silico* prediction of their binding to Estrogen Receptors

Precocene-I and Precocene-II are natural products that belong to the chromenes class. The structural similarity of dimers of precocene-I and II with the estrogen agonist 17 β-estradiol makes them possible estrogen agonists for drug design. Detailed analysis of crystal structures provides information on the possible intermolecular interactions of a molecule, which can be useful in the *in silico* prediction of its potential as an inhibitor in drug discovery research. As precocene moieties are estrogen agonists, and are present in many medicinally active molecules, information on the type and nature of intermolecular interactions from these scaffolds can be used for synthetic modifications leading to stronger binding interactions with the receptor proteins. In continuation with the ongoing research to understand the contribution of aromatic ring systems in the molecular recognition and aggregation in natural products scaffolds, six conformationally restricted precocene derivatives were studied. The analysis was carried out to understand the molecular aggregation and interaction patterns, in the absence of a strong intermolecular interactions such as hydrogen bonding. In the crystal structures, distance between the centroids of adjacent aromatic rings varied from 4.9 – 5.8 Å, indicating favourable aromatic ring interactions in some of the precocene derivatives (Fig.). Further, we analysed the binding of inhibitors to the Estrogen Receptor-α (ER-α) and Estrogen Receptor-β (ER-β) and predicted the biding of the six compounds to these receptors. A PDB analysis to examine the intermolecular interactions of estradiol, the natural ligand to estrogen receptors, binding to the protein shows that aromatic ring interaction to Phe404 at the binding site is important to the ligand binding (Fig.). The molecular docking studies using precocene derivatives also indicate the involvement of aromatic π… interactions to Phe404.

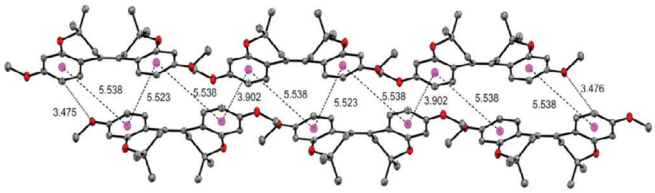


Fig.: A view of the aromatic ring interactions in the crystal packing of a precocene derivative

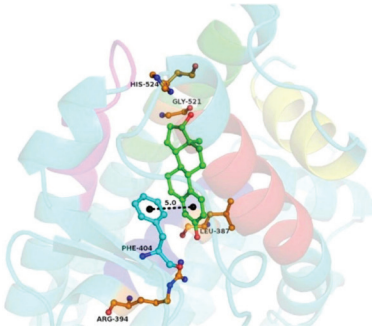


Fig.: A view of the estradiol binding to the active site of ER-α (PDB: 2YJA)



Dr. Prema G Vasudev and her team

Dr. Rakesh K. Shukla डॉ. राकेश कुमार शुक्ला

Molecular characterization of metabolic enzymes involved in bacoside biosynthesis pathway in *Bacopa monnieri*



Bacopa monnieri, commonly known as Brahmi, belonging to the family Scrophulariaceae, is an evergreen, creeping plant found in wet, humid, and swampy areas worldwide. It holds significant importance as a medicinal plant due to the presence of bacosides. Bacosides are major secondary metabolites that are highly glycosylated triterpenoids found in *B. monnieri*. This plant possesses a wide range of pharmacological properties and is employed as a neuro-tonic and medication for mental health, depression, and cognitive function. Brahmi is recognized for its antioxidant, anti-inflammatory, and anti-hepatotoxic properties. The basic structures of bacosides are di-, tri-, and tetra-glycosylated forms in common bacosides, which include bacoside A1-A3, bacopaside I-XII, bacopasaponin A-I, bacopaside N1-N2. Different sugar moieties (i.e., glucose, arabinose, or rhamnose) can be linked to the aglycon, i.e., jujubogenin and pseudojujubogenin at -OH group linked to the 3rd or 20th carbon atom. The pathway of bacoside biosynthesis is not well characterized in *B. monnieri*. However, in Bacopa, we hypothesize that dammarenediol II synthase (DS) facilitates the cyclization of 2,3-oxidosqualene, leading to the formation of a dammarane-type triterpenoidal scaffold, which is further modified by cytochrome P450 monooxygenases (CYP450) to produce isomer jujubogenin and pseudojujubogenin. The production of triterpenoid saponins with diverse structures and biological activity is facilitated by glycosyltransferases (GTs), which catalyze the glycosylation of these two isomers to produce a diverse class of bacoside. Except for *BmSQS* and *BmFPS,* no other bacoside biosynthesis pathway enzymes, including UGTs, are characterized in *B. monnieri*. Due to the important pharmacological uses of bacosides, it is essential to understand the biosynthetic pathway and characterize the pathway enzymes involved in bacoside biosynthesis for their overproduction. This study suggests that *UGT79A18* is one of the significant UDP glycosyltransferases involved in glycosylating pseudojujubogenin and enhances the pseudojujubogenin-derived bacosides in *B. monnieri*.

Since the bacopaside II standard was commercially available, we quantified bacopaside II using LC-MS/MS. MS/MS spectrum of bacopaside II standard was m/z- 929.5967 (pseudojujubogenin + Glc + Glc + Ara + H)$^+$, 797.4659 (pseudojujubogenin + Glc + Glc + H)$^+$, 767.4545 (pseudojujubogenin + Glc + Ara + H)$^+$, 635.4122 (pseudojujubogenin + Glc + H)$^+$, 473.3601 (pseudojujubogenin + H)$^+$, similar to the mass spectra of relatively quantified bacopaside II in the extract of *B. monnieri* (Fig.). In OE lines 1 and 2, bacopaside II was found to be 500.91 µg gFW^{-1} and 534.33 µg gFW^{-1}, respectively and found higher in comparison to VC, in which the concentration of bacopaside II was 284.57 µg gFW^{-1}. The same metabolite was found reduced in KD line 1 (177.28 µg gFW^{-1}) and line 2 (162.06 µg gFW^{-1}) in comparison to vector control (Fig.). Further, on comparing the mass spectra of the bacoside II standard and the differentially identified bacosides in OE and KD lines, we found 2 masses, i.e., m/z-635.4122 and 473.3601 were present in the mass spectra of bacopasaponin D (m/z- 767.4469, 635.4060, 473.3559), as pseudojujubogenin glucosyl rhamnoside (m/z- 781.3075, 635.4065, 473.3565), bacopaside II (m/z- 929.4982, 797.4557, 767.4469, 635.4060, 473.3559), and bacopaside N2 (m/z- 797.4557, 635.4060, 473.3559). On comparing both the masses with the literature, m/z-635.4122 was found to be the [pseudojujubogenin + Glc + H]$^+$ and m/z-473.3601 was found to be the [pseudojujubogenin + H]$^+$, suggesting that the first glycosylation of pseudojujubogenin is with glucose [*Physiologia Plantarum, 176 (2), e14260*].

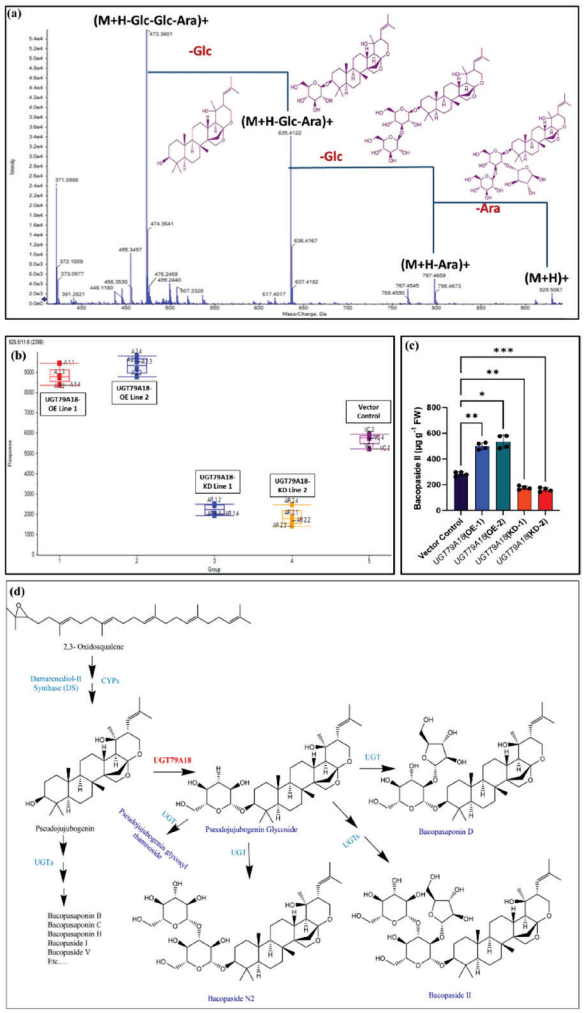


Fig.: Quantification of Bacopaside II. (a) MS/MS spectra of bacopaside II, showing the mass of 473.3601 (Aglycon+H)+, 635.4122 (Aglycon+Glc+H)+, 767.4545 (Aglycon+Glc+Ara+H)+, 797.4659 (Aglycon+Glc+Glc+H)+, 929.5967 (Aglycon+Glc+Glc+Ara+H)+. Since the structure of bacopaside II is reported, it suggests that its aglycon is pseudojujubogenin. (b) Whisker plot showing concentration difference between UGT79A18-OE lines and UGT79A18-KD lines alone with vector control for m/z- 929.4982. Whisker plot was made using Marker View software, which performs a pairwise comparison of all the groups using a t-test. (c) Quantification of bacopaside II, which was found to be 500.91 µg g FW^{-1} and 534.33 µg g FW^{-1} in both OE lines, which was higher than VC, whereas in both KD lines, it was 177.28 µg g FW^{-1} and 162.06 µg g FW^{-1} and found reduced compared to VC (284.57 µg g FW^{-1}). (d) A proposed pathway for bacoside biosynthesis in B. monnieri. Jujubogenin and pseudojujubogenin are the major triterpenoidal aglycones found in B. monnieri, whereas bacosides are major triterpenoid saponins, which are diversified by multiple glycosylation of these triterpenoidal aglycons. Our results suggest that *UGT79A18* is glycosylating pseudojujubogenin.



Dr. Rakesh Kumar Shukla and his team

Dr. Venkata Rao, D.K डॉ. वेंकटा राव, डी.के.



Optimizing the endogenous inositol signalling cascade causes increased triterpene precursor accumulation in yeast

Saccharomyces cerevisiae is a well-studied, industrially important organism that has been used for the bioproduction of several compounds with medicinal and pharmacological properties. It is well known for its ease of engineering as many tools are available for its genetic manipulation and metabolic engineering. Currently, we are investigating inositol-regulatory yeast mutants to understand the modulation of the Mevalonate/Ergosterol pathway and its impact on triterpene synthesis which will pave the way for new strategies to improve heterologous biosynthesis of triterpene-based plant secondary metabolites. Our results also demonstrated the possible role of the autophagy mechanism in the triterpene mechanism. We have screened yeast mutants of inositol signalling cascade (*ISC*) and observed their positive regulatory role in mevalonate pathway activity, and validated the mutant for high triterpene precursor accumulation (i.e., squalene). We also genetically complemented the mutant with *ISC1* gene which results in bringing down excess triterpene precursor levels. Our future

goal is to develop or modulate the ISC mechanism in yeast for future metabolic engineering for high triterpene production.

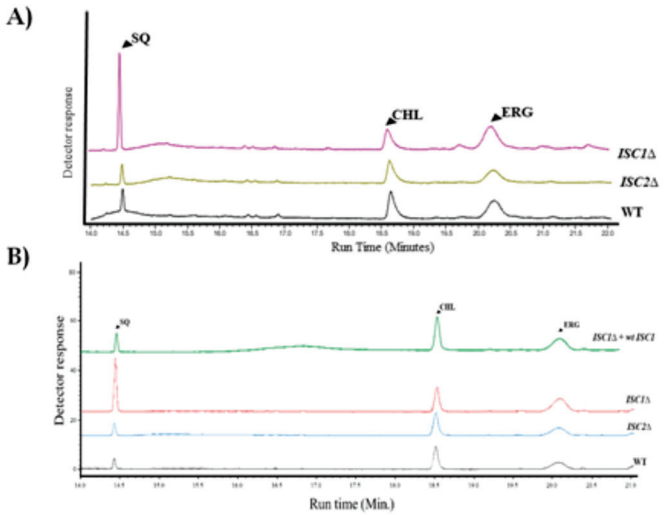


Fig.: GC chromatogram of inositol signalling cascade mutant strains. The *ISC1Δ* phenotype exhibits high SQ accumulation as compared with other ISC mutant (ie, ISC2) and wildtype (A). The wildtype *ISC1* gene (*wt ISC1*) complementation confirms the role of *ISC1* in mevalonate/ergosterol pathway activity (B). SQ, Squalene; CHL; Cholesterol (Internal standard); ERG, Ergosterol. *ISC1*Δ, Inositol signalling cascade 1 mutant strain; *ISC2*Δ, Inositol signalling cascade 2 mutant strain; WT: Wildtype strain.



Dr. Venkat Rao D.K. and his team

Dr. Pradipto Mukhopadhyay डॉ. पी. मुखोपाध्याय

Differential expression of a sterol desaturase leads to variable radial distribution in roots of tuberous roots of *Withania somnifera*



The tuberous roots of *Withania somnifera*, are in high demand and contains withanolides (steroidal lactones), the major bioactive compound in the plant. However, the withanolide content is poor in the roots and it is highly desired to breed plants developing quality root herb with increased withanolide content to meet the market demand. Despite increased cultivation, adequate supply of quality root herb and the withanolides still remains a challenge. The lack of knowledge about the complete biosynthesis pathway of withanolides, adds to the complexity of these challenges. We uncovered a radial distribution pattern of withanolides in roots, with the area outside the primary cambium accumulating 75-80% of the total withanolides while accounting for only 25-30% of total root biomass. Moreover, this distribution pattern remains related to the presence of xylary fibres which consists of dead cells. Thus, a specific gene leading to this spatial distribution of withanolides in the root could be targeted to increase the withanolide content in cell having their poor content. Through comparative RNA-seq analysis between the areas outside and inside the cambium, we identified specific transcripts encoding enzymes, regulators, and signaling proteins that likely play a crucial role in withanolide biosynthesis and its radial distribution. We identified as sterol reductase, a homolog of which has been reported to be involved in withanolide biosynthesis. However, this identified homolog is more strongly expressed in mature roots. Also, the earlier reported homolog do show a strict different expression between the two radial zones of the root, VIGS and transient overexpression of this gene shows its role in withanolides biosynthesis, similar to the one published earlier (Fig.). This study

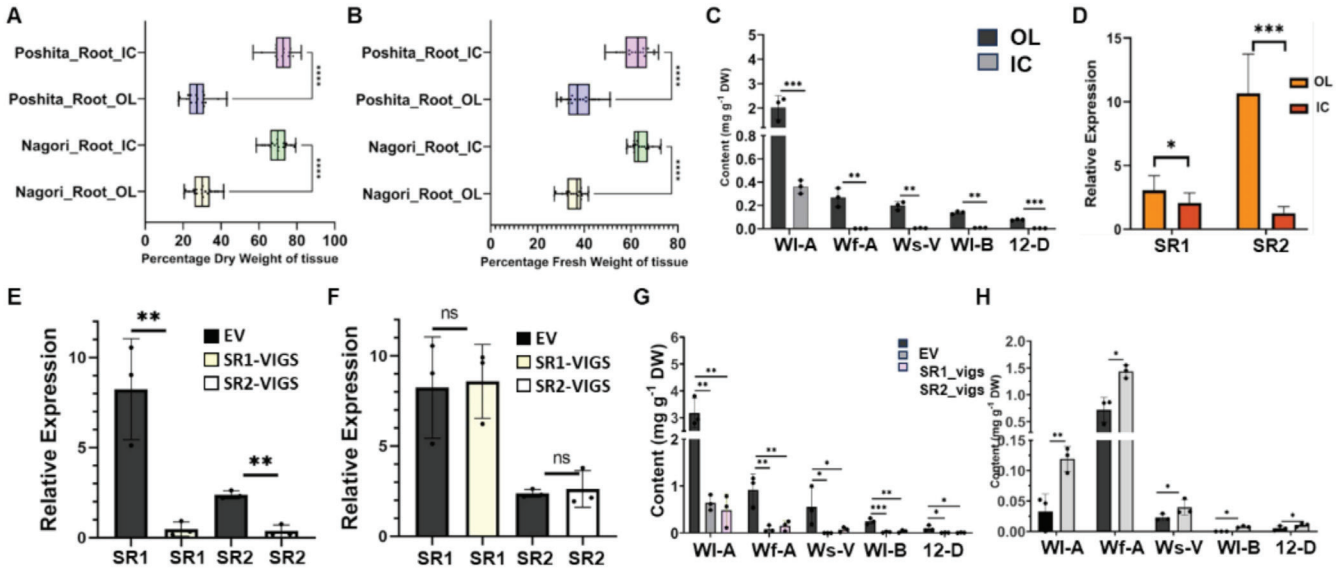


Fig.: Radial distribution of withanolide is linked to differential expression of a sterol reductase in *W. somnifera* (A-B) Percentage dry weight (A) and fresh weight (B) content of the region of root outside (OL) and inside (IC) of cambium in Nagori and Poshita cultivars. (C) Withanolides content in IC and OC regions in Nagori cultivar (D) qRT PCR analysis showing relative expression of Sterol Reductase (SR1 and SR2) in two regions of root. (E-F) qRT PCR showing relative expression of SR1 and SR2 in roots subjected to VIGS-mediated silencing of Sterol Reductase (SR) in root. (G) Withanolide content measured in roots of VIGS silenced plants (E) Withanolide content measured in leaf after transient overexpression of SRs

provides a promising avenue for further research to indentify the regulatory mechanism for this gene which can be utilized to increase withanolide content in the root.

Expression analysis and functional characterization WsALOG10.2 in *Withania somnifera*

As discussed in earlier reports a total of seven ALOG-domain containing transcripts were identified through *in silico* analysis of transcriptome data of root developmental stages of *Withania somnifera*. Heat map of the identified transcripts showed increase in expression lateral root developmental stages (85 DAS (days after sowing) onwards). Of those identified transcripts *WsnALOG10.2* whose expression pattern coincide with late tuberous root development was picked for further work. Real-time PCR was done to check for the expression pattern of this transcript in root developmental stages (45 DAS pot plant, 45 DAS, 85 DAS, 110 DAS and 125 DAS field grown of Nagori plant) and various other tissues like SAM, shoot, leaf, flower, fruit, unripen berry and ripen berry. The relative expression of ALOG10.2 showed increment with increase in root developmental stages and expression of this transcript was less in other plant tissues as compared to 125 DAS root (Fig.). Construct for overexpression was prepared in pGWB402 via gateway cloning method. Stable transformation using *Agrobacterium tumifaciens* strain (GV1301) was done in heterologous system (*Nicotiana tabaccum)*. The obtained homozygous lines were PCR confirmed using gene specific primers (Fig.). Homozygous lines were selected and preliminary experiments on 20 days old seedlings in MS media containing plates suggests significant reduction in root length of overexpression lines as compared to empty vector line (Fig.). Virus induced gene silencing (VIGS) in 45 days old Nagori seedlings reveals increase in lateral root number, increased root length and root biomass (Fig.). The work to deduce other role of this gene in transgenic lines is still under progress but primary data from overexpression and VIGS suggests its role in root development.

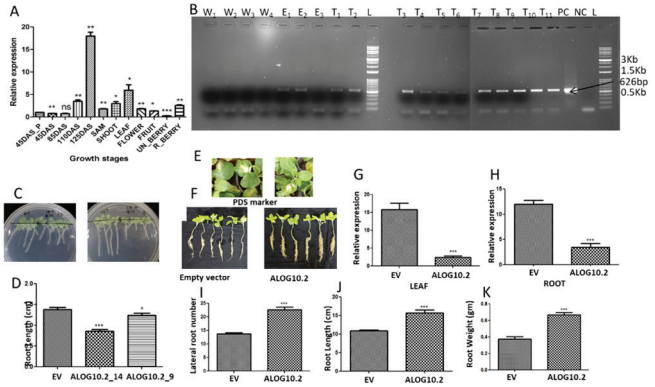


Fig.: WsALOG10.1 is a negative regular for lateral root development. (A) Relative expression of *WsALOG10.2* in various root of plants at different developmental stages (45-125 Days after sowing, DAS) and other plant parts. (B) PCR-mediated confirmation of WsALOG10.2 overexpressing transgenic tobacco plant using gene specific primers; T_1-T_{14} transgenic lines; W_1 and W_2, wild type plants, E_1 and E_2, Empty vector transformed plants. (C to D) Root length of two homozygous lines along with empty vector control. (E) PDS VIGS silenced control plant show bleaching of leaves and success of VIGS experiments. (F) Phenotype of empty vector control and *WsALOG10.2* VIGS-silenced plants. (G-H) qRT-PCR analysis depicting downregulation of the WsALOG10.2 in VIGS silenced plants. (I) Lateral root number (J) Root length and (K) Root biomass in VIGS sample. Error bars represent ±SD. * represent significance t-test ($p<0.05$).



Dr. Pradipto Mukhopadhyay and his Team

Dr. Mukti Nath Mishra डॉ. मुक्तिनाथ मिश्रा



Engineering *Azospirillum brasilense* to develop an efficient platform for isoprenoid and carotenoids production

Azospirillum brasilense, a plant growth promoting rhizobacterium, possesses a tightly regulated and high-flux endogenous isoprenoid pathway, which is manifested by regulated carotenoid over-production. However, the carotenoids produced by this bacterium have not yet been characterized. To utilize the its high-flux endogenous isoprenoid/carotenoid pathway, we have engineered this bacterium to develop an efficient FPP providing bacterial platform for high-value sesquiterpenids and known carotenoids. For this, we used two different approaches: (i) engineering to improve the isoprenoid flux; and (ii) process optimization using efficient carbon source for effective utilization of the flux. Engineering of the carotenoid regulatory pathways has improved the isoprenoid/carotenoid-flux >3-fold (from 6.1 mg/g biomass to 19.54 mg/g biomass). However, carbon source optimization has improved the yield >30-fold (from 6.30 mg/g biomass to 186.4 mg/g biomass). These outcomes showed that *A. brasilense* has ability to carry high carotenoid/isoprenoid-flux without compromising the growth rate and biomass yield. Furthermore, we have engineered the developed platform strain for high-value sesquiterpene production by heterologous expression of their biosynthetic pathway genes. Currently, we are working to improve the valenecene yield of the engineered strain by process optimization for large-scale production. We are also engineering the developed platform strain for production of high-value carotenoids. For this, we have deleted the native carotenoid biosynthetic pathway downstream of FPP, and developed an FPP providing, but carotenoid free, platform that can be used for biosynthesis of any carotenoid. To demonstrate the potential of the developed platform, we are trying to develop industrially potential strain for lycopene and bacterioruberin (a C50 carotenoid).



Dr. Mukti Nath Mishra and his team

Crop Production and Protection

HIGHLIGHTS

The Division includes 14 scientists who have expertise in various thrust areas like, development of new agro-technologies, soil fertility and plant nutrition, plant growth promoting microbes, and identification & characterization of MAPs diseases, bio-efficacy of new generation herbicides for weed management, utilization of distillation based bio-char as soil conditioner, development of essential oil based formulation for pest control, on-farm energy input-output analysis of essential oil bearing menthol mint and mechanization of MAPs.

Under Aroma Mission Phase-III, the division has extended support for technology dissemination, conducting awareness and skill development programs among the farmers of pan India, academia, industry and day to day client visited at CIMAP RCs Pantnagar, Hyderabad and Bengaluru, Purara, CSIR-



Left to right: Dr. Anandakumar T.M., Dr. Santoshkumar C. Kedar, Dr. Rakesh Kumar, Dr. Kishore Babu Bandamaravuri, Dr. Saudan Singh, Dr. Rajesh Kumar Verma, Dr. Priyanka Suryavanshi, Dr. Akanksha Singh and Dr. Puja Khare



Left to right: Dr. B.Shivanna, Dr. Jnanesha A.C., Dr. Rakesh Kumar Upadhyay, Dr. Dipender Kumar, Dr. S.G. Eswara Reddy and Dr. Yogendra N.D.

CIMAP Head Quarter Lucknow to enhance the area under cultivation of targeted plants. In addition, the division is also engaged in producing quality planting material of MAPs for area expansion under the various mission and sponsored projects.

Menthol mint is one of the promising aromatic essential oil bearing crop, currently which is being cultivated in more than 3 lakh hectares across India. During the last year, the division developed new agro-technology for the production of quality planting material for the different mint species. Further, the division has also developed sustainable clusters for the cultivation of various aromatic technologies such as EMT, alternate mint Technology (karif mint), and lemongrass (abiotic stresses). Currently, many farmers are performing well in these clusters by cultivating the above crops using CSIR-CIMAP-developed technologies. It has been reported that the essential oil of menthol mint can be maximized by spraying of Stigmasterol & Campesterol 0.01% w/w SL of 500 ml/ha or 250 ml/acre. In another study, it has been reported that the by employing an overlapping cropping system of wheat with a menthol mint at 2:1 ratio, maximum economic returns with high wheat equivalent yield and land equivalent ratio can be achieved. Bio-efficacy of new generation herbicides were examined for weed management in *Mentha arvesnis* (CIM-Unnati), it was reported that the aapplication of Oxyflurofen 23.5% EC as pre-emergence and Quizalofop ethyl 5% EC as post-emergence could completely control the weed population (broad leaf weed and grass weeds) in *Mentha arvensis* L. and could result in better yield. Further, in the same crop, the division also reported that the presence of 35 phytophagous arthropod species during the initial vegetative growth stage, 41 phytophagous arthropod species during the mid-vegetative growth stage and 40 phytophagous arthropod species during the maturation stage of the menthol mint crop.

Division scientist observed severe infection of two diseases in *Withania Somnifera*, i.e. *Fusarium* wilt and black leaf spot, with disease incidence of 55 and 70%, respectively. Further, in the lemongrass crop, two pathogens were isolated from the diseased plants on the basis of their morphological differentiation. In addition, the division has also worked on the development of various equipment for harvesting aromatic crops. In order to develop harvesting equipment for lemongrass, the power requirement for cutting lemongrass has been reported as 600 watts for cutting one clump of plant. Rosemary mother plants saving technology for north Indian plains have been developed. The *Ocimum* dry leaf powder and oil-loaded biochar formulations was examined for the sustained release of phenolics and oil constituents and herbicidal activities. Formulations showed more toxicity on *M. arvensis* and less inhibitory effect on *D. sanguinlis* than other weeds.

Kalmegh is one of the promising medicinal plants being cultivated in northern Indian plains, and it has a problem of seed shuttering during harvesting. The division reported that the seed shuttering can be reduced and its production can be enhanced by applying siliceous compounds via foliar approaches. Further, post-harvest loss of Kalmegh is also more due to a lack of suitable drying methods. Hence low-cost solar dryer has been developed and evaluated for drying of Kalmegh biomass. The developed dryer can bring the moisture content of the biomass below 10% within 2.5 hours without the loss of any chemical compound.

The division has identified 614 and 620 operational taxonomic units (OTUs), encompassing 291 and 229 genera, were identified in the shoot and root tissues of *P. graveolens*, respectively. Upon screening all isolates for plant growth-promoting traits, *Pseudomonas oryz*i habitans was found to be positive for major biochemical tests like nitrogen fixation, phosphate solubilization, etc., and on inoculation, resulted in about two-fold increase in content of essential oil accompanied by a significant rise in the geraniol and citronellol content. The plant spacing and nitrogen levels have optimized for *Orgeno* plants, and optimized that 45x30 cm plants spacing with 100 kg N//ha, was more profitable for growers.. Further, the division also reported that the Geraniol (0.01%) in MAP based biostimulants and

Moringa leaf extract can be used to enhance the yield of Linseed (*Linum usitatissimum* L.).

For the year 2023-24, the division has also been working on the application of seaweed extraction for the enhancement of the yield of MAPs. It has been reported that the Senna germination and establishment of seedlings can be improved with the application of 4% sea weed extraction. On top of that, the expression level of the patchouli plant's phenotypic plasticity was high in the 50% shade-grown plants. Concomitantly, phenotypic plasticity has shown a negative impact on essential oil yield and a positive effect on the ability to thrive under limited light-intensity conditions.About 576 hours for var. CIM-Samarth and 384 hours for var. CIM-Utkrishtis the optimal drying time for the highest oil content. Additionally, a drying period of 384-480 hours maximizes patchouli alcohol concentration in the oil.

The biochar amendments significantly ($p=0.001$) reduced the plant's uptake velocity (Vmax) and affinity (Km) of chlorpyrifos and atrazine. These results delineated that *Mentha*-distilled waste-derived biochar can potentially remediate chlorpyrifos and atrazine contaminated soils and ensure the safety of plants for consumption. Further, the division is also developed innovative decision support tools for integrated pest management in MAPs.

In this duration, the division has published 32 peer-reviewed research articles in SCI journals, like Bio-char journal, Journal of Environmental Chemical Engineering, Journal of Hazardous materials, Archive of Agronomy and Soil Science, Molecular systematic and design engineering, pesticide biochemistry and physiology, micrbioal cell factories, microbial research, Physiology & molecular biology of plants, Biochemical systematic and ecology and journal of plant disease and protection etc., with a total impact factor of 124.16 and the division also published 3 book chapters and edited two books.

Apart from this, of the faculty of the division, Dr. Puja Khare, principal scientist has admitted for three national fellowship namely, Fellow of the National Academy of Agricultural Sciences (FNAAS), Fellow of the International Society of Environmental Botanists (FISEB) and Fellow of The Royal Society of Chemistry(FRSC). Further, same faculty has received two awards such as NESA Women excellence award and Green Industry Award 2023 by National Environmental science academy, New Delhi.

Dr. Saudan Singh डॉ. सौदान सिंह

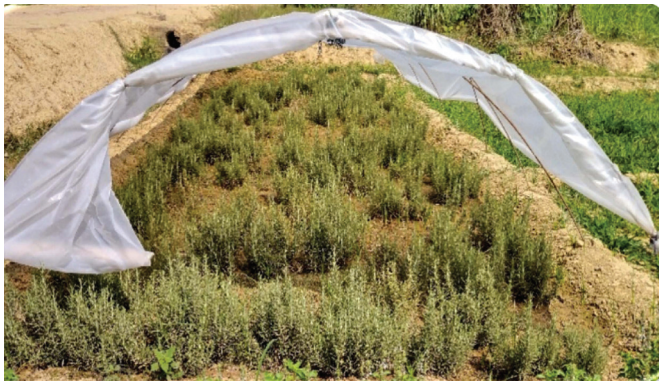


Developing a novel method for saving rosemary (*Rosmarinus officinalis* L.) mother plants during rainy season by providing polythene shed under northern Indian plains

Rosemary (*Rosmarinus officinalis* L.) is an emerging aromatic perennial crop of India, possess multifaceted potential use for various health treatments, food/feed, cosmetic and pharmaceutical industries. Generally it grows well during winter season in northern Indian plains but plants faces high mortality during rainy season under open condition. Experiment conducted at CSIR-CIMAP, research farm Lucknow for three years, revealed that rosemary can be saved under polythene tunnel prepared during rainy season.



Mortality under open condition during rainy season



Saved plants in polythene tunnel



Field view of crop in winter season



Dr. Saudan Singh & his team

Dr. Rajesh Kumar Verma डॉ. राजेश कुमार वर्मा



On-farm energy input-output and economic analysis of important essential oil-bearing *Mints* species in subtropical India

Botanical herbs are famous for their medicinal and aromatic properties since ancient times. Studies on energy assessment of these essential oil-bearing botanical herbs are very rare. This study quantifies the energy requirements and energy input-output relationship of herbs and essential oil production of different mints species (*M. arvensis, M. piperita, M. spicata, M. cardiaca and M. citrata*) in subtropical India. Results showed that mints essential oil production used more energy than herbs and *M. citrata* utilizes highest energy in both the cases. Firewood (renewable bio-fuel) (59.16%) accounts for more than half of the energy input and plays significant role to produce mints essential oil. Mints herbs and essential oils



yield was recorded higher in *M. citrata* (23.14 t ha^{-1}) and *M. arvensis* (143.2 kg ha^{-1}); respectively. Energy yields were estimated highest in *M. cardiaca* (herbs) and *M. arvensis* (essential oils) by using automated advanced oxygen bomb calorimeter. Overall, *M. arvensis* showed best results in energy productivity (0.07 kg MJ^{-1}), profitability (0.27), net return (17156.40 MJ ha^{-1}) and energy use efficiency (1.27) for mints herbs production; however, for essential oil production *M. cardiaca* was performed well. Present study revealed that mints herbs production was more energy efficient than essential oils although essential oil production is fiscally secure; however, *M. piperita* recorded economically profitable with least environmental impact.



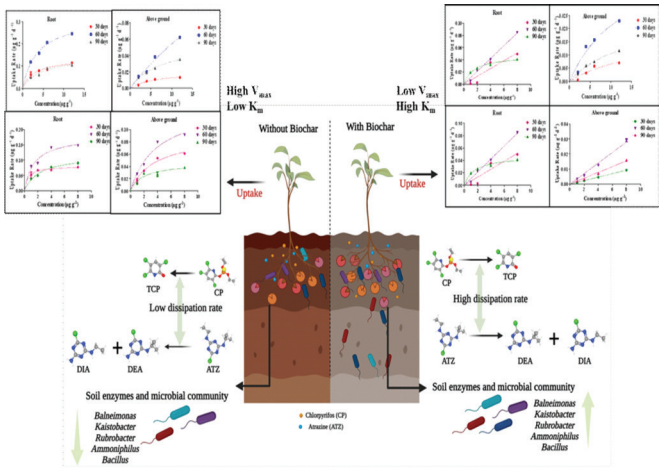
Dr. Rajesh Kumar Verma & his team

Dr. Puja Khare डॉ. पूजा खरे

Effect of biochar on soil microbial community, dissipation and uptake of chlorpyrifos and atrazine



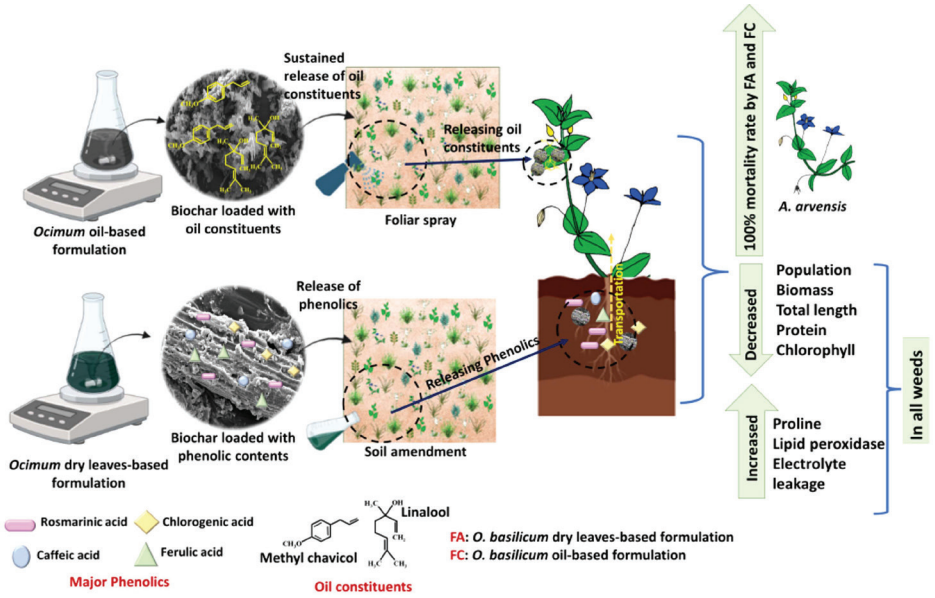
For the application of biochar in restoring pesticide-contaminated soils and minimizing the risk associated with their uptake in plants, it is crucial to understand the biochar impact on soil biological activities and dissipation and accumulation of pesticides in plant and soil systems. In this study, the effect of *Mentha*-distilled waste-derived biochar was investigated on chlorpyrifos and atrazine contaminated sandy loam soil. The four application rates of atrazine (2, 4, 6, and 8 mg kg^{-1}) and chlorpyrifos (2, 4, 6, and 12 mg kg^{-1}) and a single application rate of biochar (4%) were used in this study. The degradation of pesticides, the diversity of the bacterial community, and enzymatic activities (Alkaline phosphatase, dehydrogenase, arylsulfatase, phenol oxidase, urease activity and N-acetyl glucosaminidase) were examined in soil, while the uptake of two pesticides growth, and stress parameters were investigated in plants (*A. paniculata*). The dissipation of chlorpyrifos and atrazine followed simple first-order kinetics with a half-life of 6.6-74.6 and 21-145 days, respectively. The presence of deisopropyl atrazine desethyl atrazine (metabolites of atrazine) and 3,5,6-trichloro-2-pyridinol (a metabolite of chlorpyrifos) was observed in soil and plant



tissues. Biochar application significantly (p=0.001) enhanced the degradation rate of chlorpyrifos and atrazine leading to the lower half-life of chlorpyrifos and atrazine in soil. A significant reduction (p=0.001) in the uptake of chlorpyrifos and atrazine and alteration in their binding affinity and uptake rate in plant tissues was observed in biochar treatments. The incorporation of biochar improved chlorpyrifos/ atrazine degrader and plant growth-promoting bacterial genera such as *Balneimonas*, *Kaistobacter*, *Rubrobacter*, *Ammoniphilus*, and *Bacillus*. The upregulation of functional genes associated with nucleotide, energy, carbohydrate, amino acid metabolism, xenobiotic biodegradation, and metabolism: atrazine degradation was observed in biochar treatments. The biochar amendments significantly (p=0.001) reduced the plant's uptake velocity (Vmax) and affinity (Km) of chlorpyrifos and atrazine. These results delineated that Mentha-distilled waste-derived biochar can potentially remediate chlorpyrifos and atrazine contaminated soils and ensure the safety of plants for consumption.

An insight into herbicidal properties of *Ocimum* leaf and oil-loaded biochar formulations

The replacement of synthetic herbicides with natural herbicides is a good option for sustainable agriculture. The use of suitable and sustainable carriers for these natural further enhanced their life span and effectiveness. The *Ocimum* dry leaf powder and oil-loaded biochar formulations was examined for the sustained release of phenolics and oil constituents and herbicidal activities. Formulations showed more toxicity on *A. arvensis* and less inhibitory effect on *D. sanguinlis* as compared with other weeds.





Dr. Puja Khare & her team

Dr. R K Upadhyay डॉ. आर के उपाध्याय

A new agro-technology for the quality production of Menthol-mint shoots and suckers



On the basis of trial on study to standardize and develop best as well as affordable menthol-mint sprout production technology for quality production of menthol-mint sprouts and suckers in sustainable manner, cutting (10-15 cm length) taken from top aerial plants of menthol-mint at the time of harvest of main crops in the month of May-June and used for further used for planting material production for menthol-mint suckers



वृहत्त स्तर पर मेंथा शूट उत्पादन



मेंथा शूट उत्पादन की पुरानी एवं नवीन तकनीकी का तुलनात्मक विवरण

विवरण	मेंथा शूट उत्पादन की पुरानी तकनीकी	मेंथा शूट उत्पादन की नवीन तकनीकी
लगाने का समय तथा पौध सामग्री	मेन्था की मुख्य फसल की कटाई के बाद वांक्षित क्षेत्रफल का प्रबन्धन करना (रैतून या पेड़ी के द्वारा)।	मई–जून के माह में मुख्य फसल से कटिंग बनाकर लगाना।
समयावधि	45–60 दिन	30–35 दिन
लागत	रू0 75000–80000/– प्रति है0 निराई अधिक करनी पड़ती है।	रू0 50000–60000/– प्रति है0
मेन्था शूट का उत्पादन	20–25 कु0/है0	30–40 कु0/है0
लाभ	अधिक समय लगता है, 25–30 प्रतिशत लागत अधिक आती है तथा 25–30 प्रतिशत उत्पादन कम होता है।	नवीन तकनीकी में समय कम लगता है, 25–30 प्रतिशत लागत कम आती है तथा उत्पादन 25–30 प्रतिशत बढ़ जाता है। इस विधि में दोहरा लाभ होता है।

मेंथा शूट की तैयार पौध



किसानों को मेंथा शूट वितरण



Treatment	Days taken to attain 20-25 cm height	Nos. of branches per sprout	Nos. of sprouts per meter square	Nos. of sprouts per hectare	Weight of 100 shoots (g)	Yield of sprout (quintal/ hectare)
T_1	42	4	48	480000	490.50	23.54
T_2	47	5	50	500000	492.60	24.63
T_3	45	3	55	550000	483.40	26.59
T_4	33	3	65	650000	495.80	32.22
T_5	55	5	40	400000	550.00	22.00
SEm	1.29	0.01	1.39	NA*	6.85	0.79
$CD_{(0.05)}$	3.85	0.03	4.18	NA*	20.59	2.34

Treatment 1: Menthol-mint whole aerial plant chopped 2-4 cm in length sown in tinny furrow row to row spacing 15 cm., Treatment 2: Menthol-mint 1/3rd aerial plant chopped 2-4 cm in length sown in tinny furrow row to row spacing 15 cm., Treatment 3: Menthol-mint 2/3rd aerial plant chopped 2-4 cm in length sown in tinny furrow row to row spacing 15 cm., Treatment 4: Cutting from top aerial plant part of menthol-mint 10-15 cm in length and transplanted at 15*10 cm (row to row and plant to plant), Treatment 5: Menthol-mint sprouts after harvesting of main crops





मेंथा की कटाई के लिए तैयार फसल से कटिंग तैयार करना

production provided maximum quality menthol-mint shoot/sprout yield (32.22 q/ha) and menthol-mint suckers yield (204.42 q/ha) as compared to other treatments..

Therefore recommended to use top aerial plants cutting (10-15 cm length) from main menthol-mint crop at the time of harvest of main crops for qualitative and quantitative production of menthol-mint shoot/sprouts and suckers both in sustainable manner.

Development of sustainable cluster for menthol-mint cultivation in kharif season

The sustainable cluster developed and in progress for the for menthol-mint cultivation in kharif season in Bundelkhand region (Vilage- Mankari, Tahsil- Maharajpur, Dist. Chhatarpur M.P.) and its compared with existing cultivation practices. Total Nos. of farmers: 25



QPM distribution to beneficiary farmers



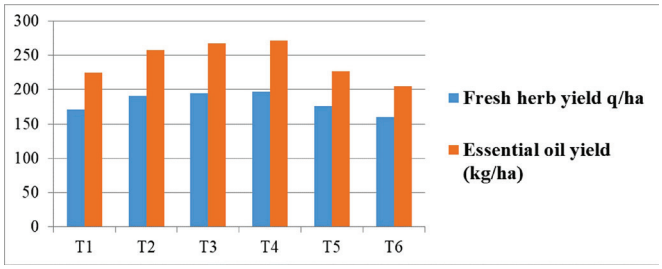
Performance of Kharif Season Mint Technology in Bundelkhand region

Area covered & essential oil productivity: 12.5 acre, Average essential oil production: 140-150 kg/ha through intervention of kharif season mint technology of CSIR-CIMAP i.e. approximately 30-40% higher as compared to existing practices (essential oil 100-110 kg/ha) in Chhatarpur.

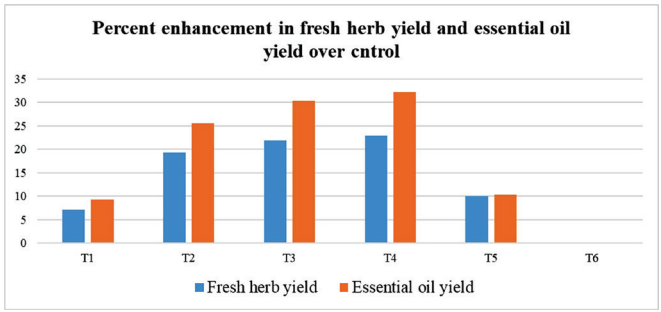
The kharif season mint technology of CSIR-CIMAP performance compared with existing practices in Chhatarpur. The results and outcomes are showed that average essential oil production 140-150 kg/ha recorded through intervention of kharif season mint technology of CSIR-CIMAP i.e. approximately 30-40% higher as compared to existing practices (essential oil 100-110 kg/ha) in Chhatarpur. In overall the kharif season mint technology of CSIR-CIMAP showed excellent performance in Bundelkhand region.

Evaluation of Stigmasterol & Campesterol 0.01% w/w SL (Brand Name: Brand) on Growth & Yield of Menthol-mint (*Mentha arvensis* L.)

Stigmasterol & Campesterol 0.01% w/w SL (Brand Name: Brand) is a biostimulant developed by WILLOWOOD CHEMICALS LTD & recommended for application in CEREALS (Paddy, Wheat), PLANTATION (Cotton, Soybean, Tea), OILS (Soybean, Mustard, Green gram, Black gram, Red gram, Groundnut) FRUITS (Apple, Watermelon,



Effect of different treatments on fresh herb yield & essential oil yield of Menthol-mint.



Effect of different treatments on percent enhancement in herb yield & essential oil yield of Menthol-mint over control (T6).

Papaya, Orange, Mango, Pomegranate, Grapes, Banana) VEGETABLES (Potato, Tomato, Peas, Guar, Brinjal, Okra, Cauliflower, Cabbage, Cucumber) SPICES (Onion, Chili, Cumin, Turmeric, Ginger, Cardamom) FLOWERS (Marigold, Tuberose, Rose). Now, WILLOWOOD CHEMICALS LTD interested to test the effect of Stigmasterol & Campesterol 0.01% w/w SL (Brand Name: Brand) on yield attributing characters, essential oil yield, and essential oil quality of *Mentha arvensis* L.



Mentha Crop Field View

On the basis of trial on study the two foliar spray of Stigmasterol & Campesterol 0.01% w/w SL (Brand Name: Brand) @1.00 ml/lt of Water at 35 & 55 DAT on on Growth & Yield of Menthol-mint (*Mentha arvensis* L. concluded that application of two foliar spray of Stigmasterol & Campesterol 0.01% w/w SL (Brand Name: Brand) @ 1.00 ml/lt of Water (estimated quantity: 500 ml/ha or 200 ml/acre) at 35 & 55 DAT in menthe crop along with standard recommended fertilizer dose (N:P_2O_5:K_2O:S @ 120:60:40:20 Kg/ha) provided statistically highest essential oil yield 257.71 kg per ha as well as no phytotoxic effect on mentha crop as compared to control. Therefore, recommended that application of Stigmasterol & Campesterol 0.01% w/w SL (Brand Name: Brand @ @ 1.00 ml/lt watwer) 500 ml/ha (dissolve in 500 litre water) or 250 ml/acre (dissolve in 200 litre water) for commercial scale cultivation of menthol-mint to achieve higher essential oil yield.

Dr. Kishore B. Bandamaravuri
डॉ. किशोर बी. बंदामारावुरि

Disease estimation of Black leaf spot and Fusarium wilt disease in *W. somnifera*



In the month of May and June 2023, severe infection *Fusarium* wilt was observed in *W. somnifera* plants



Fungal disease on *W. somnifera* : a) Healthy plant b) Black leaf spot infection c) Root rot infection and d) Leaf blight infection.

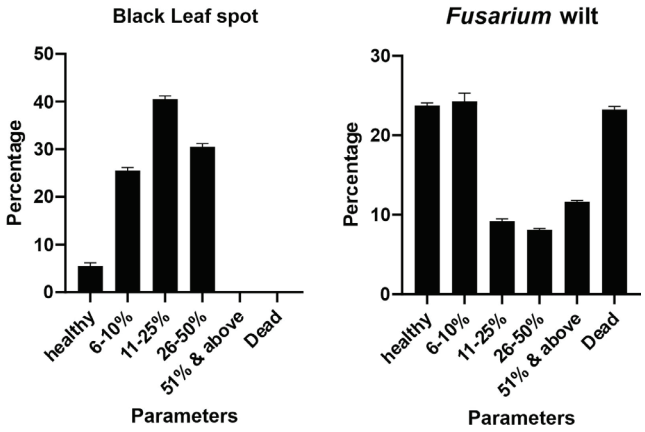


Fig.: In black leaf spot disease in *W. somnifera* infection was found to be 70% and severity above 50% while mortality was not observed. Inroot rot disease infection was found to be a bit above 50% and mortality to be approx. 20% was recorded.

in the experimental farm field of CSIR-CIMAP. The disease incidence was recorded as 55%. In the months of August and September severe infection of black leaf spot disease was observed and DI was estimated as 70%. The disease incidences were observed in CSIR-CIMAP experimental field and disease severity were recordedon the scale of 0-5.

Structure elucidation of the major active compounds in the Shrimycocin-A (AFS)

The major bioactive compounds such as 2,6 Dimethoxy Phenol n 1,2 Dihydroxy benzene in the Shri-A were separated through the preparative TLC, and pure compounds were obtained.The pure compounds along with their commercial standards were subjected to structure elucidation through NMR. The NMR spectra were obtained for both ^{1}H and ^{13}C.

The NMR spectra resulted in matching the similar multiplicity of the two compounds 2,6 Dimethoxy phenol and 1,2 Dihydroxy benzene with the standard compounds through the J- coupling construct. For 2,6 Dimethoxy phenol ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.592 (^{1}H, H-3), 6.575 (^{1}H, H-5), 6.816, 6.798, 6.782 (^{1}H, H-4), 3.889 (^{1}H, H-7), 3.889 (^{1}H, H-8), 5.295 (^{1}H, H-9). ^{13}C NMR (500 MHz, $CDCl_3$), δ 105.01 (C-3), 105.01 (C-5), 119.07 (C-4), 147.30 (C-2), 147.30 (C-6), 134.96 (C-1), 56.30 (C-7), 56.30 (C-8).

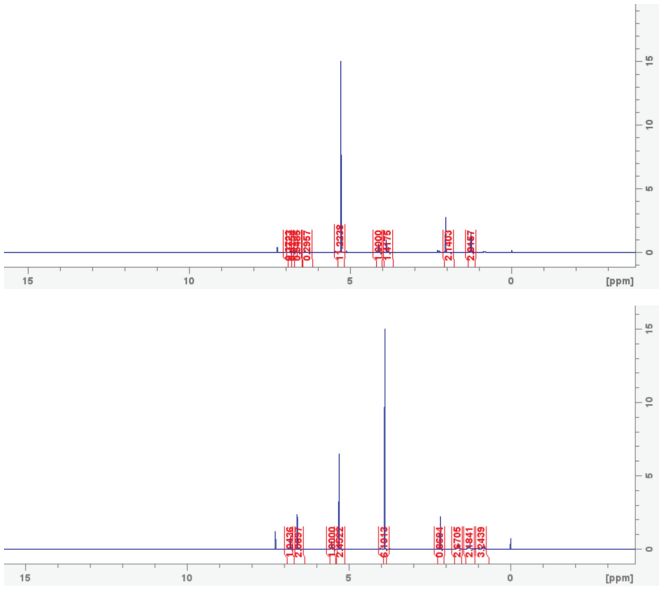


Fig.: NMR spectra and structural elucidation of major active compounds of Shri-A: indicating **a.** 1,2-Dihydroxy benzene (Catechol), and **b.** 2,6- Dimethoxy phenol.

For 1,2 Dihydroxy benzene ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.296 (^{1}H, H-7), 5.296 (^{1}H, H-8), 6.854 (^{1}H, H-3), 6.862 (^{1}H, H-6), 6.869 (^{1}H, H-4), 6.869 (^{1}H, H-5). ^{13}C NMR (500 MHz, $CDCl_3$) δ 121.20 (C-4), 121.20 (C-5), 115.502 (C-3), 115.502 (C-6), 143.598 (C-1), 143.598 (C-2) (Fig). The standard drug spectra of the two compounds were similar in their chemical shift value (δ) and their concentration in ppm with the compounds found in the fraction as 2,6 Dimethoxy phenol and 1,2 Dihydroxy benzene respectively. The NMR results defined the spatial placement of all the ^{1}H and ^{13}C accurately matched the standard molecules/drugs.

Sensitivity of the plant pathogenic fungi against different antifungal; agrochemicals

The susceptibility of phytopathogenic fungi including soil-borne and foliar plant pathogens fungal strains were studied against 10 different commercially used antifungal agrochemicals was investigated. These pathogens were *C. lunata* (CLSK-01), *M. phaseolina* (MPK-02), *F.* solani (WsRrK), *F.* oxysporum (FOK-01), *C. falactum* (AoBRK-01). Outof 5 phyto-pathogens, 4 pathogens such as CLSK, FOK, WsRrK, and MPK were found to be susceptible only to Propiconazole (0.05%)

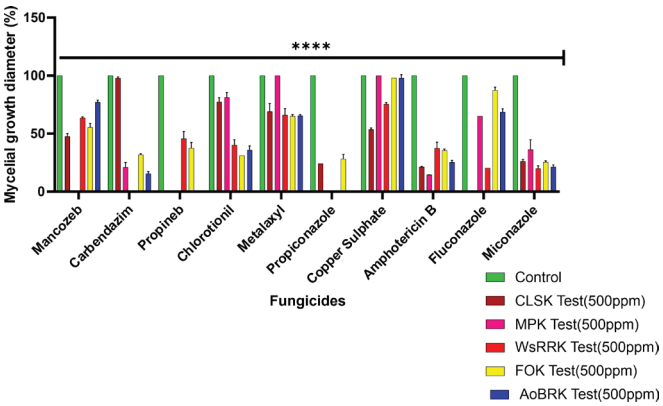


Fig: Graph depicting mycelial growth percentage of each pathogen treated with each fungicide in comparison with control or untreated fungal pathogen.

and Propineb (0.05%) while they showed resistance to 8 commercial fungicides such as Amphotericin B, Chlorothalonil, Carbendazim, Copper sulphate, Fluconazole, Mancozeb, Metalaxyl, and Miconazole. In azole-based fungicides, only the Propiconazole (0.5mg/ml) showed potential fungicidal activity against 3 phytopathogens except *Curvularialunata* and *Fusarium oxysporum.*

Identification of pathogens associated with lethal yellowing in Lemongrass

The disease occurred most frequently between July and October. Roots of infected plants showed marked discoloration, and the cortical region was completely disintegrated and sloughed from the vascular tissue. Diseased plants were chlorotic and stunted. Rotting was often found to spread from roots to stem, leading to severe chlorosis and death of the infected plants. Two pathogens were isolated from the diseased samples on the basis of their morphological differentiations.

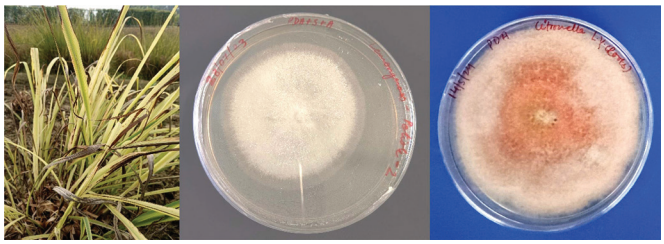


Fig.: a. infected lemongrass plant, b-c. Fungal pathogens isolated from diseased plant.



Dr. Kishore Babu Bandamaravuri & his team

Dr. S.G. Eswara Reddy डॉ. एस.जी. ईश्वर रेड्डी



Insecticidal activities of essential oils against pests

Essential oil (EO) of *Ocimum gratissimum* was found more effective against aphid, *Aphis craccivora* (LD_{50}= 0.50 µg/insect) after 96 h of treatment and was followed by *Pelargonium graveolens* and *Mentha arvensis* (LD_{50}=1.0-1.2 µg/insect). Similarly, EO of *O. gratissimum* was also found effective against *Planococcus lilacinus* (LD_{50}=1.2 µg/insect) after 96 h of treatment and was followed by *Pelargonium graveolens* and *Mentha arvensis.*

Bioactive molecules of *Triadica sebifera* as ecofriendly antifeedants against *Plutella xylostella*: a pest management approach

In this study, *in-silico* and experimental analysis was used to screen out behaviorally active molecules against third instar larvae of *Plutella xylostella*. The selected molecules were subjected to docking, MD, and SMD simulations to analyze the binding affinity, stability, and conformational changes in the OBP1 and OR1 proteins. On the basis of *in-silico* analysis, ethyl gallate and methyl gallate are selected to further check their feeding deterrence and growth inhibition against third instar larvae of *P. xylostella*. Methyl gallate showed promising feeding deterrence (DC_{50}=648.92 mg/L) against third instar larvae of *P. xylostella* after 48 h of treatment and was followed

by ethyl gallate (DC_{50}=865.88 mg/L) as compared to azadirachtin 0.15% EC (DC_{50}=949.17 mg/L). Based on inhibition concentration (IC_{50}) to inhibit 50% growth of the test population, methyl gallate reported significantly higher inhibition (IC_{50}=991.29 mg/L) and was followed by ethyl gallate (IC_{50}=1103.72 mg/L).

Cyperus rotundus L.: Invasive weed plant with insecticidal potential against *Aphis craccivora* Koch and *Planococcus lilacinus* (Cockerell)

Cyperus rotundus is a widely distributed invasive weed plant with vast traditional medicinal uses. The methanolic root extract of *C. rotundus* and its fractions were evaluated for insecticidal activity against nymphs of *Aphis craccivora* and crawlers of *P. lilacinus* for identification of lead (s). The EO extracted using water and deep eutectic solvents (DESs) as cosolvent, which revealed enhancement in EO yield (from 0.28 to 0.46% w/w) on implementing DESs. Among volatile metabolites identified in all EO samples, cyperotundone, cyperene mustakone, isolongifolen-5-one and boronia butenal are major constituents. In contact topical assay, among extract/fractions, *n*-hexane fraction exhibited more toxicity against *A. craccivora* (LD_{50}=1.12 µg/insect) and *P. lilacinus* (LD_{50}=0.94 µg/insect). The EO obtained with DES-7 [choline chloride: ethylene glycol (1:4)] and DES-6 [choline chloride: lactic acid (1:3)] were found effective against *A. craccivora* (LD_{50}=0.62-0.87 µg/insect) and *P. lilacinus* (LD_{50}=0.59-0.67 µg/insect). All the molecules were found effective against *P. lilacinus,* whereas against *A. craccivora,* cyperotundone, cyperene and cyperene epoxide were promising (LD_{50}=0.74-0.86 µg/insect). All the concentrations (625-5000 mg/L) of cyperotundone showed significant inhibition of acetylcholinesterase (AChE) and glutathione-S-transferase (GST) in target pests **(Figure 1).**

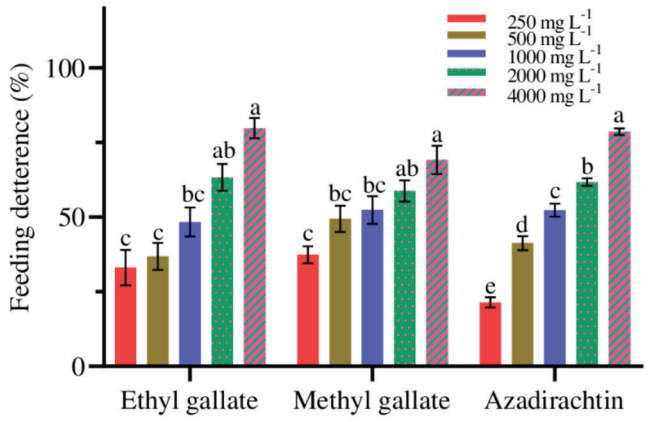


Fig. Feeding deterrence of compounds against *P. xylostella*; Means followed by the same letter within a bar diagram are not statistically different by Tukey's HSD ($p \geq 0.05$)

Natural deep eutectic solvents (NADESs) assisted extraction of essential oil from *Nardostachys jatamansi* (D. Don) DC with insecticidal activities

Natural deep eutectic solvents (NADESs) combinations were employed as a cosolvent in the conventional hydro-distillation for extraction of EO from the roots of *Nardostachys jatamansi*. The highest yield (1.7 % v/w) of EO was observed with NADES-5 (choline chloride: maleic acid; 2:1) as compared to the conventional method (0.9 % v/w,). GC and GC-MS analysis of all extracted EOs led to the identification of 34 compounds. Principal component analysis (PCA) and clustered heatmaps were used for multivariate analysis showing discrimination of the constituents in EOs. Valeranone (31.22-12.60 %) and nerolidol (13.48-1.82 %) were observed in all samples, whereas some molecules like bisabolol, *a*-cadinol, and nootkatone were specific to certain samples, showing variability in chemical composition. EOs were further examined for their insecticidal and enzyme inhibitory activity against *A. craccivora* and *P. lilacinus.* EOs obtained with water, NADES-4 (choline chloride: lactic acid; 1:2), NADES-1 (choline chloride: oxalic acid; 1:1), 3 (choline chloride: lactic acid; 1:1), and 6 (glycerol: lactic acid; 1:1) (0.80–0.98 µL/insect) showed promising toxicity (LD_{50}=0.80-0.98 µL/insect) against *A. craccivora*. Similarly, EOs obtained with water, NADES-3, and 4 (LD_{50}= 0.90-1.19 µL/insect) also showed toxicity (LD_{50}=0.90-1.19 µL/insect) against *P. lilacinus,* which may be due to high concentration of metabolites such as valeranone, *β*-patchoulene,

nerolidol, *a*-cadinol and viridiflorol. Further, LD_{50} concentrations of EO from water showed significant inhibition of GST (8.52±3.91 and 11.83±5.68 nmol/min/ml) and AchE (0.67±0.04 and 0.75±0.09 mU/mg) after 24 h in *A. craccivora* and *P. lilacinus*, respectively **(Figure 2).**

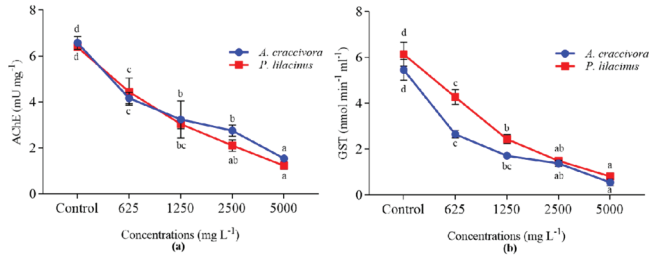


Fig. Enzyme inhibition activity of cyperotundone. AChE in *A. craccivora* and *P. lilacinus* (**a**) and GST in *A. craccivora* and *P. lilacinus* (**b**). Mean (±SE) of three replications. Figures in the same letters do not differ significantly by Tukey's HSD ($p \geq 0.05$).



Dr. S.G. Eswara Reddy and team

Dr. Jnanesha A C डॉ. ज्ञानेश ए सी



Unveiling the effect of foliar applied siliceous compounds on reducing seed shattering for the conservation of endangered kalmegh (Andrographis paniculata (Burm. f.) wall. ex Nees)

This investigation was conducted to formulate a cost-efficient and dependable technique for the extensive regeneration of the Kalmegh plant, focusing on the challenge of seed shattering during the harvesting process. Across a biennial timeframe spanning from 2022 to 2023, diverse siliceous substances were administered through foliar application to address seed-shattering issues and enhance growth parameters. The study was carried out utilizing a Randomized Complete Block Design involving seven treatments and three replications. Results revealed that the foliar application of potassium silicate at a concentration of 200 mg/L notably boosted plant height (42.86cm), plant spread (19.68 cm^2), root length (14.87 cm), and leaf dimensions (4.51 cm) compared to alternative treatments. Furthermore, the application of potassium silicate at 200 mg/L substantially decreased the number of shattered pods (262), while elevating the count of intact pods (91.23), overall pod tally (524.3), and seeds per plant (4718). Increased silicon levels were detected in capsules, suggesting a heightened silicon deposition in plant tissues after the utilization of siliceous substances. Principal component analysis and correlation assessments were utilized to evaluate the impacts of treatments and the interrelations among variables. The study highlights the effectiveness of applying siliceous compounds via foliar approaches to augment Kalmegh seed productivity and growth attributes in an environmentally sustainable manner, thereby aiding in meeting the escalating demand for this significant medicinal plant.

The results of this study emphasize the effectiveness of applying siliceous compounds to plant foliage, particularly potassium silicate, in reducing seed shattering and improving the growth parameters of kalmegh. Through rigorous experimentation and analysis, it was illustrated that this approach not only minimizes seed loss but also enhances plant health and productivity. The notable rise in relative water content and silicon content in capsules further emphasizes the beneficial influence of siliceous compound application on plant physiology and biochemistry. These findings offer practical implications for agricultural practices focused on sustainable medicinal plant production, underscoring the significance of innovative strategies for

Table: Impact of Si compounds on Growth, Seed yield Parameters of Kalmegh (A. Paniculata)

Treatments	Plant height (cm)	Plant spread (cm)	Root length (cm)	No. of shattered pods	No. of Shattered seeds	No. of unshattered pods	Leaf size (cm)	Total no. of pods	Total No. of seeds per plant
T1	38.47	17.76	14.5	264.1	2376.9	86.32	4.36	406.57	3650.92
T2	37.38	14.83	12.27	268.67	2418.03	75.26	4.23	398.24	3393.23
T3	34.24	13.17	10.93	393.65	3542.85	35.61	3.64	305.67	2751.34
T4	42.86	19.68	14.87	262.05	2358.45	91.23	4.51	524.33	4718.37
T5	37.38	13.98	11.83	302.28	2720.52	56.37	3.83	341.67	3081.56
T6	36.67	13.59	11.36	308.38	2775.42	37.86	3.67	319.67	2880.74
T7	30.53	12.56	10.57	433.33	3899.97	34.56	3.52	297.86	2673.76
Mean	36.79	15.08	12.33	318.92	2870.31	59.60	3.97	370.57	3307.13
SEm	2.09	0.64	0.70	9.50	85.47	2.61	0.16	12.43	154.16
CD	6.44	1.97	2.15	29.26	263.35	8.06	0.50	38.30	475.03
CV	9.83	7.33	9.80	5.16	5.16	7.60	7.11	5.81	8.07

T1-Copper Silicate (400 mg/0.4g/L); T2-Nano Silica (200 mg/ 0.2 g/L); T3-Calcium Silicate (800mg/0.8g/L); T4-Potassium Silicate (400 mg/0.4g/L); T5-Sodium Silicate (400 mg/0.4g/L); T6-Magnesium Silicate (400 mg/0.4g/L); T7-Control (Water Spraying)

conservation and cultivation. Overall, this research contributes to the existing knowledge on *A. paniculata* cultivation and conservation, laying the groundwork for future exploration and advancement in the realm of phytopharmaceuticals and herbal medicine.



Fig.: Masking Kalmegh plants with breathable polythene sacks

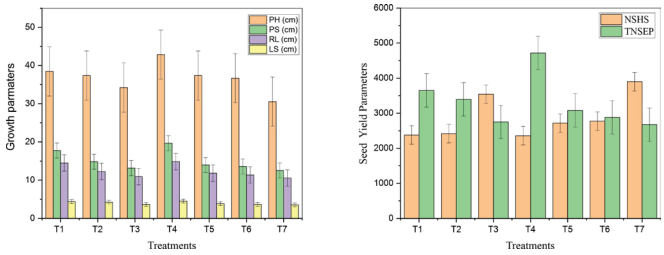


Fig 2: Growth Parameters vs Treatments Fig 2: Seed Yield Parameters Vs Treatments



Dr. Jnanesha AC & his team

Dr. Yogendra ND डॉ. योगेन्द्र एनडी

Shade-induced phenotypic plasticity and its impact on the economic traits of Patchouli, *Pogostemon cablin* (Blanco) Benth., a high-value aromatic crop



Patchouli is a moderately shade-loving aromatic crop plant. The growth, development, essential oil yield, and chemical compositions are highly influenced by the quality and intensity of sunlight. The experiment was carried out at the CSIR-CIMAP Research Centre, Bengaluru, with three different light intensity treatments, *viz.*, open condition (full sunlight), 30% shade, and 50% shade conditions. The main objective of the study is to explore shade-induced phenotypic plasticity with respect to economic traits in patchouli. The result revealed significant differences in growth, development, essential oil yield, and chemical composition between the full-sunlight and partially shade-grown plants. Plant height (113.83 cm), internodal length (8.81 cm), leaf area (59.17 cm^2), petiole length (3.78 cm) and, width (3.44 mm) increased significantly in plants grown in 50% shade compared to plants grown in open conditions. When comparing 50% shade-grown plants to open-condition grown plants, significant reductions in the number of branches/plant (14.26), fresh weight (152.95 g), dry weight (29.64 g), leaf thickness (117.57 µm), cuticle thickness (3.7 µm), palisade parenchyma thickness (26.28 µm), number of trichomes (13.14 no./mm^2), number of oil glands (10.14 no./mm^2), and oil content (0.98%). Interestingly, major anatomical modifications such as bundle sheath extensions (BSEs) were detected in both 30% and 50% of shade-grown plants, but they are absent in the open condition-grown plants. In addition, the increase in petiole width was directly correlated with the size of the BSEs in the petiole. However, there were no significant differences between plants grown under 30% shades and those grown under the open conditions with respect to oil yield and oil recovery. Consistently, the expression level of the patchouli plant's phenotypic plasticity was high in the 50% shade-grown plants. Concomitantly, phenotypic plasticity has shown a negative impact on essential oil yield and a positive effect on the ability to thrive under limited light-intensity conditions.

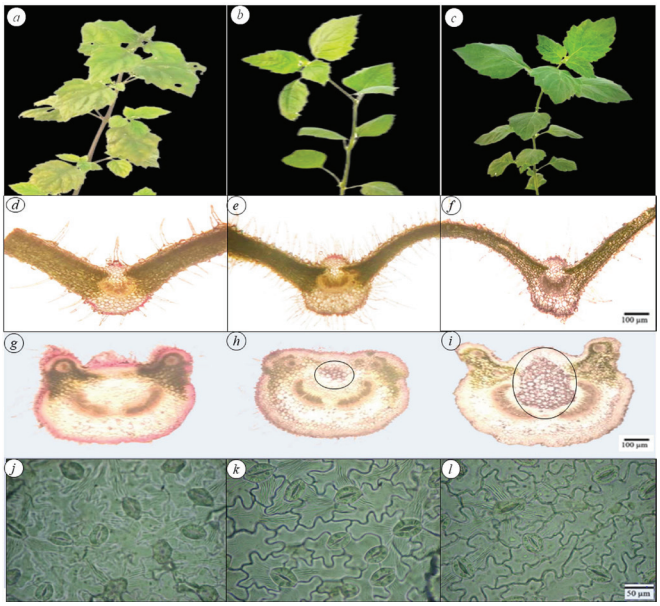


Fig.: Plant morphology: (A) full-sunlight grown plant,(B) 30% shade grown plant and (C) 50% shade grown plant; Cross section of the leaf blade: (D) full-sunlight, (E) 30% shade, and (F) 50% shade grown plant; Cross section of the petiole: (G) full-sunlight, (H) 30% shade, and (I) 50% shade grown plant; Leaf stomatal density: (J) full-sunlight, (K) 30% shade, and (L) 50% shade grown plant. (* Circle marks show the bundle sheath extensions region in the cross section of petiole).

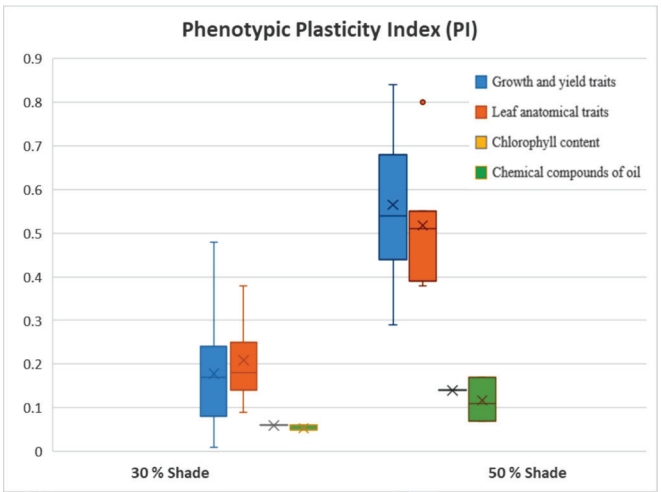


Fig.: Box plots showing the phenotypic plasticity index (PI) distribution for each of the measured traits between 30% shade and 50 % shade-grown patchouli plants.

Dr. Rakesh Kumar डॉ. राकेश कुमार

Yield assessment of Menthrol Mint as an overlap crop with wheat to increase productivity and resource use efficiency







In an overlapping system, the succeeding crop is sown in the standing crop before the harvesting; thus, in this system, one crop is sown before the harvesting of the preceding crop on a single piece of land. In the current agricultural scenario, there is a need to feed as well as better monetary return from sustainable agricultural methods along with better land utilization. *Mentha arvensis* L. and *Triticum aestivum* L. are both the major food and essential oil-yielding crops of sub-tropical climates. Present experiments were planned to overlap the menthol mint in wheat for better land use and maximum economic benefits. Experiments were conducted for two consecutive years (2021-22 & 2022-23) in which two types of planting material (direct sucker sowing and transplanting of seedlings) were planted by two methods (flatbed and ridge bed method) in different row ratio (1:1, 2:1, 2:2 of wheat: mint). Results revealed that the maximum oil yield of mint (133.0 kg ha^{-1}) was recorded on ridges. Further, the wheat equivalent yield and land equivalent ratio was recorded maximum (9.3 and 1.49, respectively) in flatbed mint with wheat in 2: 1 ratio. However maximum benefit: cost ratio (2.3) in wheat mint overlapping system was obtained in mint on ridge bed in 2: 1 ratio (wheat: mint). Overall, employing an overlapping cropping system of wheat with a mint 2: 1 ratio is best for obtaining maximum economic returns along with the highest wheat equivalent yield and land equivalent ratio.

Table: Fresh herb yield (Mg ha^{-1}), oil content (%), and oil yield (kg ha^{-1}) as affected by planting material, planting method, and row ratio under wheat-mint overlapping cropping system.

Planting method Row ratio	Herb yield (Mg ha^{-1})			Oil content (%)			Oil yield (kg ha^{-1})		
	Flatbed	Ridge	Mean	Flatbed	Ridge	Mean	Flatbed	Ridge	Mean
1:1 (T:M)	12.8	13.1	12.95	0.65	0.72	0.69	83.2	94.3	88.7
2:1 (T:M)	15.4	16.1	15.75	0.62	0.70	0.66	95.5	111.0	104.0
2:2 (T:M)	17.1	17.8	17.45	0.67	0.75	0.71	114.5	133.0	124.0
Mean	15.1	15.6	15.38	0.65	0.65	0.68	98.0	112.7	105.6
	CD at 5%			CD at 5%			CD at 5%		
M	3.05			0.01			2.73		
S	2.69			0.01			3.20		
M×S	3.80			NS			4.52		

M =Methods of planting, S= Inter cropping ratio T=*Triticum aestivum* L., M=*Mentha arvensis* L., and Letters showing the difference ($P > 0.05$)



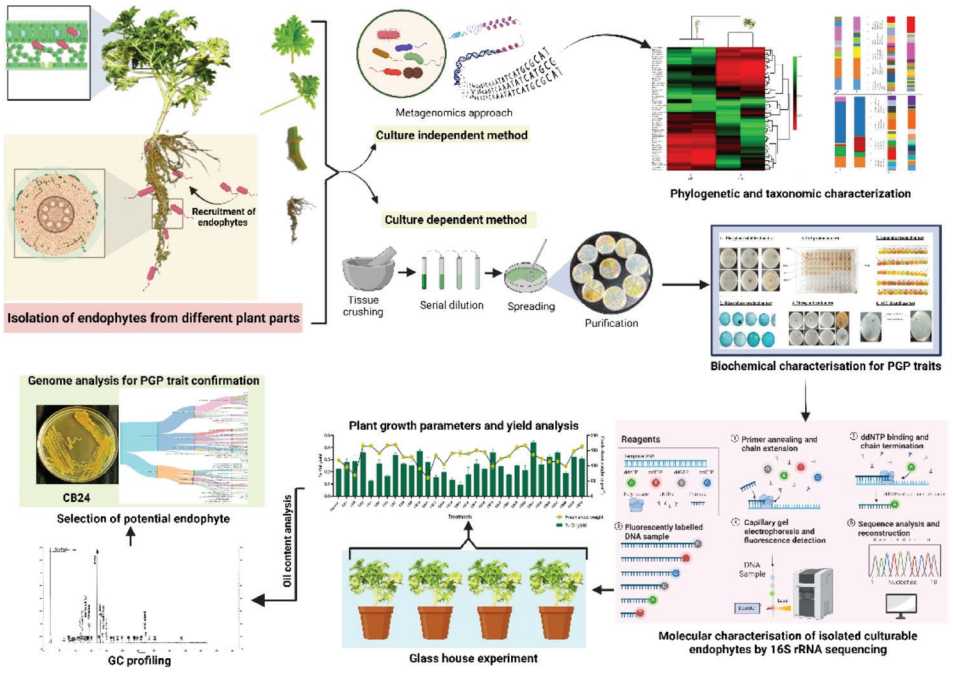
Dr. Rakesh Kumar & his team

Dr. Akanksha Singh डॉ. आकांक्षा सिंह



Unraveling the functional characteristics of endophytic bacterial diversity for plant growth promotion and enhanced secondary metabolite production in *Pelargonium graveolens*

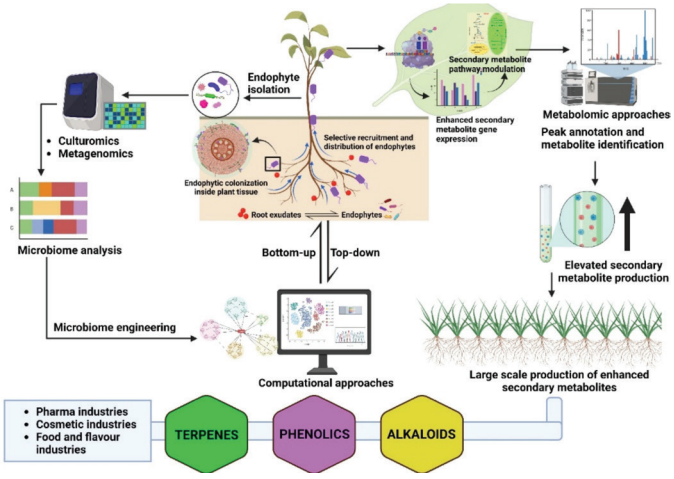
The rich diversity of microbial endophytic communities associated with plants, often referred to as the second genome, serves as a compelling illustration of efficient co-evolution. This noteworthy partnership plays a pivotal role in sustaining plant well-being and enhancing plant adaptability across diverse habitats. Therefore, examining the diversity of endophytic microbes associated with their particular host plant is valuable for gaining insights into the vast spectrum of plant-microbe interactions. The present experiments aimed at investigating the bacterial endophytic diversity in both root and shoot tissues of *Pelargonium graveolens*, employing culture dependent and culture independent high-throughput metagenomics approach. A total of 614 and 620 operational taxonomic units (OTUs), encompassing 291 and 229 genera, were identified in the shoot and root tissues of *P. graveolens*, respectively. Furthermore, the subsequent classification of OTUs revealed 15 highly abundant phyla, with Proteobacteria dominating both root and shoot tissues. Notably, an exceptionally high abundance of Firmicutes phyla was observed in the shoot compared to the root. Additionally, 30 bacterial endophytes from the root, stem, petiole, and leaves were isolated and molecularly characterized, unveiling a consistent pattern of diversity distribution between the root and shoot of *P. graveolens*. Upon screening all isolates for plant growth promoting traits, *Pseudomonas oryzihabitans* was found to be positive for major biochemical test like nitrogen fixation, phosphate solubilization etc. and on inoculation resulted in about two-fold increase in content of essential oil accompanied by a significant rise in the geraniol and citronellol content. Diving deep into the genetic constitution of *P. oryzihabitans* unveiled a substantial number of genes directly and indirectly contributing to the endophyte's capability in colonizing host plants effectively. In summary, data obtained from



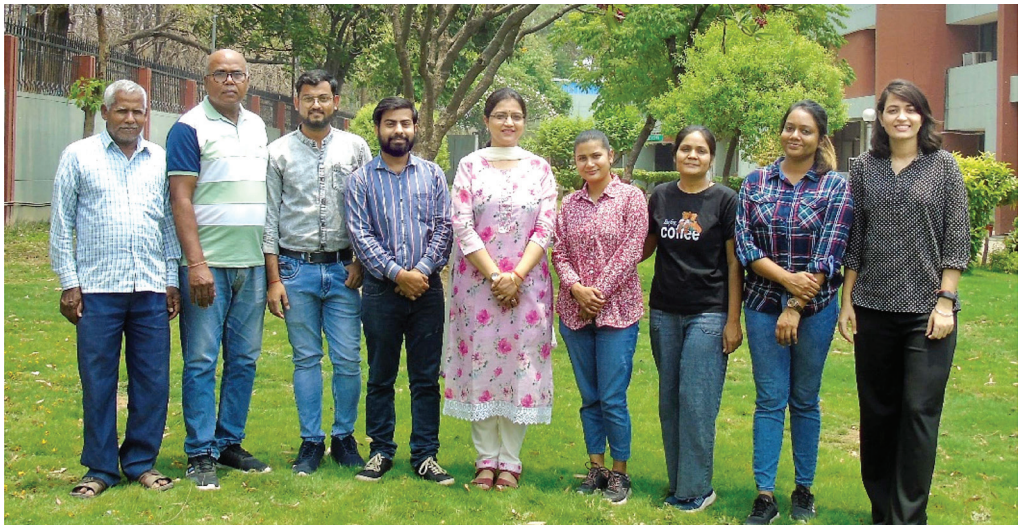
metagenomics and culture dependent approaches including glass house trials suggest potential bacterial endophytes suitable for field applications for yield enhancement and *in planta* secondary metabolite enhancement investigations.

Plants and endophytes interaction: A "secret wedlock" for sustainable biosynthesis of pharmaceutically important secondary metabolites

Many plants possess immense pharmacological properties because of the presence of various therapeutic bioactive secondary metabolites that are of great importance in many pharmaceutical industries. Therefore, to strike a balance between meeting industry demands and conserving natural habitats, medicinal plants are being cultivated on a large scale. However, to enhance the yield and simultaneously manage the various pest infestations, agrochemicals are being routinely used that have a detrimental impact on the whole ecosystem, ranging from biodiversity loss to water pollution, soil degradation, nutrient imbalance and enormous health hazards to both consumers and agricultural workers. To address the challenges, biological eco-friendly alternatives are being looked upon with high hopes where endophytes pitch in as key players due to their tight association with the host plants. The



intricate interplay between plants and endophytic microorganisms has emerged as a captivating subject of scientific investigation, with profound implications for the sustainable biosynthesis of pharmaceutically important secondary metabolites. This review delves into the hidden world of the "secret wedlock" between plants and endophytes, elucidating their multifaceted interactions that underpin the synthesis of bioactive compounds with medicinal signifcance in their plant hosts. Here, we briefy review endophytic diversity association with medicinal plants and highlight the potential role of core endomicrobiome. We also propose that successful implementation of in situ microbiome manipulation through high-end techniques can pave the way towards a more sustainable and pharmaceutically enriched future.



Dr. Akanksha Singh and her team

Dr. Dipender Kumar डॉ. दीपेन्द्र कुमार

Spacing and nitrogen application affect Indian oregano (*Origanum vulgare* L.) biomass, essential oil yield and composition



Oregano offers culinary and medicinal application for mankind. Due to its vast health benefits, its consumption has been gradually rising in the modern era. Since the nutrients and proper spacing are critical factors influencing plant growth. Therefore, current study aimed to investigate the effects of four different nitrogen levels (N_0: 0 kg/ha, N_1: 50 kg/ha, N2: 100 kg/ha, and N_3: 150 kg/ha) combined with three row spacing's (S_1 = 45 cm x 45 cm, S_2 = 45 cm x 30 cm, and S_3 = 45 cm x 15 cm) on the growth and production of oregano, with the goal of optimizing nitrogen levels and spacing for effective cultivation of a recently released Indian oregano variety i.e., CIM-Sudeeksha. The study reveals that the N_2S_2 treatment (i.e., 100 kg/h nitrogen and 45 x 30 cm spacing) produced the tallest plants, measuring 63.60±0.79 cm. On the other hand, the N_2S_3 treatment (i.e., 45x15cm spacing and

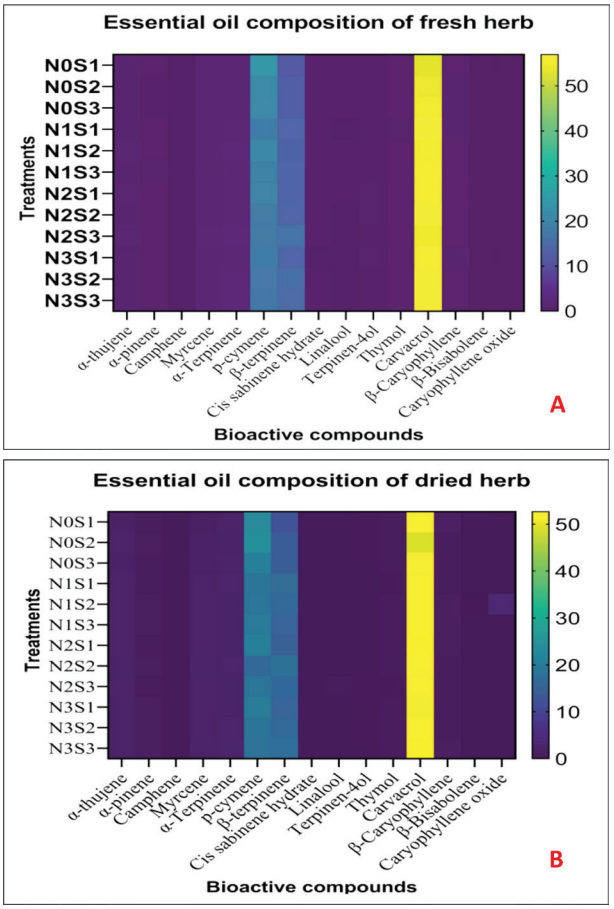


Fig.: Effect of combination of nitrogen and spacing on essential oil composition of fresh (A) and dried (B) oregano herb

Table: Effect of combination of nitrogen and spacing on agronomical traits and oil yield of Oregano

Treatments	Plant height (cm)	Fresh wt/ plant (gm)	Dry wt / plant (gm)	Fresh herb yield q/h	Dry herb yield q/h	Fresh herb oil yield Kg/h	Dry herb oil yield Kg/h
N0S1	51.53±0.96	241.97±5.35	63.00±0.88	132.84±2.93	34.59±0.48	26.57±0.58	26.52±1.29
N0S2	50.53±1.29	243.37±2.65	60.67±0.72	209.30±2.28	52.17±0.62	41.86±0.45	39.96±1.28
N0S3	42.80±0.92	125.33±2.65	31.97±0.66	215.57±4.56	54.98±1.14	39.66±4.31	36.65±1.98
N1S1	54.87±0.83	267.93±3.49	65.30±2.69	147.10±1.91	35.85±1.47	36.88±4.72	30.45±1.41
N1S2	55.93±0.64	261.57±5.02	65.27±0.97	224.95±4.32	56.13±0.83	48.86±4.62	43.07±2.37
N1S3	43.93±0.26	140.27±0.84	35.33±0.98	241.26±1.44	60.77±1.69	44.24±4.05	43.60±2.19
N2S1	61.23±0.55	335.50±4.11	88.13±2.85	184.19±2.25	48.39±1.56	42.91±2.64	39.49±1.19
N2S2	63.60±0.79	334.27±3.65	82.80±2.65	287.47±3.14	71.21±2.28	62.39±5.50	55.71±0.97
N2S3	53.47±0.31	169.90±1.18	42.47±1.51	292.23±2.03	73.04±2.61	63.37±5.27	56.14±4.14
N3S1	59.57±1.16	336.27±7.14	85.50±0.95	184.61±3.92	46.94±0.52	52.20±2.33	38.33±0.90
N3S2	60.70±0.32	331.00±5.36	83.40±0.55	284.66±4.61	71.72±0.47	61.65±4.64	54.97±2.19
N3S3	57.37±0.98	167.87±2.67	41.77±1.01	288.73±4.60	71.84±1.74	62.41±3.80	56.32±2.42

*Each value is the mean of three replicates. Mean±SE is shown in the table.

100kg/h nitrogen) resulted with the highest yields of both fresh and dry herbs, measuring 292.23±2.03 and 73.04±2.61 q/h, respectively. The results showed that the effects of nitrogen application rates of 100 kg/h and 150 kg/h on almost all agronomic traits and oil yield parameters were similar. Furthermore, the 45 x 30 cm spacing showed encouraging outcomes, increasing vegetative growth and decreasing plant competition. Given these findings, it is advised to use 45x30cm spacing and 100 kg/h nitrogen fertilization for increased Indian oregano production and economical resource utilization.

Impact assessment of drying time on essential oil content and composition in different plant parts of Patchouli (*Pogostemon cablin*) varieties

Patchouli is a perennial aromatic herb, highly valued for their aromatic oil with a distinctive base fragrance. This oil offers extensive application in industries such as perfumery, cosmetics, and medicine, making it popular worldwide. Due to the economical and simple method of shade drying, it is widespread in rural farmers. However, there is a lack of comprehensive information regarding the influence of drying time under shade condition and the key cost-effective plant part for extracting Patchouli oil. To address this, a recent investigation was conducted to assess the consequences of drying time on oil content and composition in different plant parts in two varieties of Patchouli. Results demonstrated that leaf part of Patchouli plant is more economically viable option for oil extraction, yielding 2.5-12.0 folds more oil than stem and whole plant. Results unveiled that 576 hours for var. CIM-Samarth and 384 hours for var. CIM-Utkrisht are optimal drying time for highest oil content. Additionally, a drying period of 384-480 hours maximizes patchouli alcohol concentration in the oil. Further, by persistently conducting research and putting these findings into practice, we can improve the efficiency and composition of essential oil of Patchouli to cater to diverse industry needs.

Table: Effect of drying time on % oil content in stem, leaf and whole plant of CIM Samarth and CIM Utkrisht variety of Patchouli

Drying duration	% oil content in stem		% oil content in leaf		% oil content in whole plant	
	CIM Samarth	CIM Utkrisht	CIM Samarth	CIM Utkrisht	CIM Samarth	CIM Utkrisht
24h	0.05±0.005^{aA}	0.05±0.000^{aA}	0.60±0.05^{aB}	0.30±0.02^{aA}	0.30±0.00^{aB}	0.20±0.00^{aA}
96h	0.05±0.003^{aA}	0.05±0.005^{aA}	0.80±0.00^{bB}	0.30±0.00^{aA}	0.40±0.00^{bB}	0.20±0.00^{aA}
192h	0.05±0.000^{aA}	0.05±0.000^{aA}	0.80±0.05^{bB}	0.30±0.02^{aA}	0.50±0.02^{cB}	0.20±0.00^{aA}
288h	0.05±0.005^{aA}	0.05±0.000^{aA}	0.90±0.02^{bcB}	0.35±0.02^{abA}	0.50±0.00^{cB}	0.25±0.02^{abA}
384h	0.10±0.000^{bA}	0.20±0.000^{cB}	0.90±0.00^{bcB}	0.50±0.00^{cA}	0.50±0.02^{cB}	0.30±0.02^{bA}
480h	0.10±0.000^{bA}	0.10±0.000^{bA}	1.00±0.11^{cB}	0.40±0.05^{bA}	0.60±0.00^{dB}	0.20±0.00^{aA}
576h	0.05±0.000^{aA}	0.05±0.005^{aA}	1.20±0.05^{dB}	0.40±0.00^{bA}	0.60±0.00^{dB}	0.20±0.00^{aA}
672h	0.05±0.000^{aA}	0.05±0.000^{aA}	0.90±0.00^{bcB}	0.40±0.02^{bA}	0.50±0.05^{cB}	0.25±0.02^{bA}
DT	S	S	S	S	S	S
V	S	S	S	S	S	S
DT*V	S	S	S	S	S	S

*Each value is the mean of three replicates. Mean±SE is shown in the table;
#Means±SE followed by the same letter do not differ significantly according to Duncan's test ($P < 0.05$)

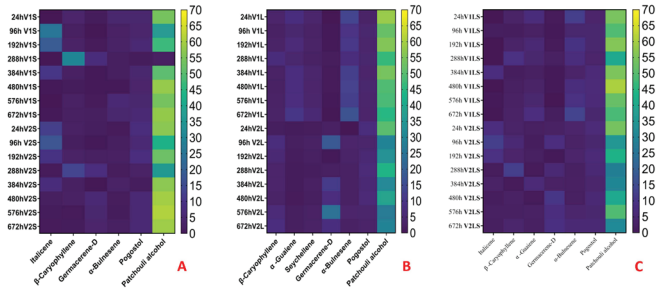


Fig.: Effect of drying time on oil composition in stem (A), leaf (B) & whole plant (C) of CIM Samarth (V1) and CIM Utkrisht (V2) variety of Patchouli



Dr. Dipender Kumar and team

Dr. Priyanka Suryavanshi डॉ. प्रियंका सूर्यवंशी



Bioefficacy of MAP based biostimulants and weed leaf extracts on growth, physiology and yield of Linseed (*Linum usitatissimum* L.)

Linseed (*Linum usitatissimum* L.) is a major oilseed crop in India, and it is a useful option for cropping systems due to the excellent quality of the seed oil, which is increasingly valued by consumers, the food, cosmetic, and ecomaterials sectors. A field experiment was conducted at research farm of CSIR-CIMAP, Lucknow during 2023-24 based on randomized complete block design with seven treatments and three replications to assess the impact of seed priming on germination percentage and days to 50% germination along with foliar application of MAPs based biostimulants and weed leaf extracts on growth, stress, photosynthetic pigments, and yield of Linseed (*Linum usitatissimum* L.). Growth attributes, proline content, photosynthetic pigments and yield of linseed was evaluated for seven following given treatments viz. T1: Control; T2: Caliterpenone (0.01%) + KNO_3 (1%); T3: Geraniol(0.01%) +KNO_3 (2%); T4: Andrographolide (0.01%) + Salicyclic acid (0.5mM); T5: Moringa leaf extract(2%) + Salicylic acid(1mM); T6: Echinochloa leaf extract (2%) T7: Lantana leaf extract (2%). Results indicated that seed priming with 2% KNO_3 gave highest germination percentage and took 2 days less to complete 50% germination in comparison to 1mM Salicylic acid. Foliar application of Geraniol (0.01%) significantly influenced the morphological attributes viz. Plant height and no. of branches/plant while Moringa leaf extract gave at par results for both the parameters of linseed. Foliar application of Geraniol (0.01%) significantly influenced the photosynthetic pigments including Total Chlorophyll and Chlorophyll a. Proline content was significantly reduced by the foliar application of Moringa leaf extract. In case of yield and yield attributes fresh biomass, number of capsules/plants, weight of seeds/m^2 and oil yield were significantly influenced by the foliar application of Geraniol(0.01%) while Moringa leaf extract(0.01%) gave at par results. Test weight was recorded highest for Moringa leaf extract(0.01%). Results indicates that Geraniol (0.01%) in MAP based biostimulants and Moringa leaf extract can be used to enhance the yield of Linseed (*Linum usitatissimum* L.).



Plate: Field view of experiment

Bio-efficacy of new generation herbicides for weed management in *Mentha arvensis* var. CIM-Unnati

Mentha arvensis L. requires approximately 10 to 15 days for complete emergence and exhibits slow initial growth, rendering it a poor competitor against weeds. Both *rabi* and *kharif* season weeds emerge and compete with the crop, with potential yield losses due to weeds reaching up to 74% therefore a field experiment has been conducted in the Zaid season of 2023-2024 in the CSIR-CIMAP farm to explore some of the new generation post-emergence herbicides which can eradicate the weeds from the field in the target based manner without leaving residues in the field while being ecologically sustainable and economical to the farmers. Field experiment was conducted with ten treatments viz. T1: Weed free; T2: Weed check; T3: Oxyflurofen 23.5% EC (Pre-emergence); T4: Bentazone 48% SL; T5: Fluazifop-p-butyl 13.4% EC; T6: Quizalofop ethyl 5% EC; T7: Oxyflurofen 23.5% EC (Post-emergence); T8: Metribuzin 70% WP; T9: Propaquizafop 10% EC; T10: Halosulfuron methyl 75% WG. The experiment was conducted in Randomized block design (RBD) with three replications. Halosulfuron methyl 75% WG as post emergence herbicides gave least weed count, lowest weed dry matter accumulation and highest weed control efficiency and weed control index but due to its high phytotoxicity it impacted the growth and yield of *Mentha arvensis* L. Quizalofop ethyl 5% EC as post emergence gave least weed index(16.067) indicating its low phytotoxicity and high weed control efficiency(77.08%). Oxyflurofen 23.5% EC also gave very low weed index(21.325) and high weed control efficiency (71.81%). Quizalofop ethyl 5% EC as post emergence gave highest fresh herb yield(25.67 t/ha), dry herb yield(75.33 q/ha), Oil yield(387.14 kg/ha). Percentage increase in fresh herb yield with the application of Quizalofop ethyl 5% EC with respect to T9(Agil) was 45.27% while with respect to the Oxyflurofen 23.5% EC it was 8.4%. Thus, experiment concluded that application of Oxyflurofen 23.5% EC as pre-emergence and Quizalofop ethyl 5% EC as post-emergence would completely control the weed population(broadleaf weed and grass weeds) in *Mentha arvensis* L. and would result in better yield.



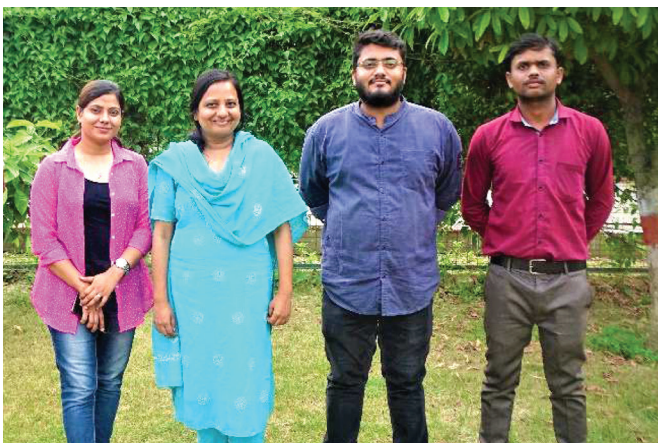
Plate: Comparative performance field view of different treatments



Plate: Fluazifop-p-butyl 13.4% EC toxicity



Plate: Halosulfuron methyl 75% WG toxicity



Dr. Priyanka Suryavanshi & her team

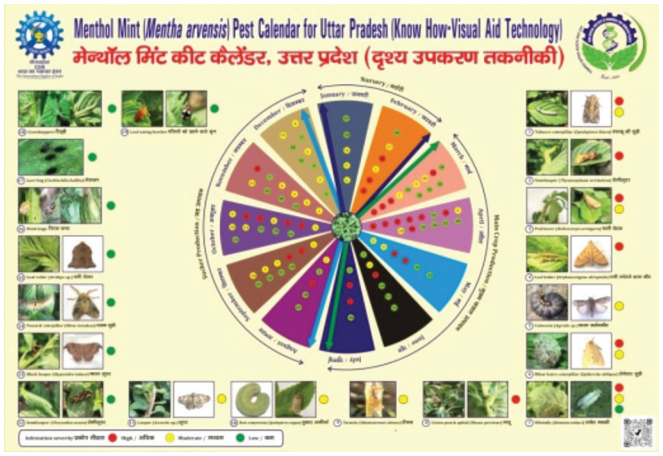
Dr. Santoshkumar C. Kedar
डॉ. संतोषकुमार सी. केदार

Development of innovative decision support tools for integrated pest management in medicinal and aromatic crops



The cultivation of medicinal and aromatic crops is pivotal to India's agricultural sector, making substantial contributions to both its economy and cultural heritage. However, these crops face persistent challenges from insect pests, impacting both yield and quality. In response, our research team has focused on developing innovative decision support tools aimed at empowering farmers and extension personnel in integrated pest management (IPM) practices across India.

Menthol Mint Pest Calendar: Menthol mint (*Mentha arvensis*), a crucial aromatic and medicinal herb cultivated extensively in Uttar Pradesh, encounters significant pest challenges throughout its growth stages. These pests not only escalate the cost of cultivation but also compromise the essential oil quality, further impacting the socioeconomic conditions of small and marginal farmers. To combat these challenges, we have developed the "Menthol Mint Pest Calendar" technology after a comprehensive four-year study. This visual aid provides essential information on pest identification, timing of occurrence, and succession in key



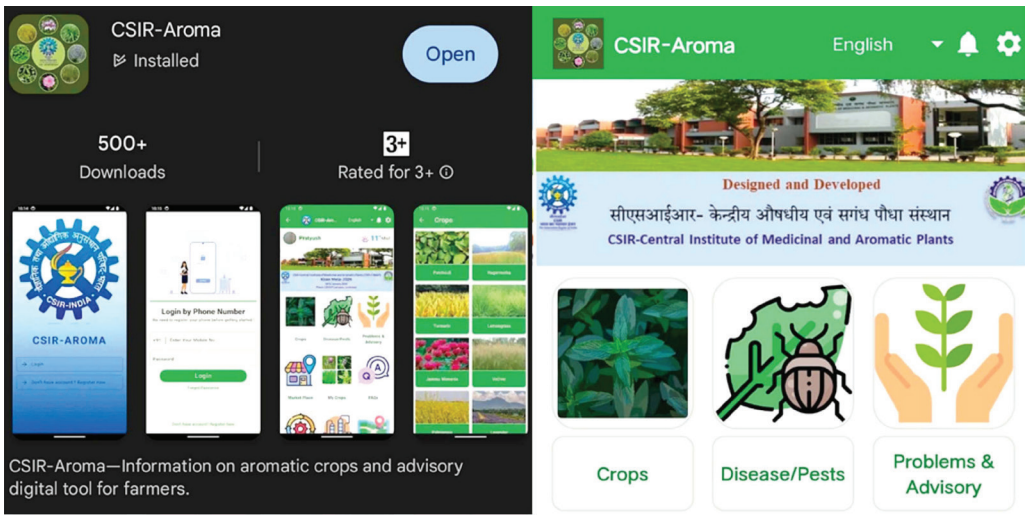


Innovative decision support tools (menthol mint pest calendar and beneficial insects' visual technologies) for IPM in MAPs

production systems. By utilizing this tool, farmers can proactively implement timely preventive measures, ensuring sustainable menthol mint production.

Visual Tool on Beneficial Insects in MAPs: Beneficial insects, including predators, parasitoids, and pollinators, are indispensable allies in sustainable agriculture. Unfortunately, their populations are threatened by indiscriminate pesticide use and climate change. To address this issue, we have developed an innovative visual aid technology showcasing various species of beneficial insects. This tool, featuring colored images and original specimens, aims to raise awareness among farmers about the significance of these biological control agents. By understanding their roles, farmers can effectively implement IPM strategies, thus fostering a balanced and healthy agro-ecosystem.

Android-based Mobile Application (CSIR-AROMA App): The CSIR-AROMA App serves as a free mobile tool designed to provide comprehensive information on aromatic crops cultivation and pest management. Users can access details on insect pest problems in various aromatic crops, including menthol mint, geranium, ocimum, patchouli, rose, citronella, lemongrass, and palmarosa. Additionally, the app offers guidance on cultivation techniques and market opportunities. A unique feature allows users to upload images of pest damage for expert diagnosis and receive tailored advisory from pest management experts. This interactive platform facilitates informed



Android-based mobile application for pest management advisory for aromatic crops

decision-making and promotes sustainable practices among farmers and extension personnel.

The development of these innovative decision support tools represents a significant advancement in integrated pest management for medicinal and aromatic crops in India. By providing farmers with accessible and practical solutions, we aim to enhance agricultural sustainability, minimize environmental impact, and improve livelihoods across the sector. Moving forward, continued research and collaboration will be essential to further refine and expand these tools, ensuring their efficacy and impact on a broader scale.

Phytophagous arthropod dynamics across phenological stages of menthol mint (*Mentha arvensis* L.)

Menthol mint, scientifically known as *Mentha arvensis* L., is a highly valued cash crop extensively cultivated in the climatic conditions of Uttar Pradesh, India. This study aims to investigate the complex interactions of phytophagous arthropods throughout the various phenological stages of menthol mint, to enable the adoption of timely and efficient pest management strategies. Field observations were meticulously recorded throughout the entire growing season, spanning from March to June, within the experimental plots. The planting of menthol mint commenced during the first fortnight of March and culminated with the harvest completed in the first fortnight of June. Through rigorous monitoring efforts using different sampling techniques, a comprehensive catalogue comprising 54 distinct species of phytophagous arthropods was documented upon *M. arvensis* during various stages of its phenological growth cycle. A detailed checklist was compiled, delineating the succession patterns of phytophagous arthropods associated with *M. arvensis*, elucidating their periods of activity, corresponding phenological growth stages, and respective pest status. Noteworthy findings revealed the presence of 35 phytophagous arthropod species during the initial vegetative growth stage, 41 phytophagous arthropod species during the mid-vegetative growth stage and 40 phytophagous arthropod species during the maturation stage of the menthol mint crop. The significant findings derived from this comprehensive study are anticipated to be instrumental in formulating effective pest management strategies targeting key pests. These strategies will be specifically designed to mitigate the adverse impacts of phytophagous arthropods at various growth stages of menthol mint cultivation, ultimately preventing potential decreases in yield.



Dr. Santoshkumar C. Kedar and his team

Dr. B. Shivanna डॉ. बी. शिवन्ना

Effect of different levels of sea weed extract application on germination of Senna seeds



A laboratory experiment was taken up to study the effect of different levels of sea weed extract on germination of Senna in CSIR CIMAP Research centre, Hyderabad in 2023. Five different concentrations of solutions such as 2%, 4%, 6%, 8% and 10% were prepared using seaweed extract. 10 seeds were selected and soaked with different concentrations of low temperature seaweed aqueous extract such as 2%, 4%, 6%, 8% and 10% in the sterilized Petri plates. The subjected seeds were analyzed for germination and analyzed at regular time intervals from the day of treatment. The results indicated that the sea weed application at 4% (T4) yielded the highest germination rate (80.67%), significantly higher seedling length (3.17 cm), higher seed vigour index(255.19), higher germination index rate (9.58), higher germination energy (95.21) and least mean germination time (15.71 days). Hence Seaweed extract application at 4% was found to be over all improvement in germination and establishment of seedlings.

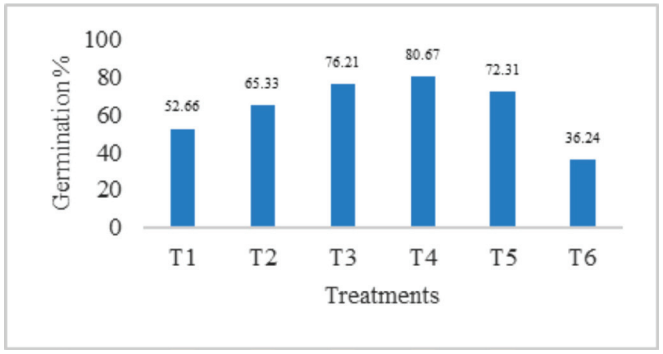


Fig.: Germination percentage

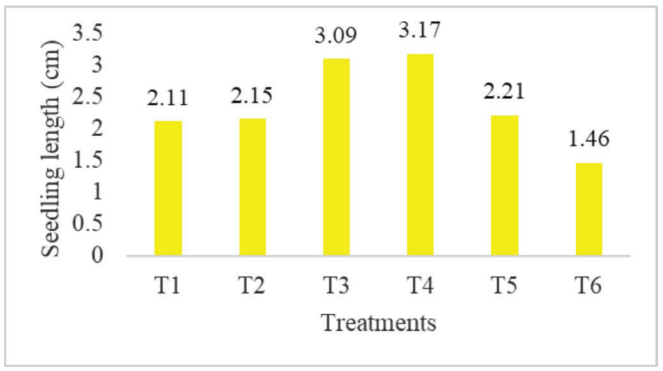


Fig.: Seedling length (cm)

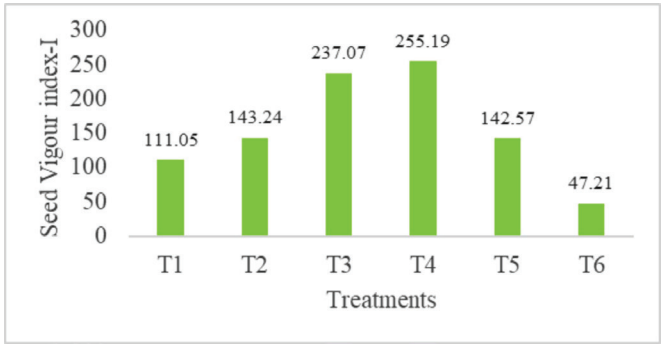


Fig.: Seed vigour index

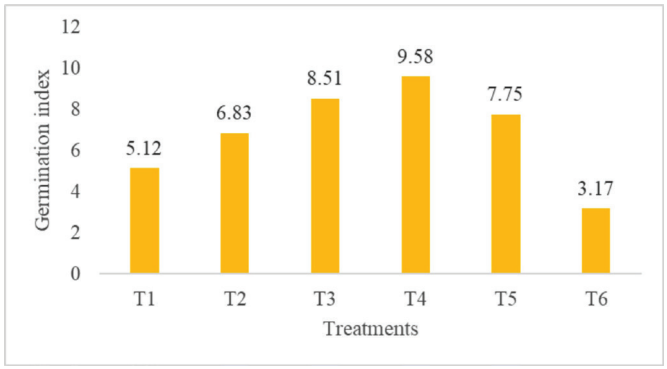


Fig.: Mean germination time

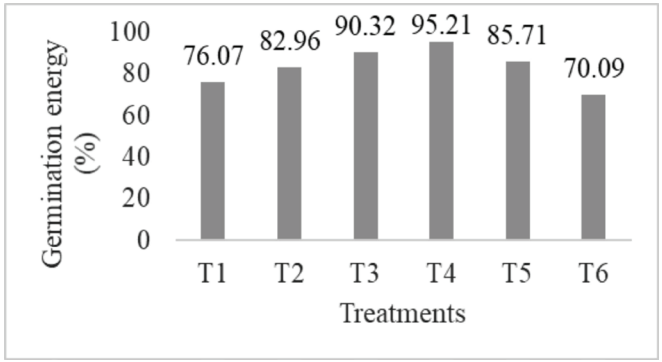


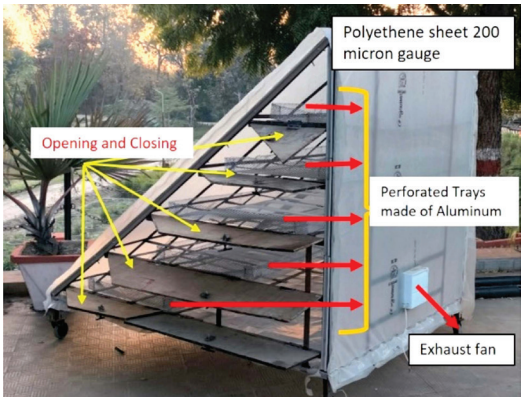
Fig.: Germination energy

Dr. Anandakumar T.M. डॉ. आनंदकुमार टी.एम.

Development of low-cost eco-friendly solar dryer for dehydration of medicinal herbs



The solar dryer has been fabricated using mild steel flats, MS angle, aluminum trays, wheels and exhaust fan. Total width, breadth and height of the dryer is 1.5, 1.5 and 2.0 m respectively. The structure has been covered with polythene sheet of 205 microns to increase the temperature inside the dryer. One side there is a opening / closing system which is made of plywood (it acts as an insulator, does not transfer heat from inside to outside) The rose petals were kept on racks provided at different heights. These racks are able to draw outside manually. To remove the



Solar dryer

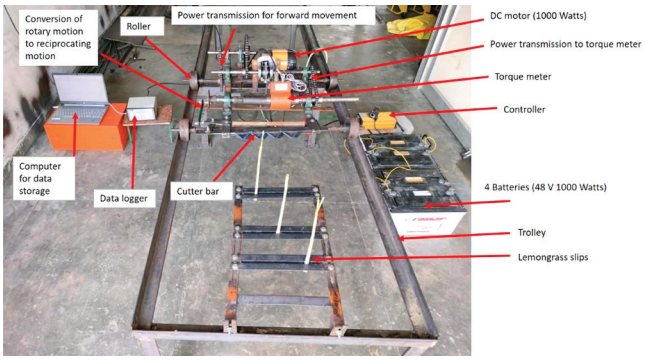
humidity in the solar operated exhaust fan has been mounted at bottom of the dryer. Total cost of material consumed for the dryer is Rs. 15,000. The maximum and minimum temperature inside the dryer was found as 59.5 C and 50 C respectively. The dryer can able to reduce moisture of rose petals from 85 % to below 8% which is safer level for storage within 3.5 hours. Dryer is able to dry about 7 – 10 kg of rose petals within 3.5 hours.

Drying kinetics of kalmegh leaves under four different methods

The drying kinetics of Kalmegh leaves have been studied under four drying methods, i.e. hot air oven, shade drying, sun drying and solar drying. Under hot air oven, in order to reach an optimum moisture content below 10 %, the time required at 50, 60, 70 and 80C was recorded as 8, 3.5, 2.5 and 2 hours respectively. Similarly under shade, sun and solar drying the time required to reach moisture content below 10% is 9.5, 7.5 and 2.5 hours respectively. There was no much variation has been observed in the andrographis content of leaves dried in all kinds of drying methods. This shows that the newly developed solar drier can able to remove the moisture content from Kalmegh leaves within 2.5 hours without loss of any chemical compound. Hence, this low-cost eco-friendly solar dryer can be recommended for farmers to follow the drying method using the solar dryer.

Development of set up and determination of power requirement for cutting of lemongrass stem to develop harvesting equipment

The cutting power is decreased exponentially with an increase in knife speed and increased linearly with respect to forward speed and number of stems. Maximum power requirement for cutting three stems is about 71 watts at knife speed of 0.29 m/s and forward speed of 1.1 km/h. whereas minimum was observed as 33.67 Watts at knife speed of 0.4 m/s with forward speed of 0.8 km/h. In order to achieve maximum field capacity (ha/h) with less power requirement, the optimum knife speed and



forward speeds are 0.4 m/s and 1 km/h respectively. Overall 600 Watts is required to cut 30 cm width of lemongrass.

Plant Breeding & Genetic Resource Conservation

HIGHLIGHTS

The primary research focus of this divisional unit (DU 5) is the development of improved varieties of medicinal and aromatic plants (MAPs), the conservation of their genetic resources, the morphological and chemical characterization of their germplasm, and the estimation of genetic diversity in MAPs. The germplasm of MAPs is being effectively conserved in the seed bank for short- and mid-term storage by DU 5. Division is extensively working on the survey, collection, authentication of MAPs from different phytogeographical regions of the country and their introduction in CSIR-CIMAP for developing new chemotypes and varieties. Division is also involved in classical and molecular taxonomy of angiosperms, phylogeny, population biology, markers, genetic diversity, botanical authentication, and DNA barcoding. Institute have state-of-the-art facilities of designated National Herbarium of Medicinal and Aromatic Plants (CIMAP) and Crude Drug Repository (CDR) and enhancement of herbarium specimens and crude drugs in the repository of CIMAP and its maintenance. The unit has a NABL accreditation for authentication of various plant samples. The seed quality laboratory is working on the development of seed standards for quality parameters and protocols.



Scientists of Plant Breeding and Genetic Resource Conservation Divisional Unit

L to R: Dr. V.R. Singh, Dr. A.K. Gupta, Dr. Birendra Kumar, Dr. V. Sundaresan, Dr. Tripta Jhang, Dr. Narendra Kumar, Dr. Channayya Hiremath, Dr. Venkatesha KT, Dr. Gunjan Tiwari.

During 2023-24, genetic diversity of sixty-six naturally occurring *Cannabis* populations from nine Indian states was examined using their qualitative and quantitative morphometric analysis and chemical profiling using HPLC. Based on Tetrahydrocannabinol (THC): Cannabidiol (CBD) ratios, 45 collections were classified as drug-type with THC content >0.3% and CBD content <0.5%. Five collections were classified as medicinal-type with THC content <0.3 % and the CBD content >0.5%. The diversity in the size, shape and surface ornamentation of female *C. sativa* seeds collected from different regions in North India was demonstrated during this period. Likewise, genetic variability of forty genotypes of *Papaver somniferum* L. was evaluated using morphological as well as biochemical parameters. Genetic diversity studies of the unexplored Bael (*Aegle marmelos*) germplasm from Karnataka and Tamil Nadu using UBC-ISSR markers were performed. Genetic and chemical diversity studies of *Taverniera cuneifolia* and Liquorice (*Glycyrrhiza glabra*) were undertaken on the germplasm collected from different parts of the country. DNA barcoding has been used to identify and authenticate the market samples of five industrially important Jasminum species: *Jasminum sambac, J. multiflorum, J. azoricum, J. grandiflorum,* and *J. auriculatum* and in Murva (*Maerua oblongifolia*), a medicinal plant used in Ayurvedic and traditional medicine. The differentiation among lemongrass varieties developed and released by CSIR-CIMAP (CIM-Shikhar, Krishna Priya, Krishna, and CIM-Atal) along with wild genotypes was done using ISSR markers. Various targeted fingerprinting marker techniques, particularly SCoT, CBDP, and EST-SSRs, were used to reveal genetic diversity, identity, and relatedness among Indian opium poppy. The quantitative determination of astragalin in the leaf of 42 accessions of *Nyctanthes arbor-tristis* L. collected from different regions was done. Studies on development of high Pellitorin content (~1%) and fresh root yield of *Anacyclus pyrethrum* (Asteraceae) breeding line through chemical mutagenesis, genetic improvement of Damask Rose (*Rosa damascena* Mill) for higher flower and oil yield and polyploid induction in *Stevia rebaudiana* Bertoni for developing a high steviol glycosides-rich variety were also carried out during the 2023-2024. In addition, gamma irradiation induced morpho-chemical and molecular diversity was assessed in the mutagenized population of *Mentha piperita* L. The genotype-environment interaction of andrographolide and neo-andrographolide in high therapeutic potential medicinal plants Kalmegh (*Andrographis paniculata* (Burm. f.) Wall. ex Nees) was carried out by AMMI and GGE biplot analysis. Registration of new high oil-yielding lemongrass *Cymbopogon flexuosus* (Nees ex Steud.) Will.Watson Variety: CIM–Krishnapriya was done during this period. CSIR-CIMAP develops the Guidelines for the conduct of Test for Distinctiveness, Uniformity and Stability on Ashwagandha (*Withania somnifera* (L.) Dunal. The Guidelines involves a set of 35 characteristics for the testing of candidate varieties and hybrids for their DUS evaluation.

During this period, division has published 24 scientific papers in reputed journals with an average impact factor of 3.34. In addition the DU received one copyright, and two new GAP/CNP projects. During this period, various CSIR (02) and 09 GAP/CNP/SSP (09) projects were going on in the division. Division has total 23 Ph.D students and out of these one student has been awarded during 2023-2024. One of the scientists from the DU, Dr. Birendra Kumar has been conferred with Indian Academy of Horticulture Sciences Fellowship-2023 by Indian Academy of Horticulture Sciences, New Delhi, Indian Botanical Society Fellowship-2023 by Indian Botanical Society and Bioved Fellowship Award-2024.

Dr. Anil Kumar Gupta डॉ. अनिल कुमार गुप्ता

The genetic diversity and chemical profiling of natural populations of Indian *Cannabis*



Cannabis L. (family *Cannabaceae*) has long been used in the pharmaceutical, nutraceutical, and textile industries. Despite the view that *Cannabis* originated either in India or China, no studies have focussed on Indian *Cannabis*. The study demonstrated the most extensive morphometric and chemometric mapping of natural populations of Indian *Cannabis*. The sixty-six naturally occurring *Cannabis* populations from all the possible habitats, representing nine Indian states (Himachal Pradesh, Uttar Pradesh, Arunachal Pradesh, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, and Rajasthan) for genetic diversity, based on their qualitative and quantitative morphometric analysis and chemical profiling using HPLC were investigated. These analyses demonstrate that a strong correlation prevails between the genetic diversity of Indian *Cannabis* and their regional distribution. Based on THC:CBD ratios, 45 collections had a THC content >0.3% and a CBD content <0.5% and were classified as drug-type; a single collection had a THC content <0.3% and the CBD content <0.5% was identified as of fiber-type; and five collections show THC content <0.3% and the CBD content >0.5% were classified as medicinal-type; 15 collections did not fit into the above classification. As assessed here, the diversity based on phenotypic and chemotypic variability set the stage for identification and selection of lines for key agronomic traits allowing maximizing the agronomic potential of this promising crop. The results of the present study declare immense scope for devising effective breeding strategies that will enable optimum utilization of *Cannabis* resources by the pharmaceutical, nutraceutical, and textile industries. **(Industrial Crops and Products, IF= 5.90)**

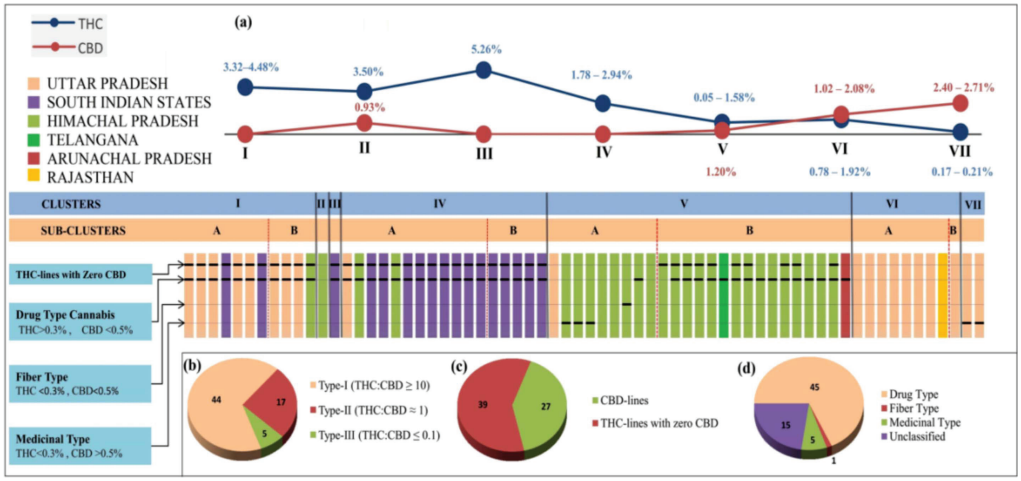


Fig. (a) Presence of Cannabinoids (THC and CBD) in 66 *Cannabis* collections with their geographical affiliation (schematic representation only), (b) Classification of 66 Indian *Cannabis* collections, as per de Meijer et al., (2003) (c) Classification of Indian *Cannabis* as 'CBD-lines' and 'THC-lines with zero CBD' (d) classification of 66 collections based on their utility

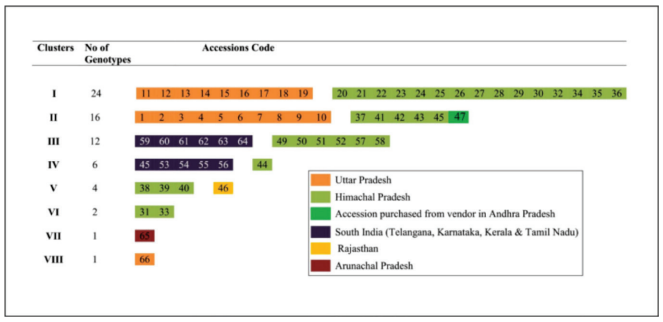


Fig. Distribution of 66 *Cannabis* collections in different clusters.

Genetic variability for qualitative and quantitative characters and study of character association for their exploitation in genetic improvement of opium poppy (*Papaver somniferum* L.)

Forty genotypes of *Papaver somniferum* L. were assessed for genetic variability using data from morphological as well as biochemical studies. For

the characterization, the morphological characters viz., plant height, primary branch, peduncle length, days to maturity, number of selfed-capsules, the weight of selfed-capsule, number of an open-pollinated capsule, weight of open-pollinated capsule were complimented with five biochemical alkalodis morphine, codeine, thebaine, papaverine, and narcotine. The results show that morphine and codeine had a highly significant positive correlation (0.68 **). Similarly, a highly positive significant correlation (0.63 **) was established between morphine and narcotine. Further, all the 40 genotypes were subjected to cluster analysis where eight primary clusters were obtained using morphological analysis, whereas nine clusters were formed based on biochemical analysis. Based on morphological analysis, 32 genotypes were assigned to one, large cluster which was further organized into 12 sub-clusters. However, clustering based on biochemical analysis yielded one, large cluster with 25 genotypes, which was further subdivided into eight subclusters. The findings from the present study can be successfully employed for developing superior lines of opium poppy. **(Industrial Crops and Products, IF= 5.90**)

Conservation of Germplasm Accessions of MAP's and Gene Bank Status

Availability of germplasm resources are the backbone for starting and running any genetic improvement program. Our **National Gene Bank** is serving the both, scientific community and society, by conserving and providing the germplasm of MAP's. The germplasm lines which seem to be useless in the present scenario may turn out to be the most important ones in the future under changed climatic or geographical conditions. Under such circumstances the germplasm accessions' already preserved in the "Gene Banks" may play a pivotal role.

Status of CSIR-CIMAP Gene Bank at Lucknow

S. No.		Seed Bank (Mid & Short term storage)	Field Gene Bank*
1	No. of Accessions	2476	868
2	Families	132	80
3	Genera	386	176
4	Species	515	227

About 150 clones of Turmeric (*Curcuma sp.*), more than 200 germplasm collections of Senna (*Casia angustifolia*), 105 germplasm collections of Ashwagandha (*Withania somnifera*), 200 lines of Coriander germplasm, 66 lines of *Cannabis*, 40 lines of Fennel, 50 lines of *Allium*, 300 lines of *Papaver* and more than 130 released varieties (from CIMAP) of different MAP crops are also maintained.



Dr. Anil Kumar Gupta & his team

Dr. Birendra Kumar डॉ. बीरेन्द्र कुमार

Gamma irradiation induced morpho-chemical and molecular diversity in the mutagenized population of *Mentha piperita* L.



Peppermint, *Mentha piperita* L. (Family 'Lamiaceae'), a vegetatively propagated, essential oil-bearing crop, is cultivated in temperate and sub-tropical countries for perfumery and aroma industries. Induced mutagenesis is a unique and supplemental breeding approach to overcome the limitations of conventional propagation methods in peppermint crops. Addressing problems of creeping growth habit, propagation only by runners, low oil content and oil yield, higher than 5% menthofuran content of peppermint varieties, the study aims to develop genotype with erect growth habit, high oil yield and oil content with high menthol and low menthofuran contents. Runners and seeds of menthofuran-rich genotype MPS-36 (*Mentha piperita* selection 36) were irradiated by applying gamma-rays at 10, 20, 30, 50, 70, 90, and 110 Gray doses at a dose rate of 55 Gray/minute, and mutants were isolated in VgM_2/ M_2 generation. Sorting was devised within and among the family to select superior variants in the VgM_3/M_3 generation. The VgM_3/M_3 to VgM_5/M_5 generations are used to screen for desirable and promising variants based on agro-economic attributes, homozygosity, and field performance stability. Morpho-chemical and molecular analyses were performed for the identification/ differentiation of mutant genotypes. A mutant, MPS-36(S-3-3), was identified as a novel and promising mutant with a globally distinct quality of peppermint oil having high menthol (77.3-79.4%) with low menthofuran (0.25-0.29%) content, sucker producing, erect growth habit, flower-bearing and an increase in herb yield, oil content, and oil yield. This mutant has been released as a commercial variety named CIM- Suras in the north Indian plain to represent a sustainable solution to overcome previous issues of available genotypes/varieties of peppermint. The introduction of the peppermint variety 'CIM-Suras' has the potential to revolutionize mint cultivation in India, by crystallizing major component L-Menthol from its essential oil in the form of menthol crystal (26.4%) and the remaining dementholised oil (63.2%) have peppermint oil quality, thereby turning it into a major producer/supplier of peppermint oil.

Development of high yielding kalmegh (*Andrographis paniculata* (Burm.f.) Wall. ex Nees) genotype: AP-15-19

One mutant treated with different doses of gamma irradiation in 2013 was identified and selected as promising and high herb-yielding with high andrographolide (3.88-4.33%) and neo-andrographolide (0.41-0.59%) content named AP-15-19. This mutant/variant was grown up to M_8 generation for their stability and homo-geneousity in yield and quality. The initial yield evaluation trail was conducted during 2021 and 2022. The results revealed



that the herb yield exhibited 20-25% improvement over check variety CIM-Megha with 50-70% in andrographolide and neo-andrographolide content.

Development of high-yielding Prishniparni (*Uraria picta* (Jacq.) Desv. ex DC.) genotype: UP-50

The seeds of the 53 Prishniparni genotypes were collected from major growing areas of Uttar Pradesh, Uttarakhand, Madhya Pradesh, West Bengal, Gujrat, Karnataka, and Telangana. A study of growth performance and yield potential of 23 viable and successfully grown germplasms was carried out during 2017-2020 at CSIR-CIMAP Lucknow. UP-50 was significantly different from the rest of the genotypes for aerial part weight and rhoifolin content in the aerial part. During initial yield evaluation trials in 2021 and 2022, the aerial herb yield, root yield, and rhoifolin content was estimated as 15.0±0.31q/ha, 5.0±0.13q/ha, and 1.96±0.96 in UP-50 respectively.





High-yielding variety/genotype/ chemotype development (*Mentha piperita/ Mentha spicata*)

The selfed-seeds and suckers of the spearmint variety CIM-Mohak and peppermint variety CIM-Indus



Fig. CIM-I452

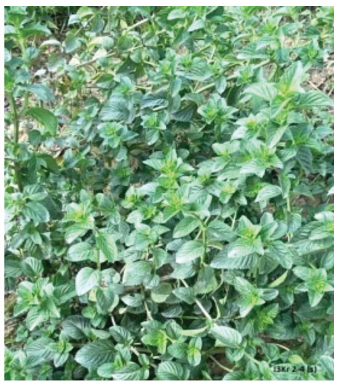


Fig. CIM-I332

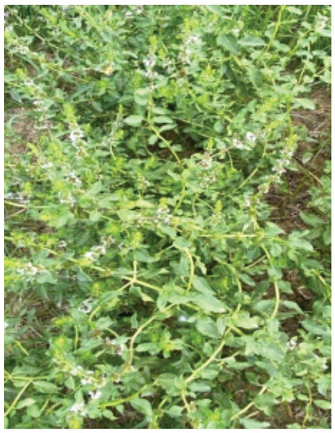


Fig. CM-64



Fig. CM-69

were subjected to gamma radiation with different doses ranging from 10Gy to 110Gy. The irradiated and un-irradiated (control), runners/suckers and seeds were grown to raise the nursery and planted at the experimental farm of CSIR-CIMAP, Lucknow. After evaluation of two consecutive years (VgM_2/M_2 and VgM_3/M_3 generation), four genotypes were selected, namely CIM-I452 and CIM-I332 in *M. piperita* and CM-64 and CM-69 for *M. spicata*, which are expressing the high herb, oil yield, and ISO standard oil quality.



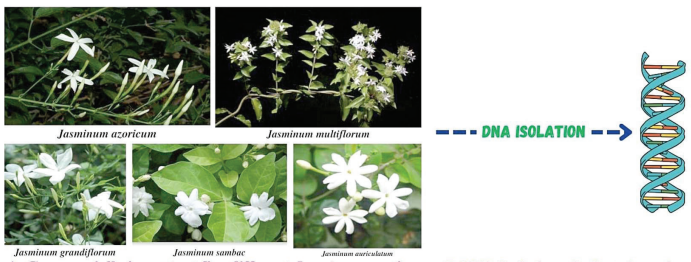
Dr. Birendra Kumar & his team

Dr. V. Sunderasan डॉ. वी. सुंदरेसन

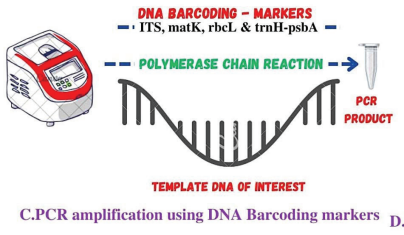
DNA barcoding of Industrially Important Jasminum species



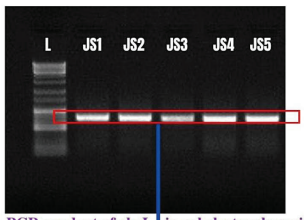
Jasminum, a large and economically significant genus in the Oleaceae family, comprises over 200 species. This genus is primarily cultivated in the Indian subcontinental region for its fragrant flowers and essential oil extracts. Of these 200 species, around 40 are found in India, among five being majorly cultivated: *Jasminum sambac, J. multiflorum, J. azoricum, J. grandiflorum,* and *J. auriculatum*. Despite their differences in vegetative morphology, distinguishing some Jasminum species can be challenging when their flowers are still in the bud stage. This difficulty can lead to the intentional or unintentional mixing of buds from less aromatic species with those of highly aromatic ones, significantly impacting the production of jasmine oils. As one of the world's leading producers and exporters of jasmine oil, India could face substantial economic losses if the quality of the oil declines. Therefore, accurate identification of the plant species at the cultivation level is crucial to maintaining the high quality of jasmine oil production. Hence this present study focuses on developing DNA barcodes for highly cultivated Jasminum species. DNA barcoding is a method that uses short genetic sequences from a standardized region of the genome to identify species. In this study, we deployed four DNA barcoding markers: matK, rbcL, trnH-psbA, and ITS2, for species-level identification of Jasminum. After the lab experiments, rigorous statistical analysis proved that ITS2 is the most effective DNA barcoding marker for species identification in jasminum species. This marker was followed in effectiveness by trnH-psbA, matK, and rbcL. This study represents a significant step forward in the application of biotechnology to support the agricultural and economic interests associated with Jasminum cultivation to mitigate economic losses and preserve the integrity of jasmine oil products.



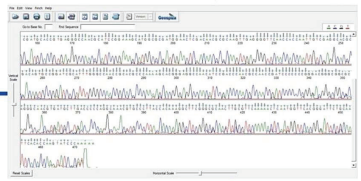
A. Commercially important five different *Jasminum* species B.DNA Isolation of selected species



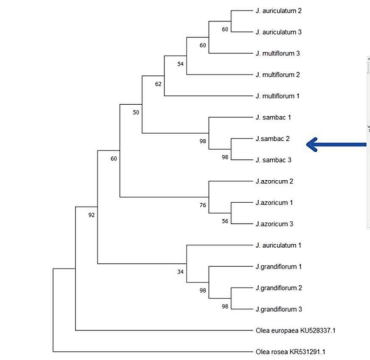
C.PCR amplification using DNA Barcoding markers



D. PCR product of rbcL in gel electrophoresis



E. Sanger sequencing of rbcL PCR product



F. Neighbor-Joining tree of rbcL sequences inferred using Kimura-2-Parameter distances.

Differentiating the Chemotypic varieties of Lemongrass through ISSR Markers – In the context of Molecular Approach

Cymbopogon is an important genus in the Poaceae family, cultivated worldwide for its aromatic essential oil and varied pharmaceutical properties. Despite its global cultivation, proper genetic diversity information is still lacking. There are nearly 21 species of Cymbopogon distributed across India, Nepal, and Burma. Unfortunately, chromosomal studies on Cymbopogon are scarce, and the chromosomal number of lemongrass remains unclear. Taxonomically, Cymbopogon species are perennial, densely tufted, often aromatic herbs with flat, coarse leaves. Citral, predominantly found in lemongrass, is the principal source of β-ionone, a precursor for

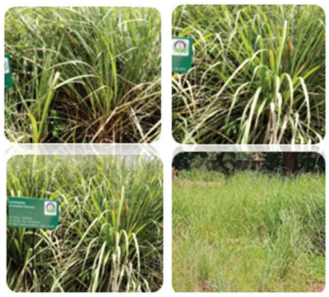


Figure: The different Chemotypes of Lemon Grass developed by CIMAP scientists through selective breeding methods

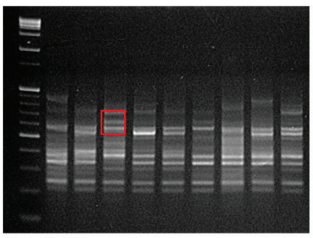


Figure: Highlighted Box showing the unique band obtained through ISSR marker - UBC 823 in variety Krishnapriya developed by CSIR CIMAP

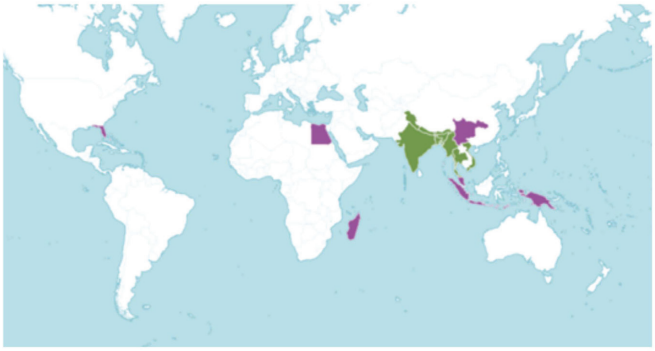
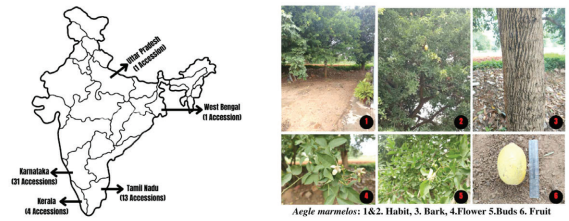


Figure: World wide distribution of the *Cymbopogon flexuosus* and its range restriction in India

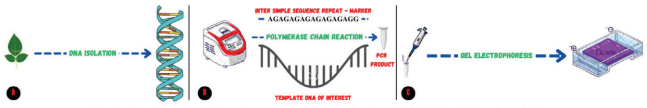
synthesizing vitamin A and other ionones. Varieties developed by CIMAP, such as CIM-Atal, also contain limonene, myrcene, and trace amounts of geraniol. There is an urgent need to differentiate these in-vitro-developed chemotypes of lemongrass for technical benefits. Morphological variations are difficult to spot in varieties developed through selective breeding. To address this, we used molecular tools to identify chemically and physiologically distinct lemongrass chemotypes. We chose ISSR markers from the University of British Columbia, the most widely used markers for identifying genetic variation. We successfully identified a unique chemotype-specific allele in one advanced chemotype, Krishna Priya. This discovery is significant for designing a Sequence Characterised Amplified Region (SCAR) marker, which helps narrow down chemo-specific varieties of lemongrass. Molecular differentiation techniques can identify the intermixing of slips during field cultivation. Additionally, they enable the study of reproductive characteristics within the chemotypes. This helps determine whether these chemotypes introduce different reproductive strategies or maintain the same natural characteristics as wild-growing lemongrass varieties.

Unraveling the genetic diversity of *Aegle marmelos* (L) Correa – A underutilized Dashamoola plant.

Aegle marmelos (L.) Correa, an underutilized medicinal tree native to India, thrives across diverse agro-climatic and geographical conditions in South and Southeast Asia. Traditionally, it has been integral to Ayurvedic, Siddha, and Unani medicine systems. In Ayurveda, it is a key component of the Dashmoola drug, which includes the roots of ten medicinal plants, including *Aegle marmelos*. Despite its medicinal significance, there have been few studies exploring the genetic germplasm of *Aegle marmelos* in southern India. This study aims to uncover the genetic diversity of *Aegle marmelos* in this region. Bael genotypes were collected from five states: Karnataka, Kerala, Tamil Nadu, West Bengal, and Uttar Pradesh. The collection included 20 different populations and 50 genotypes. After the collection,



Aegle marmelos: 1&2. Habit, 3. Bark, 4.Flower 5.Buds 6. Fruit



Lab Experiments: (A)DNA Isolation (B)PCR - UBC ISSR Markers (C)Gel electrophoresis of PCR products

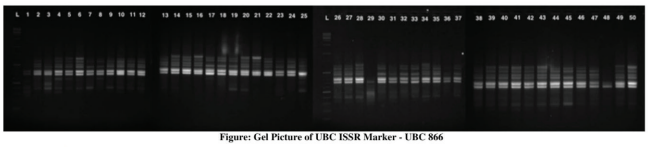
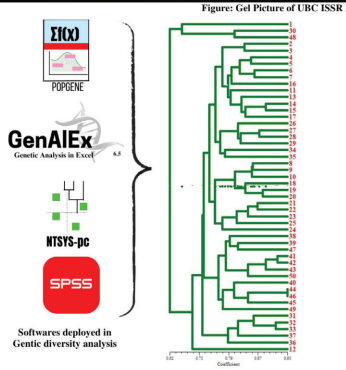


Figure: Gel Picture of UBC ISSR Marker - UBC 866



Softwares deployed in Gentic diversity analysis

Dendrogram developed using 18 ISSR markers for 50 Aegle marmelos accessions

DNA was extracted using a modified CTAB protocol. To assess genetic diversity, 20 ISSR markers were employed; 18 markers produced reproducible bands. A total of 216 bands were generated, with 200 being polymorphic, resulting in an average of 11.11 bands per primer and a polymorphism rate of 92.9%. The average Polymorphic Information Content, Effective Multiplex Ratio, and Resolving Power values were 0.36, 11.52, and 11.84, respectively. Additionally, further statistical analyses such as Principal Component Analysis, Jaccard's Genetic Similarity Coefficient, and Dendrogram development are needed. This work aims to harness the genetic potential of Aegle marmelos for future varietal development and conservation.

Molecular Authentication of Murva

Murva (*Maerua oblongifolia*) is a medicinal plant used in Ayurvedic and traditional systems of medicine locally known as *Boomichakkara kizhangu* (Tamil), *Hemkand or Ramkand* (Hindi), *Bhoochakragadda* (Telugu), *Bhoochakragedde* (Kannada). Tuberous roots of this plant are used to treat various disorders including stomach aches, urinary calculi, diabetes, skin problems, epilepsy, and fever. Its roots are stout, slender, and fleshy, with concentric deep furrows and up to 10 cm in diameter. A total of 23 accessions belonging to 5 species of *Agave,* one species of *Furcraea,* one accession of tender stem-inflorescence

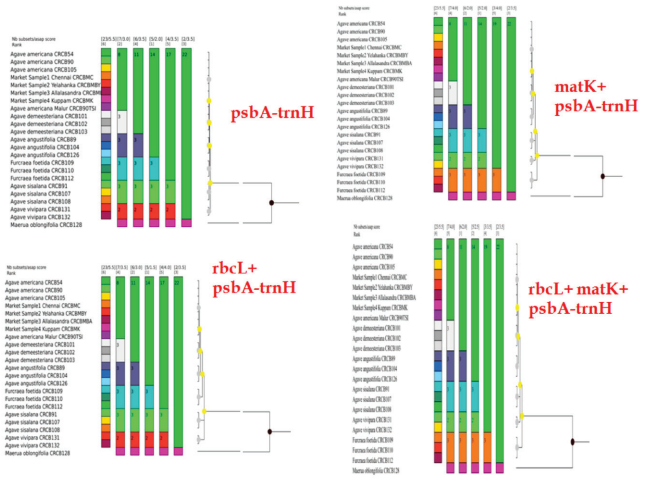


Figure: Genetic distance based species delimitation using Assemble Species by Automatic Partitioning (ASAP)

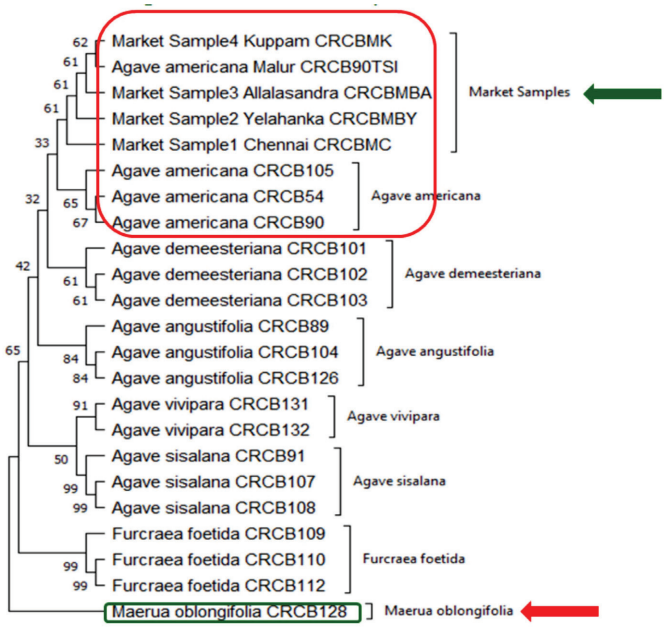


Figure: Strict consensus tree using the barcodes *rbcL* + *matK* + *trnH-psbA* showing the relationship of ambiguous market samples with *Agave, Furcraea,* and Murva species resulting from Niebuhr Joining analysis

part from the *Agave americana* species, 4 accessions of Market samples, and one accession of Murva (*Maerua oblongifolia*) have been collected from various parts of Karnataka and Tamil Nadu. Genomic DNA was isolated from all the collected samples. PCR amplification was done for all the samples using three chloroplast markers *rbcL, matK,* and *trnH-psbA*. A total of 69 samples were successfully amplified using three markers with few repetitive reactions and sent for sequencing. A total of 138 sequences (both forward and reverse) were recovered successfully with few with few repetitive.

Sequence recovery was 100% for the loci *rbcL, matK,* and *trnH-psbA*. Annotated chloroplast sequences were further used for phylogenetic analysis. Distance-based approaches such as the Neighbour Joining (NJ) method and Maximum likelihood (ML) using Kimura 2 parameters were performed to discriminate *Agave* and *Furcraea* species.

The chromatograms of all three regions were checked manually edited where required using BioEdit software and contigs were made. Assembled contigs were checked for homology with other available



Figure: Murva sold in the markets and *Agave americana*

sequences using NCBI-BLAST. The identity of the ambiguous market samples was checked with the reference library sequences using distance-based phylogenetic tree method. All the ambiguous samples sold in the markets in the names of *Boomichakkara kizhangu* (Tamil Nadu), *Hemkand or Ramkand* (Andhra Pradesh), *Bhoochakragedde* (Kannadaka) are clustered with *Agave americana* and the actual species Murva (*Maerua oblongifolia*) clustered far away from the ambiguous samples (Figs.). Hence, it is apparent that the ambiguous samples sold in the markets are from the species of *Agave americana*.



Dr. V Sunderensan & his team

Dr. Tripta Jhang डॉ. तृप्ता झंग

Development of *Anacyclus pyrethrum* breeding line with high Pellitorin content (~1%) and fresh root yield



Anacyclus pyrethrum (Asteraceae), is an indispensable medicinal plant of Ayurvedic, Unani, Siddha, Traditional Arabic, and Islamic medicine (TAIM). *Anacyclus pyrethrum* is in the globally vulnerable rating of the IUCN Red List of threatened/ endangered species. Its root extracts are known to have local anesthetic, anti-depressive, anticancer, sialagogue, antiviral, aphrodisiac, androgenic, and spermatogenic bioactivities. The high market demand for *Anacyclus pyrethrum* is evident from India's Import data statistics and the wide spectrum of commercially available topical products containing *Anacyclus pyrethrum* extracts with functional and cosmeceutical claims such as toothpaste, tooth powders, lotions, creams, toners, gels, moisturizers, melanin lightening, anti-aging, and bath care products. Akarkara root powder-derived formulations in clinical trials are Kabasura Kudineer a poly-herbal Siddha medicine for SARS-CoV2 asymptomatic COVID-19 patients (AYUSH-approved COVID-19 drug); Ustukhuddus Alavi (Persian medicine) for cognitive performance and a polyherbal formulations against HIV/AIDS patients, all for its antiviral bioactivities. With an objective of breeding for high Pellitorin and root yield, chemical mutagenized populations were subjected to recurrent selection from 2015-2023. The base population has 0.02% pellitorin content which has been enhanced to around 1.1%. The advance trail conducted in 2021-22 and 2022-2023 recorded the breeding line to be stable for the Pellitorin (0.9-1.1%) content and fresh root yield as compared to the local check(grown by the farmers).

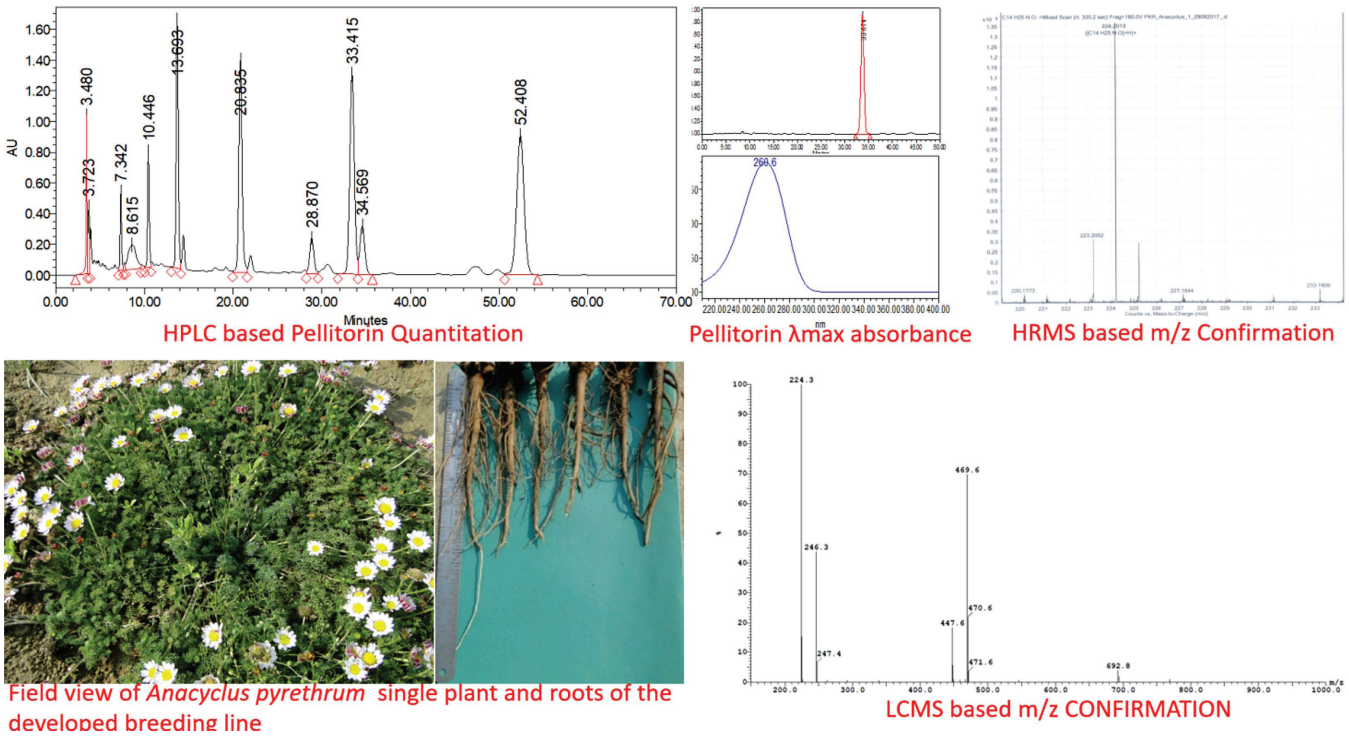


Fig. Development of *Anacyclus pyrethrum* breeding line with high Pellitorin content (~1%) and fresh root yield

Development of Guidelines for the Conduct of Test for Distinctiveness, Uniformity, and Stability on Ashwagandha (*Withania somnifera* (L.) Dunal.

CSIR-CIMAP develops the Guidelines for the Conduct of Test for Distinctiveness, Uniformity, and Stability on Ashwagandha (*Withania somnifera* (L.) Dunal. Ashwagandha varieties and their hybrids to be tested can be grouped using seven grouping characteristics. i.e. Plant: Growth habit, Appearance of the first flower, Leaf: Lamina shape, Fruit: Berry color at fruit ripening, Seed color, Root: Thickness of bark, and Root fracture. The Guidelines involve a set of 35 characteristics for the testing of candidate varieties and hybrids for their DUS. DUS test will need a minimum quantity of 60 g seed and will be subjected to a sample size of 360 plants, where the number of off-types should not exceed 7. The Protection of Plant Varieties and Farmer's Rights Authority (PPV&FRA) shall decide when, where, and in what quantity of the seed's material is required for testing a variety denomination applied for registration under the Protection of Plant Varieties & Farmers Rights (PPV&FR) Act, 2001 funded by Protection of Plant Varieties and Farmer's Rights Authority (PPV&FRA). Gazette Notification No. S.O. 1540(E) dated March 22, 2024.

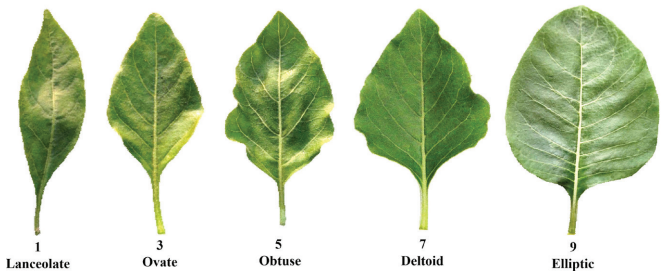


Fig.: Characteristic: Leaf lamina shape

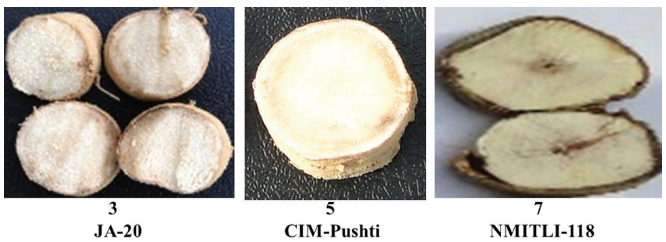


Fig. Characteristic: root bark thickness (mm)



Fig. Characteristic: Root brittleness



Dr. Tripta Jhang & her team

Dr. Channayya Hiremath डॉ. चैन्नय्या हिरेमथ



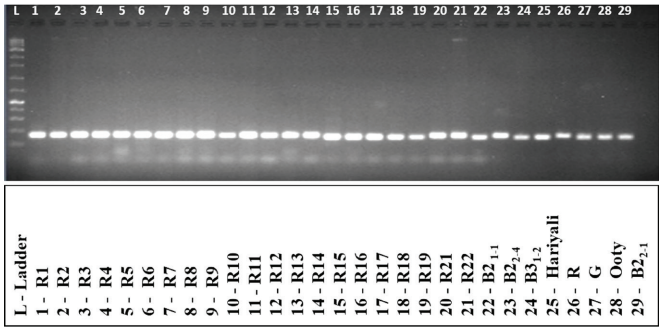
Crop Improvement of patchouli

A total of 14 stable high-yielding mutants were evaluated and in that, we have selected 5 top mutant clones for large-scale evaluation. The oil content (>3.00%) and patchouli alcohol (50-55%) of selected mutants were compared with check variety CIM-Shrestha (2.0 to 2.5 and 45%). The fresh herb yields varied from 350 gm to 600 gm per plant in selected mutants and 300 g to 600 gm per plant in control.



Molecular diversity in rosemary

In rosemary, the molecular diversity was assessed by using SSR Markers in seed progenies and clones. The lines rich in alpha-pinene, 1, 8-cineole, and camphor, verbenone than the control variety CIM-Hariyali were identified. In addition, lines with high carnosic acid, carnosol, and rosemarinic acid were also identified.



Assessment of molecular diversity among the seed progenies

Dr. Venkatesha K.T. डॉ. वेंकटेश के.टी.



Polyploid induction and characterization to develop a high steviol glycosides-rich variety in *Stevia rebaudiana* Bertoni

Thirty-seven morphologically distinct plants with putative polyploidy were produced in *Stevia rebaudiana* (variety CIM-Mithi) through colchicine treatment. Approximately 50 mg of fresh young leaves were excised from the control and all thirty-seven morphologically distinct putative polyploidy plants (one-month-old) derived from the different colchicine treatments. Nuclei were extracted from individual genotypes and analyzed for screening polyploidy using a cytoflex flow cytometer (Beckman Coulter). Out of thirty-seven putative polyploidy plants, fourteen were polyploids and all confirmed polyploids were tetraploids (ST-2, ST-6, ST-9, ST-10, ST-11, UK-3, UK-4, UK-61, UK-63, UK-65, UK-68, UK-69, and UK-70) except ST-1(triploid) (Fig. 1). Confirmed polyploid plants were further propagated through stem cuttings.

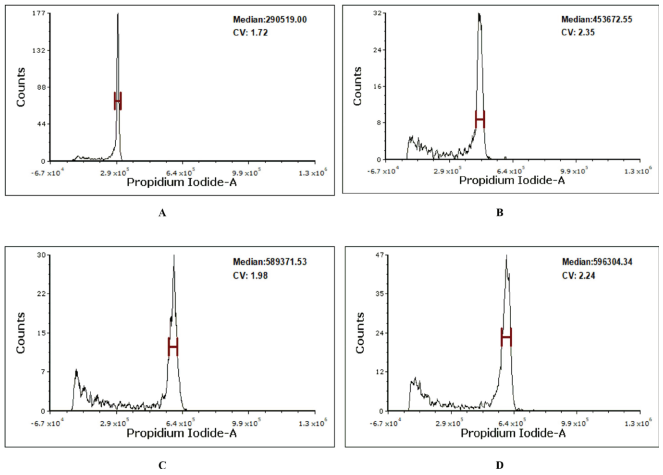


Fig.: Polyploidy identification by flow cytometric analysis. A. Control (2n=2x=22), B.ST-1(2n=3x=33), C.ST-2(2n=4x=44), D.ST-10(2n=4x=44).

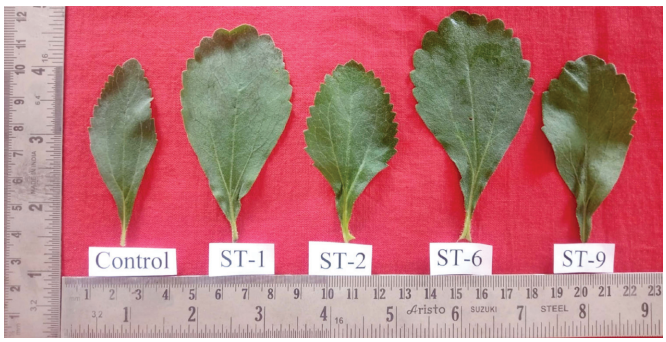


Fig.: Variability for leaf length and leaf width among polyploid genotypes of *Stevia rebaudiana*.

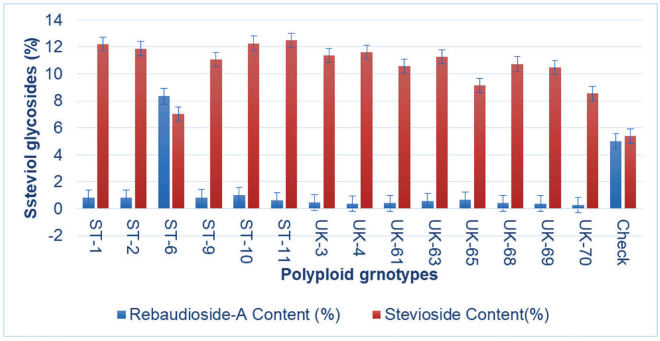


Fig.: Mean data on Rebaudioside-A and Stevioside content (%) in leaves of fourteen polyploid genotypes of *Stevia rebaudiana*.

Confirmed polyploid plants were transplanted into the field in replication along with control. Primarily, each polyploidy line including three replicates was characterized for different morphological and yield-attributing traits like plant height (cm), the number of branches per plant, internodal distance (cm), leaf thickness (mm), leaf area (cm^2), leaf fresh weight per plant (g), fresh weight of stem per plant (g), and leaf dry weight per plant (g) (Fig. 2 & 3). Thereafter, during the pre-flowering stage, leaves were collected from all fourteen lyploid plants separately and were shade-dried for the estimation of Rebaudioside-A and Stevioside content through HPLC analysis (Fig.).

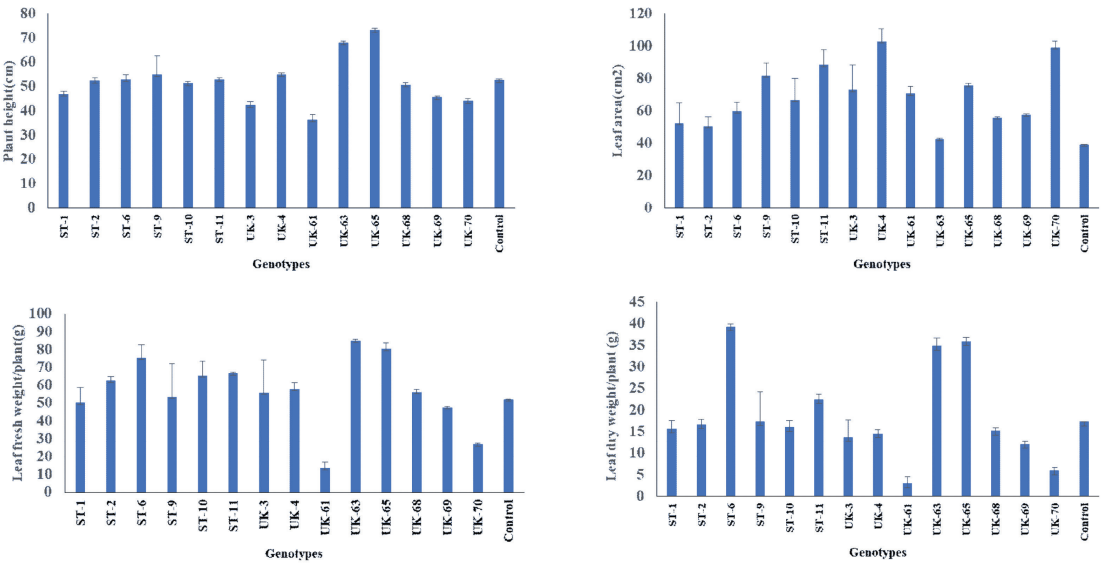


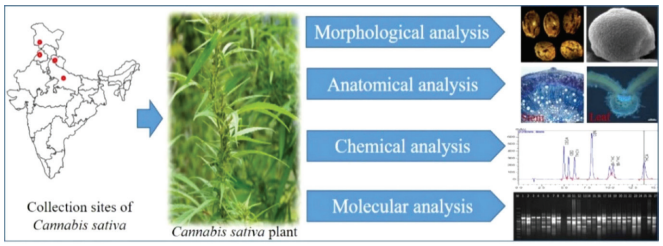
Fig.: Mean data of leaf yield and its contributing traits in polyploid genotypes, (a) Plant height(cm), (b) Leaf area(cm^2), (c) Leaf fresh weight/plant(g), and (d) Leaf dry weight/plant (g)

Dr Narendra Kumar डॉ. नरेन्द्र कुमार



Morpho-anatomical, phytochemical, and molecular diversity of North-Indian *Cannabis sativa* L. germplasms for CBD-rich genotype

Cannabis sativa L. has been an important medicinal and recreational plant since ancient times due to the presence of cannabinoids. Recently, cannabis research has remarkably emphasized cannabidiol (CBD) due to its immense medicinal properties. This study reports the morphological, anatomical, phytochemical, and molecular characterization of *C. sativa* collected from different regions in North India for diversity analysis and high-CBD accessions. The accessions significantly differed in plant height, stem diameter, leaf length, and number of primary branches ($p<0.05$). There is considerable diversity in the size, shape, and surface ornamentation of female *C. sativa* seeds. However, the shape, size, and annulus diameter of the pollen grains of male plants exhibited a narrow range in subtropical climates. The collenchymatous tissue revealed diversity among the accessions, producing wavy stems in most male accessions. The northern Indian cannabis populations are dominated by intermediate chemotypes, where both CBD and THC are present. CBD-rich fibre-type accessions are rarely found in nature. We found one CBD-rich accession with 0.19% THC and 1.36% CBD content, which could be a potential parental line for future breeding programmes. Dendrogram clustering and population structure analysis grouped the accessions into two major subpopulations irrespective of chemotype and sex. Overall, this comprehensive study provides valuable insights into the diversity of Indian *C. sativa* accessions, laying a foundation for further breeding and conservation efforts for CBD-rich Indian *cannabis* germplasms. The Nucleus, 2024.



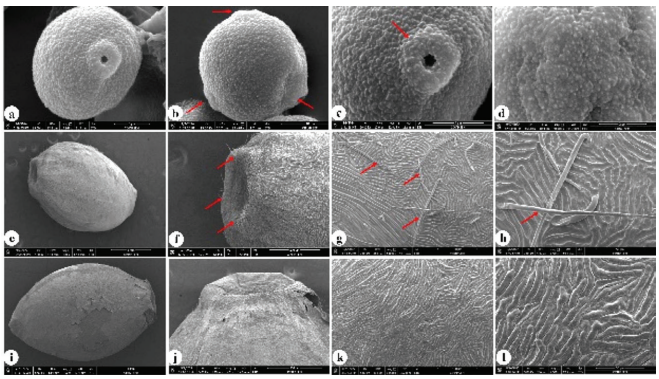


Fig. : Scanning electron micrographs of *C. sativa*. **a-d**, Pollen grains and **e-l**, seeds.

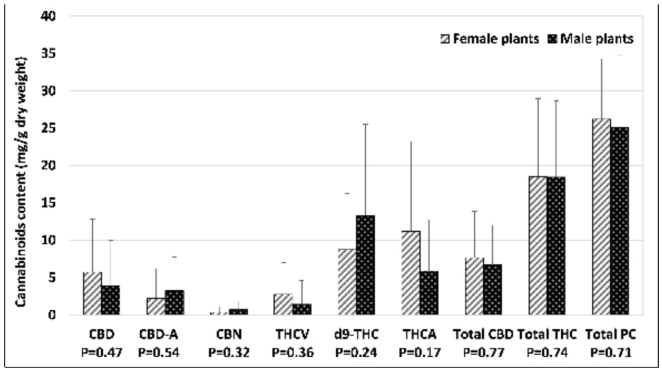


Fig. : Comparative graphical representation of phytocannabinoid content among female and male accessions. (*p* values were analysed by paired t tests.)

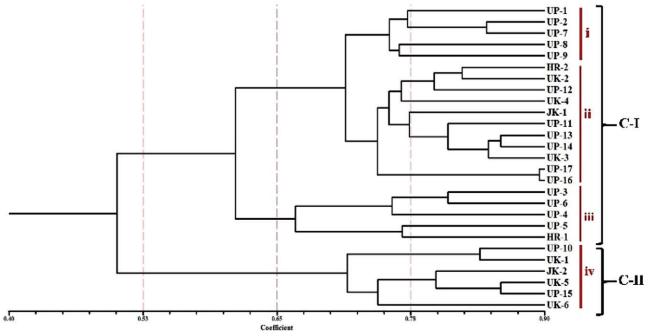


Fig. : The UPGMA method-based dendrogram of genetic distance among *C. sativa* accessions

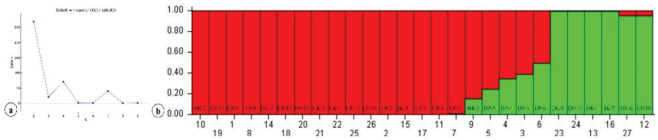


Fig. : Population structure analysis of *C. sativa* accessions using SCoT marker data.

Quantitative high-performance thin layer chromatography method development of astragalin and its chemical diversity in different populations of *Nyctanthes arbor-tristis* L.

Astragalin (kaempferol-3-O-β-D-glucoside) is a naturally occurring flavonoid that has long been used as a critical food ingredient and an essential template for developing novel drugs. The main aim of this paper is the method development and quantitative determination of astragalin in the leaf of 42 accessions of N. arbor-tristis collected from different regions. The HPTLC was performed with an optimized liquid-liquid separation, and mobile phase comprising ethyl acetate: ethanol: water: acetic acid (10:1.25:0.25:0.25) and densitometric evaluation was conducted in CAMAG TLC Scanner4 armed with WinCATS software. The R_f value of astragalin was 0.57 ± 0.01, and the linear regression data for the calibration plots showed a satisfactory linearity relationship with R^2 = 0.9994. The limits of quantification and detection were 23.76 ng/spot and 72ng/spot, respectively, and the accuracy of the method was 96.12% to 97.10% recovery. The results revealed that the astragalin



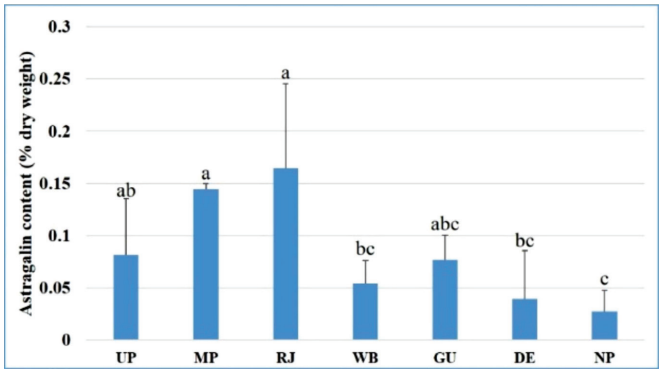


Fig. : Astragalin diversity in different populations of *N. arbor-tristis*

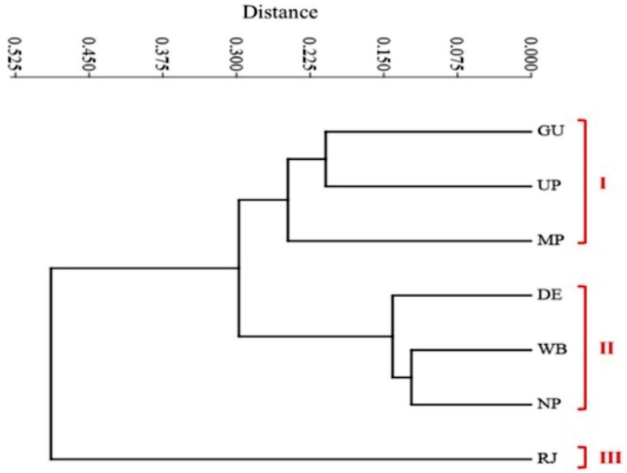


Fig. Dendrogram clustering of seven populations of *N. arbor-tristis* based on astragalin content

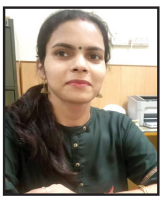
was found up to 0.25±0.01 % (dry weight sample) in leaf samples of different accessions. The astragalin content showed significant variation in accessions collected from different regions. The dendrogram clustering and PCA depicted the distinctness in plant metabolite contents between the populations. The HPTLC method could be applied to quantify astragalin in different plant samples. JPC - Journal of Planar Chromatography - Modern TLC, 2024.



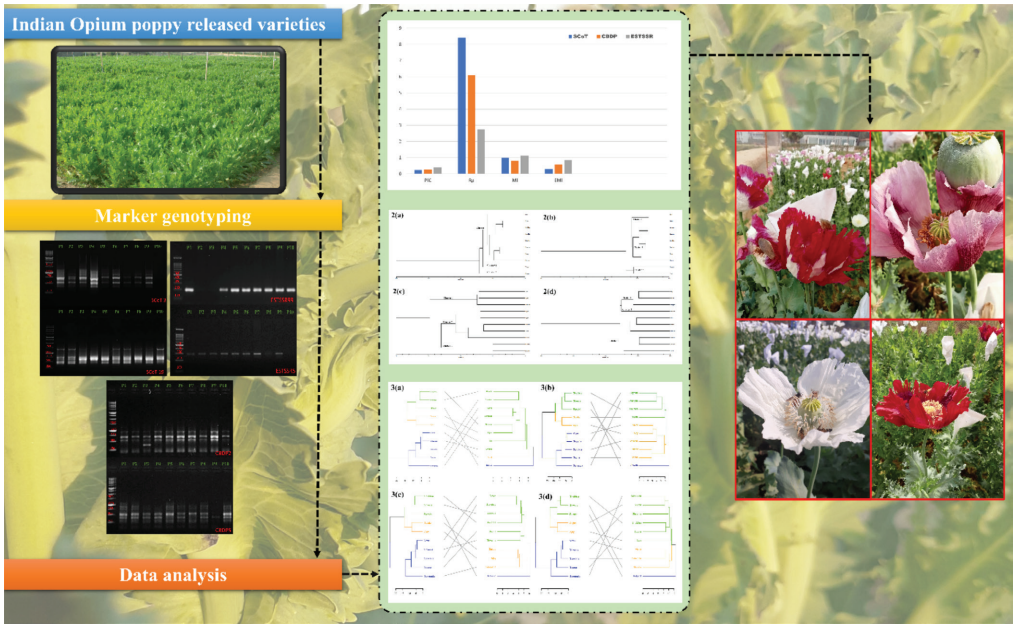
Dr. Narendra Kumar and his team

Dr Gunjan Tiwari डॉ. गुंजन तिवारी

Exploring the efficacy of targeted fingerprinting marker techniques in genetic studies of the Indian poppy (*Papaver somniferum* L.): A comparative analysis



Targeted fingerprinting marker techniques have emerged as promising tools in plant sciences, particularly in plant breeding. To initiate an effective breeding program for a licit but industrially potential plant, the opium poppy, a comparative assessment of these markers was conducted. In this study, we compared the Start Codon Targeted polymorphism (SCoT), CAAT box-derived polymorphism (CBDP), and Expressed sequence tag-simple sequence repeats (EST-SSRs) markers for their competence and informativeness in revealing genetic identity, relatedness, and diversity among ten released varieties of the Indian opium poppy. Among the markers studied, EST-SSR markers demonstrated higher discriminating power, attributed to their ability to unveil comparatively higher polymorphic information content, marker index, and effective marker index. While all three marker systems effectively discriminated the poppy varieties, EST-SSR markers showed greater genetic diversity and a more informative ancestral history-based dendrogram topology. Significant correlation coefficients were observed between EST-SSR and CBDP markers, particularly in the combined marker dataset. Furthermore, the co-phenetic correlation was significant for three marker systems, with EST-SSR markers showing maximum correlation. Notably, the dendrograms constructed using EST-SSR markers and combined marker data displayed a significant and positive correlation with phenotypic traits assessed for the ten poppy varieties. Overall, the findings highlight the superiority of EST-SSR markers in deciphering genetic relationships among Indian opium poppy varieties and suggest their potential as valuable tools in breeding and genetic diversity studies.



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Dr. Gunjan Tiwari & her team

Technology Dissemination & Computational Biology

HIGHLIGHTS

Technology Dissemination: The Technology Dissemination and Computational Biology division of CSIR-CIMAP has performed various rural development, societal, and business-related works for the stakeholders and farmers of medicinal and aromatic plants:

During the year 2023-24, 06 technologies related to different herbal formulations have been transferred. 19 agreements were signed with different industries, and three projects were also received from different industries and government departments.

16 skill development training programs have been organized in different parts of the country under various projects. In these training programs, 650 farmers and entrepreneurs have participated. About 1233 farmers were made aware of the cultivation of medicinal and aromatic plants by organizing one-day awareness cum training programs under various projects.

A step towards making it self-sustainable for the unemployed and poor women to make incense sticks using offered/used flowers for self-employment activity, CSIR-CIMAP organized 18 training programs on making incense sticks, this program was attended by 1312 women during the reporting period.

This year technology dissemination division successfully organized institutional events namely the Kisan Mela, CSIR Foundation Day, CIMAP Annual Day, National Technology Day, International Women's Day, and many more such kinds of activities.

During the period more than 8800 visitors including farmers, students, school/ college teachers, government officials, and other common people from society visited CSIR-CIMAP and were apprised about the different activities of the institute. CSIR-CIMAP technologies were also displayed in different



Scientists of Technology Dissemination and Computational Biology Divisional Units

Upper Panel (L to R): Dr Sanjay Kumar, Dr R.K. Srivastava, Dr R.S. Sharma, Dr Rushikesh
Lower Panel (L to R): Dr Manoj Semwal, Dr Feroz Khan, Dr. Bhaskar Shukla

exhibitions at various locations in the country. Three extension literature and three research articles were also published during the period.

Computational Biology: The research focus of the scientists involved in the bioinformatics related studies in the Computational Biology Unit research focus is development of bioinformatics tools & techniques. Also they are involved in Next Generation Sequencing data analysis of Medicinal and Aromatic Plants, Molecular Modelling & Simulation studies especially in lead identification/ optimization, virtual screening, biological activity/toxicity prediction through Quantitative Structure-Activity/Toxicity Relationship (QSAR/ QSTR), Pharmacophore Modeling, Structural Bioinformatics, Cheminformatics studies, In-silico studies in Bioprospection domains such as exploration of drug targets and their Mechanism of action through Molecular Docking & Molecular Dynamics, Predictive Pharmacokinetics, Predictive Toxicity Risk Assessment, Oral Bioavailability and Systems Pharmacology, Structure-Activity Relationship Studies on VEGFR2 Tyrosine Kinase Inhibitors for Identification of Potential Natural Anticancer Compounds.. Various biological databases like comprehensive relational database of Genetic Resources of Medicinal & Aromatic Plants (GRMAP) database, CoSSDb database, MAPsDb: a comprehensive repository of 27 medicinal and aromatic were designed and developed.

The QSAR model was developed through the forward stepwise Multiple Linear Regression (MLR) method to predict the inhibitory activity of natural compounds.

Scientist are also working in the precision agriculture related research activities using satellite and UAV data to develop machine learning AI models for aroma crops to predict yields and also monitor health. The unit is equipped with high end drones, hyperspectral camera, multispectral cameras, Optical Cameras and IoT sensors to use the advanced remote sensing tools and techniques for development of spectral libraries. The focus is to develop precise resource use in aroma crops using advanced remote sensing tools and techniques. During this period, externally funded projects from Haleon UK Trading Limited, United Kingdom, Industry Sponsored Project (SSP) and Region specific smart agrotechnologies for enhancing soil and plant health (RSSA) were also executed.

During the year 2023-2024 various studies on High throughput plant phenotyping system to evaluate the response of Menthol mint (Mentha arvensis) crop to water stress and Niche modelling for predicting habitat suitability for citron (*Citrus medica* L.) under climate change scenarios were also done.

Conduct various awareness programs among the farmers to upgrade their skills in the adoption of the sustainable technologies deployed and demonstrated under the collaborative project. The cluster will serve as a model for the implementation of sustainable agricultural practices and will aid by demonstration of technologies suitable for meeting zero-carbon emission targets. Also usage of the drones for precise and efficient spray of fertilizers, herbicides and insecticides at farmer's fields.

In the research work on the development of bioinformatics pipeline, an improved pipeline cncRNA Detector: a bioinformatics pipeline for distinguishing protein-coding, miRNA, and lncRNA from the Next Generation Sequencing (NGS) data or transcriptome datasets.

Seven-days Bioinformatics Skill Development Program (SDP) workshop at national level entitled "Ligand-Protein Interaction through Molecular Docking, MD Simulation & PCA in Determining Essential Dynamics" held on Dec. 07-14, 2023, sponsored by CSIR, New Delhi and organized by CSIR-CIMAP, Lucknow in hybrid mode. Total 28 participants were trained.

Organised various lectures under CSIR-JIGYASA Virtual lab project Various training programs were for school students.

During this period, the Computational Biology Unit published 01 publications in high impact journals such as Current Topics in Medicinal Chemistry.

Project Monitoring and Evaluation(PME): CSIR-CIMAP PME cell coordinates the planning for R&D activities and manages the ongoing projects funded by CSIR and various external funding agencies. PME Cell also plays a vital role in coordination between CSIR-CIMAP and CSIR-HQ, New Delhi. PME Cell organised several Lab Strategic Group (LSG) meetings of scientist to review the progress of ongoing projects and scrutinized projects before submission to different funding agencies. Coordinates the formulation and execution of new projects, contributes to creation of data metrics for CSIR-CMAP methodology. During

2023-24, 27 projects (including 17 GAPSs, 01 CNPs, 05 SSPs and 04 HCP) from various agencies like DBT, SERB-DST, State Govt., CSIR etc. were received and executed in CSIR-CIMAP.

ICT Services: Information & Communication Technology Department has the prime objective of providing networking, mailing and computer services at the institute. The major activities of the department are maintenance and up gradation of the mail, web, intranet, DHCP, DNS, router, bridge, anti-virus, backup and database servers. A campus LAN (Local Area Network) has been set which connects together approximately 350 computers spread over the CIMAP campus. The network utilises a mixture of optical fiber, UTP cables and switches. The internet access is also provided through a gateway to the external world via a 50 Mbps fibre optical link. Email and Internet services are thus brought to the user's desktops. ICT has started the initiative to establish a new Data Centre facility. Migration to improved infrastructure, with new servers to improve of the quality of service has been already completed. Multilayered firewall and antivirus solution have been implemented to enhance the overall network security. The department is also involved in development of the various in-house databases, applications (standalone & web), ICT enabled agro advisories, virtual lab for students under JIGYASAA and e-Office implementation for paperless work.

Human Resource Development: The HRD Cell coordinates academic activities related to the PhD and internship programs at CSIR-CIMAP. During 2023-24, 34 PhD students were admitted to the AcSIR PhD program in January and August sessions. Currently, CSIR-CIMAP has a total of 200 Ph.D. students registered in AcSIR or JNU. In addition to this, 8



CIMAP Students Seminar (CSS-2023)



Invited lectures by Prof. Saurav Datta

students who are registered for Ph. D. in various universities that hold MoU with CSIR-CIMAP, are carrying out their doctoral research under the co-guideship of CIMAP faculties. CSIR-CIMAP offered graduate training (internship) for 88 M. Sc. or B. Tech. (Biotechnology) students from various colleges and universities during the reporting period.

CSIR-CIMAP initiated the CIMAP Students Seminar (CSS) in 2023. The first seminar (CSS-2023) in this series was conducted on 21st December 2023, at the CIMAP Research Centre, Purara. In CSS-2023, 13 students presented their research work and interacted with the honorable member of the CIMAP Research Council, Dr. Alok Krishna Sinha. The students were also taken on a field visit at the CIMAP Research Centre Pantnagar and were shown different MAP conservatories, oil storage facilities, and quality analysis laboratories at the CRC Pantnagar.

The HRD Cell organized two invited lectures for the scientific fraternity of CSIR-CIMAP, during 2023-24. Dr. Sanjay Swarup, Director of NUS Environmental Research Institute (NERI) at the National University of Singapore talked on "How science-based support can enhance value and uptake of sustainable agriculture practices" on 5th February 2024. On 19th March 2024, Prof. Saurav Datta, Associate Professor, Indian Institute of Science Education and Research (IISER), Bhopal delivered and invited lecture on "BBX proteins regulating plant development".

Patent Cell: CIMAP Patent Cell works in cooperation with CSIR-Innovation Protection Unit, New Delhi to protect and manage intellectual property generated through research in the area of medicinal and aromatic plant varieties, agro-technology, bioactivities, chemical processes, and product formulations. During 2023-24 CSIR–CIMAP successfully filed 04 Indian patent.

Technology Dissemination:

Sanjay Kumar, Ramesh Kumar Srivastava, Ram Suresh Sharma, Rushikesh N. Bhise, R P Yadav, D.P. Mindala, Mrs. Priyanka Singh, Manoj Kumar Yadav, and Deepak Kumar Varma

Skill Development Programmes:

In this many skill development training, and awareness programs have been organized in different parts of the country under various projects.





Views of Training Programmes





Views of Training Programmes

Awareness programmes conducted under different projects

Sr. No.	Date	Place	No. of Participants		Sponsored by
			Total	Women	
1	15.05.2023	Mizoram Central University, Aizwl	40	30	HCP-0007
2	16.05.2023	Mizoram Central University, Aizwl	41	33	HCP-0007
3	04.06.2023	Ramapur Rauli, Lakhimpur Kheri	110	00	HCP-0007
4	05.06.2023	Pipraula, Suda, Dudhwa, Lakhimpur Kheri	155	45	HCP-0007
5	15.06.2023	Manikpur, East Champaran, Bihar	40	00	HCP-0007
6	16.06.2023	Sariya Baduraha, East Champaran, Bihar	45	00	HCP-0007
7	17.06.2023	Bangramuja, Muzaffarpur, Bihar	22	00	HCP-0007

8	02.07.2023	Deurbhal, Kondagaon, Chhattisgarh	50	16	HCP-0007
9	11.07.2023	CIMAP Lucknow, Sir Syed Trust, Rudauli, Ayodhya	30	05	HCP-0007
10	09.08.2023	Dhunaguru, Chwoka, Saraikela, Jharkhand	21	10	HCP-0007
11	10.08.2023	Bishunpur, Gumla, Jharkhand	08	07	HCP-0007
12	11.08.2023	Vill-Chechori, Pandawa Block, Palamu Dist. Jharkhand	48	11	HCP-0007
13	28.08.2023	Khamgaon, Nandurbar, Maharashtra	30	05	HCP-0007
14	29.08.2023	Malegaon, Nashik, Maharashtra	100	40	HCP-0007
15	31.08.2023	Baramati, Pune, Maharashtra	25	00	HCP-0007
16	06.09.2023	Kaisu, Namsai	40	00	HCP-0007
17	11.09.2023	Faink, Nagaland	42	00	HCP-0007
18	20.10.2023	IVLP, Programme, CIMAP Lucknow	55	54	HCP-0007
19	06.11.2023	Pipraula, Suda, Dudhwa, Lakhimpur Kheri	30	10	HCP-0007
20	07.11.2023	Ramapur Rauli, Lakhimpur Kheri	26	09	HCP-0007
21	23.11.2023	Pipraula, Suda, Dudhwa, Lakhimpur Kheri	60	28	HCP-0007
22	22.11.2023	Manikpur, Motihari, East Champaran, Bihar	50	05	HCP-0007
23	23.11.2023	Sareya Baduraha,Sangrampur, East Champaran, Bihar	65	02	HCP-0007
24	24.11.2023	Village Bangara, Muzaffarpur, Bihar	12	00	HCP-0007
25	01.03.2024	Village- Bangara Muja, Devriya, Muzaffarpur,Bihar	23	00	HCP-0007
26	03.01.2024	Jhadol, Udaipur, Rajasthan	10	02	HCP-0037
27	04.01.2024	Kankroli, Rajsamand, Rajasthan	08	01	HCP-0037
28	04.01.2024	Bachedi, Pratapgrah, Rajasthan	19	04	HCP-0037
29	05.01.024	Phulera, Jaipur, Rajasthan	28	08	HCP-0037
Total no. of Participants			**1233**	**325**	



Views of Awareness Programmes



Views of Awareness Programmes



Views of Awareness Programmes



Views of Awareness Programmes

Entrepreneurial training to women on making incense sticks using floral bio-resources

A step towards making self-sustainable for unemployed and poor women for making incense sticks using offered or used flowers for self-employment activity, CSIR-CIMAP organized18 training programs attended by 1312 women. The dates of such trainings along with number of participants are given in the Table below. Based on the feedback received after training, many women out of these trainings have started making incense sticks and selling them inthe local market.

Table: Training programmes on making incense sticks using floral bio resource

S. No.	Date	Place	No. of Participants Women	No. of Participants Men	Sponsored by
1.	9-May-2023	Training Programmes on Making Incense Sticks, Cones at CSIR-CIMAP Campus, Lucknow	19	19	SSP-370
2.	24-May-2023	Training Programmes on Making Incense Sticks, Cones at Haridwar	95	90	SSP-508
3.	25-May-2023	Training Programmes on Making Incense Sticks, Cones at Shaharanpur	75	5	SSP-508
4.	3-Jun-2023	Training Programmes on Making Incense Sticks, Cones at Deen Dayal Research Institute, Chitrakoot	60	57	SSP-508
5.	8-Jun-2023	Training Programmes on Making Incense Sticks, Cones at Haridwar	65	60	SSP-508
6.	25-Jul-2023	Training Programmes organized between 25-28 July, 2023 on Making Incense Sticks, Cones at CSIR-CIMAP Campus, Lucknow	41	17	HCP-0007
7.	9-Aug-2023	Training Programmes on Making Incense Sticks, Cones at CSIR-CIMAP Campus, Lucknow	24	23	SSP-508
8.	16-Sep-2023	Training Programmes on Making Incense Sticks, Cones at Madhurai, Tamil Nadu	80	80	HCP-0007
9.	20-Oct-2023	Training Programmes on Making Incense Sticks, Cones at Nandlalpura, Chhatarpur, M.P.	82	68	SSP-508
10.	26-Oct-2023	Training Programmes on Making Incense Sticks, Cones at CSIR-CIMAP Campus, Lucknow	30	30	HCP-0007
11.	13-Dec-2023	Three Days (13-15 Dec. 2023) Training-cum-Demonstration Programme in making of Incense sticks and cones at Vishakhapattanam	30	30	HCP-0007
12.	14-Dec-2023	One day training programmes on making Incense sticks at Chandrika Devi Temple, BKT, Lucknow	50	48	HCP-0007
13	21-Dec-2023	One day training programmes on making of Incense sticks at Kasauni, Uttrakhand	36	30	HCP-0007

14	31-Jan-2024	Two days training programmes on making of Incense sticks in Kisan Mela at CSIR-CIMAP	255	255	HCP-0007
15	8-Feb-2024	Training programmes on making of Incense sticks and cones at Chennai,Tamil Nadu	200	120	HCP-0007
16	12-Feb-2024	Training programmes on making of Incense sticks and cones at CSIR-CIMAP Lucknow	20	4	GAP-519
17	17-Feb-2024	Training programmes on making of Incense sticks and cones at Chunar, Mirzapur	105	105	HCP-037
18	20-Feb-2024	Training programmes on making of Incense sticks and cones at Agartala, Tripura	45	45	HCP-0007
Total no. of Participants			**1312**	**1086**	



Views of the Agarbatti Making Training Programme

Visitors

During 2023-24 more than 8800 visitors including students, teachers' farmers, government officials, and other common people visited the CSIR-CIMAP institute and were aware of the different research activities of the institute.



Views of Visitors at CSIR-CIMAP



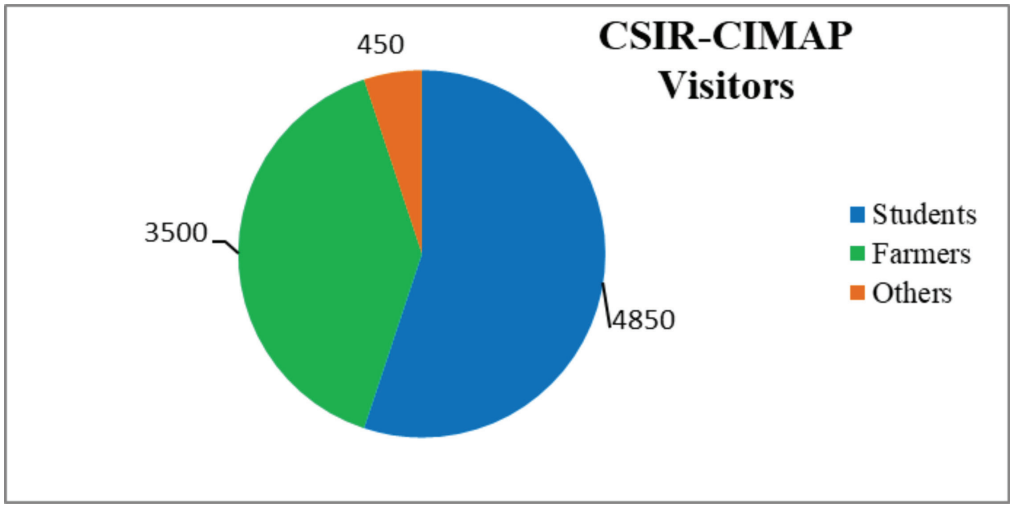


Views of Visitors at CSIR-CIMAP





Views of Visitors at CSIR-CIMAP



Visitors at CIMAP

CSIR-CIMAP Kisan Mela- 2024

CSIR-CIMAP Kisan Mela is the most popular event of the institute and is organized every year in the month of January to provide a unique platform for Scientists, Farmers, and Industries for interaction related to medicinal and aromatic plants. This year Kisan Mela was organized between 30-31January 2024in CSIR-CIMAP, Lucknow campus. A total of 5500 farmers, women, students, entrepreneurs, and representatives of industries participated in the 02-days Kisan Mela.

The main function of Kisan Mela was celebrated on 31st January 2024. On this occasion the chief guest Mr. Yogi Adityanath, Hon'ble Chief Minister Govt. of UP along with Mr. Surya Pratap Shahi, Hon'ble Cabinet Minister (Agriculture, Agriculture Education and Agriculture Research) Govt. of UP, and Dr. N. Kalaiselvi, Director General, CSIR graced the event. Dr. Prabodh Kumar Trivedi, Director, CSIR-CIMAP also addressed farmers during the Kisan Mela.

On this occasion released Kisan Mela souvenir book 'Aus Gyanya', an Informative booklet on 164 varieties developed by CSIR-CIMAP, the CSIR-Aroma mobile app, and a plant product Aloe Roma Gel were released in the presence of the chief guest.



Shri Adityanath Yogi, Hon'ble Chief Minister Govt. of UP



Address by Chief Guest



Glimpse of Kisan mela



Glimpse of Kisan mela



Hon. Chief Guest of Kisan Mela Explore CIMAP Technologies



SHGs Showcase their Agarbatti Making Skills



Dignitaries During CSIR-CIMA Kisan Mela-2024



Planting Material Distribution



Address by Dr. N. Kalaiselvi, Director General, CSIR



Address by Dr. P.K. Trivedi, Director, CSIR-CIMAP



Release of Aus Gyanya



Felicitation of Chief Guest

Participation in national and state-level exhibitions

During 2023-24, Scientists and technical teams demonstrated the CSIR-CIMAP technologies window in various exhibitions at different state and national levels. With these efforts and initiation, a large number of youth, women, and farmers were motivated toward the CIMAP mission program and technologies.

Sl. No.	Organized by	Period	Event	Place
1	J&K Government	24-27 April, 2022	DSIR/CSIR, GOI,	Palli Sabha, Jammu & K
2	ICAR-NBGPB	12-15 Sep 2023	Global Symposium on Farmer's Right	New Delhi
3	CSIR-NIScPR	11-16 Sep 2023	Grassroots Innovations and Skill Development Conclave for Rural Development	New Delhi
4	UP Government	17-19 Feb 2024	Regional Fruit, Vegetable and Flowers Exhibition	Rajbhavan, Lucknow
5	Rajasthan Govt	26-28 Feb 2024	Rajasthan Vigyan Mahostshov	Jaipur, Rajasthan



Awadh Shipgram, Lucknow

ICAR-NBPGR, New Delhi



CSIR- NIScPR, New Delhi



Jaipur, Rajasthan

CSIR-CIMAP participation in National Level Exhibitions.

Export-Import Performance of Patchouli oil in India

Patchouli is a perennial, erect, branched aromatic herb with fragrant leaves grown in tropical and subtropical regions with warm and humid climate conditions. It is cultivated mainly for its essential oil which is extracted by steam distillation from the tender parts of the dried leaves and stems using a small amount of oil. Patchouli oil is deep orange to amber in color and has an exotic, heavy, earthy aroma. The aroma of patchouli oil is usually described as a blend of earthy, woody, sweet, and musky notes. The objective of the study is an attempt to examine the annual and compound growth rates in the export and import of patchouli oil. The time series data of patchouli oil (export-import) was collected through the Department of Commerce, Ministry of Commerce and Industry, Government of India for a period of 2001-22 and was analyzed by using a growth model i.e., annual, compound growth rate instability and variation.

The results revealed that compound growth rates (CGRs) of export and import both are statistically significant at a 1% probability level. The CGRs of quantity export and value export are 14.26% and 15.47% respectively and in the case of import CGRs of quantity import are 22.15% per annum and CGRs of imported value are high i.e.,38.28% per annum. It is found that the import of patchouli oil is much higher than the quantity exported. The significant import of Patchouli oil was observed from countries Indonesia, Singapore, Spain, and Switzerland. Since the increase in the demand for patchouli oil in both domestic and international markets, there is a significant opportunity to enhance production by expanding the patchouli crop area. It is also necessary to increase cultivation to reduce its import from other countries.

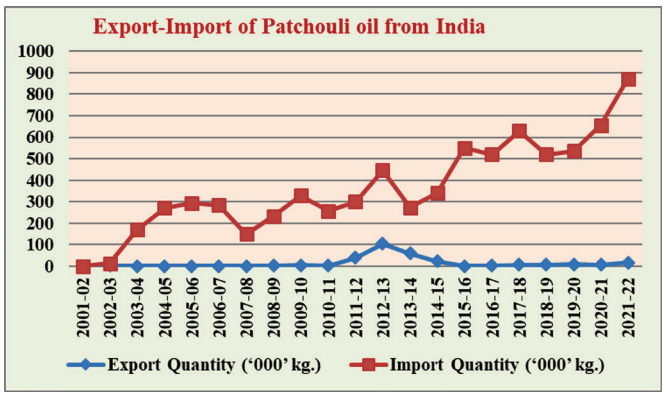


Fig. Export and Import Quantity (000' Kg.) of Patchouli Oil

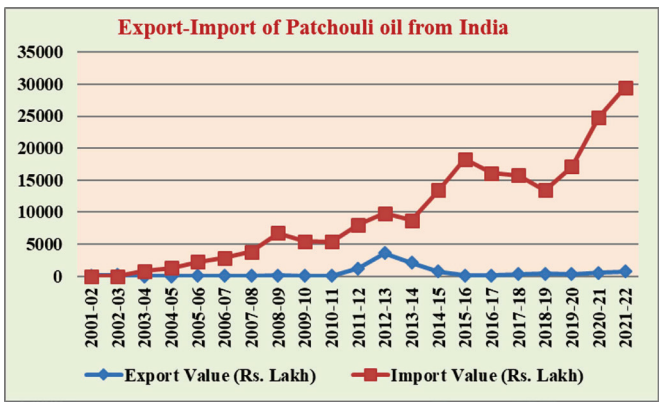
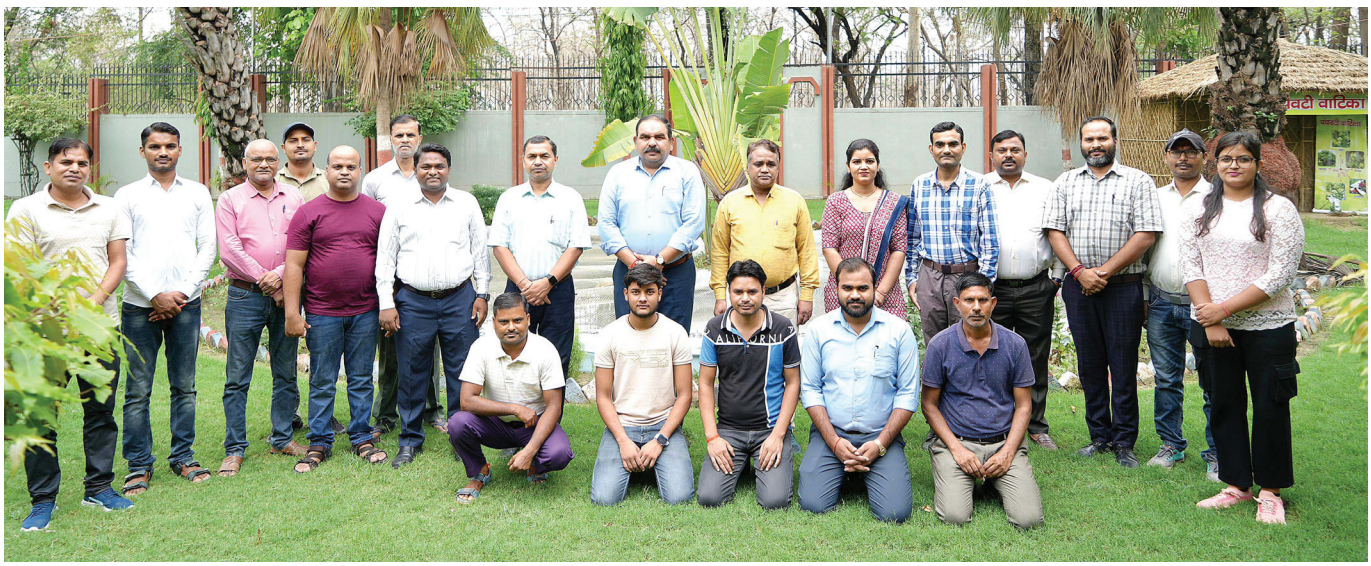


Fig. Export and Import Value (Rs. in Lakh) of Patchouli Oil



Technology Dissemination Team

Dr. Manoj Semwal डॉ. मनोज सेमवाल

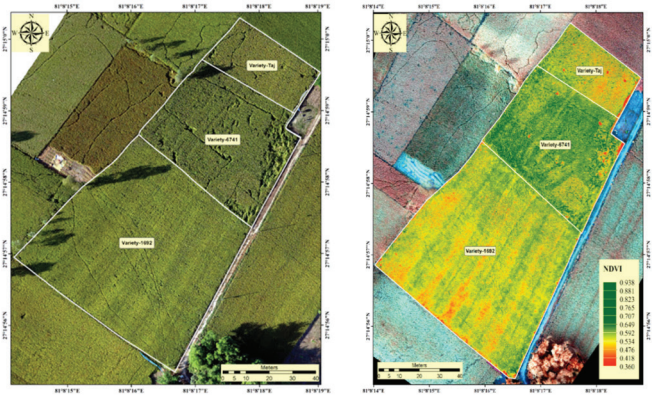


UAV based geo-tagged multispectral, proximal hyperspectral and LiDAR images collection during different crop stages for the development of predictive analytic tools for early detection of crop stresses

Conventional way of crop management practices to decide the crop management strategies often fails due to not considering the actual requirement of the crops during their growth phases and that often leads towards overexploitation which in turn can result in scarcity of available resources in the long term. The actual challenge to developing crop management practices is to improve efficiency and yield without compromising the long-term sustainability of the cropping system. Advances in automated and high-throughput imaging technologies today provide large amounts of high-resolution images and sensor data of plants. Extracting patterns and features from this large corpus of data requires the use of machine and deep learning (ML/DL) tools to enable data assimilation and feature identification for stress phenotyping. Research work at CSIR-CIMAP under the HCP-057 project, focuses on the development of predictive crop models for paddy and menthol mint crops where different ML/DL approaches can be deployed using early predictive models for classification, quantification, and management/ interventions in the crops.

The highlights of the work done are:

- UAV equipped with Micasense Altum (multispectral sensor) was flown over the three different paddy varieties and data was captured at three different altitudes i.e. 40, 80 and 120-meter for optimum altitude of UAV flight. 80 m was found to be optimum based on the area to be covered, ground sampling distance acquired, and spectral resolution of the imagery obtained. Paddy crop (one-square-meter plot) was also cut to collect the samples for biomass and grain yield measurements at the farmer's field to derive averages of crop yields for individual fields using the random stratified sampling approach just after the UAV data collection. Also, the data on crop variety, plant height, total tillers per hill, grain: straw ratio, grain yield, panicle length and number, filled grains per panicle, and above ground biomass was recorded



Discrimination of Paddy Varieties using multispectral camera on UAV

Demonstration, Deployment and Popularization of sustainable mint based agro-technologies in Barabanki district, Uttar Pradesh for 'Building a resilient mint supply chain in India'

Under the project sponsored by 'M/s Haleon UK Pvt. Ltd.', CSIR-CIMAP is demonstrating, deploying and popularizing sustainable menthol mint-based agro and processing technologies in Barabanki district, Uttar Pradesh. These activities will not only enhance the farmer's income but also help in sustainable production of menthol mint in the clusters. The major objectives of the project are:

Deploy high-yielding menthol mint varieties developed by the institute and generate sufficient quantities of planting material at 5000 farmer's field of the high-yielding varieties to be distributed to enhance their incomes.



Mentha suckers distribution to more than 1200 beneficiary farmers under clusters



Demonstration of Early Mint Technology and plantation of mentha crop



Awareness cum training programs conducted under the project

Create awareness about Good Agricultural Practices (GAP) and deploy and demonstrate them at farmers' fields in the selected clusters farmers.

Deploy one hybrid solar distillation unit in a selected cluster for reduction of the carbon emissions

Utilize drones for real-time crop monitoring and spraying at selected fields for efficient use of resources and reduction of losses to human health and soil due to exposure to pesticides, and herbicides.

Menthol mint deoiled herb bio-waste utilization for vermicomposting, etc for sustainable production of mints, which will not only enhance the farmer's income but also help in sustainable production of menthol mint in the clusters.

Conduct various awareness programs among the farmers to upgrade their skills in the adoption of the sustainable technologies deployed and demonstrated under the collaborative project.



Dr. Manoj Semwal & his team

Dr Feroz Khan डॉ. फिरोज खान



Structure-activity relationship studies on VEGFR2 Tyrosine Kinase inhibitors for identification of potential natural anticancer compounds

The QSAR model was developed through the forward stepwise multiple linear regression (MLR) method. A developed QSAR model was used to predict the inhibitory activity of natural compounds. Absorption, distribution, metabolism, excretion, and toxicity (ADMET) assessment and molecular docking studies were performed. The binding stability of the natural compounds with VEGFR2 was elucidated through molecular dynamics (MD) simulation. The developed QSAR model against VEGFR2 showed the regression coefficient of the training dataset (r2) to be 0.81 and the external regression coefficient of the test dataset (r2 pred) to be 0.71. Descriptors, viz., electro-topological state of potential hydrogen bonds (maxHBint2, nHBint6), atom types (minssNH), maximum topological distance matrix (SpMAD_Dt), and 2D autocorrelation (ATSC7v), have been identified. Using this model, 14 natural compounds have been selected that have shown inhibitory activity for VEGFR2, of which six natural compounds have been found to possess a strong binding affinity with VEGFR2. In MD simulation, four complexes have shown binding stability up to 100 ns. The developed QSAR model has identified 5 conserved activity-inducing physiochemical properties, which have been found to be correlated with the anticancer activity of the non-identical ligand molecules bound with the VEGFR2 kinase. Lavendustin_A, 3'-O-acetylhamaudol, and arctigenin have been obtained as possible lead natural compounds against the VEGFR2 kinase.

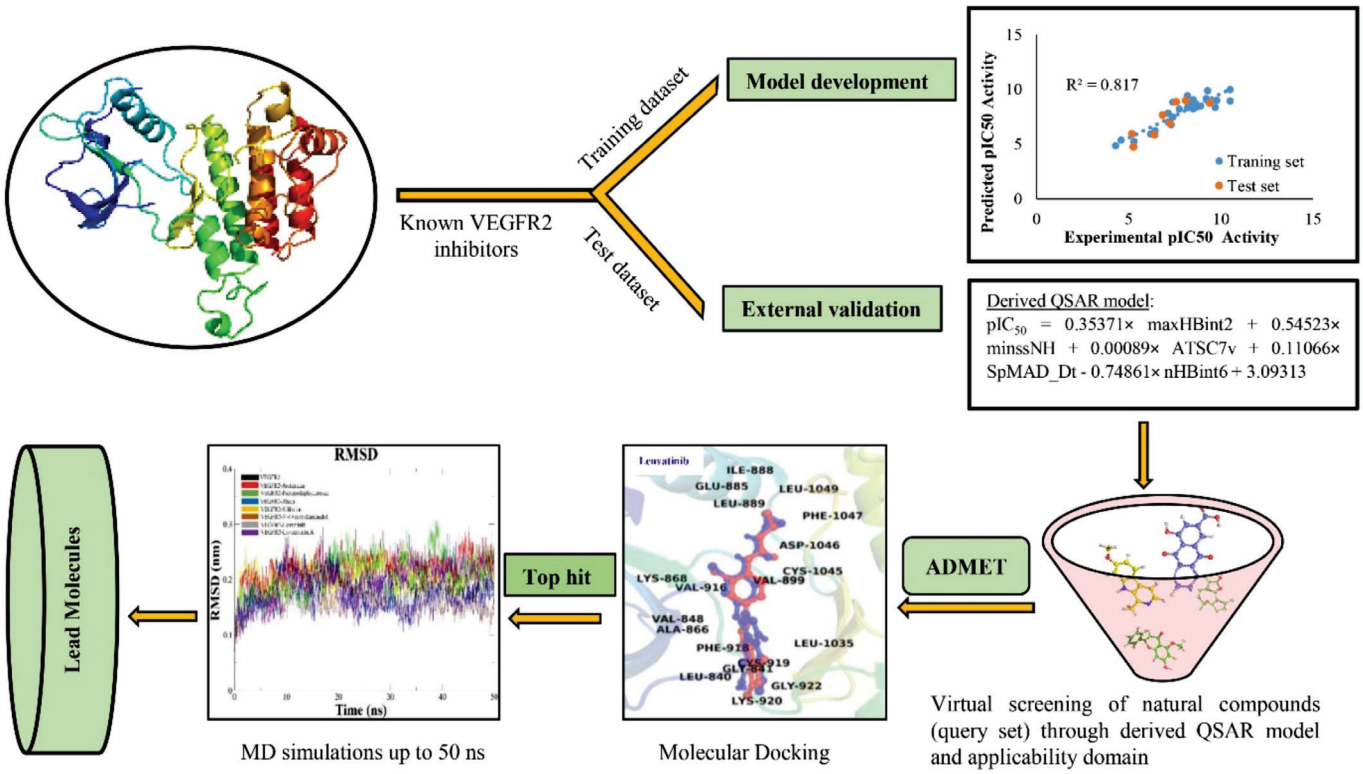
Over-expression of Vascular Endothelial Growth Factor Receptors (VEGFRs) leads to the hyperactivation of oncogenes. For inhibition of this hyperactivation, the USA Food Drug Administration (FDA) has approved many drugs that show adverse effects, such as hypertension, hypothyroidism, etc. There is a need to discover potent natural compounds that show minimal side effects. In the present study, we have taken structurally diverse known VEGFR2 inhibitors to develop a Quantitative Structure-Activity Relationship (QSAR) model and used this model to predict the inhibitory activity of natural compounds for VEGFR2.

The QSAR model was developed through the forward stepwise Multiple Linear Regression (MLR) method. A developed QSAR model was used to predict the inhibitory activity of natural compounds. Absorption, Distribution, Metabolism, Excretion, and Toxicity (ADMET) assessment and molecular docking studies were performed. The binding stability of the natural compounds with VEGFR2 was elucidated through Molecular Dynamics (MD) simulation.

The developed QSAR model against VEGFR2 showed the regression coefficient of the training dataset (r2) as 0.81 and the external regression coefficient of the test dataset (r2 test) 0.71. Descriptors, *viz.*, electro-topological state of potential hydrogen bonds (maxHBint2, nHBint6), atom types (minssNH), maximum topological distance matrix (SpMAD_Dt), and 2D autocorrelation (ATSC7v), have been identified. Using this model, 14 natural compounds have been selected that have shown inhibitory activity for VEGFR2, of which six natural compounds have been found to possess a strong binding affinity with VEGFR2. In MD simulation, four complexes have shown binding stability up to 50 nanoseconds.

The developed QSAR model has identified five conserved activity-inducing physio-chemical properties, which have been found to be correlated with the anticancer activity of the non-identical ligand molecules bound with the VEGFR2 kinase. Lavendustin_A, 3'-O-acetylhamaudol, and arctigenin have been obtained as possible lead natural compounds against the VEGFR2 kinase.

Medicinal Chemistry, 20(6):646-661. (IF: 2.3)



Derived QSAR equation:

Predicted pIC_{50} = (0.35371× maxHBint2) + (0.54523× minssNH) + (0.00089× ATSC7v) + (0.11066× SpMAD_Dt) + (- 0.74861× nHBint6) + 3.0931

Table: Description of independent chemical descriptors.

Descriptor	Type of descriptor	Descriptor description
maxHBint2	Electrotopological State Atom Type Descriptor (2D)	Maximum E-State descriptors of strength for potential Hydrogen Bonds of path length 2
minssNH	Electrotopological State Atom Type Descriptor (2D)	Minimum atom-type E-State: -NH-
SpMAD_Dt	Detour Matrix Descriptor (2D)	Spectral mean absolute deviation from detour matrix
nHBint6	Electrotopological State Atom Type Descriptor (2D)	Count of E-State descriptors of strength for potential Hydrogen Bonds of path length 6
ATSC7v	Autocorrelation Descriptor (2D)	CenteredBroto-Moreau autocorrelation - lag 7 / weighted by van der Waals volumes

Table: Statistical parameters for QSAR model assessment.

Statistical parameter	Explanation	Accepted range	Result of the selected model
$r^2_{\text{training set}}$	Squared correlation coefficient of the training set	≥ 0.6	0.819
Q^2cv	Cross-validation coefficient	≥ 0.5	0.772
r^2- Q^2cv	difference between r^2 and Q^2cv	≤ 0.3	0.047
$N_{(\text{test set})}$	Number of external test set	≥ 5	8
$r^2_{\text{pred.}}$	Squared correlation coefficient of the test set	≥ 0.5	0.7135

Table: Statistical correlation matrix of independent descriptors and their Variation Inflation Factors (VIF).

	maxHBint2	minssNH	ATSC7v	SpMAD_Dt	nHBint6	VIF
maxHBint2	1					1.72
minssNH	0.341708	1				1.50
ATSC7v	-0.47559	0.171132	1			1.57
SpMAD_Dt	0.024342	0.182491	-0.05087	1		1.11
nHBint6	0.088084	0.225489	0.057444	-0.17679	1	1.11

Availability: https://github.com/csircimapbioinfo/QSARMV

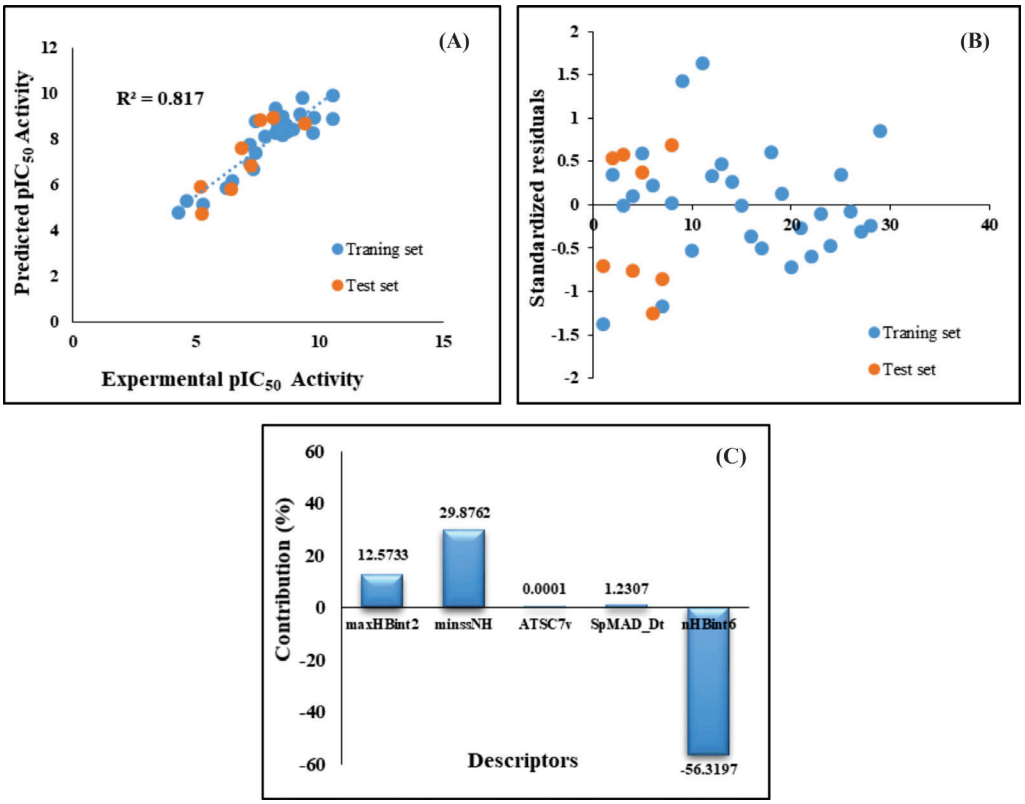


Fig.: **A.** Scatter plot showing linear relationship of the experimental and predicted pic_{50} values for training set compounds (Blue) and the external test set compounds (Orange). **B.** Standardized residual plot of the experimental and predicted activity (Blue: training set; orange: test set). **C.** Contribution plot of each independent descriptor with inhibitory activity.

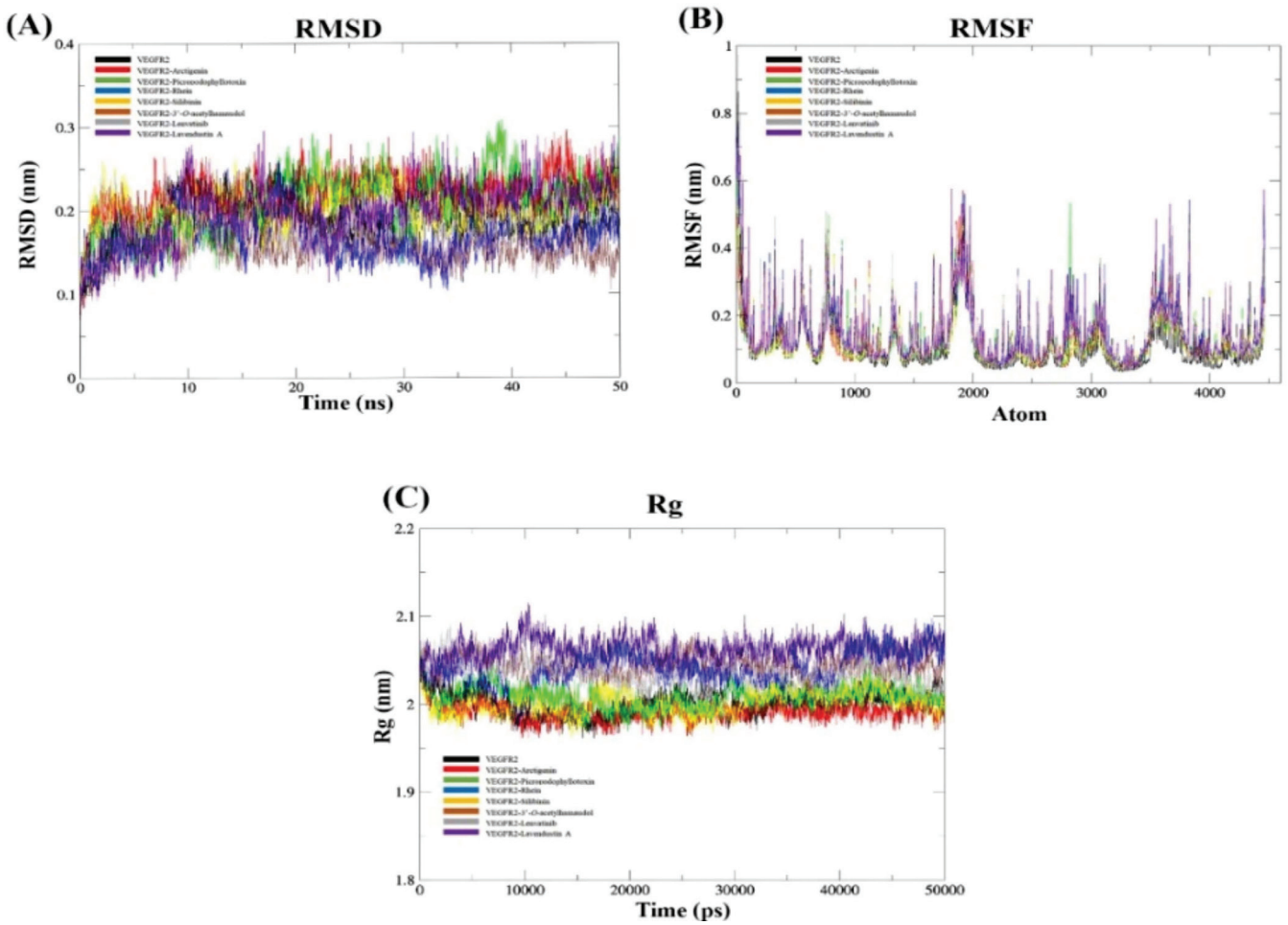


Fig.: **A.** Correlative stability of docking complex on the basis of average root-mean-square deviation (RMSD) **B.** Correlative stability of docking complex on the basis of root-mean-square fluctuations (RMSFs). **C.** Correlative stability of docking complex on the basis of radius of gyration (R_g).

Other Research Studies

- ***In-silico* Transcriptome (RNA-Seq) data analysis & functional annotation of *Pelargonium graveolens*:** Analyzed De-novo transcriptional profile (transcriptome RNA-Seq data analysis) of different genotype/lines of Pelargonium graveolens which indicate that auxin-regulated longifolia gene is accountable for augmentation in leaf size and ZF RICESLEEPER attributes growth upregulation. Collectively, data provides valuable insights into unravelling the mechanism of Thchit42-mediated crosstalk between morphological and chemical alteration in transgenic plants. This knowledge might create novel opportunities to cultivate fungal-resistant geranium throughout all seasons to fulfil the industrial demand. Predicted genes were confirmed through wet lab characterization.
- ***In-silico* inhibition mechanism exploration through Molecular Docking, MD Simulation & eADMET studies on *Andrographis paniculata* root active phytochemical MDHW for anti-obesity activity by inhibiting Pancreatic lipase:** Performed Molecular docking, MD simulation and eADMET studies on 7-O-methyl-dihydro wogonin (MDHW), an active phytochemical from Andrographis paniculata root by inhibiting Pancreatic lipase for managing lipid metabolism-associated disorders, especially obesity management. Predicted results also validated

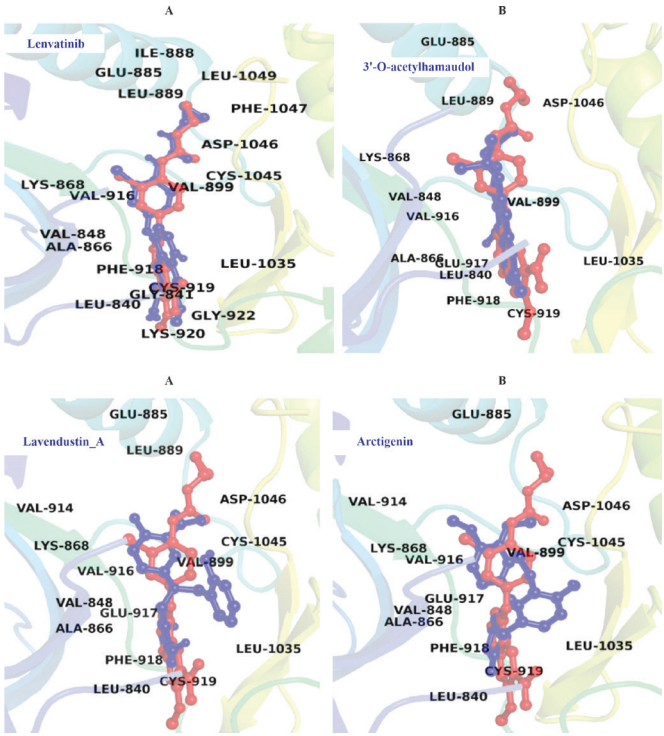


Figure 3. Molecular docking poses of the predicted hit natural compounds on VEGFR2 kinase receptor. (A) Re-docking of Lenvatinib (+ve control) on VEGFR2 with docked binding energy of -10.4 Kcal/mol, (B) 3'-O-acetylhamaudol with docked binding energy of -8.7 Kcal/mol, (C) Lavendustin-A with docked binding energy of -8.6 Kcal/mol, (D) Arctigenin with docked binding energy of -8.6 Kcal/mol.

through analytical chemistry (HPLC study) and in-vitro evaluation studies.

- ***In-silico* studies of Glycyrrhetinic acid derivatives as Antitubercular agents:** Glycyrrhetinic acid (GA) is a biologically active triterpenoid acid, isolated from the root of the Glycyrrhiza plant species. In our earlier studies, the semisynthetic analogs of GA have been reported to possess improved anticancer activities against various cell lines, antimalarial, and antifilarial activities. The derivatives, Methyl glycyrrhetinate (GA-1), 3-O-(4-methyl-phenyl)-ethanoyl methyl glycyrrhetinate (GA-1a), 3-O-(4-fluoro phenyl)-ethanoyl methyl glycyrrhetinate (GA-1c), 3-O-(4-methoxy trans cinnamyl)-ethanoyl methyl glycyrrhetinate (GA-1e) and 3-O-{(4-chlorophenyl)-ethanoyl methyl glycyrrhetinate (GA-1g) showed improved antitubercular activity (in the range 38.76 to 51.546 mM) over the parent molecule (MIC >106.157 mM). The derivative, 3-O-(4-aminobenzoyl)- methyl glycyrrhetinate (GA-1h) was found most active (MIC 20.695 mM), which was further supported by high binding affinity with the selected antitubercular target proteins in molecular docking studies.
- ***In-silico* Molecular Docking & eADMET studies on 6-alkoxy and 6-hydroxy-alkyl amine derivatives of Braylin as Vasorelaxing agents:** performed molecular docking and eADMET studies on 6 alkoxy and 12 6-hydroxy-alkyl amine derivatives of Braylin (8,8-dimethyl chromenocoumarin) present in the plants of family Rutaceae and Meliaceae showed vasorelaxing and anti-inflammatory activities. Also confirmed through chemical synthesis and *in-vitro/in-vivo* activity evaluation.
- ***In-silico* Molecular Docking studies on amide derivatives of 3-aryl-3H-benzopyrans as osteogenic agent concomitant with anticancer activity.** Compound 24b showed significant binding affinity with estrogen receptor-beta (ER-â).



Dr. Feroz Khan & his team

Dr Bhaskar Shukla डॉ. भास्कर शुक्ला

Identification of mRNAs, lncRNAs and miRNAs in MAPs



cncRNADetector is an accurate bioinformatics pipeline for identification of coding and noncoding RNA such as lncRNA, miRNA and other by combining entire filtering steps into a single platform. It takes SRA files or assembled transcript sequences in FASTA format as input and gives the output of every step in separate files. The steps involve various filtering strategies and utilization of Coding Potential Calculators such as CPC2, LGC and PLEK.The non-coding RNA has gotten a lot of interest in the scientific community over a few decades because of its involvement in gene regulation. Experimentally validated plant lncRNAs have been shown to regulate important agronomic traits such as phosphate starvation response, flowering time and interaction with symbiotic organisms, making them of great interest in plant biology and in breeding. We are working on new pipeline cncRNADetector which will not only classify lncRNAs but also mRNAs and miRNA.

MAPsDb is a comprehensive database of RNAs identified computationally in 27 MAPs species. We applied several filters to discriminate between non-coding and protein-coding transcripts. MAPsDb has many unique features such as statistical charts, annotated mRNAs, phsiochemical properties, secondary structure, miRNA, gene and SRA data providing convenient data accesses and download engines. We believe MAPsDb is a truly functional knowledgebase and will provide novel insights into Medicinal and Aromatic plant research and benefit the whole research community.



Fig.: MAPsDb

"CSIR-Aroma": A Bilingual Informatory digital android mobile App for Aroma Crops

'CSIR-Aroma' is an android mobile app has been developed for providing information on aromatic crops and advisory digital tool for farmers and entrepreneurs interested in aroma crops and products.

This app provides comprehensive information on aromatic crops covered under CSIR-Aroma mission which includes crop cultivation, harvesting, yield, quality, popular varieties and distillation processes. Pest and disease-related information, along with their symptoms and management has also been provided. Farmers can interact through this app with scientists to obtain any scientific advice related to their crop cultivation, processing, disease and pest's information. Geocoded crop wise aroma cluster and distillation units under the mission have been displayed in this app which will be very helpful for the farmers to distill their produce from nearby distillation units.

Information related to the products that are developed under the aroma mission has been provided for industry and entrepreneurs. A market platform has also been created as a part of this app, so that registered buyers and sellers can contact each other.



Fig.: Snapshot of CISR-Aroma android mobile app



CSIR-CENTRAL INSTITUTE OF MEDICINAL AND AROMATIC PLANTS

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National & International Programs

CSIR-Aroma Mission Phase-III

Highlights of the major activities carried out under the CSIR Aroma Mission

OVERALL PROGRESS AT A GLANCE

Total Area Covered (ha)	**1100**
Technology Transfers (number)	**02**
Total Awareness/Training Programs (number)	**132**
Total Manpower Trained (number)	**7768**

CSIR Aroma Mission was conceptualized aiming at popularizing aromatic crops among farmers and positioning the nation in the global market, recognizing the ever-growing demand for aromatic crops and their products. The main objective of the mission is to raise awareness among farmers about the potential benefits of growing aromatic crops, such as higher benefits, lower input costs and reduced environmental impact. By promoting the cultivation of aromatic crops and providing farmers with the necessary knowledge, training and resources, the mission strives to diversify their cropping patterns for higher incomes in order to enhance their livelihoods. Thus, the mission recognizes the potential of aroma crops in terms of economic value and environmental sustainability.

The Council of Scientific & Industrial Research (CSIR) has successfully carried out two phases of the Aroma Mission, namely Phase-I (2017-20) and Phase-II (2020-23), and has now moved on to Phase III (2023-2026) aiming at sustainable development, covering an additional area of about 16,000 hectares through the interventions of CSIR along with value addition and entrepreneurship development. Ever since its inception, through the application of scientific and technological advancements, CSIR-CIMAP, as the nodal laboratory, has effectively executed the mission's initiatives in cultivation, processing, value addition, and other related areas.

This phase of the mission will promote the cultivation of aroma crops for essential oils, which are imported in huge amounts by our domestic aroma industry; an effort towards Atma Nirbharta and mainly targets the aroma crops whose essential oils are still imported in massive amounts so that our user industry could minimize their dependence on other countries for raw materials. Also, efforts would be made to sustain the productivity of crops where India positions itself as one of the largest producers of specific essential oils.



CSIR-CIMAP Aroma mission team visited the Cyclone affected coastal Vetiver cluster at Nochikadu, Cuddalore (Dt.), Tamil Nadu



Team of CSIR CIMAP scientists visited Dhanushkodi, an abandoned town at the southeastern tip of Rameswaram island, where erosion of the soil has caused enormous losses.

During the first year of CSIR-Aroma Mission Phase-III (2023-24), CSIR-CIMAP has made significant strides in expanding the cultivation of aromatic crops and implementing various initiatives. This has led to the successful coverage of an additional 1100 hectares



Farmers planting Lemongrass in Vidisha district of Madhya Pradesh



Performance of Kharif Season Mint Technology in Bundelkhand region



Menthol Mint CIM-UNNATI variety cluster in Villages Nawa Pind, Pipli, Donawala of Jalandhar district, where farmers are adopting EMT technique of Menthol Mint



CSIR-CIMAP Research Centre, Hyderabad distributed Lemongrass slips to farmers.



The ICICI Foundation sponsored the essential oil distillation unit whereas the technical know-how was provided by the CSIR-CIMAP Research Centre, Hyderabad.



Tractor Mount Solar Distillation Unit Installed by CSIR-CIMAP under CSIR-Aroma Mission Phase-III

of land with aromatic crops. Furthermore, technical support to enable farmers in processing their own crops was provided.

CSIR-CIMAP also organized numerous awareness, training, and skill development programs to enhance the knowledge and skills of farmers involved in cultivating and processing aromatic crops. During this year, about 132 programmes were conducted including training programmes on making incense sticks and cones and about 7800 trained human resource were developed. The training programmes helped developing about 35 entrepreneurs under the CSIR-Aroma Mission Phase-III.



Three-day training programme on Agarbatti making utilizing waste flowers was organized by CSIR-CIMAP under CSIR-Aroma Mission Phase-III



One-day awareness programme on cultivation, processing and marketing of aromatic plants at Arkaneer, West Tripura under CSIR-Aroma Mission-III.



A one-day training, awareness and demonstration programme on aromatic crops at Chhoi, Ramnagar, Nainital under CSIR Aroma Mission Phase-III



A glimpse of the second day (22nd February 2024) of the 3-day Skill Development-cum-Training Program organized by CSIR-CIMAP Research Centre, Hyderabad under CSIR-Aroma Mission, Phase-III



MOU signed between BigM Pharmaceutical company and CSIR-CIMAP



Agreement signed between CSIR-CIMAP and Trichy Tech

Moreover, MoUs have also been signed with various organizations/ NGOs/ Universities/ State Government/ FPOs, etc. in the year 2023-24. These efforts by CSIR-CIMAP aim to strengthen the aromatic crop sector and contribute to the economic and social well-being of farmers and local communities.

Other achievements of CSIR-CIMAP (2023-24) under CSIR-Aroma Mission Phase-III

Interventions made under the sustainable clusters:

- Spraying for nano-urea and pesticides in scientific manner through Drones
- Solar powered field distillation unit
- Recycling of distilled aromatic crop wastes through vermicomposting
- Reducing chemical inputs by 50%
- Integration of other activities like beekeeping, vermicomposting and mushroom growing for income enhancement



Spraying at farmer's field through Drones

- CSIR-CIMAP highlighted the cultivation practices of various aromatic crops at Akashwani through live Phone in Programme. One beneficiary farmer of CSIR-Aroma Mission presented his success story on Akashwani, Lucknow.
- The Exclusive Vetiver stall opened under "One Station One Product" at Nungampakkam railway station, Chennai by Aroma Mission beneficiary Mr. Sriram Nath from Rameshwar.
- CSIR-CIMAP launched CSIR-Aroma Mission mobile app for crop-advisory and establishing market linkages
- CSIR-CIMAP Participated in 25th EOAI Biennial Event World Aroma Ingredients Congress & Expo 2024 from 8-10 February at Chennai, Tamil Nadu for interaction with the aroma industry.
- A decade of Science Technology Panorama for Atma Nirbhar Bharat. A compilation by Honorable Principal Scientific Advisor, Govt. of India, featuring of CSIR Aroma led by CSIR and CSIR-CIMAP & partner institutions of CSIR, playing an important role in enhancing rural



Recycling of distilled aromatic crop waste through vermicomposting



Mushroom cultivation utilizing distillation waste in sustainable cluster

economy & entrepreneurship development in the country in sector aroma crops and their products.

- Coffee Table Book, highlighting technological interventions and benefits accrued by tribal farmers of 20 Tribal Clusters established by CSIR-CIMAP, was released by Dr. Jitendra Singh, Hon'ble minister, Ministry of Science and Technology.









CSIR-Floriculture Mission Phase-II

The Floriculture Mission of CSIR is achieving a successful national and international market leading the floriculture business and industries. Farmer's income is expected to increase at least two folds. New improved varieties and technologies were provided, disseminated to the farmers to enhance their income and livelihood. Advanced training and skill development programmes were conducted to the farmer's field to educate them about cultivation practices processing and value additions of targeted floricultural crops. CSIR-CIMAP has intensively involved in expansion of floriculture crops.

Under floriculture mission various crops like marigold, Jasmine, tuberose and rose has been promoted for cultivated in different states of India. The maximum area is covered with marigold in 17 states like Uttar Pradesh (25 ha) followed by North East (07 ha). However, southern states such as Karnataka (12 ha), Tamil Nadu (10 ha) and Andhra Pradesh (03 ha) cultivated with crop like Jasmine.













Maharashtra and Orissa has successfully cultivated and increased their area with Jasmine crop. CSIR-CIMAP has been organized scientist-industry – farmers interactions workshops, and awareness program in different parts of the country making farmers aware of benefits of production of floral



crops, value additions and marketing. Under this mission generating and providing QPM of superior varieties among the project beneficiaries farmers.

CSIR- CIMAP has been organized scientist-industry –farmers meet, and awareness program in different parts of the country making farmers aware of benefits of said crop. Under this mission generating and providing QPM of superior varieties among the farmers.

Production/multiplication of Quality Planting Materials (QPM) under Floriculture Mission (2023-24)

Floral crops	Proposed target	Achieved
Marigold	30 lakh saplings	48 lakh saplings
Tuberose	35,000 corms	2.8 lakh corms
Rose	15,000 rooted cuttings	74000 (Rooted plants)
Jasmine	1,90,000 rooted plants	3.5 lakh (Rooted plants)
Total	32.4 lakh saplings	55.04 lakh saplings

Expansion of Area under Floriculture Mission (2023-24)

Floral crops	Proposed Target (ha)	Achieved (ha)	Beneficiary farmers
Marigold	50	62.51	356
Tuberose	5	4.20	25
Rose	01	2.90	26
Jasmine	25	31.58	96
Total	81.0	101.19	503

IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP)

IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP) is dedicated to advancing research and innovation across the Indian Ocean Region. With a focus on fostering collaboration, ICCMP emphasizes knowledge sharing and capacity building as key priorities within its bilateral programs.

The Centre is committed to promoting international scientific exchanges, facilitating partnerships between academies, research councils, and science-promotion organizations in Member States and Dialogue Partners.

ICCMP is dedicated to enhancing regional scientific and technological capabilities by offering hands-on training programs and facilitating collaborations through Memorandums of Understanding (MoUs). The center actively organizes conferences, workshops, and seminars to share knowledge, foster partnerships, and engage in community outreach, promoting the advancement of science and technology in the region.

Activities at a glance (FY 2023-24)

Title	Date	Speaker
Bioprospecting for Development of Knowledge-Based Value-added Products from Medicinal and Aromatic Plants	August 07-08, 2023	Dr. Anirban Pal, CSIR-CIMAP, India
Medicinal Plants used for diabetes in Mauritius	October 10, 2023	Dr. Comalchandra Radhakishoon, Ministry of Health and Wellness, Mauritius
Quality development of traditional herbs preparations and herbal products: Malaysia's experience	November 30, 2023	Dr. Fadzureena Binti Jamaludin, Forest Research Institute, Malaysia
Current and Future Medicinal Plants Trends in South Africa	February 16, 2024	Prof. John Mellem, Durban University of Technology, South Africa
Overview of Medicinal Plants Exports	March 12, 2024	Dr. Tripta Dixit and Mr. Mihir Ajit Shah, Ayushexcil, Ministry of Ayush, New Delhi

Visit

Ms. Vishakha Yaduvanshi, the Director (Indo-Pacific), visited the IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP) at CSIR-CIMAP in Lucknow on January 29th, 2024. The visit aimed to strengthen cooperation among the Indian Ocean Rim Association (IORA) Member States, Dialogue Partners, and to contribute to the welfare and prosperity of the Indian Ocean Region. This visit underscores the importance of collaboration in the field of medicinal plants, which can have significant implications for health, trade, and sustainable development in the region.





International Science & Technology Affairs Group (ISTAG)

Nepal

An online meeting with the Department of Plant Resources, Nepal was held on 2nd May 2023. DPR Nepal wishes to formalize an MoU with CSIR-CIMAP for collaboration in the area of Medicinal and Aromatic Plants.

Germany

A meeting with the representatives of Symrise and GIZ (Germany) took place on 19th May 2023 on the technologies of CSIR-CIMAP that would benefit farmers into mint cultivation. GIZ is considering funding of a project to CSIR-CIMAP for the welfare of the farmers who have adopted the technologies.

South Korea

Dr. Chang Heasook, Ministry of Environment, South Korea visited various facilities & demonstration plots. Possibilities of collaborations in the areas of medicinal and aromatic plants were discussed.



France

A delegation from the French Institute in India and, the French Embassy in India visited CSIR-CIMAP on the 11th of July, 2023 to learn about the existing cooperation with French Institutions if any and to explore further possibilities for collaboration. The team comprised of Dr Didier Raboisson, Attaché for Scientific and Academic Cooperation, Dr Meenakshi Singh, Scientific Coordinator and Mr Aymmeric VOQUANG, Project Manager, French Embassy in Delhi.

Dr. Prabodh K Trivedi elaborated on the capabilities and success stories of CSIR-CIMAP, which was food for thought for Dr Didier Raboisson to consider MAPs as one of the priority areas for future project funding opportunities. Both sides discussed the areas which could bring about a win-win situation for both countries. The delegation also emphasised CIMAP for being on the lookout for collaborative opportunities with French Institutions under call for projects.



L'Oreal

As an initiative to promote Industry-Academia collaborative research, an online meeting with L'Oreal, Paris stationed at Bangalore was held on 6th July 2023. Both the organisations shared their interest and capabilities for future collaboration.

Visits of scientists

Dr. Debabrata Chanda visited USA for a period of three months through the Short Term ICMR-DHR International Fellowship for Senior Bio-medical Scientists with Dr. Vijay Yechoor, Professor and Chair, Department of Medicine, School of Medicine, University of Pittsburg, USA.



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Science & Technology

Herbal Products Released

ALOEROMA GEL

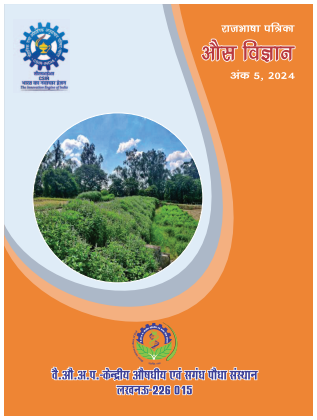
A UV protecting, nourishing and skin soothing Aloe vera gel free from chemical preservatives was developed, upscaled, tested for its efficacy and released by Honorable CM of Uttar Pradesh on occasion of CIMAP Kisan Mela on 31st January 2024. The *Aloe vera* gel meticulously crafted by the CSIR-CIMAP team stands out as a skin-soothing marvel, delivering a refreshing and moisturizing impact upon application. What sets this formulation apart is not only its efficacy of UV protection but also its commitment to environmental sustainability – formulated through an eco-friendly method, it proudly bears the distinction of being free from any chemical preservatives, making it a truly unique, green and versatile solution suitable for all skin types. The unique features of the product include free from any chemical preservatives, natural active ingredients, protection from both UVA and UVB radiations, effective against low grade skin inflammation, devoid of skin irritants like silicates, parabens, silicones phthalates, cooling and soothing effect on skin, stable shelf life up to 12 months and having pure *Aloe vera* sap with minimal dilution.





CIMAP Publications

राजभाषा पत्रिका 'औस विज्ञान'



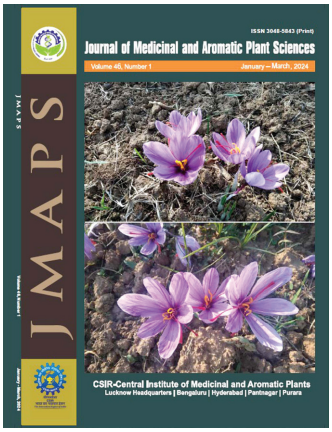
संस्थान द्वारा गृह राजभाषा पत्रिका 'औस विज्ञान' वर्ष 2024, अंक–5 का प्रकाशन हो चुका है। इस पत्रिका में संस्थान के विभिन्न वैज्ञानिकों, शोधार्थियों, प्रशासनिक, तकनीकी अधिकारियों, कर्मचारियों द्वारा सीमैप प्रयोगशाला में हो रहे शोध एवं विकास कार्यो को हिन्दी के माध्यम को प्रोत्साहित करने हेतु प्रस्तुत किया गया है। यह पत्रिका हमारे भावों की वाहिनी होने के साथ–साथ हमारी प्रगति को जन–जन तक पहुँचाने का सबल माध्यम है।

औषधीय एवं सगंध पौधों के अनुसंधान से होने वाले लाभ जनसाधारण तक पहुँचाने के लिये 'औस विज्ञान' तत्पर है। एक ओर जहां अनुसंधान व ज्ञान का लाभ सभी तक पहुँचाने में 'औस विज्ञान' जुटी है, वही हमारी मातृ भाषा का उपयोग वैज्ञानिक उपलब्धियों को यथार्थ में परिवर्तित कर पाना संभव हो पा रहा है। औस विज्ञान पिछले वर्ष से अधिक योगदान 'विज्ञान से सशक्त समाज' की परिकलपना के लिये देने में सफल हो सकी है।

"औस ज्ञान्या" स्मारिका

औषधीय एवं सगन्ध पौधों की उन्नत कृषि तथा प्रसंस्करण प्रौद्योगिकियों की वैज्ञानिक स्मारिका है। सीएसआईआर–सीमैप प्रति वर्ष किसान मेला कार्यक्रम मे औषधीय एवं सगंध कृषि तकनीकियों एवं उनके प्रसंस्करण आधारित उद्योग तथा व्यापार संबंधी महत्वपूर्ण जानकारी को किसानों मे प्रचार–प्रसार करने हेतु "औस–ज्ञान्या" पुस्तिका का प्रकाशन करता है। "औस–ज्ञान्या" पुस्तिका की उपयोगिता के कारण प्रतिवर्ष यह किसानों के बीच लोकप्रिय होती जा रही है। इस स्मारिका मे औस फसलों के कृषि तकनीकियों की जानकारी दी गयी है तथा बाजार भाव संबंधी महत्वपूर्ण जानकारी देने का प्रयास किया गया है। इसका मुख्य उद्देश्य किसानों द्वारा उत्पादित उत्पाद के क्रय–विक्रय मे महत्वपूर्ण भूमिका निभाना है। यह पुस्तिका हरस्सल लगभग 10000 से 15000 किसानों तक विभिन्न कार्यक्रमों के अंतर्गत पहुँचाई जाती है।





Journal of Medicinal and Aromatic Plant Sciences (ISSN 0253-7125; NLM ID: 9801900), popularly known as JMAPS, is a peer reviewed quarterly journal published from CSIR-CIMAP. The Journal was incepted in 1979 under the popular name of Current Research on Medicinal and Aromatic Plants (CROMAP) and renamed as Journal of Medicinal and Aromatic Plant Sciences (JMAPs) in 1996. It is dedicated to publish the Original Research Articles, Review Articles, Short Communications, and expert opinion on different aspects of R&D related to Medicinal and Aromatic Plants (MAPs) following a double-blind peer review process. Besides, it also provides data on the production, utilization, foreign trade, as well as market trend analysis of MAPs and related products. An additional attraction of JMAPS is the registration reports on new varieties of MAPs.

The journal is covered by abstracting services of Medicinal and Aromatic Plants Abstracts (NISCAIR, India), Chemical Abstracts (USA), Plant Breeding Abstracts, Review of Aromatic and Medicinal Plants (CAB International, Wallingford, UK) and Biosis Preview, USA.

During 2023-24, the journal published volume 45 covering its four issues namely Vol. 45(1-2), 2023 and Vol. 45(3-4), 2023. These volumes featured five Original Research papers, six Review Articles, and three Variety Registrations.

S&T Activities

CSIR-CIMAP Annual Day 11 August 2023

CSIR-CIMAP celebrates its, 45th CSIR-CIMAP Annual Day Function 2023 on 11th August 2023. Dr. Anil Prakash Joshi, Environmentalist & Padma Shri and Padma Bhushan Awardee would be the chief guest, Dr. GN Singh and Shri Awanish Kumar Awasthi, I.A.S. (Ret.) would be the guest of honour during this occasion.



Felicitation of Guests During the Programme.





The Glimpse of the Annual Day Program.

CSIR Foundation Day



On the occasion of the 82nd CSIR Foundation Day on 26 September 2023, CSIR-CIMAP invited students from schools and colleges for an exposure visit and to explore the research work carried outby CSIR-CIMAP and ongoing activities with the students. Dr. Bhaskar Narayan, Director, CSIR-Indian Institute of Toxicology Research (CSIR-IITR), Lucknow, was the chief guest on this occasion.A total of 400 students participated from 07 schools and colleges in this event. The motive behind this exposure visit is to enlighten the R&D activities related to medicinal and aromatic plants and their utility perception for society.





Glimpse of CSIR- Foundation Day-2024

National Science Day

On the occasion of National Science Day-2024 CSIR-CIMAP organized a special talk of Dr. Pragya D. Yadav, Scientist-F, ICMR-National Institute of Virology. Dr. Pragya D. Yadav in her speech briefly discussed the efforts, research, and achievements made by India for the vaccine development against Covid-19 on the global stage.





Dr. Pragya D. Yadav





A Glimpse of National Science Day-2024

International Women's Day:

Every year United Nations celebrates International Women's Day with different themes all over the world. CSIR-CIMAP also celebrated the International Women's Day celebration on its Lucknow campus. For this year CSIR-CIMAP celebrated 'International Women's Day- 2024' by organizing a panel discussion on "CSIR-CIMAP: Expectations and suggestions for improvement" 'By Women, For Women' on 8th March 2024.



Dr. Ritu Trivedi



Dr. Sunita Singh Dhawan





Felicitation of Panelistson International Women's Day





A Glimpse of Panel Discussion on International Women's Day

Three days Training programs

Training Programme on 'Improved Production Technologies of Aromatic and Medicinal Plants & Aromatic Oils' was conducted from 22-24, November, 2023 at CIMAP Research Centre, Bengaluru. About 32 trainees from 5 different states have been participated. In this programme, trainees received information regarding different agro-technologies for economically important MAPs, post-harvest processing techniques.





CSIR-CIMAP Resource centre Bengaluru conducted two awareness programs in Puttur and Dharwad WALMI Karnataka on 05-06-2023 and 28-12-2023, with a participants of 350 and 50 respectively. In these programs, the resource persons Dr. Dinesh A. Nagegowda and Dr. Channayya Hiremath briefed the importance of MAPs and its cultivation techniques.



Awareness program in Puttur Karnataka



Awareness program in Dharwad Karnataka

A one-day awareness programme was conducted at Kanamala, Erumeli, Kottayam (D) on 20/08/2023. It was organized by St. Thomas U.P School and SAN Thomas Kanamala, Teachers Student Alumini association for the MAPs as an alternative crop to enhance the source of income. A total of 105 participants from Kanamala and surrounding villages have participated in the programme



Visited Devikulam Tribal cluster, Annakatti, Palakkad (D), Kerala on 18/08/2023, where One 500kg MS distillation unit was provided under Aroma Mission – II from CRC-Bengaluru. Tribal farmers of this region are happy and expressed gratitude to Director, CSIR-CIMAP. More than 25-30 acres of wild lemongrass are spreading in the hills and farmers are now distilling the wild lemongrass grass later the whole area will slowly change with an improved variety of Krishna.





Formation of Tirunelveli Aroma Mission Beneficiary Farmer Cluster

Tirunelveli Aroma Mission Beneficiary cluster was formed during the year 2023–2024 at Kallidaikurichi of Tirunelveli district, Tamil Nadu with Mr. V. Gasten Varghese as a nodal farmer. It consists of a total of 30 beneficiary farmers including 25 male and 5 female farmers from the Kallidaikurichi and neighbouring villages. Various planting materials including Lemongrass, Vetiver, and Palmarosa were provided to the beneficiary farmers of Tirunelveli Aroma Mission Cluster.

Awareness Programs and field visits

A total of two one-day awareness programmes followed by field visits were made during the year. The Programmes were conducted by the CSIR-CIMAP headquarters scientists and CSIR-CIMAP, Research Centre, Bengaluru Scientists. The team also monitored the newly launched Field Distillation Unit under Aroma Mission for the benefits of Rameshwaram Aroma Mission beneficiary cluster, Rameshwaram.

Place	Date	Participants
Kuruvadipatti village, Sivagangai District	14-09-2023	30
Palkulam village, Ramanathapuram District	15-09-2023	60
Total		**400**



Kuruvadipatti village of Sivagangai district



Palkulam village, Ramanathapuram District

One-day skill development program under *"Waste to Wealth"* theme titled *"Skill development programme of Agarbathi making from offered flowers in temples"* was conducted at Thiruverumbur of Tiruchirapalli district of Tamil Nadu on 16th September 2023 for the women participants of Thiruverumbur and neighbouring area. The programme was organised by CSIR-CIMAP, RCB in collaboration with Excel Agro, Tiruchirapalli. A total of 120 women participants participated in the programme.



Training Program

Three days training programme on *"Improved Production Technologies of Aromatic & Medicinal plants and Aromatic Oil"* was organized during 11th to 13th September 2023 at Gandhigram, Dindigul District, Tamil Nadu in collaboration with Gandhigram Trust. A total of thirty-one participants, including 3 women were enrolled for the training programme.







Vetiver Mela

One day "*Vetiver Mela*" was organized on 7th February 2024 at Kuruvadipatti village, Tiruppathur taluk of Sivagangai District, Tamil Nadu in assistance with CM Eco Herbal Plantations. A total of 200 participants, including 90 women, farmers, entrepreneurs and industrialists participated in the Vetiver Mela. Vetiver value addition product stalls of about 18 numbers was put by entrepreneurs. CSIR-CIMAP, Research Centre Bengaluru team exhibited posters on the CSIR-Aroma Mission, cultivation technology of various improved vetiver varieties developed by the CSIR-CIMAP, information on various distillation units, essential oil distillation and its chemistry, CSIR-CIMAP's intervention through Aroma Mission were displayed. The team also exhibited CSIR-CIMAP developed technologies during the programme.



Kisan Mela at CRC Pantnagar

One-day farmer's fair was organized at CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Research Centre, Pantnagar on 04.02.2024. About 800 participants (including farmers, entrepreneurs, academicians, Scientists, industry representatives etc.) from different states viz. Uttarakhand, Uttar Pradesh, Punjab and Haryana participated in this farmer fair.

The Kisan mela was inaugurated by the chief guest, Dr. Sanjay Kumar, Director, Uttarakhand Council of Biotechnology, Uttarakhand, and he highlighted the importance of the integration of MAPs in traditional cropping with proper scientific input for higher income generation. A Kisan Gosthi was organized among famers, Scientists, Academicians and industry representatives that covered various aspects of MAPs cultivation, processing, marketing, and recent advances in MAPs. Dr. Sanjay Kumar, Dr. R.S. Sharma, Dr. R.C. Padalia, Dr. R.K. Upadhyay, Dr. Venkatesha KT, Dr. Dipender Kumar, Dr. Amit Chauhan, Mr. A.K. Tiwari, Pramod Kumar were present and interacted with famers in the Kisan Gosthi. The experts of GBPUA&T, Pantnagar, Uttarakhand Council for Biotechnology, Haldi, and DIBER, Haldwani and industry representatives also interacted with farmers.





CSIR-CIMAP RC Pantnagar and Purara organised a hands-on training programme on the use of offered flowers and bioresources available in nearby areas for making incense sticks and fragrant cones for women and unemployed youth at Kausani Uttarakhand, under the Aroma Mission. More than 40 women and youth have participated in this programme. The programme was locally supported by the Buransh Retreat Kausani.





Under CSIR Jigyasa project (HCP-101), scientist student connect interactive program was organised at Kholia Vivekananda Inter college, Garur, Bageshwar for 80 students of class 12. Students were briefed about career opportunities in chemistry and artificial intelligence.

On the 12th of October 2023, a workshop focusing on medicinal and aromatic plants was jointly organized by CSIR CIMAP and District Administration





Bageshwar at CSIR-CIMAP Research Centre Purara.

Dr. R.C. Padalia, Scientist-In-charge CIMAP Purara provided comprehensive information about the various activities undertaken by CIMAP. Mr. Prawal PS Verma, the Technical Officer shared his insights into the cultivation of medicinal and aromatic plants. Additionally, scientists Dr. Deependra Kumar and Dr. Venkatesh K.T. conducted an informative session, focusing on the extensive cultivation techniques of Chamomile and Oregano. Towards the conclusion of the program, practical demonstration at the research farm, providing hands-on training for enhancing the value of products, particularly in the context of dry herbs.



List of one-day awareness, 3-day skill development programs, VIP, and student visits organised CRC-Hyderabad

S. No.	Date	Name of The Institute	The Number of People Attended		Total
			Male	Female	
One-Day Awareness Programs for Farmers & Entrepreneurs					
1	25/05/2023	Awareness program for the farmers from Prakasam District, organized at Ongole Collector Office, Andhra Pradesh.	80	25	105
2	02/08/2023	Awareness program for the farmers from Prakasam District, organized at CRC – Hyderabad.	38	02	40
3	10/02/2024	Awareness program for the farmers from Telangana & Andhra Pradesh organised at CRC – Hyderabad.	35	00	35
4	16/02/2024	Awareness program for the farmers of East Godavari District organized at ICAR-CTRI, Rajahmundry (AP)	33	8	41
5	17/02/2024 (FN)	Awareness program for the farmers of Anakapalli District organized at PL Puram Village, Payakaraopeta, Andhra Pradesh.	43	9	52
6	17/02/2024 (AN)	An awareness program for the students from Sri Prakash Academy of Science Institutions was organized at PL Puram Village, Payakaraopeta, Anakapalli District, Andhra Pradesh.	7	63	70
Three Days Training Program for Farmers & Entrepreneurs					
7	21/02/2024 to 23/02/2024	3-Day Skill Development-cum-Training Program at CRC – Hyderabad.	48	19	67
TOTAL			**284**	**126**	**410**

Student Visits					
1	11/05/2023	Mahendra University	30	35	65
2	11/08/2023	Zenas School, Boduppal	16	21	37
3	26/09/2023	School of Pharmacy, Gurunanak Institutions Technical Ghatkesar, Campus, Hyderabad	19	30	49
4	29/09/2023	St. Mary's College of Pharmacy, Regimental Bazar, Secunderabad-500025	0	11	11
5	14/11/2023	GDC Khairatabad, Chintal Basti, Hyderabad	18	22	40
6	14/11/2023	St. Mary's Institution, Group of Pharmacy College	8	17	25
7	8/12/2023	Vision College of Pharmaceutical Sciences and Research	19	21	40
8	12/12/2023	Sanskruti College of Pharmacy, Ghatkesar, Kondapur	38	29	67
9	21/12/2023	PM Shri KV of Medak, Eddumailaram, Sangareddy	38	62	100
10	22/12/2023	Ni-MSME, Yusufguda, Hyderabad, Odisha University of Agriculture and Technology (OUAT)	36	65	101
11	12/01/2024	Loyola Academy, Degree and PG College, Department of B.Sc Biotechnology	22	28	50
12	23/ 01/2024	NIMSME/ AYUSH Doctors, Yousufguda, Hyderabad	9	18	27
13	30/01/2024	TSWRD and PGC, Mahendra hills, Ghatkesar	22	33	55
14	31/01/2024	AL Government Ayurvedic College, Warangal	19	28	47
15	02/ 02/ 2024	Department of Botany, UCS, Saifabad	8	11	19
16	02/ 02/ 2024	University College of Sciences, Saifabad, Hyderabad	6	9	15
17	13/ 02/ 2024	Department of Botany, Government Degree College for Women (A), Begumpet, Hyderabad	0	39	39
18	28/02/2024	P.G. Department of Botany, Berhampur University, Berhampur, Odisha.	18	24	42
19	29/-2/2024	School of Agriculture & Food Technology, Vignan University, Vadlamudi, Guntur, A.P.	33	50	83
20	07.03/2024	Chaitanya College of Pharmacy Education & Research.	36	51	87
21	26/03/2024	Loyola Academy, Old Alwal, Hyderabad.	38	44	82
TOTAL			**433**	**648**	**1,081**

Activities of Experimental Research Farm

CSIR-CIMAP has a well-established experimental research farm (ERF), and it covers an area of 25 hectares of cultivable land. ERF is known for the combination of Farm, MAPs conservation, varieties & agro-technologies demonstration, advanced MAPs/agricultural implements, Vermicomposting, Horticulture and Landscape Service Unit. Further, the farm is being used for conducting experimental research on various MAPs, conservation of MAPs, demonstration of varieties & agro-technologies, seed production, multiplication of authentic MAPs/ verities, etc. The objective of this unit is to plan and provide various operational and machinery services to the scientific, technical staff and research scholars of CSIR-CIMAP, Lucknow. The ERF also engaged in producing and selling the quality planting material of various MAPs like slips/runners/suckers/ plants/ seeds/ cuttings to the users (farmers/entrepreneurs/ students/ institutions/academics etc.). CSIR-CIMAP farm routinely supplies slips of lemongrass, citronella and vetivers to the public at reasonable prices. Also, planting materials like tulsi, stevia, bramhi, kalmegh, mints, geranium, patchouli, rosemary, guggul, ghritkumari, pipli, coleus, satavar, damask rose, sarpgandha, mulethi, vach, mandukaparni, etc. are in demand. We also supply seeds of medicinal plants (ashwagandha, tulsi, satavar, kalmegh, African marigold, chamomile, palmarosa, senna, isabgol, milk thistle, clarysage etc.) to all over India. The main activity of farm services to supply *Mentha* suckers to various farmers during Kisan Mela each year. We have supplied an average of 30-40 tons of Mentha suckers during the last financial year and generated an average ECF of Rs. 17,26,000. Experimental Farm has maintained Manav Park for visitors and farmers. The horticulture unit manages all the landscaping work, maintenance of gardens/lawns, rose rosary and participation in various flower events (Coleus and chrysanthemum exhibition, rose and gladiolus exhibition) organized by different organizations such as CSIR-NBRI, Governor House of UP and Nagar Nigam, Lucknow. In the chain of value addition,



Fig: Elite plating materials



Fig: Biodegradable product making machine



Fig: Vermicompost harvesting

cutlery items like spoons, bowls, and plates are being produced using de-oiled waste of aromatic crops. Further, used cutlery items and de-oiled waste may be successfully bio-converted into nutrient and microbe-rich vermi-compost. Distillation waste is also utilized to grow edible mushrooms. Weather station and central distillation facility are maintained to record weather-related data and essential oil content, respectively, for user scientists/technical staff/students. Essential oil store is also maintained where off-farm produced aromatic oil and rose water is kept and supplied to the researchers and sold to various firms all over India. In addition, the experimental farm is also using slope land for the producing quality planting material using efficient drip irrigation system.

Infrastructural Development (Engineering Works & Services)

The Engineering Services Section of CSIR-CIMAP is actively involved in routine maintenance activities, renovation and upgradation of all existing and developing new infrastructural facilities of the institute, research centres and CSIR-CIMAP staff colony including civil, electrical, laboratory and air-conditioning works.



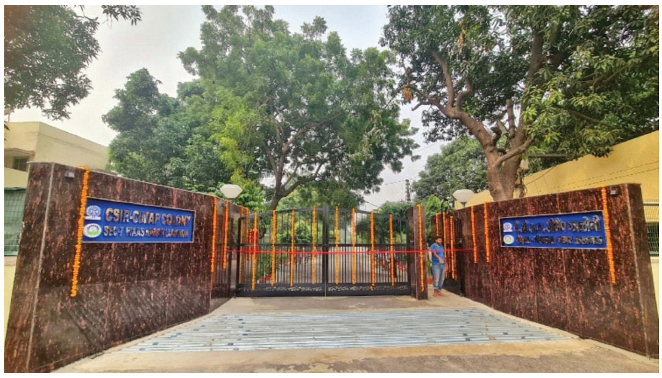
Developing New Transgenic Glass House and Tobacco Net House Along With Pathway At CSIR- CIMAP, Lucknow



Renovation of Samvad Conference Hall at CSIR -CIMAP, Lucknow.



Renovation and Up Gradation of Facility for Walk in Plant Growth Chamber at CSIR-CIMAP, Lucknow.



New Entry Gate No. 1 at CSIR - CIMAP Colony Vikas Nagar, Lucknow.



Developing New Poly Houses at CSIR-CIMAP R.C. Bangalore and CIMAP Lucknow



Works and Services Team



Others

Technology Transfer for Commercialization

Technology Transfer

In the year 2023-24, seven numbers of technologies were transferred to different industries. three projects were also received from different industries, and apart from that 19 MoUs were signed with different organizations and institutes.

Sl. No.	Name of the technology	Date of transfer of technology	Name of industry
1	Cough Syrup, Relaxomap Pain Oil and CIM-Phalse	22-May-2023	M/s Desvari Global Pharmaceuticals LLP, Mohali
2	Tulsi Drop	11-Aug-2023	M/s Big M Health Care Private Limited, Puri
3	Sanitary Pad NAARI	11-Aug-2023	M/s Ecobhumi Bioagri Concepts Pvt. Ltd., Kolkata
4	Incense Sticks and Fragrant Cones	16-Sep-2023	M/s Excel Agro, Trichy
5	Incense Sticks and Fragrant Cones	10-Jan-2024	Tripura State Council for Science and Technology, Agartala, Tripura
6	Incense Sticks and Fragrant Cones	13-Mar-2024	Saajhee Rekha Svayan Sahaayata Samooh, Semra, Chinhat, Lucknow
7	Designing of improved distillation units based on CSIR-CIMAP know-how		(i) Mr. V. Nanda Kumar, Vengai Biotech Tamilnadu. (ii) Shivaji S. Dole, Chairman Venkateshwara Cooperative Power & Agro Processing Society Ltd., Nashik, Maharashtra.



Agreement with M/s Big M Health Care Pvt Ltd



Agreement with M/s Ecoland Bioagri Concepts Pvt. Ltd.

MoUs /Agreements

MoUs/Agreements signed with different organizations

Sl. No.	Title of the MoUs/Agreement	Date of Signing	Name of Institute/University/Client
1.	Agreement for market seeding of CSIR-CIMAP research-based herbal products/formulations between CSIR-CIMAP and M/s Nirmal Nature, Gurugram, Haryana	21-04-2023	M/s Nirmal Nature, Gurugram
2.	Memorandum of Understanding/ MoU for collaborating centre for smooth functioning of the Project entitled Outreach Programme on Enthnoveterinary Medicine	01-05-2023	ICAR-Indian Veterinary Research Institue
3.	Agreement for Market seeding of CSIR-CIMAP research based products/formulations between CSIR-CIMAP and M/s Kavela Cares Pvt. Ltd, Agra, Uttar Pradesh	08-05-2023	M/s Kavela Cares Pvt. Ltd, Agra
4.	Memorandum of Understanding/ MoU for collaborating centre for smooth functioning of the Project entitled Outreach Programme on Enthnoveterinary Medicine	15-05-2023	National Institute of Pharmaceutical Education and Research, Raebareli, Uttar Pradesh
5.	Technology transfer agreement between CSIR-CIMAP and M/s Desvari Global Pharmaceutical LLP, Mohali for Herbal Cough Syrup, Relaxomap Pain Oil and CIM-Phalse	22-05-2023	M/s Desvari Global Pharmaceuticals LLP, Mohali
6.	Memorandum of Understanding	01-06-2023	Indian Pharmacopoeia Commission, Gaziabad
7.	Memorandum of Understanding	22-06-2023	King George's Medical University, Lucknow
8.	Agreement for undertaking sponsored contract R&D project for exploring medicinal and aromatic plants as source of green agrochemicals	21-08-2023	M/s Hindustan Gum & Chemicals Ltd, Hryana
9.	Agreement for sustainable aromatic crops cultivation a collaborative initiative by CSIR-CIMAP with Sant Sanganeria foundation & Ultra International Ltd to empower aroma clusters in India under Aroma Mission - III	11-08-2023	Sant Sanganeria Foundation & Ultra International Ltd, Ghaziabad
10.	Agreement for providing technical know-how and quality planting material of aromatic crops under Aroma Mission-III	11-08-2023	Merino Industries Limited, Ghaziabad
11.	Technology transfer agreement between M/s Big M Health Care Private Limited, Puri for Immunity booster (Tulsi Drop)	11-08-2023	M/s Big M Health Care Private Limited, Puri
12.	Technology transfer agreement between M/s Ecobhumi Bioagri Concepts Pvt. Ltd., for Medicated sanitary Pad (NAARI)	11-08-2023	M/s Ecobhumi Bioagri Concepts Pvt. Ltd., Kolkata
13.	Technology transfer agreement between M/s Excel Agro, Trichy for Incense Sticks and Fragrant Cones from offered flowers	16-09-2023	M/s Excel Agro, Trichy

14.	Memorandum of understanding between ORMAS, Bhubaneswar & CSIR-CIMAP Lucknow for providing Technical know-how and quality planting material of aromatic crops & scented flowers, under CSIR Aroma Mission - III and CSIR-Floriculture Mission-II	16-10-2023	Odisha Rural Development and Marketing Society (ORMAS), Bhubaneswar
15.	Memorandum of Understanding	06-02-2024	Nagpur Veterinary College, Nagpur
16.	Technology transfer agreement between Tripura State Council for Science and Technology, Agartala Tripura for making Incense Sticks and Fragrant Cones	10-01-2024	Tripura State Council for Science and Technology, Agartala, Tripura
17.	Memorandum of Understanding	12-03-2024	Sant Gadge Baba Amravati University
18.	Technology transfer agreement between Saajhee Rekha Svayan Sahaayata Samooh, Semra, Chinhat, Lucknow for making Incense Sticks and Fragrant Cones	13-03-2024	Saajhee Rekha Svayan Sahaayata Samooh, Semra, Chinhat, Lucknow
19.	Memorandum of Understanding	19-03-2024	Sri Dev Suman Uttrakhand Univrsity



A view of Technology Transfer to Women Entrepreneur

Technology Business Incubation Centre

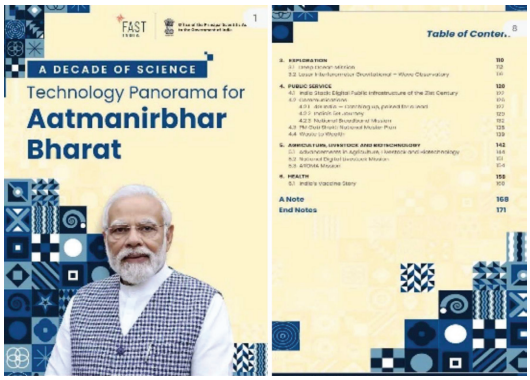
Start-ups/Entrepreneurs/MSMEs utilized the pilot plant facility (TBIC) in the FY 2023-24

S. No.	Company Name	CSIR-CIMAP Products
1.	M/s Chandraveda Herbals, Ghaziabad	Mos-ex (Mosquito repellant lotion)
2.	M/s Nirmal Nature, Gurugram	Keenzie face wash, Geranium active shampoo, Lipbalm (Lip care formulation), Acne preventive face wash.
3.	M/s Waggle, Bengaluru	Geranium active shampoo, Cimkesh, hair oil, Poly herbal toothpaste
4.	M/s Pragya Yog, Varanasi	Relaxomap (Pain reliving oil)
5.	M/s Ajay Shree Enterprises, Lucknow	Herbi- chew

Awards and Recognitions (2023-24)

CSIR Aroma Mission led by CSIR and CSIR-CIMAP & partner institution of CSIR has been featured in "**A decade of Science Technology Panorama for Atma Nirbhar Bharat**" a compilation by Honorable Principal Scientific Advisor, Govt. of India. CSIR Aroma Mission immensely contributed in enhancing rural economy & entrepreneurship development in the country in sector aroma crops and their products.

भारत सरकार, गृह मंत्रालय, राजभाषा विभाग, नराकास, जोन–3, लखनऊ की छमाही बैठक 21 नवम्बर 2023 में हिन्दी कार्यशाला के सफल आयोजन के लिए सीएसआईआर–सीमैप को प्रशस्ति पत्र एवं संस्थान की राजभाषा पत्रिका "औस विज्ञान" अंक–4 को प्रथम पुरस्कार प्राप्त हुआ।







- Dr. Birendra Kumar, Chief Scientist, CSIR-CIMAP has been elected Fellow of the Indian Botanical Society. He was also conferred the Fellowship of the Indian Academy of Horticultural Sciences, New Delhi.



- Dr. Sumit Ghosh, Senior Principal Scientist CSIR-CIMAP has been elected as Fellow of the National Academy of Sciences, India (NASI).



- Dr. Akansha Singh, Scientist CSIR-CIMAP received SERB Women Excellence Award.



- Dr. Puja Khare, Principal Scientist CSIR-CIMAP has been elected as the Fellow of the National Academy of Agricultural Sciences (FNAAS), Fellow of International Society of Environmental Botanists (FISEB) and Fellow of the Royal Society of Chemistry (FRSC).



- Dr. Abha Meena, Principal Scientist CSIR-CIMAP has been selected as a recipient of the 'Long Term ICMR-DHR International Fellowship for Young Scientists 2023-24. She is set to embark on a one-year research visit to Kings College London as part of this prestigious fellowship.



Glimpses of Events



CSIR-CIMAP organized Hindi workshop on 22/03/2024 inaugurated by Prof. Yogendra Pratap Singh, Prof. Hindi Department, University of Lucknow.



CSIR-CIMAP celebrated International Women's day on 8th March 2024



CSIR-CIMAP celebrated national science day on 28th February 2024 by providing demonstration on various technologies developed by the institute



CSIR-CIMAP Celebrated 75th republic day on 26-01-2024



CSIR-CIMAP celebrated Hindi Karyashala on 28th December 2023



CSIR-CIMAP conducted student's seminar on 21st December 2023 at CIMAP Research Centre Purara Uttarkhand



CSIR-CIMAP organized a skill up-gradation training program for 30 M.Sc. students of Department of Chemistry, University of Lucknow



Hon'ble Chief Minister of Uttar Pradesh Shri Yogi Adityanath Ji Inaugurated Kisan Mela – 2024



Hon'ble Chief Minister of Uttar Pradesh Shri Yogi Adityanath Ji distributing quality planting material to the farmers during Kisan Mela – 2024



Hon'ble Chief Minister of Uttar Pradesh, Shri Yogi Adityanath visualizing menthol mint pest calendar and beneficial insects' visual technology during Kisan Mela 2024



Hon'ble Chief Minister of Uttar Pradesh Shri Yogi Adityanath Ji planting sandal wood plant during Kisan Mela – 2024



Release of innovative decision support technologies for integrated pest management in medicinal and aromatic crops in Kisan Mela 2024



View of Celebration of National Science Day



CSIR-CIMAP conducted an awareness program on prevention of sexual harassment at workplace



CSIR-CIMAP was conducted a vigilance awareness program



CSIR-CIMAP Staff took the pledge to commit to the highest standards of honesty and integrity at all times



CSIR-CIMAP organised Nukkad Natak to spread awareness about PIDPI Resolution, 2004.



A cleanliness drive was organized on October 2nd 2023



CSIR-CIMAP organized a thought-provoking lecture on PIDPI Resolution, 2004.



CSIR-CIMAP Celebrated 82nd foundation day of CSIR on 29th September 2023



CSIR-CIMAP conducted Hindi Karyashala on 27 Sept 2023



CSIR-CIMAP Celebrated 77th Independence day on 15th August 2023



CSIR-CIMAP organized Kavi Sammelan on the occasion of Hindi Pakhwada



CSIR-CIMAP organized International Yoga day on 21st June 2023



CSIR-CIMAP celebrated its 45th Annual day



A view of release of CSIR-CIMAP Annual report of 2022-23

Media Coverage

'मंदिर में चढ़े फूलों को एकत्र करके भी किसान बढ़ा सकते हैं अपनी आय'

फरीदपुर/फतेहगंज पूर्वी। भगवानपुर कुंदन में किसान दिवस के अवसर पर केंद्रीय औषधि एवं सुगंध पौधा संस्थान (सीमैप) के निदेशक डॉ प्रबोध कुमार त्रिवेदी व वरिष्ठ वैज्ञानिक डॉ संजय कुमार ने वैज्ञानिक व शोधार्थी छात्रों के साथ गांव में किसानों से चर्चा करके आय बढ़ाने के तरीके सिखाए।



सुगंधित फसलों के बारे में वैज्ञानिकों ने शनिवार को किसानों को जानकारी दी।

खेतों पर खड़ी सुगंधित फसल व ग्रामीणों को कई फसलों गेंदा, लेमनग्रास, पामारोजा, मेंथा, जिरेनियम आदि के बारे में जानकारी प्रदान कर फसलों के महत्वपूर्ण बिंदुओं पर चर्चा की। टीम के वैज्ञानिक डॉक्टर संजय ने बताया कि हम वेस्ट फूलों को प्रयोग करने के वाद एक घड़े में रख कर जैविक खाद को तैयार कर सकते है। साथ ही साथ फूलों के वेस्ट से पूजा पाठ काम में आने वाली धूपबत्ती व अगरबत्ती समेत गुलाब जल का भी निर्माण कर किसान अपनी आय को बढ़ा सकते हैं। मंदिर पर चढ़े फूलों को भी एकत्रित कर रोजगार के तरीके बताएं। अधिक जानकारी के लिए किसानों से ग्रुप में जुड़कर बरेली में आयोजित होने वाले किसान मेले में आने का निमंत्रण दिया। इस मौके पर किसान गौरव शर्मा, मनोज शर्मा, सचिन शर्मा आदि के खेतों पर भ्रमण किया।

लखनऊ स्थित सीएसआईआर प्रयोगशालाओं ने संयुक्त रूप से मनाया 82वां सीएसआईआर स्थापना दिवस

वैज्ञानिक शक्ति एवं उद्यमिता कौशल का संयोजन देश की अर्थव्यवस्था बदलने की क्षमता रखता है: डॉ. रेनू

वैचारिक तूफान.संवाददाता।

लखनऊ लखनऊ में सीएसआईआर प्रयोगशालाओं (सीएसआईआर-सीडीआरआई, सीएसआईआर-एनबीआरआई, सीएसआईआर-सीमैप, तथा सीएसआईआर-आईआईटीआर) ने संयुक्त रूप से अटल बिहारी वाजपेयी वैज्ञानिक कन्वेंशन सेंटर, किंग जॉर्ज मेडिकल यूनिवर्सिटी (केजीएमयू) लखनऊ में अपना 82 वां सीएसआईआर स्थापना दिवस मनाया। इस कार्यक्रम ने सीएसआईआर लैब्स के निदेशकों, वैज्ञानिकों और अनुसंधान विद्वानों को एक साथ लाया, जिससे सहयोग और नवाचार का माहौल तैयार किया जा सके।

इस अवसर पर सीएसआईआर की महानिदेशक डॉ. एन. कलैसेल्वी ने अपने वीडियो संदेश के माध्यम से इस आयोजन के प्रति उत्साह व्यक्त करते हुए कहा कि यह कार्यक्रम वैज्ञानिक समुदाय में नई ऊर्जा लाने का कार्य कर रहा है। उन्होंने इन प्रयोगशालाओं के वैज्ञानिकों को नई परियोजनाओं, मिशनों और सामाजिक अनुप्रयोगों को जन्म देने की क्षमता के साथ जुड़ने, विचार साझा करने एवं एक-दूसरे के कौशल को बढ़ाने के लिए प्रोत्साहित किया।



कार्यक्रम की शुरुआत में सीएसआईआर-एनबीआरआई के निदेशक डॉ. अजीत शासनी ने सभी गणमान्य व्यक्तियों और मेहमानों का स्वागत किया और इस संयुक्त उत्सव के पीछे के विचार की उत्पत्ति यानी कनेक्ट, कन्वर्ज एवं कोलेबोरेट पर चर्चा की, जिसके बारे में बाद में मुख्य अतिथि ने भी अपने संबोधन में उद्धृत किया।

सीएसआईआर-सीमैप के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने सभी चार प्रयोगशालाओं की उपलब्धियों का अवलोकन प्रस्तुत किया। उन्होंने उपलब्धियों के विभिन्न उदाहरण दिखाए, जो दर्शाते हैं कि कैसे सहयोगात्मक प्रयास सफलता की कहानियों में परिवर्तित हुए तथा नए प्रतिमान स्थापित किए।

सीएसआईआर-सीडीआरआई की निदेशक डॉ. राधा रंगराजन ने सीएसआईआर प्रयोगशालाओं की इस सामूहिक कार्यक्रम पर अपने विचार साझा किए। उन्होंने सम्मानित अतिथि किंग जॉर्ज मेडिकल कॉलेज की कुलपति डॉ. सोनिया नित्यानंद तथा मुख्य अतिथि विज्ञान मंत्रालय के जैव प्रौद्योगिकी विभाग (डीबीटी) की पूर्व सचिव डॉ. रेनू स्वरूप का परिचय कराया।

डॉ. सोनिया नित्यानंद ने अपने संबोधन में कहा कि लखनऊ ज्ञान-विज्ञान का शहर है और सहयोगात्मक अनुसंधान के लिए अद्वितीय वातावरण प्रदान करता है। सतत विकास के लिए अकादमिक-शैक्षणिक सहयोग के साथ-साथ अकादमिक-उद्योग सहयोग समय की मांग है एवं इस अमृतकाल में हमारे लक्ष्यों को प्राप्त करने के लिए यह आवश्यक भी है।

डॉ. रेनू स्वरूप ने समाज को प्रभावित करने वाली महत्वपूर्ण प्राथमिकताओं को संबोधित करने वाले तकनीकी नवाचार- विषय पर एक आकर्षक स्थापना दिवस उद्बोधन दिया। अपने संबोधन के दौरान, उन्होंने आगामी वर्ष के लिए भारत की योजनाओं पर चर्चा की, जिसमें नए टीके डिजाइन करने, नए एंटीबायोटिक्स विकसित करना, पशु चिकित्सा टीके विकसित करना, स्वच्छ ऊर्जा प्रौद्योगिकियों को आगे बढ़ाने और उनके लिए एक मंच तैयार करना आदि बहुत कुछ शामिल है। उन्होंने प्रौद्योगिकी नवाचार पर चर्चा की जो कैंसर, कार्डियो तथा मस्तिष्क विकार, मातृ एवं शिशु स्वास्थ्य और आनुवंशिक विकार के इलाज जैसे पूर्वानुमानित निदान में किफायती स्वास्थ्य देखभाल को प्रभावित करती है।

CSIR institutes welcome 2,600 schoolchildren on 'Open Day'

TIMES NEWS NETWORK

Lucknow: Over 2,600 students of the city got a chance to learn and interact with some top scientists when they visited three scientific institutes , including CSIR-Central Drug Research Institute (CDRI), National Botanical Research Institute (NBRI) and Central Institute of Medicinal and Aromatic Plants (CIMAP), on Tuesday.



A DATE WITH SCIENCE Students studying scientific models at CDRI

The occasion was 'Open Day' celebrations that marks the inauguration of CSIR on September 26, 1942. In commemoration of CSIR Foundation Day, every year the gates of the institutes are opened to the public.

At CIMAP, around 400 students and farmers visited the campus to learn about science, laboratories and research.

"We were not aware that such a big scientific institute is there in the city which makes medicine. We had a lot of queries and all were answered by the scientists," said class VI student of Lucknow Public School Janvi Gupta.

Another student Shipra from the same school said: "We can never learn so much science in classrooms. In a single day, we got to do hands-on experiments, take part in interactive session with scientists, visited different laboratories, saw a science exhibition, quiz competition, science model competition and a lot more."

CIMAP spokesperson Manoj Semwal said: "Students and farmers were taken on tour to various laboratories, field demonstrations, distillation units and human parks."

CDRI spokesperson Sanjeev Yadav said about 1100 students and educators from 25 schools and colleges participated in the annual event that aims at preparing the future scientists by giving them exposure at a young age.

AT NBRI, students were awestruck to have a look at the cactus garden, plant houses, herbarium and a lot more.

"This year, over 1200 students from 17 institutes of Lucknow and nearby districts have visited NBRI. Scientists informed them about the research and development activities and achievements of the institute," said NBRI spokesperson Rajat Raj Rastogi.

CIMAP launches basil-based drops to boost immunity

Lucknow: CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) launched Ocimmune, a Tulsi (basil)-based immunity-enhancing drop during its annual day celebrations on Friday.

Developed by a team of nine scientists, Ocimmune firm. "Basil has been used in traditional medicine systems across different cultures for their potential health benefits. We decided to develop this product realizing the importance of a strong and healthy immune system after the pandemic. The institute has standardized a

SCIENTIFICALLY YOURS

RESEARCH BYPRODUCT: GIFTS FOR COMMON MAN

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Be it monitoring the air quality of Lucknow, developing herbal beauty or health products, hosting flower shows, or organising Kisan Melas to help farmers reap rich benefits by cultivation of medicinal and aromatic plants, the scientific institutes of the city have been making immense contributions to the field of research and development in the city and the country.

The CSIR-ITTR (Indian Institute of Toxicology Research), the only toxicology institute in the country, has been consistently monitoring and releasing reports on the air quality and noise pollution levels in the city during post- and pre-monsoon season along with recommendations.

The institute has given several technologies to the country like a water analysis kit for physicochemical and bacteriological analysis of water to determine the quality of drinking water to ensure public health, especially in rural areas. The institute has developed a mobile laboratory van which is a mobile water quality testing facility for physicochemical and bacteriological assessment of potable water in villages and remote areas.



(From left) Scientists conduct research on low-nicotine tobacco plant variety at CIMAP; a flower plant at NBRI; Apparel made of fibre obtained from plants

Another product developed by IITR is a CD-strip for detection of butter yellow, a carcinogenic dye in mustard oil.

It can be used by housewives as well as health authorities for random preliminary checks.

Similarly, CSIR-NBRI (National Botanical Research Institute) has also developed a range of herbal products in the last four decades.

It has developed antioxidant formulations useful for neutralizing stress conditions, herbal lip care formulations, polyherbal dental cream useful in prevention of tooth decay, and natural colours for application in cosmetics. Other products of NBRI include 'herbichew' for tobacco de-addiction, herbal formulation for diabetes management, herbal floor disinfectant and cleaner (Floor Mop), cotton technology, transgenic crop plants for improved resistance to insect pests, whitefly resistance technology, and many more.

The institute has also conducted research and came up with a new variety of roses, lotus, coleus, chrysanthemum, bougainvillea, and gladiolus. NBRI hosts a flower show annually attracting people in droves.

CSIR-CIMAP (Central Institute of Medicinal and Aromatic Plants) is also known for herbal products, developing new and high-yielding varieties of medicinal plants like menthe and tulsi. Also, the institute discovered a variety of oregano that can be developed in India. Other products are Mosex, a natural formulation to repel mosquitoes, Germanium active herbal shampoo, Myconil an anti-fungal cream, Relaxomap and aroma-therapeutic topical formulation against pain and inflammation.

Another CSIR institute, the Central Drug Research Institute (CDRI), has played a major role in drug discovery in India. The institute came up with the first non-steroidal female oral contraceptive (Saheli), a herbal medication for bone health (Reunion), and an anti-parasitic medication (E-Mal) for cerebral malaria as a second-line treatment for chloroquine-resistant cases.

These scientific innovations, discoveries and researches have not only enriched scientific research and development, but have also given a unique identity to the city as a science hub.



Photos: Y Sahi & Ajay Kumar

CIMAP helps Puri farmer develop immunity booster

Aakash Ghosh
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LUCKNOW: A group of scientists from CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow in collaboration with a farmer from Puri in Odisha, has developed a Tulsi-based immunity booster 'ocimmune'. The product developed with over two years of research is a combination of five species of Tulsi.

With Tulsi grown in abundance in Puri, the farmer Ashok K Patra who is a beneficiary of the aroma mission of the institute, was already extracting the essential oils from the plant. Claiming that he found it to be quite effective during the Covid pandemic, he reached to the scientists here.

"Since Tulsi is grown in abundance in Puri for its use as offerings at the Jagannath temple, my company's production facility is established here itself. I started extracting oil from the plants that were surplus after being used in temples. The oil extracted proved beneficial to many people during the Covid pandemic. Thus, I contacted CIMAP that guided me scientifically and technically to develop this product," said Patra.

"The technology was transferred to a Puri-based farmer who is also one of the beneficiaries of the institute's aroma mission for mass production," said institute's director Prabodh Kumar Trivedi.

45TH ANNUAL DAY

CSIR-CIMAP Lucknow celebrated 45th annual day of CIMAP on Friday.

Anil Prakash Joshi, an environmentalist and Padma Shri and Padma Bhushan awardee was invited as the chief guest along with GN Singh, advisor to chief minister, and Awanish Kumar Awasthi, administrative advisor to the chief minister as the guest of honour.

CIMAP's aromatic plants to bloom in Uttarakhand

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Lucknow: Soon, new varieties of Rosemary and Damask rose — high-value aromatic crop — developed by city-based CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) will spread their fragrance in Uttarakhand and bring smiles to the faces of farmers struggling with financial, climatic and crop loss due to wild animals.

Under its 'Aroma Mission', the CIMAP aims at increasing the income of farmers through cultivation of aromatic plants.

It was started in India in 2016 but will be launched in Uttarakhand for the first time.



Damask rose developed by city-based CSIR

▶ Help farmers, P 12

Aroma Mission will help farmers boost income, says CIMAP director

CIMAP Will Train Them In Cultivating Rosemary, Damask

▶Continued from P 1

To begin with, the institute will run a pilot project in Champawat district of Uttarakhand where farmers have been leaving agriculture due to uncontrolled wildlife menace and irrigation challenges in the hilly terrain.

"CIMAP and Uttarakhand State Council For Science and Technology (USCOST) have come together to implement Aroma Mission so that not only farmers are benefitted at large but the initiative boosts' the state's economy, empowers local farmers and stimulates growth in various industries," said CIMAP director Dr Prabodh Kumar Trivedi.

CIMAP will train farmers in cultivating Rosemary and Damask Rose varieties and provide the varieties to them.

According to scientists, the essential oils extracted from the two aromatic plants is in high demand and of great economical value. Also, the varieties developed by the institute can be easily cultivated in the climatic conditions and soil of the region.

If all goes well, then the farmers of the region who at present earn a few thousand as annual income will reap rich benefits by earning Rs 5 lakh annually. CIMAP scientist Manoj Semwal said: "The Rosemary and Damask Rose crops will help in bringing considerable financial gains to Uttarakhand farmers. The essential oil extracted from the two crops is used for high-quality perfumes, aroma therapy, food and flavour."

He said Damask rose production is 2.5-3.0 tonne per hectare and oil yield is 600-750 grams per hectare. Profit per year per hectare is about Rs 5 lakh. Whereas Rosemary is used in the food and flavour industry.

The production of herbs is 100-150 quintals per hectare per year and oil yield is about 100 Kg per hectare per year. Profit per year per hectare is about Rs 2.5 lakh, he added.

U'Khand CM Dhami lauds initiative

CM Pushkar Singh Dhami recently tweeted a video expressing his happiness on CIMAP and UCOST together launching Aroma Mission in the state. He expressed hope that the mission will help in economic prosperity of the state and its farmers.

Why Champawat?

Champawat was once known as a leading area of cash crop cultivation in Uttarakhand but off late farmers have abandoned agriculture mainly due to wildlife menace. Scientists hope that since Damask Rose has thorns and Rosemary is a bushy plant with no fruits hence their chances of being destroyed by wildlife are almost negligible.



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पांच किस्मों की तुलसी बढ़ाएगी इम्यूनिटी

सीमैप के 45वें वार्षिक दिवस में तुलसी ड्राप इम्यूनबूस्टर तथा नारी सैनिटरी नैपकिन का तकनीकी हस्तांतरण

जासं, लखनऊ: सीमैप के वैज्ञानिकों ने पुरी (ओडीशा) के किसान के साथ मिलकर तुलसी की पांच किस्मों पर आधारित इम्यूनिटी बूस्टर 'ओसिम्यून' तैयार किया है। इस उत्पाद की एक से दो ड्राप ही न केवल आपकी सेहत बनाएगी, बल्कि कई बीमारियों से भी बचाव करेगी। दो वर्षों के शोध के बाद अब अगले माह से यह बाजार में उतरने को तैयार है। सीमैप के 45वें वार्षिक दिवस समारोह के अवसर पर शुक्रवार को 'ओसिम्यून' के साथ 'नारी' सैनिटरी नैपकिन और एरोमा एसेंशियल आयल किट की तकनीकी का हस्तांतरण किया गया। इस अवसर पर देश भर के विभिन्न स्टार्टअप और कंपनियों के साथ इंडस्ट्री मीट भी हुई।

सीमैप की पांच किस्में शामिल : ओसिम्यून उत्पाद को विकसित करने वाले वैज्ञानिकों में डा. अनिर्बन पाल ने बताया कि इसमें सीमैप में विकसित की गई तुलसी की पांच प्रजातियों को शामिल किया गया है। इनमें ओसिमम बैसिकम यानी सिम-अंगना समेत सिम-सिलिंद्र, सिम-सौम्या, सिम-सुवास और सिम-ज्योति शामिल हैं। यह एंटीआक्सीडेंट और एंटीमाइक्रोबियल्स के गुणों के हर्बल फार्मूले के साथ तैयार की गई है, जिसे गर्म पानी के अलावा चाय में भी दो बूंद डालकर दिन में दो से तीन बार पिया जा सकता है।

पुरी के मंदिर से बजार तक : इसकी तकनीकी लेने वाले पुरी के किसान और अरोमा मिशन के लाभार्थी अशोक कुमार पात्रा ने कहा कि जगन्नाथ धाम पुरी में बड़ी मात्रा में तुलसी चढ़ाई जाती है। हम उसी तुलसी को एकत्र कर उससे तेल का उत्पादन करते हैं। कोरोना काल में वह तेल कई लोगों के काम आया था। इसके बाद हमने सीमैप के साथ मिलकर वैज्ञानिक और तकनीकी रूप से इस उत्पाद को विकसित करने में सहयोग किया है। इस उत्पाद को बनाने को लेकर सभी तरह के मलीनरी हमारे पास पहले से है। ऐसे में एक स्टार्टअप के तौर पर इस तकनीकी को लेकर हम इसे अगले माह से ही बाजार में उतरने को तैयार हैं।

इंडस्ट्री से छात्रों्ग जरूरी : वार्षिक दिवस समारोह में मुख्य अतिथि हिमालयन पर्यावरण अध्ययन और संरक्षण संगठन देहरादून के संस्थापक पद्मभूषण डा. अनिल प्रकाश जोशी ने कहा कि किसान सिर्फ फसलों के उत्पादन तक ही सीमित न रहकर उनके उत्पाद में भी वैल्यू एडिशन कर सकते हैं। इस पर सीमैप किसानों को प्रशिक्षण दे सकता है। इसकी वजह से जीडीपी के साथ पर्सनैलिटी रोल को भी संतुलित किया जा सकता है। मुख्य अतिथि ने यह भी कहा कि अक्सर शोध होने के बाद तकनीकी हस्तांतरित होती है और उसके बाद की सभी परेशानियां इंडस्ट्री की ही जाती हैं, लेकिन यह पहली बार है कि वैज्ञानिक और उद्योग से जुड़े व्यक्ति आमने-सामने बैठे हैं ताकि तकनीकी हस्तांतरण से जुड़ी परेशानियों पर वैज्ञानिक फालोअप कर बात कर सकें और फसलों की नई किस्मों पर चर्चा की जा सके। उन्होंने सीमैप को लोक किसान संस्थान का भी दर्जा दिया।

विशिष्ट अतिथि मुख्यमंत्री के सलाहकार डा. जीएन. सिंह ने कहा कि शोध के परिणाम को उत्पाद के रूप में सामने लाना जटिल प्रक्रिया है। वैज्ञानिकों की खोज जनमानस तक पहुंचनी चाहिए। समय की मांग है कि वैज्ञानिक और उद्योग, सामाजिक और आर्थिक प्रगति के लिए मिलकर कार्य किया जाए। मुख्यमंत्री के प्रशासनिक सलाहकार अवनीश कुमार अवस्थी ने कहा कि वैज्ञानिक संस्था ऐसी होनी चाहिए जो किसानों एवं उद्यमियों के साथ-साथ आत्मनि[illegible] के कदम को आगे बढ़ाए। सीमैप के निदेशक डा. प्रबोध कुमार त्रिवेदी ने बताया कि सीमैप के वैज्ञानिकों द्वारा देश में किसानों की आमदनी बढ़ाने के लिए लगातार काम हो रहा है। सीएसआइआर के एरोमा मिशन के तहत एरोमा क्लस्टर विकसित कर आदिवासी व दूरदराज के किसानों को प्रशिक्षित और फसलों के उत्पादन में प्रशिक्षण की और हम अग्रसर हैं। इस अवसर पर किसानों के मूल्य संवर्धन के लिए पांच तेलों की एरोमा आयल किट लांच की गई। इसमें खस, जिरेनियम, तुलसी, पामारोजा और लेमनग्रास के तेल शामिल हैं। इस सीमैप के सेल्स काउंटर से 800 रुपये में खरीद जा सकता है। इसके साथ ही मेसर्स बिर्ग एम हैल्थ केयर प्राइवेट लिमिटेड पुरी के साथ तुलसी ड्राप इम्यूनबूस्टर की तकनीकी का हस्तांतरण किया गया।

समारोह में ओसिम्यून इम्यून बूस्टर तुलसी ड्राप उत्पाद का विमोचन करते डा. अनिल प्रकाश जोशी, साथ में मुख्यमंत्री के सलाहकार अवनीश कुमार अवस्थी, सीमैप के निदेशक डा.प्रबोध कुमार त्रिवेदी, डा.जीएन सिंह व डा.राजेश कुमार ■ जागरण

ओसिम्यून इम्यून बूस्टर तुलसी ड्राप

टीम में ये रहे शामिल

इस उत्पाद को तैयार करने वाली टीम में संस्थान के निदेशक डा. प्रबोध कुमार त्रिवेदी का निर्देशन मिला। वहीं डा. अनिर्बन पाल के साथ डा. प्रशांत कुमार राहत, डा. वंदन सिंह चनौटिया, डा. देवव्रत पंत, डा. धनैंद सैकिया, डा. नारायण प्रसाद यादव, डा. आरके लाल, डा. अजीत कुमार शासनी और अन्य शोधार्थी भी शामिल रहे।

Breakthrough: CIMAP lowers nicotine in tobacco by 70%

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Ajay Kumar

Lucknow: Is quitting tobacco tough for you? If you have tried tobacco products with zero nicotine but found nothing works, here is research that has come as a ray of hope ahead of 'World No Tobacco Day'.

CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) has successfully lowered nicotine content in the Petit Havana To-



CIMAP director Dr P K Trivedi (right) with the team

CSIR-CIMAP now plans to lower nicotine in commercial varieties to help people

'Inst lowered Nicotine content by altering transcription factor'

▶Continued from P 1

As a result of four years of research, CIMAP director Dr P K Trivedi, along with research scholars Dr Deeksha Singh and Shambhavi Dwivedi, succeeded in lowering nicotine in the Petit Havana tobacco plant.



Ajay Kumar

"When several studies highlighted that zero nicotine products were disliked by people who were aiming at de-addiction, we thought why not lower it to the extent that it becomes less harmful and can be given up gradually," said Trivedi, adding that there is a biosynthetic pathway for nicotine present in the root of the plant, by which nicotine is synthesised in the root tissue and transported to the leaves. Among the several pathways, only one facilitates nicotine biosynthesis and if it is blocked, there will be zero nicotine in the leaves of the plant. On the other hand, if instead of blocking, we regulate this pathway, nicotine will be there but its production will slow down, he added.

Trivedi said, "We have used CRISPR-Cas9 for genome-editing which is a unique technology that helps scientists edit parts of the genome by adding or altering sections of the DNA sequence. It's much faster, cheaper and more accurate than previous techniques of editing DNA. CIMAP has identified a transcription factor in tobacco plant which is a protein that helps turn specific genes 'on' or 'off' by binding to their regulatory regions. The Institute has altered or knocked out the 'transcription factor' which has helped in lowering Nicotine content in the plant.

Toxic killer

According to World Health Organisation, around 8 million deaths are caused by tobacco consumption every year across the globe. The main culprit present is nicotine that leads to cancer, heart attack, impotence, and other health issues.

Feat on video

Elated with CIMAP's finding, Council of Scientific and Industrial Research, New Delhi, has made a video showing how the institute successfully lowered nicotine in tobacco.

What is nicotine?

Colourless or yellowish oily liquid present in plants' leaves, nicotine is an addictive, toxic liquid chemical found in tobacco. India is world's second-largest tobacco producer, hence, this achievement will benefit at large population that consumes tobacco.

गंगा किनारे लगाएं लाभकारी व सुगंधित पौधे

प्रयागराज। गंगा के तटवर्ती इलाकों में लाभकारी और सुगंधित पौधे लगाएं। इनकी खेती गंगा के प्रदूषण को रोकेगी और किसानों की आय में भी वृद्धि होगी। इसके प्रति किसानों को जागरूक करने की जरूरत है। यह बातें बायोवेद कृषि प्रौद्योगिकी एवं विज्ञान शोध संस्थान, प्रयागराज के निदेशक डॉ. बी के द्विवेदी ने मंगलवार को कहीं।

वे श्रृंग्वेरपुर में केंद्रीय औषधीय एवं सुगंध पौधा संस्थान (सीमैप) के किसान जागरूकता कार्यक्रम में बोल रहे थे। सीमैप के मुख्य वैज्ञानिक डॉ. बीरेंद्र कुमार ने राष्ट्रीय स्वच्छ गंगा मिशन के अंतर्गत चयनित तीन गांवों श्रृंग्वेरपुर, ककरा उपरहार और लाक्षागृह के उत्थान के बारे में चर्चा की। इन गांवों के सौंदर्यीकरण के लिए राष्ट्रीय पादप बोर्ड की परियोजना के बारे में भी जानकारी दी। इस दौरान लेमन ग्रास, सिट्रोनेला, वच, स्टीविया और तुलसी के पौधों का वितरण भी किया गया। संवाद

केंद्रीय औषधीय सगंध पौधा संस्थान का एक दिवसीय जागरूकता कार्यक्रम का आयोजन

प्रयागराज। जिले में मंगलवार को राष्ट्रीय औषधीय पादप बोर्ड के वित्तीय सहयोग द्वारा नवाबगंज थाना क्षेत्र के श्रृंगवेरपुर गांव में सीएसआईआर-केंद्रीयऔषधीय सगंध पौधा संस्थान, लखनऊ (सीमैप) ने एक दिवसीय जागरूकता कार्यक्रम तथा पौध वितरण कार्यक्रम का आयोजन किया। इसके अंतर्गत क्षेत्रीय किसानों की समस्याओं को सुनकर उन्हें उन्नत फसल उत्पादन तथा प्रबंधन के विषय में जानकारी दी गई। कार्यक्रम में उपस्थित विशिष्ट अतिथि डॉ. बी के द्विवेदी (निदेशक, बायोवेद कृषि एवं तकनीकी अनुसंधान केंद्र, प्रयागराज) के साथ कार्यक्रम के मुख्य अतिथि के रूप में मौजूद परि फुरर्वीपना दन अनुसंधान केंद्र के वैज्ञानिक डॉ. कुमुद दुबे ने गंगा के तटीय क्षेत्रों में औषधीय एवं औषधीय महत्व वाले सुगंध पौधों को लगाने से जीवनदायनी गंगा को प्रदूषण मुक्त बनाने तथा किसानों को इन पौधों की खेती से होने वाली अतिरिक्त आय में वृद्धि के विषय में चर्चा की। सीमैप के मुख्य वैज्ञानिक डॉ बीरेंद्र कुमार ने राष्ट्रीय स्वच्छ गंगा मिशन के अंतर्गत जिले के चयनित तीन गंगा ग्रामों: श्रृंगवेरपुर, ककरा उपहार तथा लाक्षागृह के उत्थान एवं सौंदरीकरण के उद्देश्य से संस्थान में राष्ट्रीय पादप बोर्ड द्वारा प्रायोजित परियोजना के विषय में जानकारी दी। संस्थान के वरिष्ठ वैज्ञानिक डॉक्टर नरेंद्र कुमार ने औषधीय तथा औषधीय रूप से महत्वपूर्ण सुगंधित पौधों का वर्गनित गंगा



ग्रामों में पूर्व स्थाने संरक्षण के विषय में प्रकाश डालते हुए बताया कि राष्ट्रीय औषधीय पादप बोर्ड तथा सीमैप की यह संयुक्त पहल न सिर्फ अविरल गंगा को प्रदूषण मुक्त बनाएगी बल्कि इन औषधीय पौधों के प्रसार हेतु पादप सामग्री उपलब्ध कराने में भी सक्षम होगी। इस एक दिवसीय जागरूकता कार्यक्रम के अंतर्गत सीमैप के वरिष्ठ प्रधान वैज्ञानिक डॉ. राजेश कुमार वर्मा ने तुलसी तथा सुगंधित घासों की विभिन्न प्रजातियों की खेती तथा इससे संबद्ध कृषि प्रौद्योगिकी के विषय में जानकारी दी। वहीं, वरिष्ठ वैज्ञानिक डॉ. राकेश कुमार ने किसानों से औषधीय पौधों के विषय में चर्चा की। संस्थान के प्रधान वैज्ञानिक डॉ आर एस वर्मा ने औषधीय एवं औषधि रूप से महत्वपूर्ण सुगंधित पौधों द्वारा अधिक सारभूत तेल की गुणवत्ता के विषय में किसानों को जानकारी दी। कार्यक्रम के अंत में सीमैप के वैज्ञानिकों द्वारा किसानों में औषधीय तथा सुगंध पौधों, लेमन ग्रास, सिट्रोनेला, वच, स्टीविया, तुलसी आदि का वितरण किया गया तथा किसानों से उनकी कृषि संबंधित समस्याओं के विषय में चर्चा भी की गई। जिले में आयोजित इस प्रकार की गतिविधियों से किसानों की जागरूकता को बढ़ावा मिलने के साथ ही उनकी आय में वृद्धि भी लक्षित होगी जिससे राष्ट्र के सतत विकास में हमारे किसान भी महत्वपूर्ण योगदान करेंगे अहम भूमिका निभाएगा।

UP's lst eco-friendly aroma cluster in Barabanki

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Lucknow: UP has made an aromatic and eco-friendly start in the green world. The CSIR-Central Institute Medicinal and Aromatic Plants (CIMAP) on Thursday launched Uttar Pradesh's first 'Sustainable Aroma Cluster' in Bhagauli locality of Barabanki, demonstrating to farmers how modern technology can be used for sustainable agriculture practices that do not harm the ecosystem.

The sustainable aroma cluster has been developed by CIMAP on the land of 30 farmers by cultivating aromatic plants in an eco-friendly manner. The cluster will set an example of use of sustainable practices in agriculture and help the country attain zero-carbon emission goals.

A BOON FOR FARMERS TOO

- Will save environment by tackling problems like crops residue burning that leads to air pollution
- Use of drone for sprinkling pesticides will save farmers from health risks during the process
- Will help save water by using drone for irrigation
- Will discourage soil pollution by producing vermicompost out of the crop residue



NEW START: CIMAP officials inaugurate aromatic cluster on Thursday and (L) a demonstration of drone use in agriculture

CIMAP has planted a high-yielding mint variety (CIM-Unnati) in the cluster which is resistant to biotic stress, including plant pests and diseases and tolerant to abiotic stresses, including drought, untimely rains, salinity, heat, cold and heavy metals. The cluster will serve as a model for farmers to replicate across the state.

CIMAP scientists demonstrated before farmers how drones are used to irrigate fields and for sprinkling of pesticides in a precise and efficient manner. They were shown how manual irrigation leads to wastage of water and manual pesticide sprinkling harms people involved in it as well as the environment. Farmers also got tips on soil testing. Solar-powered units to extract mint oil were also inaugurated on the occasion.

CIMAP director Prabodh K Trivedi said the institute has used an improved agri-technique called Early Mint Technology in the development of the cluster. "The technology saves 20-25% of irrigation water and reduces weed infestations. Besides, it helps in early maturity of crop," he said.

"Farmers use new technologies, farm mechanisation and chemicals for getting maximum crop yield to meet the ever-increasing demand. It could be helpful in reducing food prices, but may lead to a progressive decrease in soil fertility, topsoil depletion, contamination of groundwater, air pollution, greenhouse gas emissions, and newer threats to human health," he said

"The cluster developed by CIMAP aims at zero-carbon emission by adopting sustainable practices in agriculture. Similar clusters will be established in other parts of the state to save the environment and reduce health risks," he added.

Two-day Kisan Mela begins at CSIR-CIMAP

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LUCKNOW: Two-day Kisan Mela began at CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow on Tuesday.

While welcoming chief guest Ajit Kumar Shasany and other industry representatives, director, CSIR-NBRI, Prabodh Kumar Trivedi, said that CSIR-CIMAP under its flagship programme 'Aroma Mission' helped India in becoming self-sufficient in producing lemongrass essential oil which was earlier imported from other countries.

"On Wednesday chief minister Yogi Adityanath will be the chief guest and agriculture minister Surya Pratap Shahi will be the guest of honour," he said.

"Nallathambi Kalaiselvi, director general, CSIR and secretary, Department of Scientific and Industrial Research (DSIR) will also be present," he added.

During the inaugural ceremony, the Mentha insect crop calendar along with herbal products and an essential oil kit was released by the dignitaries.



Guests at the Kisan Mela venue that began here on Tuesday. HT

दो-दिवसीय सीमैप किसान मेला 2024 सम्पन्न

किसान खुशहाल होगा तो प्रदेश खुशहाल होगा : योगी आदित्यनाथ



महिला लाभार्थियों से मिले मुख्यमंत्री योगी, चंदन का पौधा भी लगाया

■ एनबीटी, लखनऊः केंद्रीय औषधीय एवं सगंध पौधा संस्थान में बुधवार को आयोजित किसान मेले में सीएम योगी आदित्यनाथ ने कहा कि देशभर के किसान ऐसे समय में आए है, जब रामलला विराजमान हुए हैं। किसानों से रूबरू होते हुए सीएम ने कहा कि रामलला के दर्शन करने है तो बता दें, हम व्यवस्था कर देंगे। सीएम के इतना कहते ही पूरा परिसर श्रीराम के नारों से गूंज उठा।



केंद्रीय औषधीय एवं सगंध पौधा संस्थान में आयोजित किसान मेले में शामिल हुए सीएम योगी आदित्यनाथ।

किसानों में दिखा जबरदस्त उत्साहः इससे पहले आयोजन स्थल पर सीएम को अपने बीच पाकर किसान उत्साह से भर उठे। सीएम ने संबोधन से पहले संस्थान परिसर में चंदन का पौधा लगाने के साथ ही 15 सरकारी संस्थानों के ग्रामीण प्रौद्योगिकी पवेलियन का उद्घाटन किया। इनमें कृषि में ड्रोन का उपयोग, उच्च मूल्य वाले फूलों की खेती, बाजरा और खाद्य प्रसंस्करण, उच्च उपज वाले बासमती चावल की किस्म जैसी तकनीकों का प्रदर्शन किया गया। मुख्यमंत्री ने स्टालों का जायजा लेने के साथ ही वैज्ञानिकों से जानकारी भी ली। सीएम ने मंदिर में चढ़ाए गए फूलों से अगरबत्ती बनाने में शामिल 20 नवोदित उद्यमियों और 50 से अधिक महिला लाभार्थियों से बातचीत भी की। इसके साथ ही किसान मेला स्मारिका पुस्तक 'औस ज्ञान्या', सीएसआईआर-सीमैप द्वारा विकसित 164 किस्मों की पुस्तिका, सीएसआईआर-अरोमा एंड्रॉइड मोबाइल ऐप और एक हर्बल उत्पाद एलो रोमा जेल का भी लोकार्पण किया। इस मौके पर सीएसआईआर-सीमैप ने औषधीय और सुगंधित पौधों की 75 उच्च उपज वाली किस्मों के साथ-साथ सौर आसवन इकाई सहित उन्नत आसवन इकाइयों को भी प्रदर्शित किया।

CM launches CIMAP's herbal gel, farmer app

4,000 Farmers Participate In Kisan Mela

Times News Network

Lucknow: CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) has come up with a farmer's friendly CSIR-Aroma android mobile app, offering solutions to all crop related problems, a herbal skincare product 'Aloe Roma' gel and a souvenir 'Aus Gyana'.

The mobile app, herbal product and the souvenir were launched by Chief Minister Yogi Adityanath during annual Kisan Mela which culminated on Wednesday.

"Our CSIR-Aroma android mobile-based app will help farmers to get guidance from experts of CSIR laboratories of the country. For example, they can upload a picture of their crop to learn ways to control weeds, insect infestation and diseases," said CIMAP spokesperson Manoj Semwal. He said that 100% pure aloe vera gel with essential oil named 'Aloe Roma' for skincare and 'Aus Gyanya', a book containing 164 varieties



Chief minister Yogi Adityanath at kisan mela organised by CIMAP

Visit Ram Lalla temple after kisan mela, CM tells farmers

▶Continued from P 1

Highlighting the fertile land and abundant water resources in Uttar Pradesh, CM Yogi outlined the state's pivotal role in agricultural production, contributing over 22% of the country's food grains despite having only 11% cultivable land. "Both agriculture and farmers are strengthened if they get the support of innovation and technology. At present 89 agricultural science centres and four state agricultural universities are present and the establishment of the fifth one is underway in the state," said the CM.

necting UP farmers to medicinal farming/horticulture and promoting herbal products.

CM also encouraged collaboration between CIMAP and various institutions related to agriculture, horticulture, and AYUSH within the state to foster a culture of innovation and research, ultimately contributing to the continuous betterment of the agricultural sector in the state.

The CM invited farmers, who came from different states, to visit the newly constructed Ram temple once the Kisan Mela culminates.

Agriculture Minister Surya Pratap Shahi, director ge-

Yogi: Farmers' income "almost doubled" since 2018, trend extends beyond U.P.

Lucknow lucky to have four CSIR labs, potential should be fully tapped, CM tells farmers

HT Correspondent
letters@htlive.com

LUCKNOW: Chief minister Yogi Adityanath on Wednesday said farmers' income "has almost doubled" since 2018 and this "positive trend" extends beyond Uttar Pradesh. He said farmers across the country are embracing agricultural diversification, aligning with Prime Minister Narendra Modi's "visionary approach", consequently "doubling their income."

Inaugurating the 'Kisan Mela' organised by the Central Institute of Medicinal and Aromatic Plants (CIMAP) at its Kukrail premises, Adityanath highlighted the PM's transformative vision.

The CM, according to a press statement issued by the state



Chief minister Yogi Adityanath at the inauguration of Kisan Mela organised by CIMAP in Lucknow on Wednesday. DEEPAK GUPTA

upliftment, coupled with a robust integration of scientific research and innovation.

"The state capital is lucky to have four Council of Scientific and Industrial Research (CSIR) labs including CIMAP, NBRI, CDRI, and IITR, and we all should strive together to tap their full potential," said Adityanath.

"The existence of four central laboratories is an opportunity

Highlighting the fertile land and abundant water resources in UP, the chief minister outlined the state's pivotal role in agricultural production, contributing over 22% of the country's foodgrains despite having 11% cultivable land.

Adityanath stressed the government's proactive role in connecting farmers of UP to medicinal farming and horticulture and promoting herbal products.

CM INVITES FARMERS TO VISIT AYODHYA

While addressing farmers, the CM said: "You are lucky to have arrived in the state right after Ram Mandir inauguration. I invite you all to visit Ayodhya." He said bus services to Ayodhya will be expanded and those willing to visit the temple town can go there. He asked officials to make necessary arrangements for the visit.

Earlier, Adityanath also launched an "Aroma Mission App" for farmers, a Kisan Mela souvenir book - 'Aus Gyanya', mentioning164 varieties of medicinal and aromatic plants and a herbal "Aloe Roma" gel.

technologies developed in the labs to enhance rural incomes.

"I have been part of parliament for long where farmers' suicide was a big issue. They would commit suicide for rea-

Ram Temple, Panchvati replicas major attractions

Aakash Ghosh
aakash.ghosh@htlive.com

LUCKNOW: The second season of Kisan Mela was drenched in Ram fervour, with a number of religious stalls, including replicas of the Ram temple and Panchvati. To add to the participating farmers' joy, chief minister Yogi Adityanath also invited them to Ayodhya.

The CSIR-NBRI set up its Ram temple made of 70 kg flowers while the CSIR-CIMAP set up a replica of Panchvati that drew a large crowd for selfies and photos. The Panchvati replica showcased the institute's five medicinal and herbal plants, as well as Ram cutouts, monkey and deer cutouts and a scene from the jungle portraying Ram's 14-year exile.

CM Yogi also inaugurated an exhibition at the fair and inspected the stalls, while interacting with the farmers from



A replica of Ayodhya Ram Temple at the Kisan Mela venue. DEEPAK GUPTA

living in the Terai region on the Indo-Nepal border of Uttar Pradesh .

Sunita Singh Dhawan, senior principal scientist, CSIR-CIMAP, said that earlier they were into traditional farming but mentha and lemongrass cultivation added to their income.

Pandian, a farmer from near

किसानों की आय हुई दोगुनीः आदित्यनाथ

राजेश मिश्र

लखनऊ, 31 जनवरी। मुख्यमंत्री योगी आदित्यनाथ ने बुधवार को कहा कि प्रधानमंत्री नरेन्द्र मोदी के विजन के अनुरूप खेती करने के कारण किसान लाभान्वित हो रहे हैं। उनकी आय दो गुनी हुई है। आज उत्तर प्रदेश ही नहीं बल्कि देश के अन्य राज्यों का किसान भी मोदी के विजन के अनुरूप परंपरागत खेती के अलावा कृषि विविधिकरण अपना रहा है।

योगी ने कहा कि हमारी सरकार ने प्रदेश के किसानों को औषधीय खेती और बागवानी से भी जोड़ा है। उनके हर्बल प्रोडक्ट्स को प्रमोट कर रही है। इससे किसान अपने उत्पाद का कई गुना दाम प्राप्त कर रहा है। यह अन्नदाता किसानों के जीवन में परिवर्तन का एक बड़ा माध्यम बना है। मुख्यमंत्री ने पिकनिक स्पॉट रोड स्थित केंद्रीय औषधि एवं सगंध पौधा संस्थान (सीमैप) के



- मुख्यमंत्री योगी ने किसान मेले का किया उद्घाटन
- किसान अपने औषधीय उत्पाद का कई गुना दाम प्राप्त कर रहा
- पीसीएस अधिकारी प्रशासनिक व्यवस्था की रीढ़ : मुख्यमंत्री

तत्वावधान में आयोजित किसान मेले का उद्घाटन किया। इस अवसर पर योगी ने कहा कि पहले की सरकारों में किसानों को उनकी उपज का सही मूल्य नहीं मिल पाता था। ■ शेष पेज 11 पर

अब देश में ही तैयार होगा आड़ू का प्राकृतिक फ्लेवर

रामांती मिश्रा • लखनऊ

पीच यानी आड़ू का फ्लेवर खाद्य और सुगंध इंडस्ट्री में बहुतायत में उपयोग किया जाता है, लेकिन देश में अब तक इसे बाहर से मंगाया जाता है, जो कि केमिकल युक्त होता है। वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद (सीएसआइआर) की लखनऊ स्थित प्रयोगशाला केंद्रीय औषधि एवं सगंध पौधा संस्थान (सीमैप) के वैज्ञानिकों ने कैस्टर आयल यानी अरंडी के तेल से खाद्य पदार्थों में उपयोग होने वाले आड़ू के फ्लेवर का शुद्ध रूप विकसित किया है। इसका पेटेंट भी लिया जा चुका है यानी अब देश में आसानी से और शुद्ध रूप से औद्योगिक इकाइयों को पीच फ्लेवर मिल सकेगा।

सीमैप के निदेशक डा. प्रबोध कुमार त्रिवेदी के अनुसार, खाद्य पदार्थों में मिलावट से बचाव और

- अब देश में ही तैयार होगा आड़ू का प्राकृतिक फ्लेवर
- सीमैप ने अरंडी के तेल से निकाला आड़ू का फ्लेवर,



अरंडी के तेल से पीच फ्लेवर निकालने की प्रक्रिया •

प्राकृतिक स्वाद की मांग लगातार बढ़ रही है। अरंडी के तेल में उपस्थित रिसिनोलिक एसिड से ही पीच फ्लेवर तैयार किया जाता है। भारत में अरंडी के तेल का उत्पादन काफी अधिक मात्रा में होता है और इसे देश से कच्चे रूप में निर्यात भी किया जाता है। विदेश में इससे आड़ू का फ्लेवर निकालकर कुछ रसायनों का मिश्रण कर तैयार किया जाता है। अंतरराष्ट्रीय बाजार में इसका मूल्य लगभग पांच हजार रुपये प्रति किलोग्राम है। सीमैप द्वारा विकसित प्राकृतिक मिश्रण न केवल बेहतर मूल्य पर उपलब्ध होगा, खाद्य और सुगंध उद्योग के लिए बाजार में उपलब्ध अन्य फ्लेवर



डा. प्रबोध कुमार त्रिवेदी, सीमैप निदेशक व डा. प्रशांत राउत •

की तुलना में भी बेहतर होगा।

कैस्टर आयल में यह शोध करने वाले सीमैप के वैज्ञानिक डा. प्रशांत राउत ने बताया कि अरंडी के तेल में उपस्थित रिसिनोलिक एसिड से जैव संवर्धन तकनीक से 99 प्रतिशत प्राकृतिक गामा डेकालेक्टोन मिश्रण की तकनीक विकसित की है। इस तकनीक द्वारा खाद्य पदार्थों में प्राकृतिक रूप से किसी भी फ्लेवर को शामिल किया जा सकता है। इससे केमिकल युक्त फ्लेवर से होने वाले दुष्प्रभाव शरीर पर नहीं पड़ेंगे। साथ ही खाद्य पदार्थ भी गुणवत्ता युक्त होंगे।

यह है प्रक्रिया

अरंडी के बीज द्वारा तेल उत्पादन बहुतायत रहा है, लेकिन उच्च गुणवत्ता उत्पाद और मूल्य संवर्धन के लिए भारतीय उद्योगों द्वारा इसका उपयोग नहीं हो पा रहा है। अरंडी तेल का मुख्य रासायनिक घटक रिसिनोलिक एसिड है। इसकी मात्रा 80 प्रतिशत से भी अधिक होती है। जैव संवर्धन द्वारा रिसिनोलिक एसिड को अरंडी के तेल से अलग करके खाद्य स्वाद घटक गामा-डेकालेक्टोन विकसित किया है। इसमें आड़ू जैसी सुगंध होती है। सामान्यतया प्राकृतिक रूप से स्वाद खाद्य पदार्थों से स्वाद और सुगंध को अलग करना काफी कठिन, महंगा और अधिक समय लेने वाली प्रक्रिया होती है। सीमैप की तकनीक से कई महत्वपूर्ण प्राकृतिक खाद्य स्वाद पदार्थ सरलता से उपलब्ध हो पाएंगे।

प्रधानमंत्री वन धन प्रशिक्षण कार्यक्रम संपन्न

मुख्य अतिथि संजय कुमार पाठक जनरल मैनेजर प्रोडक्शन उ0 प्र0 वन निगम

साइबर एक्सप्रेस जिला ब्यूरो/अनिल कुमार मौर्य



मोतीपुर बहराइच लॉगिंग प्रभाग के अंतर्गत संचालित आदिवासी बाहुल्य ग्रामों के समूहों को प्रधानमंत्री वन धन केंद्र द्वारा चयनित वन धन केंद्र आम्बा, कारीकोट, एवं सोहनीबालाई गांव के 45 समूहों का 07 दिवशीय प्रशिक्षण कार्यक्रम का आयोजन किया गया ,इस कार्यक्रम में वन्य उपज के प्रयोग से आजीविका कैसे चलाए और आय कैसे बढ़ाएं जैसे बांस से बने उत्पाद चटाई टोकरी का प्रशिक्षण हल्दी प्रोसेसिंग सरसों के लड्डूमहुआ के लड्डू बनाने का प्रशिक्षण फूलों की खेती करके आय बढ़ाने संबंधित प्रशिक्षण इत्यादि कार्यक्रम की मुख्य विषयवस्तु रही जिसमें मुख्य अतिथि श्री संजय कुमार पाठक उ0 प्र0 वन निगम द्वारा उद्घाटन किया गया जिसमे प्रभागीय वनाधिकारी कतरनियाघाट आकाशदीप बधवान प्रभागीय लॉगिंग प्रबंधक बहराइच रवीन्द्र नाथ सिंह, एवं रक्षपाल सिंह (वरिष्ठ तकनीकी अधिकारी), निखिल लोथे, डा0 अजय सी एस आई आर ,आशीर्वाद वेलफेयर सोसाइटी से आए मास्टर ट्रेनर देशराज व चार सदस्सीय टीम सुश्री इंदु करासी अध्यक्ष जीजीविशा सोसाइटी प्रेमलाल रिंग्याल शिल्पकार मनसुसा रुद्रप्रयाग उत्तराखंड श्री अनूप कुमार तिवारी (वन धन केंद्र प्रभारी रेनुकूट), अक्षत सिंह (सेक्शन अधिकारी इको टूरिज्म), नरेंद्र प्रताप सिंह प्रभारी इको टूरिज्म कटरनियाघाट, व प्रदीप शर्मा (प्रभारी वन धन केंद्र) एवं उ0 प्र0 वन निगम के अन्य स्टाफ मौजूद रहे अपने वैज्ञानिको को प्रशिक्षण कार्यक्रम में शामिल होने की अनुमति देने के लिए माननीय निदेशक सी एस आई आर को विशेष धन्यवाद दिया गया कार्यक्रम में प्रधान मंत्री वन धन योजना प्रभारी श्री प्रदीप शर्मा एवं श्री कबीरदास के साथ विभागीय स्टाफ एवं वन विभाग के स्थानीय कर्मचारी भी उपस्थित रहे ।



மாலை மலர்

இந்தியாவின் No.1 மாலை நாளிதழ்

MAALAI MALAR

திருச்சி 18-9-2023 (திங்கட் கிழமை) 8 பக்கம் ₹ 5 ★★★ மலர் 46 இதழ் 277

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CENTRAL INSTITUTE OF MEDICINAL AND AROMATIC PLANTS (CIMAP)

It is a premier multi-disciplinary research facility that focuses on exploiting the potential of medicinal and aromatic plants (MAPs). It has played a key role in positioning India as a global leader in the production of mint, vetiver and other aromatic grasses, and in ensuring indigenous production of artemisinin – a WHO-approved anti-malarial drug. It houses a National Gene Bank on MAPs and has helped in commercializing an Ayurvedic herbal-based anti-diabetic formulation.

विद्यार्थियों व किसानों ने देखा सीमैप

कार्यालय संवाददाता, लखनऊ

अमृत विचार : मंगलवार को राजधानी के सीएसआईआर-केन्द्रीय औषधीय एवं सगंध पौधा संस्थान में सीएसआईआर का 82वां स्थापना दिवस मनाया गया, जिसमें विद्यार्थीयों एवं किसानों ने सीमैप की वैज्ञानिक तकनीकी की बारीकियों को समझा।

इस मौके पर सीमैप विद्यार्थियों व आम जनमानस के लिए खुला रहा। उत्तर प्रदेश के सात विद्यालयों व विश्वविद्यालयों से आए करीब 400 विद्यार्थियों एवं किसानों ने संस्थान का भ्रमण कर प्रयोगशालाओं, प्रक्षेत्र-प्रदर्शन, आसवन इकाइयों व मानव पार्क के बारे में विस्तृत जानकारी ली। सीएसआईआर स्थापना दिवस पर भ्रमण करने वाले सहभागी छात्रों और किसानों ने अपने प्रतिक्रिया में बताया कि औषधीय एवं सुगंधित फसलों की खेती, प्रसंस्करण, विपणन व बायोलॉजिकल एवं केमिकल साईसेज से संबन्धित दी गई जानकारी रोचक है, जो उनके भविष्य मे काफी लाभदायक सिद्ध होगी। कार्यक्रम के सफल आयोजन के लिए निदेशक सीएसआईआर-सीमैप के मार्गदर्शन मे वैज्ञानिक, तकनीकी अधिकारी, कर्मचारी एवं शोध छात्रों ने अहम भूमिका रहीं।



सीमैप भ्रमण करने आए छात्र । अमृत विचार

वैज्ञानिक संस्थानों में मना CSIR का स्थापना दिवस

लखनऊ (एसएनबी)। राजधानी स्थित विभिन्न वैज्ञानिक संस्थानों में मंगलवार को वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद, नई दिल्ली (सीएसआईआर) का 82वां स्थापना दिवस मनाया गया। इस दौरान सभी संस्थान विद्यार्थियों तथा आम जन मानस के लिए खुले तथा आम लोगों ने यहां भ्रमण कर संस्थानों में हो रहे विभिन्न शोधों तथा अन्य जानकारियां प्राप्त की। केन्द्रीय औषधीय एवं संगन्ध पौधा संस्थान (सीमैप) 82वां सीएसआईआर स्थापना दिवस मनाया। इस अवसर पर सीमैप विद्यार्थियों व आम जनमानस के लिए खुला रहा तथा सात विद्यालयों व विश्वविद्यालयों से आए विद्यार्थियों एवं किसानों ने भाग लिया।



खुले रहे संस्थान, विद्यार्थियों व आम जनों ने भ्रमण कर प्राप्त कीं जानकारियां

सीएसआईआर के स्थापना दिवस पर एनबीआरआई की प्रयोगशालाएं एवं सुविधायें आम जन एवं छात्रों के लिए दिन भर खुली रहीं। इस वर्ष लखनऊ एवं आस पास के जिलों के 17 विद्यालयों के विद्यार्थियों, शोधकर्ताओं एवं आम लोगों ने संस्थान की विभिन्न प्रयोगशालाओं, वनस्पति उद्यान, पादपलय, अभिदर्शन आदि का भ्रमण किया। संस्थान के वैज्ञानिकों एवं अन्य विशेषज्ञों की टीम ने पूरे उत्साह से संस्थान के भ्रमण के लिए आये विद्यार्थियों को संस्थान के इतिहास, विभिन्न क्रिया-कलापों, उपलब्धियों और विकसित विभिन्न उत्पादों आदि के विषय में विस्तार से जानकारी दी।

सेंट्रल ड्रग रिसर्च इंस्टीट्यूट (सीडीआरआई) ने 82वें सीएसआईआर स्थापना दिवस पर छात्रों के लिए 'ओपन डे' का आयोजन किया। इस दौरान प्रयोगशाला दौरे के साथ-साथ प्रतिभागियों के लिए विभिन्न इंटरैक्टिव कार्यक्रम एवं प्रतियोगिताएं आयोजित की गईं। कार्यक्रम में सुल्तानपुर, हरदोई, रायबरेली, उन्नाव, कानपुर और लखनऊ सहित पूरे क्षेत्र से कुल 25 स्कूलों और कॉलेजों के छात्रों व शिक्षकों ने उत्साहपूर्वक भाग लिया।

छात्रों को सीडीआरआई के वैज्ञानिकों के साथ पारस्परिक चर्चा में शामिल होने का अवसर भी मिला। इस दौरान विज्ञान मॉडल प्रतियोगिता, प्रश्नोत्तरी प्रतियोगिता, वाद-विवाद प्रतियोगिता का भी आयोजन किया गया। ओपन डे कार्यक्रम के अध्यक्ष और संयोजक डा. वी.एन. सिंह ने छात्रों और स्कूलों से मिली प्रतिक्रिया पर प्रसन्नता व्यक्त की और कम उम्र से ही वैज्ञानिक जिज्ञासा को बढ़ावा देने के महत्व पर जोर दिया।

Sponsored Projects

Externally Funded Projects

S.N.	Funding Agency	Project No.	Project Title	PI	Start Date	Total Cost (Rs. in Lakh)	End Date
1	M/s. Lex Orbis Consulting Private Limited, New Delhi	SSP-508	Training-cum demonstration programme on utilization of offered flowers collected from places of worship for making incense sticks and fragrant cones for women towards employment generation and income enhancement	Dr. RK Srivastava	01.04.2023	9.10	31.03.2024
2	DST-WOS A	GAP-510	Rational design and development of non-steroidal small molecules from flavonoids of Glycyrrinhza glabra for Breast carcinoma and triple negative Breast cancer (TNBC).	Dr. Asha Budakoti	01.05.2023	31.374	30.04.2026
3	SERB	GAP-512	Development of chemical signature for purity and authentication of Rudravati (Astragalus candolleanus Royle) and its substitute (Cressa Cretica L.)	Dr. Karuna Shanker	19.07.2023	41.92	18.07.2026
4	Hindustan Gum & Chemicals Ltd.	SSP-513	Exploring medicinal and aromatic plants as source of green agrochemicals for selected vegetables.	Dr. Priyanka Suryavanshi	21.08.2023	11.8	20.08.2024
5	Chhattisgarh Tribal Local Health Traditions & Medicinal Plants Board, Raipur	GAP-514	Marker Compounds Mapping in Andrographis paniculata by HPLC from Wild Habitat of Chhattisgarh.	Dr. Jonnala Kotesh Kumar	31.08.2023	6.875	30.08.2024
6	DBT	GAP-515	Unraveling key enzymes for medicinal triterpenes biosynthesis in Boswellia Serrata	Dr. Sumit Ghosh	12.09.2023	51.28	11.09.2026

7	A P Medicinal and Aromatic Plants Board, Vijayawada	GAP-516	Development and distribution of quality planting material of Ashwagandha, Senna, Kalmegh, Tulsi and Sarpagandha to the farmers of Andra Pradesh.	Dr. Jnanesha A C	11.09.2023	6.25	10.09.2024
8	Office of the Director Agriculture (ATMA)	SSP-517	Training program on cultivation, processing and marketing of economically important Aromatic and medicinal crops suitable for Maharashtra State as a collaborative project under CSIR-Aroma Mission.	Dr. Rushikesh Nanasaheb Bhise	07.09.2023	15.61	06.09.2024
9	Sant Sanganeria Foundation for Health & Education and Ultra International Ltd.	SSP-518	Sustainable Aromatic Crops Cultivation A Collaborative Initiative by CSIR-CIMAP with Sant Sanganeria Foundation & Ultra International Ltd. To Empower Aroma Clusters in india under Aroma Mission-III.	Dr. Rajesh Kumar Verma	11.10.2023	37.2	10.10.2025
10	Ministry of Micro, Small and Medium Enterprises (MSME), Government of India, New Delhi	GAP-519	Hands-on Training program on Herbal Product Technologies for Entrepreneurs and Advanced Skill Development Programme covering all aspects of technologies related to Medicinal and Aromatic Plants.	Dr. Ramesh Kr. Srivastava	18.10.2023	16	17.10.2024
11	Science & Engineering Research Board(SERB), New Delhi	GAP-520	Discovering noval plant peptides for the treatment of prevalent female reproductive cancer through the suppression of angiogenesis and metastasis.	Dr. Suaib Luqman	16.10.2023	50.37	15.10.2026
12	Science & Engineering Research Board(SERB), New Delhi	GAP-521	Elucidating the uptake and transportation mechanism of toxic metals in different genotypes of *A.paniculata.*	Dr. Puja Khare	15.11.2023	30.39724	14.11.2026
13	DBT	GAP-522	National Network Project of CSIR-Central Drug Research Institute, Lucknow.	Dr. Feroz Khan	27.12.2023	45.91	26.12.2028
14	Protection of Plant Varieties & Farmers Rights Authority (PPV&FRA)	GAP-523	Development of DUS Testing guidelines for Ocimum spp.	Dr. Anil K Gupta	09.01.2024	13.86	08.01.2026

15	Council of Science & Technology (UPCST)	GAP-524	Radiofrequency cold plasma treatment on seed germination potential, oil yield and quality attributes in *Ocimum africanum*.	Dr. Birendra Kumar	19.01.2024	13.86	18.01.2027
16	Department of Biotechnology	GAP-525	Deciphering the oleoresin and aroma formation in the agarwood tree through transcriptomics, functional genomics and synthetic biology.	Dr. Dinesh A Nagegowda	18.01.2024	40.838	17.01.2027
17	Indian Council of Medical Research	GAP-526	IND compliance preclinical development of indonone-based anticancer agent against breast cancer.	Dr. Arvind Singh Negi	01.03.2024	103.782	28.02.2027
18	Haleon UK Trading Limited, United Kingdom	SSP-527	Demonstration, deployment and popularization of sustainable mint based agro-technologies in Barabanki District, Uttar Pradesh.	Dr. Manoj Semwal	29.02.2024	524.1973	29.02.2028
19	SERB	GAP-528	Molecular characterization of negative regulators of patchoulol biosynthesis and trichome development for aroma trait improvement in Pogostemon cablin.	Dr. Dinesh A. Nagegowda	12.03.2024	33.69596	11.03.2027
20	SERB	GAP-529	Engineering efflux pumps in Azospirillum brasilense to improve sesquiterpenoid production	Dr. Mukti Nath Mishra	13.03.2024	40.18766	12.03.2027
21	SERB	GAP-530	Elucidating the mechanism of triterpene transport and accumulation in plant surface.	Dr. Sumit Ghosh	13.03.2024	39.03724	12.03.2027
22	Krishi Vigyan Kendra, Saharsa(Bihar Agricultural University, Sabour, Bhagalpur)	CNP-531	Providing consultancy for designing, installation and commissioning of improved Mild Steel 500 kg herb capacity directly fired type field distillation unit, SS condenser, SS oil separator, material unloading chain pulley system, water storage tank etc. for Krishi Vigyan Kendra, Saharsa.	Dr. Sudeep Tandon	28.03.2024	7.72725	27.03.2025

23	Uttarakhand State Council for Science & Technology(UCOST) Government of Uttarakhand	GAP-532	Pilot scale implementation for catalyzing rural empowerment through cultivation, processing. value addition and marketing of aromatic plants in Champawat, Uttarakhand.	Dr. Manoj Semwal	07.03.2024	29	06.03.2027
24	CSIR	HCP0037 (Phase-II)	CSIR Floriculture Mission Project Phase-II	Dr. Rajesh Kumar Verma	26.04.2023	640.19	31.03.2026
25	CSIR	HCP0007 (Phase III)	CSIR Aroma Mission – Phase III: Catalyzing rural empowerment and entrepreneurship development through Cultivation, Processing, Value Addition and Marketing of Aromatic Plants	Dr. Sanjay Kumar/ Dr. Manoj Semwal	26.04.2023	2689.20	31.03.2026
26	CSIR	HCP-51	Development of nicotine-less tobacco plants through genome-editing approach	Dr. Prabodh Kumar Trivedi	24.07.2023	345.00	31.03.2025
27	CSIR	HCP-57	Region specific smart agrotechnologies for enhancing soil and plant health (RSSA)	Dr. Manoj Semwal	29.08.2023	355.6	31.03.2026

DBT-Department of Biotechnology, DST-Department of Science and Technology, UPCST-Council of Science and Technology, UP NMPB-National Medicinal Plants Board
DHR-Department of Health Research, SERB-Science and Engineering Research Board, IORA-Indian Ocean Rim Association

Staff Members (As on 31 March 2024)

Dr. Prabodh Kumar Trivedi
Director

Chief Scientist

Dr. Saudan Singh
Dr Arvind Singh Negi
Dr. AK Gupta
Dr. Sudeep Tandon
Dr. Birendra Kumar
Dr. Laiq-Ur-Rahman
Dr. Dharmendra Saikia
Er. Garikapati. D. Kiranbabu
Dr. Dinesh A. Nagegowda
Dr. Vikrant Gupta
Dr. Anirban Pal

Senior Principal Scientist

Dr. J Kotesh Kumar
Dr. Karuna Shanker
Dr. (Mrs) Sunita Singh Dhawan
Dr. Dayanandan Mani
Dr. Sumit Ghosh
Dr. Rajesh Kumar Verma
Dr. Sanjay Kumar
Dr. Manoj Semwal
Dr. Dnyaneshwar Umrao Bawankule
Dr. Feroz Khan
Dr. Ashutosh Kumar Shukla
Dr. Narayan Prasad Yadav
Dr. Suaib Luqman
Dr. Rajendra Chandra Padalia

Principal Scientist

Dr. V. Sunderesan
Mr. Ram Swaroop Verma
Mr. KVN. Satya Srinivas
Dr. Chandan Singh Chanotiya
Dr. Debabrata Chanda
Dr. Prasanta Kumar Rout
Dr. (Mrs) Prema G. Vasudev
Dr. Rakesh K. Shukla
Dr. Venkata Rao D.K
Dr. (Smt) Puja Khare
Dr. Ramesh Kumar Srivastava
Dr. (Mrs) Abha Meena
Dr. Atul Gupta
Dr. Pradipto Mukhopadhyay
Dr. Ram Suresh Sharma
Dr. Rakesh Kumar Upadhyay
Dr. (Ms.) Tripta Jhang
Er. Ashween D. Nannaware
Dr. Bhaskar Shukla
Dr. Kishore Babu Bandamaravuri
Dr. S.G. Eswara Reddy

Sr. Scientist

Dr. Mukti Nath Mishra
Dr. Hari Om Gupta
Dr. Narendra Kumar
Dr. Channayya Hiremath
Dr. Venkatesha K.T.
Dr. Yogendra N.D.
Dr. Jnanesha A.C
Dr. Rakesh Kumar

Scientist

Dr. Akanksha Singh
Dr. Dipendra Kumar
Dr. (Mrs) Gunjan Tiwari
Dr. Kapil Dev
Dr. (Ms) Priyanka Suryavanshi
Dr. Bhise Rushikesh Nanasaheb
Dr. Santosh Kumar Chandappa Kedar
Dr. B Shivanna
Dr. V S Pragadheesh
Dr. Anand Kumar T.M.
Dr. Ratnashekhar C.H.

Group-III

Principal Technical Officer

Shri K Bhaskaran

Sr. Technical Officer (2)

Dr. Neerja Tiwari
Smt. Anju Kumari Yadav
Shri Shiv Prakash
Dr. (Mrs.) Manju Singh
Dr. Anil Kumar Singh
Dr. Rajendra Prasad Patel
Dr. Rakshpal Singh
Shri A.K. Tiwari
Shri Ram Pravesh
Dr. Devesh Shukla
Dr. Vipool Anand Thorat

Sr. Technical Officer (1)

Dr. Amit Chauhan
Dr. Anil Kumar Maurya
Mr. Amit Mohan
Smt Namita Gupta
Shri Sanjay Singh
Shri A. Niranjan Kumar
Mrs. Anju Kesarwani
Shri Balakishan Bhukya
Mrs Priyanka Singh
Shri Durga Prasad Mindala
Dr. (Mrs) Pankhuri Singh

Technical Officer (Gr. III (3))

Shri Amit Kumar Tiwari
Shri Manoj Kumar Yadav
Shri Ashish Kumar
Sh. Prawal Pratap Singh Verma
Shri Ashish Kumar Shukla

Technical Assistant

Shri Manish Arya
Dr. Sanjeet Kumar Verma
Shri Deepak Kumar Verma
Dr (Mrs) Pooja Singh
Shri Sonveer Singh
Shri Abhishek Kushwaha
Shri Ranjith Kumar Sunkari
Mr Abhishek Singh
Dr (Mrs) Sujata Singh Yadav
Shri Mohd Danish Hussain
Miss. Rajni Gautam
Mrs. Parul Sharma
Mr. Parmanand Kumar

Group-II

Sr. Technician (3)

Dr. Abdul Khaliq
Shri Raghubind Kumar
Shri Salim Uddin Beg

Sr. Technician (2)

Shri Joseph M Massey
Shri Ram Lakhan
Shri PK Tiwari
Shri Vinod Kumar
Shri Dharam Pal Singh

Sr. Technician (1)

Shri Pankaj Kumar Shukla
Shri Kundan Narayan Wasnik
Shri Basant Kumar Dubey
Shri Yalla VVS Swamy

Technician (2)

Shri Vijay Kumar Verma
Shri Harendra Nath Pathak
Shri Hemraj Sharma
Shri Jitendra Kumar Verma
Shri Pramod Kumar

Technician (1)

Mr Santosh Prasad Saroj
Mr Junaid
Mr Sonu Kumar
Mr Manish Kumar Maurya
Mr Sujit Singh Chauhan
Mr Sateesh Kumar

Group-I

Lab Assistant

Shri Subhash Kumar
Shri Bharat Singh Bisht
Shri Nurul Huda
Shri Lal Chand Prasad
Shri TP Suresh

Administrative Staff

Group-A (Gazetted)

Administrative Officer
Shri Naresh Kumar
Shri Anil Kumar

Controller of Finance & Account

Shri IB Dixit

Controller of Store & Purchase

Shri Sanjay Kale

Store & Purchase Officer

Shri Kumar Ji Jha

Group-B (Gazetted)

Sec. Officer [Gen.]

Shri Vikas Verma
Shri Rahul Singh
Ms Sanyogita Sainger

Sec. Officer [F&A]

Shri Rajesh Kumar Sonkar
Shri Ayush Singhal

Sec. Officer [S&P]

Shri Shamiullah Khan

Private Secretary

Miss Gaitry Sharda
Ms Suchita Gupta
Smt P Sabitha
Shri Srikar Ji Sinha

Group-B (Non-Gazetted)

Asstt. Section Officer (Gen)

Shri Sant Lal
Shri Kaushal Kishore
Shri Siddharth Shukla
Shri Ravi Prakash
Shri Manoj Swaroop Shukla
Mrs. Sheela Yadav

Asstt. Section Officer (F&A)

Shri AL Sahoo

Asstt. Section Officer (S&P)

Shri Ajeet Verma

Group-C Posts

Sr. Secretariat Asstt (Gen)

Sri Ravi Prakash Mishra
Ms Pratibha Maurya

Senior Secretariat Asstt. (F&A)

Ms. Sonali Kumari Yadav

Jr. Secretariat Asstt (Gen)

Shri Abdul Nadir Khan

Jr. Secretariat Asstt (S&P)

Shri Tula Singh

Jr. Secretariat Asstt (F&A)

Shri. Mohd. Shameem

Group C (Non –Tech)

Drivers (Isolated)

Shri Ajay Kumar Verma
Shri Sanjay Kr. Singh
Shri Sarwesh Yadav
Shri Chandrapal Verma
Shri Rajesh Kumar

Multi-Tasking Staff

Shri Ashok Kr. Pathak
Smt Nirmala Verma
Smt Tara Devi
Smt Sunita Devi
Shri Sant Ram
Shri Sudhir Kumar Bhattacharya
Shri Praveen Kumar
Shri Kishan Ram
Smt. Zarina Bano
Shri Dharam Pal Balmiki
Shri Arvind Kumar
Smt. Raj Mati
Shri Mohd. Moseen
Smt. Pushpa
Ms. Kamalini Algarsamy

CIMAP Welcomes New Staff Members

S.No	Name	Designation	Date of Joining	Posting
1.	Dr. S.G. Eswara Reddy	Principal Scientist	09-06-2023	CSIR-CIMAP (RC- Bangalore)
2.	Ms. Kamalini Algarsamy	Multi -Tasking Staff	12-06-2023	CSIR-CIMAP (RC- Bangalore)

Staff Superannuated

S.No.	Name	Designation	Date of Retirement
1.	Shri. Rohit Khanna	Sr. Hindi. Translator	30-06-2023
2.	Shri. Hari Har	Gr. D (NT)	31-07-2023
3.	Shri. Hari Pal	Lab Assistant	31-07-2023
4.	Shri. Alok Kumar Krishna	Chief Scientist	31-07-2023
5.	Shri. Srinivas Pedasnagnati	ASO (G)	31-07-2023
6.	Shri. Ram Ujagir	Lab Assistant	31-08-2023
7.	Shri. Sukhmal Chand	PTO	31-08-2023
8.	Shri. Surendra Nath	Lab Assistant	31-12-2023
9.	Shri. Ved Ram Singh	Chief Scientist	31-01-2024
10.	Shri. Shiv Kumar	SO(F&A)	31-01-2024
11.	Shri. Pramod Kumar Chaturvedi	ASO(GEN)	31-01-2024
12.	Mrs. Nirmala Verma	PEON(ACP)	31-03-2024

Superannuated Scientist

Dr VR Singh



Dr VR Singh, joined in CSIR-CIMAP RC Pulwama (Kasmir) as Scientist-B in September 1989. Due to some terrorist activities in Kashmir valley and move to CSIR-IHBT Palampur March, 1991 (HP). After three years in June 1994, repatriation at CSIR-CIMAP RC Pantnagar (Uttarakhand) and subsequently got transferred in Head Quarter Lucknow July 2009. He served more than 34 years working in the area of Genetics and Plant Breeding for crop improvement, agrotechnology and dissemination of Medicinal and Aromatic Plants and superannuated as Chief Scientist & Head of Division Plant Breeding & GRC (Professor of AcSIR academy in Biologicals Science) in January 2024.

During this period HQ Lucknow in different capacities (Chairman of Committees/alternate of chairmen) and as scientist-in-charge for RC Pantnagar (more than 5 years). He was published 98 research papers in national and international journal and 7 International patents also. Besides, he was involved in the development of improved 30 varieties of different medicinal and aromatic plants. Most popular varieties Kosi and CIM-Unnati of menthol mint (as landmark of menthol mint development for production and export of menthol).

He has significant contributed to the institute major mission project aroma mission phase I & II under this project major aromatic crops (Lemongrass, Palmarosa, Citronella, Vetiver slips and seeds and menthol-mint of suckers) have been provided quality planning material of said of aromatic crops in across the country (24 states). He also served as PI of Project "Improvement of latex-less and low alkaloid variety of *Papaver somniferum* L. towards development of phenotypically distinct variety for commercial exploitation as nutritive seed crop" for development of new genotypes and production of opium poppy seeds (Project funded by Ministry of Finance, Department of Revenue, New Delhi).

Dr. VR Singh was recipient of several prestigious awards, The CSIR Technology Prize for biological sciences and Technology in 199, for development of high yielding varieties Himalaya and Kosi in menthol mint as are team member. Including "CSIR Award for Science and Technology Innovations for Rural Development" 2008 best owed on CIMAP for Bio-village strategy for Agribusiness of Medicinal and Aromatic plants. EOAI-SOM 2003-2005, award given by Essential Oil Association of India, New Delhi for being actively involved in the development and dissemination of the new variety of menthol mint Kosi which had made substantial contribution to the economy of mint growers in U. P. and development of mint industry in India as a whole. FICCI award in 2004-2005 recognition of corporate imitative in Rural Development through innovative R&D in Medicinal & Aromatic Plants. The best paper award -2016, ICAHPS given by IJTA and serial publication New Delhi.

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2. Kumar Yogesh, Verma Deepak Kumar, Bhise Rushikesh N, Sharma Ram Suresh, Srivastava RK, and Kumar Sanjay. (2024) Economic and analysis of Tulsi cultivation in Jharkhand. *Rajbhasha Magazine, Aus Vigyan.* 05:134-137.
3. Sharma Ram Suresh, Kumar Yogesh, Verma Deepak Kumar, Bhise Rushikesh N, Srivastava RK and Kumar Sanjay. (2024) Economic analysis and study of Vetiver cultivation in East Champaran, Motihari district of Bihar state. *Rajbhasha Magazine, Aus Vigyan*. 05,147-149.
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6. Singh P, Kumar V, Yadav H, Singh P and Srivastava RK. (2023) Farmers of Amroha and Sambhal are getting profit by adopting Early Mint technology of Mentha. *Rajbhasha Magazine, Aus Vigyan* (Published by CSIR-CIMAP), 4:109-113.
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2. RK Srivastava, S Kumar, RS Sharma, BR Nanasaheb, MK Yadav, H Yadav, A Kumar, R Singh and HT Lalmuankima. (2023) Cultivation, Processing and Marketing of Suitable Aromatic crops for Mizoram, North East Region of India. ISBN No. 978-93-89490-17-6.
3. Singh P, Khare P, Mishra D, Muhammad B, Sillapna M. (2023) Nanotechnology and Nanomaterials in the Agri-Food Industries: Smart nano architectures, Technologies, Challenges and Applications. ISBN: 978-0-323-99682-2, P-431, Publisher: *Elesvier*.

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1. Gupta P, Dhawan SS, Lal RK, Mishra A, Chanotiya CS. (2024) Low-temperature perception and modulations in *Ocimum basilicum* commercial cultivar CIM-Shishir: Biosynthetic potential with insight towards climate-smart resilience. *Gene*. 896:148041.
2. Mishra D, Jain S, Khare P, Singh R. (2023) Comparative investigation of biochar-based nanocomposites over pristine biochar: an overview. *Biochar-Based Nanocomposites for Contaminant Management.* 2:57-68.
3. Mishra D, Singh P, Pandey V, Yadav A, Khare P. (2024) The emerging role of nanotechnology in agri-food sector: recent trends and opportunities. *Nanotechnology and Nanomaterials in the Agri-Food Industries.* 1:1-9.
4. Rout PK, Gupta M, Kumar D, Kumar CMS,

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6. Sharma PK, Singh S, Syed N, Kumar P, Chaturvedi S, Nannaware AD, Khare SK, Rout PK. (2024) Value Addition/Biorefinery Approaches Towards Bio-lubricants Production. *Lubricants from Renewable Feedstocks*. 22:407-43.

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10. Yadav H, Maurya A, Sharma R, Srivastava RK, Shukla AC. (2024) Cultivation practices of *Cymbopogon spp*. Chemical composition, industrial uses and trade economics. *Advances in Medicinal and Aromatic Plants Research. Lois Bet Print & Publication*. ISBN: 978-93-89490-71-8.

11. Bhatt D, Bawankule DU. (2024) Molecular mechanism of inflammatory signaling pathway in severe malaria pathogenesis. Falciparum Malaria. 3-26. Academic Press. ISBN: 9780323953283

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2. Kumar D, Agarwal S, Darokar MP, Pal A, Rajasekharan R, Jaiswal N, Chanda D, Gupta VK, Singh AK. An aromatic biodegradable infection preventing sanitary napkin, India, Dated: 5.7.2023. Grant No. 437371.

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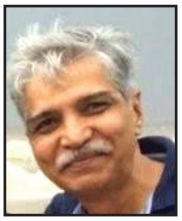

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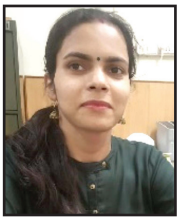

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Dr. Rajendra Prasad Patel
Sr. Technical Officer (2)
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Controller of Administration / Administrative Officer



Controller of Finance & Account / Finance & Account Officer

Right to Information Act

Following officials have been designated as per the requirement of the act:

Central Public Information Officer

Mr. Naresh Kumar
CSIR-CIMAP
E-mail: ao@cimap.res.in

Assistant Central Public Information Officer

Mr. Rahul Singh
CSIR-CIMAP
E-mail: rahulsingh@cimap.res.in

Dr. R K Srivastava
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Nodal Officer

Dr. Bhaskar Shukla
CSIR-CIMAP
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Budget at a Glance (As on 31 March 2024)

Name of Lab.	Csir Cimap		
	Final Allocation (₹ In Lakhs)	Actual Expenditure (₹ In Lakhs)	Expenditure (₹ In Lakhs)
Head of Expenditure	From Govt.grant (Csir Bud)	From Govt. Grant (Csir Bud)	Met From Lab.reserve
	2023-24		
1	2	3	4
1.National Labs.			
A. Revenue			
1. Salary & Sal. Linked Allowances	**3287.074**	**3287.074**	
2. Other Allowances			
a. Re-imburs. of Med.Exp./CGHS/Med.charges	128.036	128.033	
b. Overtime Allowance			
c. Honorarium	1.000	1.000	
d. Leave Travel Concession	14.787	14.787	
e. T.A. (India)	23.000	23.000	
f. T.A. (Foreign)			
g. Professional Update Allowance			
h. Total Other Allowances (a to g)	**166.823**	**166.820**	
3. Total Salaries (1+2h)	**3453.897**	**3453.894**	
4. P-04 Contingencies	550.000	549.949	0.618
5. P-05 H.R.D.			
6. P-06 Lab. Maintenance	420.000	420.000	1.707
7. P-701 Staff Qrs. Maintenance	55.000	55.000	
8. P07 Chemical/Consum.& Other Res.Exp.	945.000	945.000	12.434
9. Total Revenue (3 to 8)	**5423.897**	**5423.843**	**14.759**
B. Capital			
a) P-50 Land Cost			
a) P-50 Land Cost			
b) (i) P-50 Works & Services/Elec. Installations (Lumpsum)	92.000	93.198	
b) (ii) P-50 Works & Services/Elec. Installations (Other)			
c) P-50 App. & Equip./Computer Equipments	550.000	550.000	7.104
d) P-50 Workshop Machinery			
e) P-50 Office Equipments			
f) P-50 Furniture & Fittings	20.000	19.927	
g) P-50 Library			

h) P-50 Model & Exhibits			
i) P-50 Vehicles			
j) P-50 Tools & Plants			
k) P-50 Software development/procurement/ LAN/WAN			
l) P-26 -ICT			
m) (i) P-702 Staff Qrs.(Construction) (Lumpsum)	8.000	6.520	
m) (ii) P-702 Staff Qrs.(Construction) (Other)			
Total Capital (a to l)	**670.000**	**669.645**	**7.104**
Total A+B	**6093.897**	**6093.488**	**21.863**
C. Special Proj. FBR/NCP/FTC/FTT/RSP/HCP/HARIT/lab. project etc.			
1. Revenue			
(i) T. A. (India)	54.647	54.599	
(ii) T.A. (Foreign)			
(iii) Contingencies	104.125	103.179	
(iv) Maintenance	23.000	22.996	
(v) Chemical, Consum.& Other Res.Exp.	278.530	276.194	
(v) ORE	192.500	192.230	
(v) Tech HR	328.931	324.778	
Total Rev.(C1)	**981.733**	**973.975**	
2. Capital			
(i) Work's & Services	138.975	124.880	
(ii) Appartus & Equipment	250.825	247.402	
(iii) Other Capitals			
Total Capital(C2)	**389.800**	**372.282**	
C. Total allocation ; FBR/NCP/FTC/FTT/RSP/ HCP/HARIT/lab. project etc.	**1371.533**	**1346.257**	
Total National Labs. (A+B+C)	**7465.430**	**7439.745**	**21.863**
2. Others			
P-804 Pension & Other retirement benefits	2900.000	2899.999	
Grand Total	**10365.430**	**10339.744**	**21.863**

Ph.D. Awarded

1st April 2023 to 31st March 2024							
S. No.	**Student**	**Supervisor**	**Batch**	**Enrollment No.**	**Thesis Title**	**Date of viva Voce**	**University**
1.	Mr. Surendra Chandra Verma	Dr. Atul Gupta	Aug 2017	CIMAP/2017/009	Chemotherapeutic approach for Targeting cancer and osteoporosis through structural modification of the plant phenolics	04-10-2023	JNU
2.	Ms. Shama Afroz	Dr. L.Rahman	Jan 2017	CIMAP/2017/001	Studies on pentacyclic triterpenoid secondary metabolic pathway and regulation in Centella asiatica	27-04-2023	JNU
3.	Ms. Sneha Singh	Dr. Arvind Singh Negi	Aug 2015	CIMAP/2015/005	Studies on diosgenin, gallic acid and berberine analogues as anticancer and antibacterial agents	05-12-2023	JNU
4.	Ms. Ranjana	Dr. Karuna Shanker	Aug 2015	CIMAP/2015/007	Pharmacognostical characterization and HPLC based activity profiling of selected plants for xanthine oxidase inhibitors	06-05-2023	JNU
5.	Km. Uma Kumari	Dr. Suaib Luqman Guide Co- Guide: Dr. NP Yadav	Jan 2018	CIMAP/2018/013	Antimicrobial efficacy of selected essential oils against dandruff associated Microbes	23-06-2023	JNU
6.	Ms. Jyoti Singh	Dr. Abha Meena	Jan 2018	CIMAP/2018/004	Exploring the efficacy of selected phytomolecules on lung cancer cell lines by targeting biomarkers	26-06-2023	JNU
7.	Mr. Laxmi Kant Trivedi	Dr. Prema G. Vasudev	Aug 2016	CIMAP/2016/007	Crystal Engineering of Biologically Active Natural Products and Synthetic Compounds: Role of Intermolecular Aromatic Interactions	16-08-2023	JNU

8.	Mr. Ashish Kumar	Dr. Ajit Kumar Shasany (Guide) / Dr. Ashutosh Kumar Shukla (Co-Guide)	Jan 2017	CIMAP/2017/002	Prospecting Gene(S) of Terpene Biosynthesis for high value aromatic compounds	29-09-2023	JNU
9.	Mr. Anuj Kumar	Dr. Saudan Singh	Aug 2016	CIMAP/2016/006	Agro and Biotechnological studies on protection of rose scented geranium (Pelargonium graveolens L.) propagules during adverse weather condition in northern Indian plains	05-12 2023	JNU
10.	Mr. Parmanand Kumar	Dr. Anirban Pal	Aug 2015	CIMAP/2015/004	Prospecting medicinal plant bio-actives against *Salmonella* bacteremia and its relapse through *in-vitro* and *in-vivo* models	15-12 2023	JNU
11.	Mr. Gaurav Srivastava	Dr. Sumit Ghosh	Jan 2018	CIMAP/2018/009	Understanding Triterpene Saponin Biosynthesis in Arjuna [Terminalia arjuna (Roxburgh) Wight and Arnott]	20-12 2023	JNU
12.	Ms. Pooja Singh	Dr.Ashutosh Kumar Shukla	Aug 2016	CIMAP/2016/008	Molecular studies on *Catharanthus roseus* with special reference to vindoline	21-12 2023	JNU
13.	Ms. Divya Bhatt	Dr. D. U. Bawankule	Jan 2018	CIMAP/2018/005	Mechanism of Selected Flavonoids Against Activated Inflammatory Response in Malaria Pathogenesis	19-02-2024	JNU
14.	Ms. Priyanka Sharma	Dr. M.P. Darokar Guide/ Dr. A.Pal Co-Guide	Aug 2016	CIMAP/2016/009	Evaluating the potential role of phytochemicals as bioavailability enhancer of Vitamin Bl2	27-02-2024	JNU
15.	Mr. Sunil Kumar	Dr. Rakesh Kumar Shukla	Aug 2017	CIMAP/2017/010	"Molecular Analysis and Characterization of Methyl Jasmonate Inducible PSPG Motif Containing Glycosyltransferase from *Bacopa monnieri*"	18-03-2024	JNU

16.	Priyambada Singh	Dr. Alok Krishna (Guide) Dr. Puja Khare (Co-Guide)	Jan 2016	10BB16J10005	Studies on productivity and quality of Lemongrass (Cymbopogon flexuosus) and soil properties of selected sites in Bundelkhand and Vindhyanchal regions under rainfed conditions	01-04-2023	AcSIR
17.	Pooja Gaur	Dr. Karuna Shanker	Jan 2017	10CC17J10004	HPLC based bio-activity profiling of selected Indian medicinal plants for Lipase Inhibitors	01-05-2023	AcSIR
18.	Ashween Deepak Nannaware	Dr. Prasanta Kumar Rout (Guide) Dr. Somendu Roy (Co-Guide)	Jan 2017	10CC17J10002	Improved distillation process for the isolation of volatiles from aromatic plants using solar energy and comparison with conventional energy sources	28-07-2023	AcSIR
19.	Devendra Kumar	Dr. Saudan Singh	Jan 2018	10BB18J10009	Optimizing deficit irrigation practices for better adaptability, enhancing yield and quality of essential oil in selected cultivars of menthol mint (*Mentha arvensis* L.)"	25-07-2023	AcSIR
20.	Geetu Singh	Dr. Rajesh Kumar Verma	Jan 2016	10BB16J10001	Microbial Assisted Decontamination of Municipal and Tanery Sludge Using Aromatic Grasses	30-05-2023	AcSIR
21.	Payal Srivastava	Dr. Sumit Ghosh	Jan 2018	10BB18J10001	Understanding the role of UDP- glycosyltransferase in diterpene glycoside biosynthesis in kalmegh [Andrographis panicula (Burm.f.) Wall.ex Nees]	20-12-2023	AcSIR
22.	Amit Kaushik	Dr. Ashutosh Kumar Shukla (Guide) Dr. Daya N Mani (Co-Guide)	Aug 2018	10BB18A10001	Investigation of anti-allergic potential of Achyranthes aspera through traditional and modern concepts	22-12-2023	AcSIR

23.	Kripa Shankar	Dr. Atul Gupta	Aug 2019	10CC19A10010	Value Addition of naturally occurring oxygen heterocycles for Biological actions	31-10-2023	AcSIR
24.	Yusuf Hussain	Dr. Abha Meena	Jan 2019	10BB19J10005	Exploring the anticancer activity of selected phytochemicals in combination with sorafenib in liver and lung cancer	22-12-2023	AcSIR
25.	Meenakshi Verma	Dr. Prema G Vasudev Dr. Feroz Khan (Co-Guide)	Aug 2017	10BB17A10003	Structure-Activity Correlation studies on Protein Kinase Inhibitors for Anticancer activity through Crystallographic data analysis and Molecular Modelling.	14-02-2024	AcSIR

*__JNU__: - Jawaharlal Nehru University

*__AcSIR__: - Academy of Scientific and Innovative Research

Glimpses from the CIMAP History*

CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) is a premier multidisciplinary research institute of Council of Scientific and Industrial Research (CSIR), India with its major focus on exploiting the potential of medicinal and aromatic plants (MAPs) by cultivation, bioprospection, chemical characterization, extraction, and formulation of bioactive phytomolecules. With a strength of 100 scientists, 162 technical officers, 129 support staff and nearly 300 doctoral and post-doctoral scholars at its HQ in Lucknow and research centers at Bengaluru, Hyderabad, Pantnagar, and Purara, CSIRCIMAP has played a key role in positioning India as a global leader in production of mints, vetiver and other aromatic grasses, and in ensuring indigenous production of artemisinin - a WHO approved anti-malarial. CSIR-CIMAP houses a National Gene Bank on MAPs, which is one of the three of its kind in India. CSIR-CIMAP has played a key role in successfully commercializing an ayurvedic herbs-based anti-diabetic formulation, which has now benefitted millions. The institute is presently accredited by ICS-UNIDO and Indian-Ocean Rim Association (IORA) as a focal point for research and training on Medicinal Plants among 21 participating member countries.

History at a Glance

- Initially set up as Central Indian Medicinal Plants Organisation (CIMPO) in the year 1957 with a mandate to work and stimulate research on medicinal plants; subsequently aromatic plants also brought under its ambit
- CIMPO started functioning from 26th March 1959 with the appointment of late Shri P.M. Nabar its first Officer Incharge and rechristened as Central Institute of Medicinal and Aromatic Plants (CIMAP) in the year 1978
- The institute shifted to its present campus near Kukrail forest, Lucknow in the year 1980

Our Mandate

- CSIR-CIMAP is engaged in multi-disciplinary high-quality research in agricultural, biological and chemical sciences and extending technologies and services to the growers and entrepreneurs of MAPs with the following mandate:
- Genetic improvement, cultivation, production and chemical processing of economically important MAPs
- Characterization and conservation of genetic resources
- Production of planting material of the improved cultivars
- Bioprospecting plants and their constituents for various biological activities using different in vitro and in vivo techniques
- Metabolic pathway studies for identifying and modulating yield determinants
- Herbal products and formulations for better life
- Knowledge management for the enhancement and dissemination of R&D
- Human resource development for R&D in the basic and applied areas of MAPs

**cited from the 2018 brochure of the CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP)*

Notes

Salient Contributions of CSIR-CIMAP

- Catalyzing transformation of India from a menthol importing country to the largest producer and exporter of menthol mint oil globally by developing short-duration and high-yielding varieties, and superior agro- and processing- technologies of menthol leading to the spread of Mentha cultivation in more than 300,000 hectares and enhancing the income of nearly 600,000 farming families.

- Ensured "Making in India" of the anti-malarial drug artemisinin by developing high-yielding varieties of Artemisia annua, chemical process for extraction and derivatization of artemisinin, and promoting cultivation of improved varieties in farmers' field.

- Profitable utilization of salt-affected and flood-prone coastal and river bank areas by developing and deploying short-duration and high-yielding varieties of Vetiver (Khus).

- Promotion of lemongrass and palmarosa cultivation in under-utilized rain-deficit areas like Bundelkhand, Vidharbha, Kutch and Marathwada.

- Developed one of the most successful herbal formulation for the management of diabetes type II (with NBRI) using medicinal plants used in Ayruveda ensuring clinical efficacy and safety.

- Leading CSIR Aroma Mission to empower Indian farmer and aroma industry by cultivation, processing, value addition and marketing of aromatic crops.

- Coordinating promotion of exchange of knowledge and commerce of medicinal plants in IORA member states of Indian Ocean rim countries.



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