

वार्षिक प्रतिवेदन

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Annual Report

2024-2025



CSIR-Central Institute of Medicinal and Aromatic Plants

(Council of Scientific and Industrial Research)

Lucknow | Bengaluru | Hyderabad | Pantnagar | Purara



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Dr. N.P. Yadav, Dr. Puja Khare, Dr. Bhaskar Shukla, Dr. Pradipto Mukhopadhyay, Dr. Kishore Babu Bandamaravuri, Dr. B. Rushikesh Nanasaheb, Dr. Kapil Dev, Dr. Sumya Pathak, Dr. Manju Singh, Dr. Rakshapal Singh, Dr. Devesh Shukla, Dr. Anil Kumar Maurya, Shri Deepak Kumar Verma, Shri Sant Lal, Shri Uttam Kumar Jha and Dr. Anandakumar T.M.

Cover page

Cover page depicts the CSIR-CIMAP's research contribution to the society through improved varieties of medicinal and aromatic plants (MAPs), process technologies of plant leads and development of standardized herbal products to achieve the goal of Viksit Bharat.



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From The Director's Desk....

It's my great pleasure to present the annual progress report of the CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) for the year 2024-25. 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.



CSIR-CIMAP has made remarkable progress in improving the livelihoods of small and marginal farmers through the CSIR Aroma Mission implemented nationwide. During 2024-25, the Institute successfully brought 2,500 hectares of agricultural land under various aromatic crops, including Lemongrass, Palmarosa, Citronella, Menthol Mint, and Vetiver, and organized over 90 awareness and training programs across the country. Under this mission, a new geranium variety, CIM-Sangham, was developed; 11 distillation units for essential oil extraction were installed at different locations; and 4,679 farmers received hands-on training and support.

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 200 hectares of agricultural land has been covered with floral crops benefitting more than 600 farmers. The net income of these farmers has increased many folds.

CSIR-CIMAP is actively participating in the CSIR Phytopharmaceutical Mission III, which focuses on developing drugs through the phytopharmaceutical route for both domestic and global markets. The mission aims to transform the global perception of herbal medicines. CSIR, through its specialized laboratories and collaborations with public and private enterprises, is deploying advanced technologies while ensuring environmental sustainability. By promoting captive cultivation and maintaining high-quality standards, the mission seeks to position India as a global leader in the phytopharmaceutical and herbal sectors.

Researchers from the Division of Phyto-Chemistry developed a green extraction method for lutein from marigold flowers, reducing the process by 2-3 steps compared to conventional methods. This method is crucial for producing lutein, a key compound that helps maintain eye health and prevent age-related macular degeneration (AMD). The technology was successfully transferred to Industry. In another study published in Food Chemistry, researchers developed an environmentally benign process for synthesizing vanillin and other substituted phenyl aldehydes using natural phenylpropenes. Phytochemistry Division is working to develop eleven phyto-molecules as Certified Reference Materials (CRMs). With the help of Machine learning, various analytical techniques have been developed to distinguish among the different varieties of MAPs and also to know the adulterations (Mentha, Ocimum and Ashwagandha). A new high end GC-MS/MS facility has also been created.

In the Bioprospection and product development division, scientists demonstrated that Naringin and chloroquine combination mitigates chloroquine-resistant parasite-induced malaria pathogenesis by attenuating the inflammatory response. Another group of scientists developed the technology of fennel oil-loaded polymeric beads for mosquito larvicidal action and filed the patent of the technology in India, USA and published the study in Industrial Crops and Products. This technology is also licensed to industry for commercialization. In another study, Indian Patent was filed on 'Indanone-based hydroxamic acid compound as anti-hypertensive agent'.

The plant biotechnology group is working on improving the metabolite content and/or composition in various plants, characterization of genes for facilitating the production of high-on-demand Phyto-molecules from heterologous



systems, development of plant varieties with better resistant to biotic and abiotic stresses, and standardization of *in-vitro* regeneration and genetic transformation protocols for MAPs. Under CSIR mission project “Genome-editing for crop improvement” genome-edited plants of tomato, which reduces SGA content has been developed and genome-edited tomato plants with improved flavonoid content are being developed. Under the same project, genome-edited plants for five MAPs are being developed to improve the yield of desirable phytomolecules. The scientists from the group have characterized many important genes such as *CrPMEs* and *CrZIP* for vindoline accumulation in *Catharanthus*, *PsSAD* from *Papaver somniferum*, *Ocimum* UGTs for 7-O glycosylation of apigenin, and CYPs and UGTs for triterpenoid biosynthesis in *Terminalia arjuna*. The scientists of the group have also done genetic engineering to improve bacoside content in *Bacopa monnieri*. The scientists are also involved in the development of fungal resistant and chilling tolerant MAP varieties like *Palorgonium graveoulance* and *Ocimum* sp. using tissue culture and other molecular techniques. The group is also involved in genome sequencing of MAPs like *Cymbopogon flexuosus* in addition to identification of genes and peptides related to flowering and trichome and root development and biosynthesis of important metabolites in various MAPs.

The Plant Breeding and Genetic Resource Conservation division is actively engaged in developing improved varieties of medicinal and aromatic plants (MAPs). In addition, efforts are underway toward biodiversity conservation of high-demand medicinal plants that are increasingly threatened by climate change and overexploitation. Crop production and protection division developed an energy and resource efficient Agro-technology of selected medicinal and aromatic plants. Evaluated carbon sequestration potential and carbon budgeting in aromatic grasses and mint species. Further, the division also developed climate-resilient Agro-technology for geranium, withania, vetiver, lemongrass, and mint species. Scientists also assessed the natural mortality factors of *Helicoverpa armigera* in menthol mint ecosystems and documented 23 natural enemies (18 predators and 5 parasitoids), highlighting the crucial role of native pollinators and beneficial insects in enhancing essential oil crop productivity and promoting sustainable pest management. Group has been elucidating role of various endophytes in MAPs and shown that endophytic *Pseudomonas oryzihabitans* CB24 boosts photosynthesis through lipid reprogramming.

During the FY 2024-25, the institute published more than 160 research articles in high impact peer reviewed journals, transferred 12 technologies related to herbal formulations to different industries/ MSMEs / Start-Ups and filed 5 patents. The institute has signed 23 agreements with different institute/industries. During the same period, approximately 8,327 farmers / entrepreneurs, students school /college teachers, government officials, and other members of the public visited the institute. Further, a total of 26 students were awarded PhD through the ACSIR and JNU PhD programs.

During FY 2024-25, the institute successfully organised an International Conference on Advances in Medicinal & Aromatic Plant Research in Context to the Indian Ocean Region (Ensuring Trade, Sustainability and Global Transformation) “IORA-AMAR 2025” during February 4-6, 2025.

The scientists of the institute have received various recognitions during FY 2024-25, including Fellow of Indian National Science Academy, New Delhi, India (FNA) and Indian Academy of Sciences, Bangalore, India (FASc) (Dr. Dinesh A. Nagegowda), Fellow of the Indian Society of Plant Genetic Resources, New Delhi and National Academy of Biological Sciences, Chennai (Dr. Birendra Kumar), Fellow of the National Environmental Science Academy (FNESA), New Delhi, India and Uttar Pradesh Academy of Agricultural Sciences (UPAAS), Lucknow (Dr. Karuna Shanker), Fellow of Indian Society of Veterinary Pharmacology and Toxicology (Dr. DU Bawankule), Fellow of the Royal Society of Chemistry (FRSC), London, UK (Dr. Chandan Singh Chanotiya) and Dr. Puja Khare has been elected as a Fellow of the National Environmental Science Academy of Agricultural Sciences (FNESA), New Delhi.

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)



Research & Development



PHYTOCHEMISTRY

HIGHLIGHTS

Phytochemistry Division is involved in the various R&D activities of Medicinal and Aromatic Plants (MAPs), including phytochemical investigation, bioactivity guided isolation, structure elucidation, quality control, metabolic profiling, new chemical processes of high-value phyto-molecules, downstream processing, target-based synthesis of designer molecules, nano-formulations, chemical ecology, bio-conversion of phytomolecules and various extraction technologies, including Supercritical Fluid Extraction (SFE) processes, etc.

During the period 2024-25, the Phytochemistry Division collaborated with other Divisions of the institute and also with other research organisations and universities of the country. Division has Chemical Central Facility (CCF) as an advanced instrumentation facility hosting sophisticated instruments like GC-MS, LC-MS, LC-MS/MS, GC-MS/MS, 500 MHz NMR, UPLC, HPLC, FT-IR, AFM-Raman spectrometer, etc. to serve analytical research support to internal projects and also external samples from farmers, academia and industries. Division has significantly contributed to high-priority mission projects.

The division has been involved in CSIR Aroma Mission Phase-III, proactively extending support for efficient distillation processing *via* procurement and functioning at the farmers' site. Division is notably contributing to the development of efficient process technologies for high-value aroma molecules desired by industries, namely vanillin, menthone, *cis*-3-hexenol, citronellyl nitrile, and isomenthone etc. Under this project, eleven improved distillation units have also been installed in ten different districts. Division is also working on fixed and mobile solar distillation units and has installed few at the farmers' field. Division has also been working in other CSIR-Mission projects, like CSIR-Floriculture Mission

Phase-II and CSIR-Phytopharmaceutical Mission Phase-III, extending support for value addition and technological guidance and product development in both mission projects.

In the phytochemical investigation, four flavonoids, namely, Oroxylum A, Chrysin, Baicalein, and Hispidulin, were isolated from the stem bark of *Oroxylum indicum* and evaluated for opioid modulatory activity. A new sesquiterpene has been isolated from aqueous methanolic extract of *Ainsliaea smithii*. Two labdane diterpenoids have also been isolated and characterized from *Curcuma amada*.

Division has been working on the development of high-demand phytomolecules as Certified Reference Materials (CRMs). There are about nineteen such phytochemicals, namely, Withaferin A, Withanone, Withanolide-A, Withanoside-IV, Andrographolide, 14-Deoxy-11,12-didehydroandrographolide (14-DDA), Gymnemagenin, and (+)-*gamma*-decalactone, Lutein, 2-Phenylethyl alcohol, Scopoletin, Tambulin, Oleanolic acid, Elliagic acid, Berberine hydrochloride, Piperine, Caffeine, Carnosol, Ursolic acid, etc., are under development.

In aroma chemistry, three unique interspecific hybrids (L1, L4 and L5) of *Ocimum africanum* L. were investigated for their volatile secondary metabolites. Seasonal variation in the aroma profiles of *Wedelia chinensis* was explored. Phenological stages on essential oil yield and composition of *Salvia sclarea* L. were undertaken. Two chemotypes of *Pittosporum napaulense*, *viz.*, sabinene and pinene-rich, were identified in southern India, and their essential oils were characterised. Compositional variation and enantiomeric distribution of compounds in the essential oils and oleoresins of *Myristica fragrans* fruits were evaluated to explore the possibility of substituting essential oils for oleoresins. The division is also working on chemical characterisation

of unexplored potential aromatic plants from the Himalayan region. A pilot-scale production of concrete and absolute from commercially cultivated *Rosa damascena* flowers being cultivated in the Etawa district of Uttar Pradesh was carried out under an industry-sponsored project. A non-invasive approach has been developed for the authentication of four *Mentha* species and three *Ocimum* varieties and their adulteration with vegetable oils. Further, a machine learning guided high-resolution, accurate mass spectrometry-based rapid metabolomic fingerprinting of three different varieties and their three different tissues of *Withania somnifera* has been established. Optimisation of harvest, post-harvest and storage of Marjoram, Oregano, Cinnamon, Basil and Sage, etc., has also been studied. Bioconversion of the spent biomass of Lemongrass and *Mentha* plants is in progress. The hydro-distillation of the geranium, on addition of surfactants, salts and onion scales into the distillation tank at specific concentrations, increased the geranium oil yields while keeping the quality unaltered.

Several new processes have also been developed under the process technologies for the preparation of high-value aroma compounds like vanillin, *cis*-3-hexenol and citronellyl nitrile, etc. A new composite of palladium acetate with aluminium and boron has been developed to transform pullegone to thymol. Mintlactone has also been prepared from Pullegone. In a novel biotransformation process, ricinoleic acid has been transformed to (+)- γ -decalactone. Turmeric leaf waste has been utilised to get some essential oils rich in specific aroma chemicals.

In the quality assurance of MAPs, several analytical techniques have been developed. A UPLC-PDA method identified for simultaneous analysis of six bioactive components of *Withania somnifera* berries cultivars first time. A comprehensive metabolomics GI tag for Indian turmeric has been developed using LC-MS/MS and GC-MS. An RP-HPLC-based method has been developed for the simultaneous determination of vasicine and vasicinone in the *Adhatoda vasica* plant.

Several bioactives have also been identified during this period. In *Withania somnifera*, both withanamide and withanolide chemotypes were investigated for neuroprotective potential. Unsaturated fatty acids of *Ocimum*, *Cannabis*, and Poppy seed oils have been shown to have significant anti-hypertension activity. *Cymbopogon distans* was explored as a source of essential oil with potential antibacterial, antifungal, and mosquito-repelling properties. The isatin-1,2,3-triazole hybrid analogues exhibited a potent anti-inflammatory activity. Benzopyran-based compounds showed ER-targeting osteogenic and anti-breast cancer activity. Vanillin analogues have exhibited anticancer effects. Novel thymol hybrids exhibited a potent cytotoxic effect against human cancer cell lines. Several zinc oxide-based nano-formulations of spent biomass of aromatic plants have been used for sequestration of some of the contaminants, like dyes and antibiotics. Some of the nano-formulations also showed anti-neuroinflammatory effects.

In this period, several externally funded (GAP) projects and consultancy projects (CNP) were successfully executed in the division. Three new externally funded projects were granted, and eleven ongoing externally funded projects were continuing. Seven research students earned their PhD degrees. The division has organised eight training programmes and participated in other such programs to upgrade the skills of the students, entrepreneurs and other beneficiaries.

The faculties of the division also delivered several invited talks at the distinguished forums. In the Chemical Central Facility, more than thirty-six thousand samples were analysed for analytical support. Dr. Chandan Singh Chanotiya has been awarded the prestigious Fellow of the Royal Society of Chemistry. Dr. Karuna Shanker got third prize in the PD Sethi award. Ms. Shraddha Srivastava was awarded the *SFE-Young Researcher Award-2024*; *Prof. Peter Houghton Memorial Award* at an International Conference. Ms. Mini Gupta was awarded the Best oral presentation, *Peter J. Houghton Memorial award* in another International conference. Ms. Neha Kumari was awarded 2nd prize for best oral presentation in



Phytochemistry

an International conference. Mr. Aman Savita got the best poster award at an International Conference. Dr. Ratnasekhar CH and Dr. Atul Gupta jointly received the CSIR-CIMAP Best Research Publication award for the year 2024-2025. During this period, the

division has transferred the know-how of processing technology of lutein from marigold flowers. Phytochemistry Division earned forty-seven research publications in SCI journals, and three new patents were also filed from the division.



Upper Panel (L to R) : Dr. Arvind S. Negi, Dr. Sudeep Tandon, Er. G.D. Kiran Babu, Dr. Karuna Shanker, Dr. J. Kotesch Kumar, Dr. R.C. Padalia

Middle Panel (L to R) : Dr. R.S. Verma, Dr. C.S. Chanotiya, Dr. P.K. Rout, Dr. KVN Satya Srinivas, Dr. Atul Gupta, Er. Ashween D. Nannaware

Lower Panel (L to R): Dr. Hariom Gupta, Dr. Ratnasekhar CH, Dr. Kapil Dev, Dr. VS Pragadheesh, Dr. Sanjeet Mehariya

Dr. Arvind Singh Negi डॉ. अरविंद सिंह नेगी

A new protocol for the preparation of 5H-benzo[c]fluorene derivatives and their antiproliferative activity *via* microtubule destabilisation



Cancer chemotherapy has entered into a new era of molecularly targeted therapeutics possessing high selectivity and low toxicity. There are several chemical cores exhibiting anticancer activity by modulating various biological targets. However, most of these are associated with drug resistance over the period of time and safety issues. To get an effective, safer and affordable anticancer drug with a newer pharmacophore is still a challenge.

In the present study, we aimed at a single-component cyclisation of 2-benzylidene-1-tetralones for the preparation of diverse 5H-benzo[c]fluorenes and their antiproliferative activity. This ring closure reaction was undergone *via* reductive cyclisation in the presence of a sodium borohydride-aluminium chloride system.

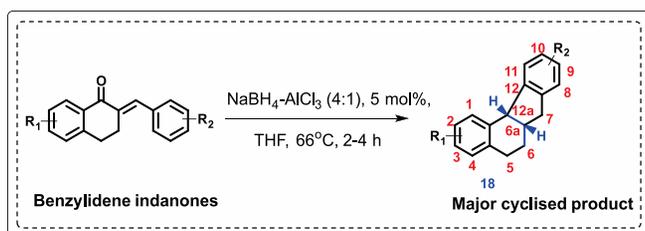


Fig.: A new synthetic protocol to prepare the benzofluorene moiety from 2-benzylidene indanones.

Using this protocol, we prepared several diverse 5H-benzo[c]fluorene derivatives and evaluated them for antiproliferative activity against three human cancer cell lines by Sulphorhodamine assay.

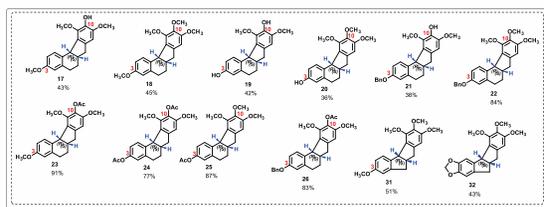


Fig.: Representative benzofluorene compounds

Four of these benzofluorenes exhibited a significant antiproliferative effect with an IC_{50} less than $10.75 \mu\text{M}$. As depicted in the Fig., the best representative compound **21** exhibited IC_{50} against K562 leukemic cells at $3.27 \mu\text{M}$ in the SRB assay and $7.68 \mu\text{M}$ in the Soft agar colony assay. It exhibited a microtubule destabilisation effect in tubulin kinetics and inhibited 82.9% microtubule polymer mass at $10 \mu\text{M}$ concentration in the Microtubule Protein Sedimentation assay. Compound **21** exerted G0/G1 phase arrest in cell division cycle analysis in K562 leukemic cells. It also induced apoptosis in K562 cells *via* activation of the Caspase cascade pathway. Furthermore, compound **21** also possessed anti-inflammatory activity by inhibiting TNF- α and IL-6, moderately. It exhibited significant *in vivo* efficacy and reduced the K562 tumour in Xenograft mice by 47% at an 80 mg/kg oral dose. Further, it was found to be safe and well-tolerable up to 1000 mg/kg in Swiss albino mice. Compound **21** needs to be optimised for better *in vivo* efficacy in rodent models for further development [Bioorg. Chem. 2024].

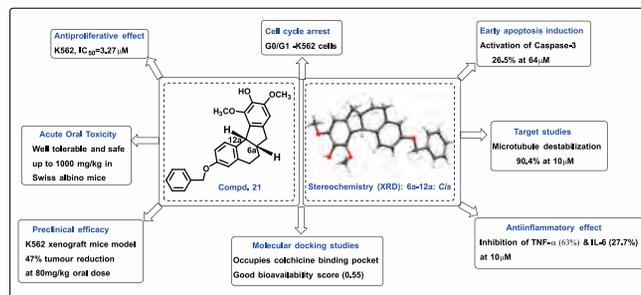


Fig.: The best representative benzofluorene **21**: Its stereochemistry and pharmacological profile.

Gallic acid-derived Aza Michael adducts on diarylpropanones exhibit synergistic antibacterial activities

Development of resistance against most of the clinical antibiotics is a menace to mankind for their use in future, as reported by the WHO in 2023. Most of the pathogens exhibit multidrug resistance (MDR) and extensive drug resistance (XDR) against the present clinical antibiotics. Some of the organisms, like *Staphylococcus aureus*, Methicillin-resistant *S.*

Phytochemistry

aureus (MRSA), *Streptococcus pneumonia*, *Pseudomonas aeruginosa*, and *Mycobacterium tuberculosis* (MTb), have developed even pan-drug resistance (PDR), also known as 'Superbugs'.

The present study aimed to design and synthesise of some microtubule dynamics modulators as antibacterial and anticancer agents. We incorporated two different 3,4,5-trimethoxyphenyl motifs at two different ends of the pharmacophore. One unit has restricted rotation due to the ketone group, while another unit was kept flexible. Further, an amino alkyl unit was introduced *via* Aza-Michael reaction

to have better bioavailability of this pharmacophore. Eight diverse Aza-Michael adducts were prepared at the diarylpropenone core possessing desired motifs in 38-57% yields.

As depicted in the Figure, compound **6b** showed significant antiproliferative activity against K562, a leukemic cell line. Compound **6h** exhibited potent antibacterial activity against methicillin-resistant *Staphylococcus aureus* and methicillin-resistant *S. epidermidis*. In the checkerboard experiment, **6h** showed a synergistic effect in combination of penicillin and also with norfloxacin, up to a four-fold reduction in quantity of the antibiotic drug.

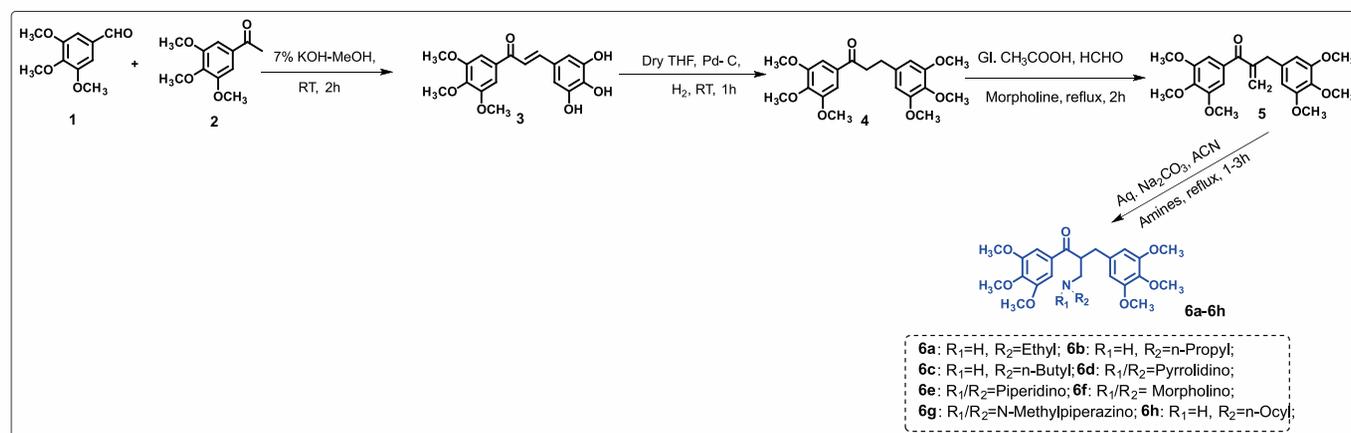


Fig.: Synthetic strategy to prepare gallic acid-based aza-Michael adducts

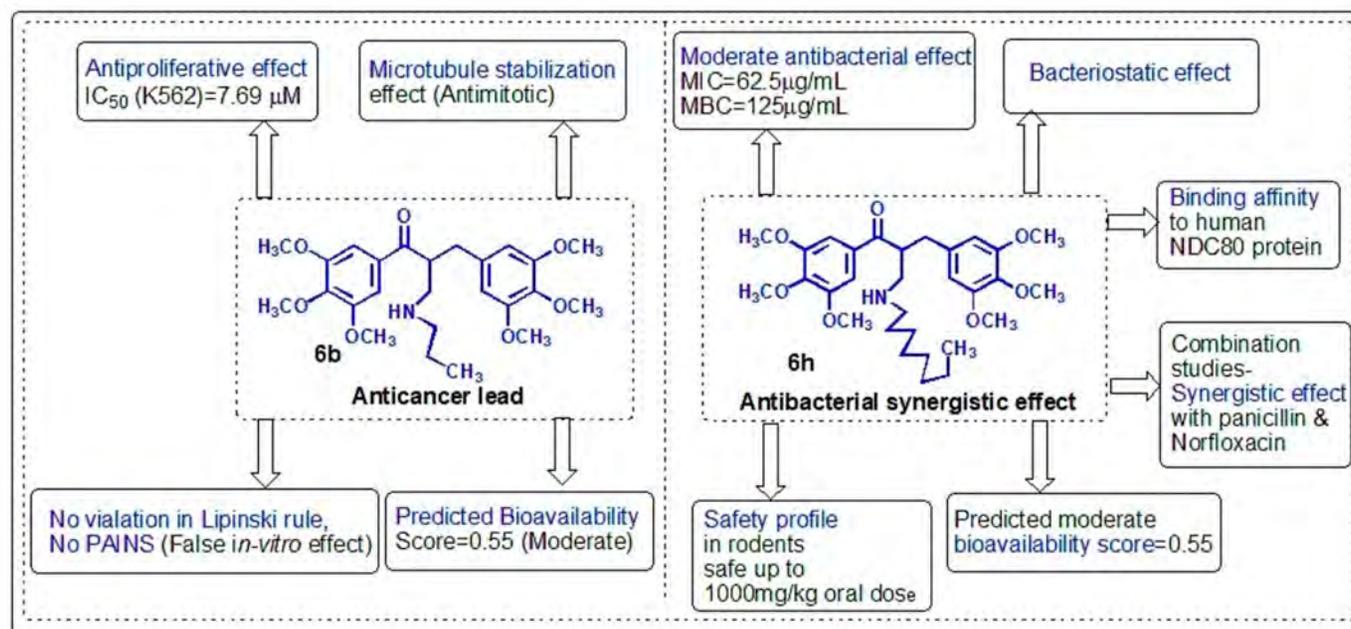


Fig.: Diverse pharmacological profile of representative compounds **6b** and **6h**.

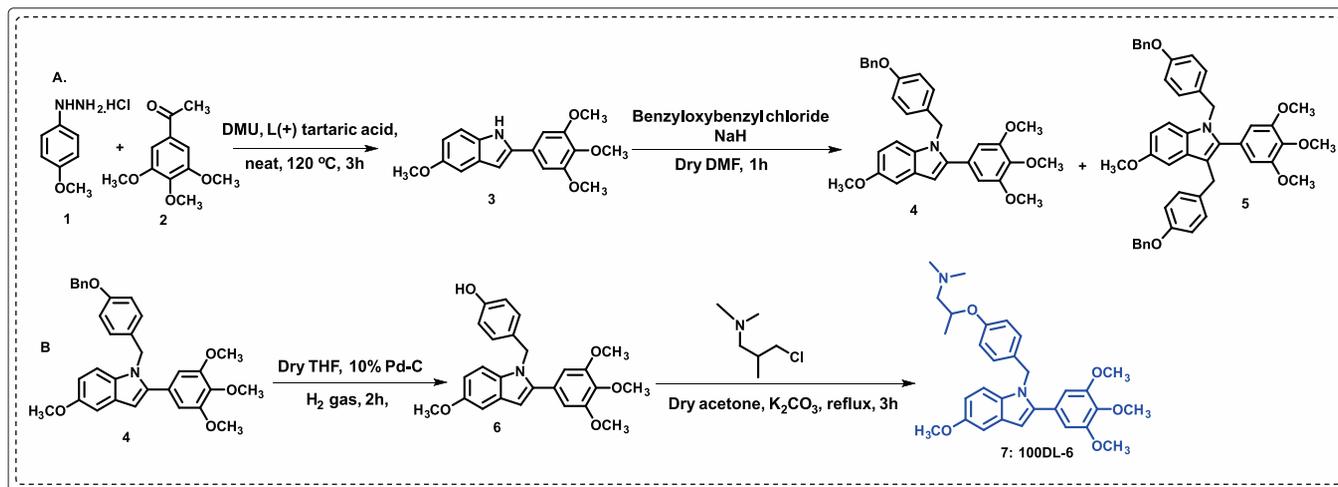


Fig.: Preparation of the antifungal indole derivative **7:100DL-6**.

Its effect was bacteriostatic, as evident from the time kill assay. The 3,4,5-trimethoxyphenyl motif induces antitubulin effect in Aza Michael adduct **6b** for anticancer activity. Both the leads can further be optimised for better efficacy in future [Med. Chem. Res. 2024].

Diarylindole derived from gallic acid exhibits potential antifungal effect against *Candida* Strain

Systemic fungal infections have become a significant consequence and an important cause of morbidity and mortality in immunocompromised persons, like cancer patients receiving chemotherapy or organ transplant recipients, and AIDS patients. In recent decades, *Candida albicans* has become a serious issue for public health. The worldwide rapid rise in drug resistance to conventional therapies is the main contributing reason. Because of their potent activity at low concentrations and apparent lack of toxicity, compounds originating from plants are used in treatments.

Present study describes the synthetic strategy for the preparation of an indole derivative 1-(4-((5-methoxy-2-(3,4,5-trimethoxyphenyl)-1H-indol-1-yl) methyl) phenoxy)-N, N-dimethylethan-1-amine (**7**, **100DL-6**) and antifungal activity by using an *in-silico* and *in-vitro* anti-candidal activity against two *Candida*

strains; *Candida kefyr*-DS-02 (ATCC-204093) and *Candida albicans* (AI-clinical isolate, AIIMS-Delhi).

The efficacy of compound **7** was determined by the combination synergy study, ergosterol binding assay, MTT toxicity study and mutagenicity.

Compound **7** was obtained in 65% yield on the desired motifs. Comparable docking scores were found for both **7** (-8.7 kcal/mol) and Fluconazole (-7.6 kcal/mol). Further, RMSD were shown for **7** (0.26 ± 0.23 nm) and fluconazole (1.2 ± 0.62 nm). The indole derivative **7** was active against the tested fungal pathogens, and the total zone of inhibition was measured between 13-14 mm in diameter and MIC values between 31.25 µg/mL to 250 µg/mL, and MFC values between 62.5 µg/mL to 500 µg/mL. In the checkerboard assay synergistic mode of interaction of **7** with known antifungal drugs was observed. In the presence of ergosterol, **7** and standard drug (s) increased their MIC values, demonstrating a considerable affinity for ergosterol. The compound **7** is considered to be less cytotoxic to the cells, as determined by the MTT assay. Lead compound **7** was found to be non-mutagenic. Overall, the indole derivative **7** significantly abrupt the ergosterol biosynthetic pathway and showed moderate anti-*Candida* effects. These studies suggest that compound **7** significantly enhances the antifungal activity of the clinical drug fluconazole synergistically [Curr. Topics in Med. Chem. 2024].



Dr Arvind Singh Negi & his team

Dr. Sudeep Tandon डॉ. सुदीप टंडन

Pilot-scale studies on the production of concrete and absolute from commercially cultivated *Rosa damascena*



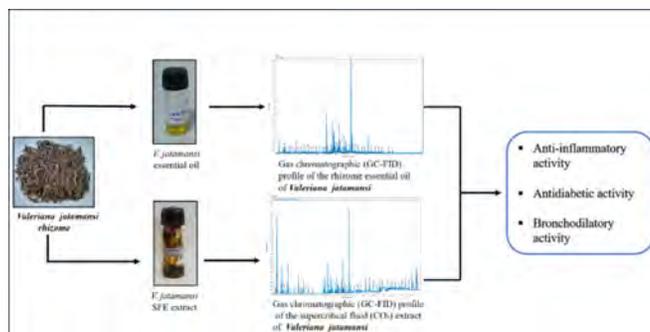
Pilot-scale production of concrete and absolute of *Rosa damascena* flowers being cultivated in the Etawah district of Uttar Pradesh was carried out under an industry-sponsored project in April 2024. Three batches of concrete and absolute were prepared by varying the parameters such as petal-to-solvent ratio, first and second wash time, and temperature. The maximum yield of absolute was observed at a 1:5 ratio of petals to solvent for 40 minutes of wash and a 1:2 ratio of petals to solvent for 30 minutes at slightly elevated temperatures. The percentage yield of concrete varied from 0.36% to 0.38%, whereas the percentage yield of absolute was observed to be in the range of 0.19 to 0.21%. According to Gas chromatography-flame ionisation detector (GC-FID) and Gas chromatography-mass spectrometry (GC-MS) analysis, the major compounds present in absolute have been characterised as 2-phenyl ethyl alcohol (46.01%), a mixture of citronellol and nerol (11.57%), geraniol (7.14%), *n*-heneicosane (5.04%) and *n*-nonadecane (4.29%).



Fig.: Photographs of concrete and absolute from *Rosa damascena*.

Chemical composition and pharmacological activities of essential oil and supercritical CO₂ extracts of *Valeriana jatamansi* Jones (Sugandh Bala)

Valeriana jatamansi Jones (Indian Valerian), commonly known as Sugandh Bala, a perennial herb of the Caprifoliaceae family, was studied for its essential oil (VJEO) and supercritical CO₂ extract (VJSFE) from its rhizomes. GC-FID and GC-MS analyses identified 66 compounds, with patchouli alcohol, β -patchoulene, α -guaiene, and isovaleric acid as major constituents. Both VJEO and VJSFE inhibited neuroinflammation by reducing TNF- α and IL-6 in BV2 microglial cells without cytotoxicity. They also improved glucose uptake in L6 skeletal muscle cells under hyperglycemia, with VJSFE showing stronger antidiabetic potential. Additionally, both extracts produced dose-dependent bronchodilation in mouse bronchial rings. These findings highlight *V. jatamansi* extracts as promising anti-inflammatory, antidiabetic, and bronchodilator agents for potential therapeutic use.



Designing, fabrication and installation of distillation units

Designing, fabrication and installation of eleven improved distillation units of various capacities and types were done in ten districts covering nine states in India namely Motihari, Bihar, Palamu, Jharkhand, Kankavli, Maharashtra, Kanker, Chhattisgarh, Ernakulam, Kerala, Koraput, Orissa, Serchhip, Mizoram, Tirunelveli, Tamil Nadu (2 units) and CIMAP Lucknow, U.P. (2 units) under CSIR-Aroma Mission Ph-III project. All units have been successfully commissioned.



Technical consultancy for processing of Mint oil

Providing technical support to M/s Sewa Trust to support the project "Mint with purpose" on the processing aspects of Mint oils being cultivated in and around Moradabad & Gajraula of UP under CNP-536 project. Field distillation units of five different farmers of 2-ton capacity modified by replacing the MS coil / square pipe condensers with improved Stainless Steel Shell & tube type condensers and MS box type separators with new improved improved-designed SS conical oil separators. The design modifications have resulted in enhanced yields of the mint oil by 10-15% with better oil appearance and quality. The increase in oil yields would not only minimise the losses of

mint oils due to high condensate temperatures but also reduce the oil production costs of the farmers.



Dr. Sudeep Tandon & his team

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

Value addition of turmeric leaf biomass: storage optimisation for essential oil production



Curcuma longa (Turmeric) leaf is an agro-waste generated in enormous quantities every year from the farmers' fields of Telangana (TG), India, which is one of the largest turmeric-growing states, with a cultivation area of 42,098 acres, in 2024-25, and produces 1.33 lakh tonnes of rhizomes. Nizamabad is the largest turmeric-producing district in Telangana with a cultivation area of 22,941 acres in 2024-25. After harvesting rhizomes, farmers usually burn leaves, which creates environmental issues. The CIMAP RC, Hyderabad, has focused on the value addition through utilising this agro-waste for the generation of additional income for turmeric-growing farmers by producing the leaf essential oils. Since the harvest is collected at once during the period, processing of this foliage is not possible in a short period due to the low or limited throughput capacity of the distillation facility at farmers' fields. A mechanism must be designed to process the foliage in a batch mode over a period of a few months. However, there is a concern regarding oil losses during this storage period. Therefore, the present study was aimed at evaluating the yields and quality of turmeric leaf essential oil over a one-month storage period to optimise the storage time through evaluating the yield and quality of leaf essential oil samples.

The foliage was harvested from a 6-month-old crop (*C. longa* var. *Armur*) from the farmers' field in Kammarpalli village, Nizamabad district, TG, on 9th January 2025 and 200 g (fwb) of the sample was hydro distilled in a Clevenger-type apparatus at 4-day intervals for 36 days. The data on moisture losses during the storage were also recorded. The oil samples were collected, measured, dried over anhydrous sodium sulphate and stored at 4°C till analysed by GC-FID. The essential oil yields of the samples distilled during the experiments.

The drying experimental data revealed that the maximum moisture loss was recorded (53.5%) within 4 days after harvest, and around 80% of the moisture was evaporated within 12 days of drying, and thereafter remained almost constant in the given ambient conditions. After 36 days of storage, the foliage becomes highly brittle, a condition that makes it difficult to handle during distillation in the commercial distillation units.

Variation in quantitative and qualitative characteristics

The fresh foliage yielded 0.62% oil yield, while the highest oil yield was recorded at 16 days of storage (0.7%), i.e., a marginal increase over the control. In general, the oil yield varied from 0.6% to 0.68% during the present experimental conditions. The concentration of the major chemical constituents of the turmeric leaf oil is *a*-phellandrene, which decreased from 60% (in the first 4 days) to 55% (at the 36th day), whereas no significant variation in terpinolene concentration was observed. On the contrary, the concentration of *p*-cymene doubled from 3.1% to 6.3% as drying time increased. However, no variations in the concentration of other minor constituents, viz., *a*-pinene, β -myrcene, δ -3-carene, limonene, and 1,8-cineole were observed during the drying period. It is evident from the foregoing observations that the turmeric foliage harvested from the farmer's fields can be dried and stored for up to 36 days without significant losses in essential oil yields and quality. This study is of great importance for the

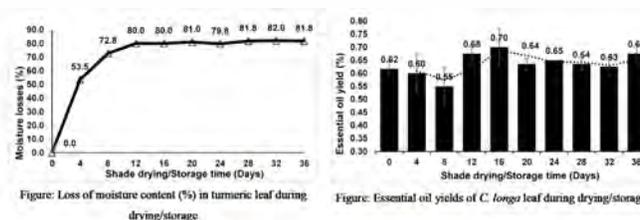


Figure: Temperature (°C) and Relative Humidity (RH, %) data at the experimental site during the study.

turmeric farmers, as they have a limited distillation unit capacity that restricts turmeric leaf processing harvested from the fields at once.

Process improvement studies on geranium oil production

Process improvement studies on Geranium oil extraction reveal significant quantitative and qualitative variations across different innovative approaches as compared to the conventional hydro distillation technique. The innovative approaches include the addition of biological and non-biological additives such as surfactants (Tween-80 and Tween-20), salts (NaCl and CaCl₂), and onion scales (*Allium cepa*) at selected concentrations into the water during hydro distillation of the foliage. Further, experiments on shade drying of the foliage at 24 hours and 48 hours were also conducted.

Variations in geranium oil yields

The conventional hydro distillation (control) produced an oil yield of 0.15%. Among surfactants, Tween-20 at 0.625% gave the highest yield (0.25%), followed closely by Tween-80 at 0.25% concentration (0.22%). For salt treatments, NaCl (0.125% to 0.15%), at all tested concentrations (0.1% to 1.0%) showed no real improvement in the oil yields over control (0.15%), whereas 0.10% CaCl₂ raised the oil yield to 0.25%. The 2% onion peels also increased the oil yield to 0.25%, while shade drying showed modest results (0.2% on 24h drying and 0.1% oil yields on 48 h drying). Thus, the top-performing treatments in terms of oil yields were 0.625% Tween-20, 0.1% CaCl₂ and 2% onion scales, each producing about 66.7% improvement compared to the control.

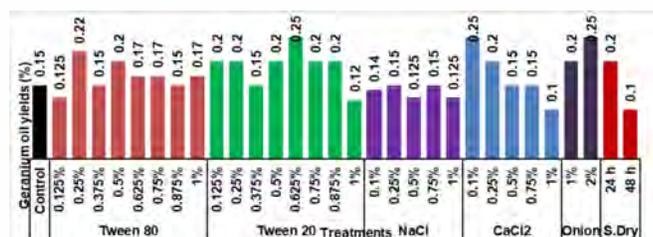


Fig.: Effect of different additives on geranium oil yields during hydrodistillation

Variations in geranium oil quality

Effect of surfactants: Geranium oil distilled from fresh foliage by conventional hydro distillation (control) contained 42.8% citronellol, 10.4% citronellyl formate, 8.6% isomenthone, and 5.1% geraniol. Surfactant treatments influenced these constituents differently. Tween-80 produced the highest citronellol content at concentrations of 0.75% (44.612%), 0.375% (44.18%), and 0.625% (44.014%), whereas Tween 20 yielded lower citronellol content at all concentrations as compared to the control. Citronellyl formate, the second major compound in geranium oil, was found to be the highest at 0.625% & 0.75% Tween-20 (11.624% & 11.588% respectively) and 0.875% & 1.0% Tween-80 (11.307% & 11.234%, respectively). No significant variations were observed in the case of isomenthone. Tween-80 produced higher geraniol content at 0.25%, 1.0% and 0.5% concentrations, while subtle changes were noted in the Tween-20.

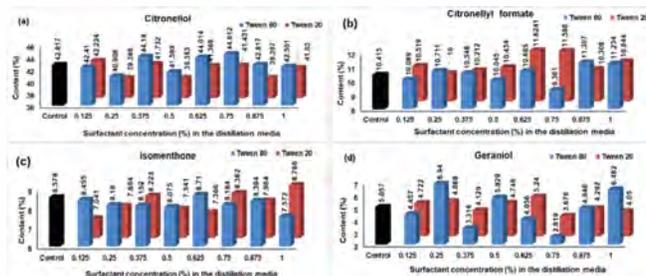


Fig.: Effect of surfactants on the chemical composition of geranium oil

Effect of salts: Salt treatments showed limited qualitative improvement. In general, CaCl₂ produced higher levels of citronellol, citronellyl formate, and isomenthone than NaCl at all concentrations, while geraniol behaved differently. When onion was added to the distillation medium, the major compound, citronellol, was highest compared to the control and shade drying treatment. Citronellyl formate and isomenthone were higher in shade-dried samples than in the control and onion treatment. The studies revealed that Tween-20 is the most effective treatment, increasing oil yields, while Tween-80 improved oil quality. CaCl₂ and onion offer alternative strategies depending on cost and production goals.

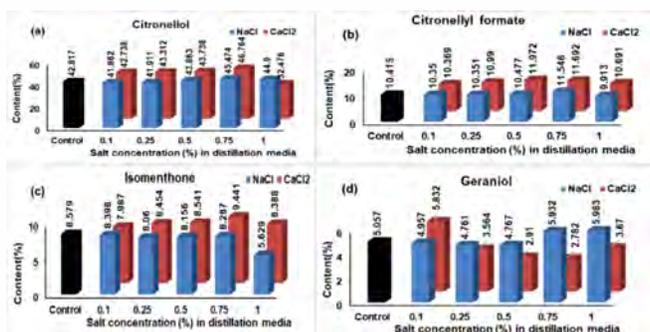


Fig.: Effect of salts on the chemical composition of geranium oil.

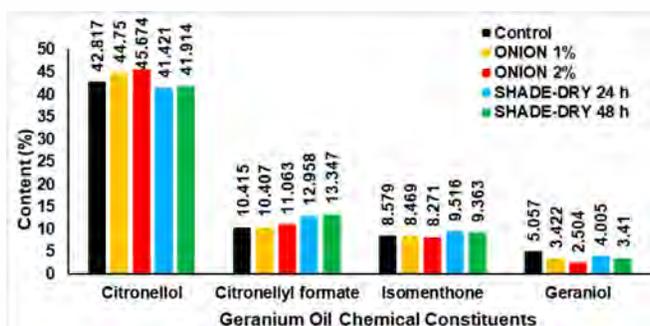


Fig.: Effect of onion and shade drying on the chemical composition of geranium oil



Er. G.D. Kiran Babu & his team

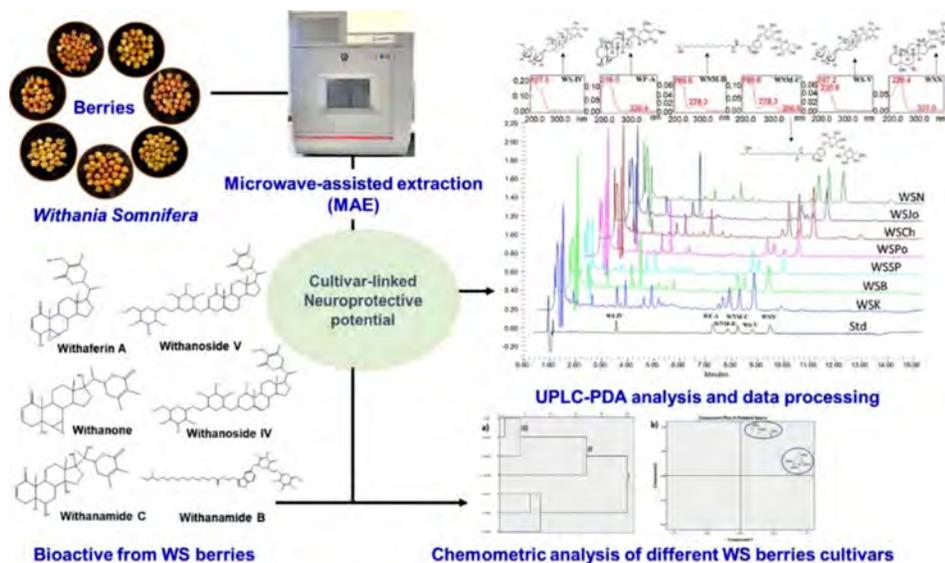
Dr. Karuna Shanker डॉ. करुणा शंकर

New UPLC method for Withanamides and withanolides defining in the berries of *Withania somnifera* Linn cultivars: Chemotypic categorisation for neuroprotective potential



Ashwagandha (*Withania somnifera*), often referred to as Indian ginseng, is the second-largest cultivated

medicinal plant from India globally used in functional foods and botanicals for its health advantages. As per the latest market research, the global trade of *Withania* in 2023 was valued at about 693 million and is predicted to reach 1.9 billion USD in 2043 with a compound annual growth rate (CAGR) of 9.2%. India is the largest producer and exporter of *W. somnifera* root in the world. It is widespread worldwide and reported from other arid and warm climatic regions like Africa, America, Israel, the Mediterranean basin, Italy, Portugal, and Spain. The roots and leaves of *Withania* have been studied extensively. Despite the neuroprotective potential and ethnofood of its berries, there is limited information on its phytochemical and nutritional potential due to the non-availability of a marker-based method for its quality assessment. The present report deals with the design of experiment (DoE) based microwave-assisted extraction (MAE) coupled with universal RP-UPLC-PDA high throughput method for the simultaneous quantification of six (06) non-volatile components (02 withanamides and 04 withanolides) of WS (*W. somnifera*) berries. The developed method was applied to evaluate the chemotypic nature of WS berries cultivars based on key withanamides and withanolides. Furthermore, path analysis of the chemical profile and inhibitory potential of neuro-inflammatory cytokines in glial cells revealed the relationship of withanolides and withanamides content with the neuroprotective potential of WS berries cultivars. With required sensitivity, *i.e.*, limits of detection (0.54–2.46 $\mu\text{g}/\text{mL}$) and quantification (1.78–7.40 $\mu\text{g}/\text{mL}$); precision (%RSD <1.14); accuracy (%RSD <1.34), and recovery (90.86–98.37%), the developed method complied ICH guideline and fulfilled the requirements of the EURACHEM/CITAC guide CG-4 guidelines. Chemometric methods were applied to analyse 07 different cultivars/eco-types. Path analysis was used to correlate the neuroprotective potential of WS berries with anolides and withanamides content. Withanone (WNN), along with two withanamides (WNM-B and WNM-C), were the key phytochemicals for the neuroprotective activities of the WS berries. Overall, results have also demonstrated the variability in

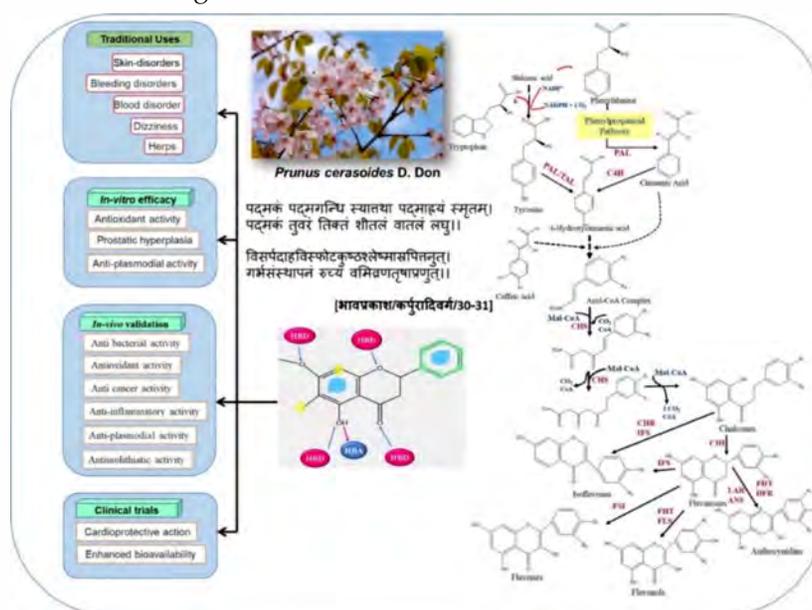


proximate parameters in WS berries. Two ecotypes, i.e., WSJo and WSSP, could be exploited to create novel food with neuroprotective benefits [Industrial Crops and Products 2025].

Padamka or Indian Himalayan cherry (*Prunus cerasoides* Don.): Updates on phytochemistry, pharmacological evidences, traditional uses, safety and toxicity

Prunus cerasoides D. Don, commonly used for religious purposes in India, is commonly known as Padmaka or Wild Himalayan Cherry. The *Prunus* genus has 400–430 species, including shrubs and trees. It is widely distributed across the Himalayan region of India, China, Myanmar, Nepal, and Thailand. It is used in many classical formulations of various Asian traditional medicinal systems, viz., Ayurveda, TCM (traditional Chinese medicines) and TTM (Traditional Thai Medicines) for treating burning sensations, Blisters, blood disorders, dizziness, bleeding disorders, herpes, and skin disorders. The species is considered data deficient and listed in the IUCN Red List of threatened species. *P. cerasoids* have been used for medicinal

P. cerasoides is highly remarkable in its biological properties, such as antimicrobial, antioxidant, anti-inflammatory, and neuroprotective properties. More than 200 phytomolecules have been investigated for their biological potential and the discovery of pharmacophore-inspired drugs. Padmaka instigated over fifty diverse phytochemicals, viz. flavones, isoflavones, chalcones, terpenoids, glycosides, and sterols. The phytochemical flux of *P. cerasoides* is dominant with phenylpropanoids, anthocyanins, carotenoids, and terpenoids. Several experimental shreds of evidence emphasised the biological significance of *P. cerasoides* extracts and their derived



phytochemicals. Medicinal significance and its safety in clinical validation have been discussed efficiently. Moreover, the barrier in validated therapeutics is a lack of information on the bioavailability of specialised bioactive compounds, standardisation, safety, and toxicokinetics. Chemicals responsible for the extract's designated biological activities should be undertaken to enriched, separated, and identify bioactive compounds to assign biological action. The present review can be used to validate and support the traditional and ethnomedicinal properties, which can further help claim the therapeutic efficacy of *P. cerasoides*. The plant should be explored for its synergistic approach and single-molecule mechanism of action, and a substantial mechanistic trail should be provided to rationalise its diverse ethnomedicinal claims. This review also provides

insight into discussions on the key specialised secondary metabolism in *P. cerasoides* responsible for pharmacological/therapeutic action [Chemistry & Biodiversity 2025].



Dr. Karuna Shanker & his team

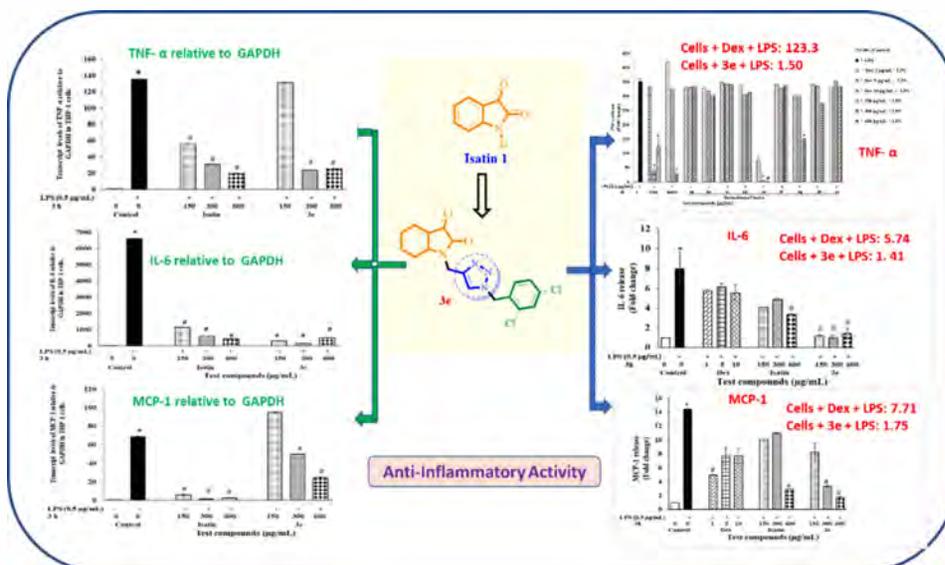
Dr. J Kotesch Kumar डॉ. जे. कोटेश कुमार

Design and development of an Isatin-1,2,3-triazole hybrid analogues as a potent anti-inflammatory agent with enhanced efficacy and gene expression modulation



Isatin (1H-indole-2,3-dione) and its derivatives have been found to exhibit various biological activities, including anticancer and antidiabetic properties. In this study, a series of nine isatin-1,2,3-triazole conjugates were synthesized and evaluated for their anti-inflammatory potential via *in vitro* experiments. The synthesis involved the propargylation of isatin 1 with propargyl bromide to obtain *N*-propargyl isatin 2, which was then subjected to click reactions with different

aromatic azides to yield isatin-*N*-1,2,3-triazoles (3a-i). The structures of all the compounds were confirmed via NMR and HR-MS. The final isatin analogues were tested for their ability to attenuate the production of proinflammatory cytokines in LPS-induced human leukemia monocytic cell line THP-1 cells. Importantly, none of the compounds had any negative effect on THP-1 cell viability at the tested concentrations of 4 mM and 8 mM, respectively. LPS-induced the production of the cytokines: TNF- α , IL-6 and Monocyte chemoattractant protein-1 (MCP-1) by



351.4, 7.9 and 14.3-fold respectively, in THP-1 cells. However, treatment with compound **3e** markedly attenuated the levels of TNF- α (by 6.6-fold and 1.5-fold), IL-6 (by 1.03 fold and 1.41 fold) and MCP-1 (by 3.3-fold and 1.7-fold) by several fold at 4 mM and 8 mM concentrations, respectively. Furthermore, in the gene expression modulation studies, **3e** was found to downregulate the genes responsible for the production of TNF- α (24 and 25-fold), IL-6 (148 and 502-fold) and MCP-1 (50 and 25 fold) at the two tested concentrations compared with their expression in LPS induced THP-1 cells (135-fold, 6612-fold, and 68.8-fold, respectively). Thus, **3e** markedly attenuated the secretion of TNF- α , IL-6 and MCP-1 from LPS treated THP-1 cells, and also the expression of concerned genes. At the lowest dose tested, *i.e.*, 4mM, **3e** had the greatest effect on both gene expression and marker secretion.

In conclusion, the synthesized isatin-1,2,3-triazole hybrid analogues demonstrated significant anti-inflammatory activity, with compound **3e** showing the most potent effects. Specifically, compound **3e** significantly attenuated the secretion of TNF- α by 6.65-fold, and 1.50-fold; that of IL-6 by 1.03, and 1.41-fold; and that of MCP-1 by 3.32, and 1.75-fold at concentrations of 4 mM and 8 mM, respectively. Gene expression analysis further revealed that **3e** downregulated TNF- α by 24-fold, and 25-fold; IL-6 by 148-fold and 502-fold; and MCP-1 by 50-fold and 25-fold at the same concentrations. Importantly, none of the synthesized analogues, including **3e**, exhibited cytotoxicity toward THP-1 cells at the tested concentrations, confirming their safety. These findings highlight the potential of isatin-1,2,3-triazole hybrids, particularly compound **3e**, as nontoxic and effective anti-inflammatory agents [RSC Adv., 2025].

Synthesis of novel Thymol hybrids by coupling with substituted triazoles and chalcones

Thymol, a natural monoterpenoid phenol and isomer of carvacrol, is the principal active constituent of *Thymus vulgaris* oil and is also present in plants such as *Ocimum gratissimum*, *Origanum*, *Trachyspermum*

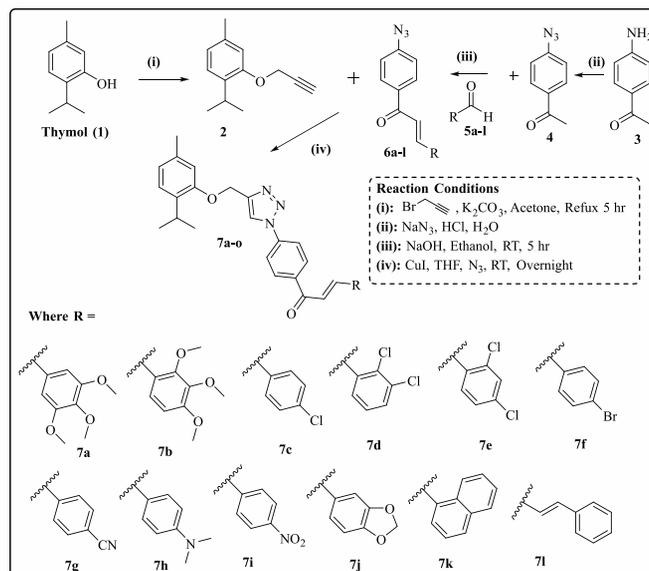


Fig.: Synthesis of Novel thymol-1,2,3-Triazole-Chalcones.

ammi, *Carum copticum*, *Oliveria decumbens*, and *Anemopsis californica*. It exhibits diverse biological activities including antiseptic, antimicrobial, antioxidant, anti-inflammatory, anxiolytic, and repellent properties, with applications in perfumes, flavoring, and animal feed additives. Similarly, 1,2,3-triazoles, easily synthesized via click chemistry,

Table. Anticancer activity of thymol-triazole compounds

Compound Name	Cell Lines (IC 50 μ M)			
	HEK-293	HEPG2	HELA	DU145
T-1	58.3 \pm 4.3	56.4 \pm 1.9	99.4 \pm 2.6	83.3 \pm 2.1
T-7a	41.8 \pm 1.1	55.2 \pm 6.2	39.1 \pm 1.8	72.8 \pm 3.8
T-7b	44.5 \pm 4.5	35.3 \pm 2.3	52.2 \pm 2.2	70.3 \pm 3.7
T-7c	99.8 \pm 4.1	46.0 \pm 3.5	48.7 \pm 0.03	70.4 \pm 1.7
T-7d	7.5 \pm 0.02	16.2 \pm 0.4	30.6 \pm 0.9	16.3 \pm 0.8
T-7e	43.8 \pm 2.5	34.3 \pm 1.9	39.5 \pm 2.7	76.1 \pm 2.3
T-7f	73.8 \pm 7.3	46.8 \pm 4.8	45.8 \pm 3.5	50.1 \pm 5.2
T-7g	50.4 \pm 4.4	15.7 \pm 1.2	35.6 \pm 0.09	7.1 \pm 0.08
T-7h	62.5 \pm 4.1	44.1 \pm 2.0	63.3 \pm 1.0	42.1 \pm 2.7
T-7i	30.4 \pm 3.0	25.7 \pm 2.8	39.5 \pm 3.6	32.7 \pm 1.2
T-7j	65.9 \pm 2.0	44.5 \pm 0.2	46.3 \pm 1.6	45.7 \pm 4.1
T-7k	64.8 \pm 2.3	82.9 \pm 5.8	41.2 \pm 1.1	60.1 \pm 5.1
T-7l	45.4 \pm 5.1	40.0 \pm 0.3	42.1 \pm 0.4	41.3 \pm 5.1
Doxorubicin	6.12 \pm 0.5	0.72 \pm 0.012	0.45 \pm 0.52	2.5 \pm 1.42

Phytochemistry

plays an important role in medicinal chemistry due to their wide range of activities such as antifungal, antibacterial, antiallergic, anti-HIV, antitubercular, and anti-inflammatory effects, while chalcones, belonging to the flavonoid family, are known for their anti-inflammatory, antibacterial, antioxidant, antimalarial, and anticancer properties and often act as tumour suppressors and chemopreventive agents without the genotoxic side effects of many anticancer drugs. Considering the significance of these scaffolds, we synthesized twelve novel thymol-1,2,3-triazole-chalcone hybrids with various aromatic substitutions via aldol condensation and 1,3-dipolar cycloaddition, and their structures were confirmed by NMR, IR, and mass spectroscopy. Biological evaluation revealed promising anticancer potential, with compound **7d** showing significant cytotoxicity against HEK-293 cells (IC_{50} $7.5 \pm 0.02 \mu\text{M}$) comparable to doxorubicin (IC_{50} $6.12 \pm 0.5 \mu\text{M}$), while compound **7g** exhibited potent activity against DU-145 cells (IC_{50} $7.1 \pm 0.08 \mu\text{M}$) relative to doxorubicin (IC_{50} $2.5 \pm 1.42 \mu\text{M}$).



Dr. Jonnala Kotesh Kumar & his team

Dr. R.C. Padalia डॉ. आर.सी. पडालिया

Effect of phenological stages on essential oil yield, composition of *Salvia sclarea* (L.)



Salvia sclarea (family: Lamiaceae) is a popular aromatic plant commonly known as clary sage widely distributed in South-west Asia, Central Asia and Europe. The main objective of the present experiment is to evaluate the influence of

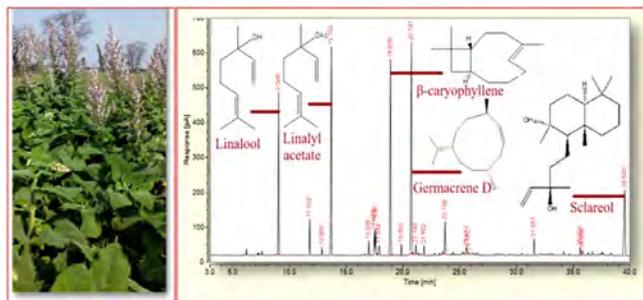


Fig.: Gas chromatogram of *Salvia sclarea* essential oil collected at the full flowering stage.

phenological stages *viz.* half flowering, full flowering, seed setting stage on the yield and chemical profile of aerial part and flower essential oil of *S. sclarea* var. CIM-Harit. The essential oil yield of aerial part was higher in the full flowering stage (0.20 %) than in the other stages (0.05 %). Similarly, essential oil yield of flowers was also higher in the full flowering stage (0.27 %) than in half bloom stages (0.20 %). The major compounds identified in aerial part essential oil were linalool (2.16-10.27%), linalyl acetate (3.48-22.04%), β -caryophyllene (6.59-19.05%), germacrene D (9.68-50.74%), and sclareol (1.70-12.85%). The content of β -caryophyllene (3.45-4.94%), germacrene D (5.55-8.30%), was found less in flower essential oil while linalyl acetate (34.27-41.66%), linalool (16.09-18.36%) and sclareol (6.65-13.34%) were found in higher percentage as compare to aerial part of *S. sclarea* during different phenological stages. The yield of essential oil and volatiles of *S. sclarea* was significantly ($p < 0.05$) affected by the phenological stages.

Seasonal variations in the aroma profiles of *Wedelia chinensis*

Wedelia chinensis is a perennial herb of the Asteraceae family. This plant is tolerant to drought and humidity, and widely distributed in India, China, Indonesia, Japan and other Asian countries. *Wedelia chinensis* is grown in the experimental field of CRC Pantnagar for analyzing its aroma profile in different seasons. The major compound found in all seasons was α -pinene



Fig.: Seasonal variation in the content of the aroma constituents of *Wedelia chinensis*.

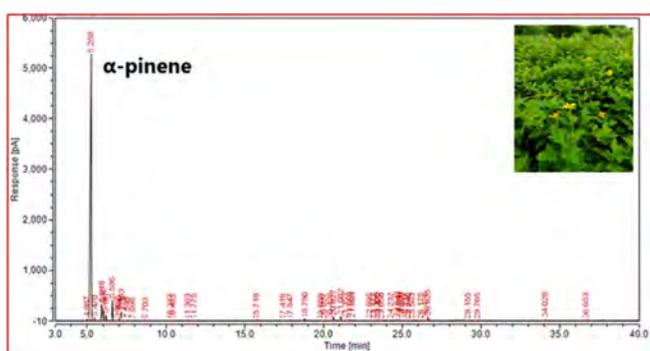


Fig.: Gas chromatogram of *Wedelia chinensis* essential oil.

(78.0-81.3%). The other major compounds identified were α -phellandrene (2.2-4.3 %), limonene (1.8-2.2%), germacrene D (0.9-1.9%). α -pinene is found at higher levels in the rainy season, followed by the summer and autumn seasons.



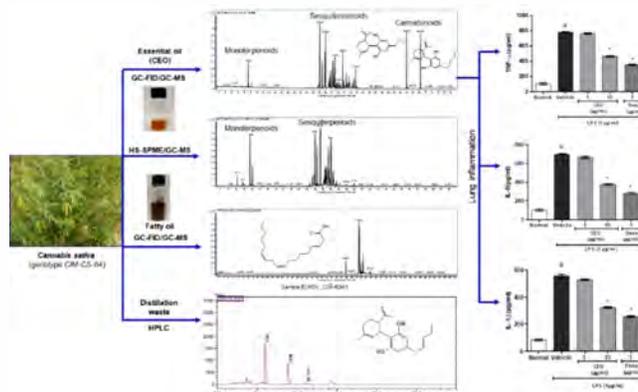
Dr. RC Padalia & his team

Dr. Ram Swaroop Verma डॉ. राम स्वरूप वर्मा

Investigating the phytochemical diversity and anti-inflammatory activity of a non-psychoactive genotype of *Cannabis sativa*



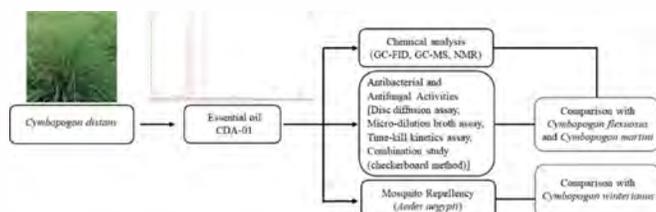
The global market for *Cannabis sativa* L. has received much attention in recent years. This study aimed to analyse the volatile terpenes, phytocannabinoids, fatty acids, and anti-inflammatory potential of *C. sativa* genotype CIM-CS-64. The essential oil (CEO) and phytocannabinoids were sequentially extracted from flowering biomass by hydro-distillation and from spent distillation wastes by solvent extraction, and then analysed using chromatographic and spectroscopic techniques. In total, 94 terpenes,



eight cannabinoids, and ten fatty acids were characterised. The CEO contained limonene ($10 \pm 6\%$), β -caryophyllene ($15 \pm 4\%$), (*E*)- β -farnesene ($10 \pm 2\%$), cannabidiol ($13 \pm 5\%$), and cannabidivarin ($5.5 \pm 2.7\%$) as main constituents. The spent distillation waste extract was rich in cannabidiol ($14 \pm 0.2\%$) and cannabinol ($4.4 \pm 0.1\%$). The seeds gave $29 \pm 2\%$ of fatty oil, which was predominantly composed of polyunsaturated fatty acid (linoleic acid: $50 \pm 4\%$, α -linolenic acid: $12 \pm 0.5\%$). The CEO observed significant inhibition of pro-inflammatory mediators (TNF- α , IL-6 and IL-1 β) in LPS-activated alveolar macrophages (MH-S) in a dose-dependent manner without any cytotoxicity [Microchemical Journal, 2025].

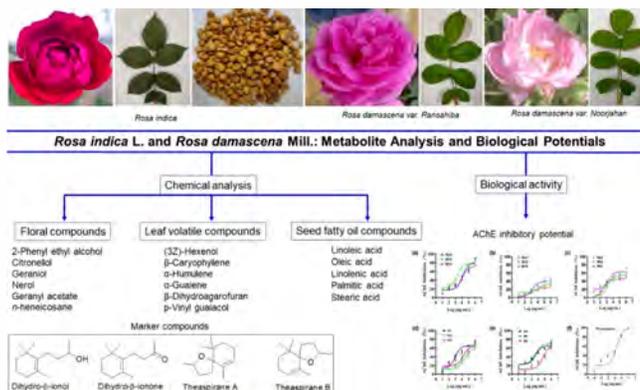
Cymbopogon distans: A source of essential oil with potential antibacterial, antifungal, and mosquito-repelling properties

This study explored the chemical composition and antibacterial, antifungal, and mosquito-repellent properties of *Cymbopogon distans*. The fresh biomasses of *C. distans* and two commercial *Cymbopogon* species, namely *C. flexuosus* and *C. martinii*, were hydrodistilled to extract their essential oils. Analyses of the essential oil revealed the presence of citral, geraniol, and geranyl acetate as major constituents of *C. distans*. However, the essential oils of *C. flexuosus* and *C. martinii* were dominated by citral and geraniol, respectively. The antibacterial and antifungal activities of the essential oils were evaluated using disc diffusion and microdilution methods. *C. distans* essential oil showed a broader spectrum of potent antibacterial and antifungal activities (minimum inhibitory concentration: 0.41 mg/ml and minimum bactericidal concentration/minimum fungicidal



concentration: 0.82 mg/ml) against the test strains. *C. distans* essential oil, in combination with norfloxacin and penicillin G, showed synergistic interactions (fractional inhibitory concentration ≤ 0.5) against *Staphylococcus aureus* and *Staphylococcus epidermidis*. *C. distans* essential oil showed a repellent effect against *Aedes aegypti* (73.3%) that was comparable to *C. winterianus* essential oil (75.6%). This study suggests that *C. distans* essential oil may be a promising natural candidate for developing new herbal therapies for combating microbial infections and mosquito-borne diseases [Food Bioscience, 2024].

Analysing floral, leaf, and seed metabolites and biological potentials of commercial fragrant roses



Roses have been valued for their exquisite colour, shape, fragrance, nutrition, and medicinal properties since ancient times. Two species of roses, *Rosa indica* L. and *Rosa damascena* Mill., are farmed in India to produce high-end fragrance materials. The floral, leaf, and seed metabolite signatures were developed using different extraction methods and gas chromatography-mass spectrometry analysis. Significant differences were observed depending on the species, variety, plant organ, and extraction technique. In all, more than two hundred volatile metabolites, representing twenty-four chemical classes, were characterised in the flowers and leaves. In the seeds of *R. indica*, nine fatty acids and fourteen aliphatic hydrocarbons were characterised. By analysing the chemical and biological profiles of rose oils, absolutes, rose-water extracts, and leaf and seed metabolites, it may be possible to authenticate them and unlock their unrealised potential for flavour and fragrance as well as for the treatment of neurological illnesses [Industrial Crops and Products, 2024].



Dr. Ram Swaroop Verma & his team

Dr. CS Chanotiya डॉ. सी.एस. चनौटिया

Chemistry and characterization of high-value acyclic alcohols in *Ocimum africanum* Lour. Hybrids



Three unique interspecific hybrids (L1, L4 & L5) of *Ocimum africanum* L. were investigated for their volatile secondary metabolites. Acyclic

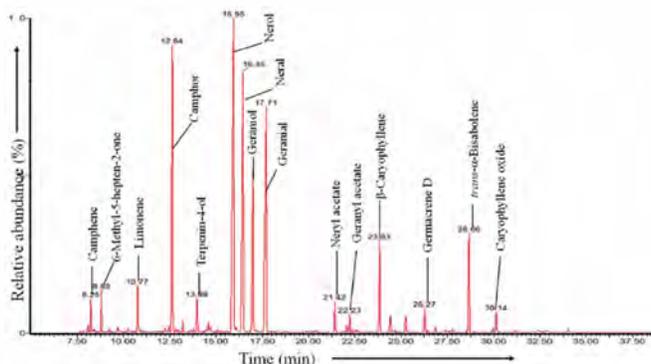


Fig.: The fingerprint of inflorescence-derived essential oil contained high proportions of nerol.

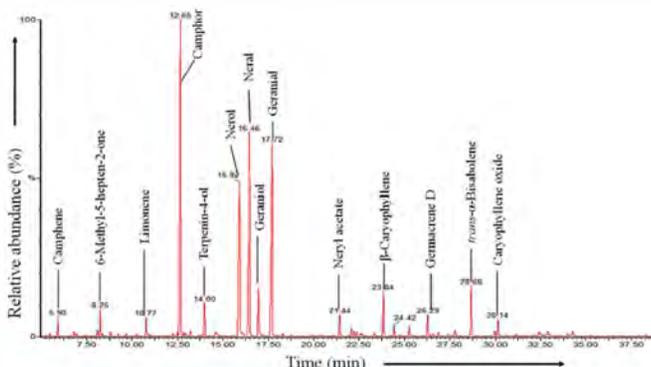


Fig.: Fingerprint of leaf essential oil depicting high proportions of camphor

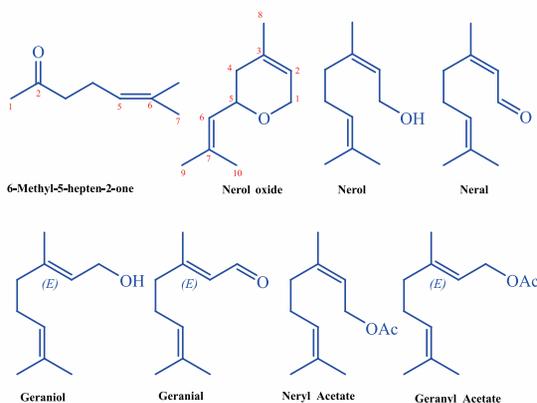


Fig.: Marker constituents of inter-specific *Ocimum* hybrids.

monoterpene classes such as alcohol, ketone, aldehyde and esters were identified in the volatile fractions obtained using hydro distillation. Nerol was identified in high proportions in the inflorescence oil first time. Single enantiomers of (+)-camphor and (-)-germacrene D were recorded.

Vasoreactivity and mechanistic insights through molecular docking of rare antipodal sesquiterpene alcohol from *Chrysopogon zizanioides* L. Roberty essential oil

A crystalline rare antipodal sesquiterpene alcohol was isolated from *Chrysopogon zizanioides*. This study identified an elusive crystal structure using CD, FT-IR, NMR, MS, and X-ray diffraction methods. Flack (Paterson) parameter revealed the absolute stereochemistry as Khusinol. The compound possessed concentration-dependent vasorelaxation in the rat mesenteric artery. As revealed in docking experiments, the hydrogen bond and the binding energy are the two major factors for the proposed activity of the khusinol. We also recorded moderate anti-neuroinflammatory effects of khusinol against BV2 cells. Importantly, the vetiver-based molecule has been identified as a major lead in developing plant-derived cardiovascular disease agents.

The experiment with CaCl_2 demonstrated that the major target of vasorelaxation response induced by khusinol is VDCC. As shown Figure, pre-incubation of the superior mesenteric artery with khusinol

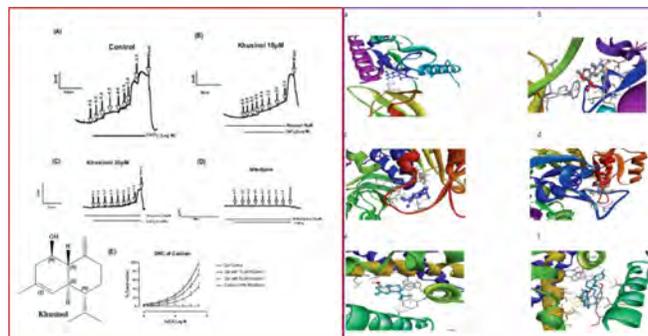


Fig.: The vasorelaxation activity of khusinol ($10\mu\text{M}$) and 3D representations of docked poses representing crucial amino acid residues involved within the active site of target proteins interacting with ligands.

significantly abolished the CaCl_2 -induced contraction response and reduced the E_{max} from 100 ± 0.00 in control to 76.3 ± 2.16 and 46.40 ± 2.10 for khusinol 10 and $30 \mu\text{M}$, respectively ($n=4$) and decreased pD_2 values from 3.04 ± 0.02 in control to 2.95 ± 0.03 and 2.88 ± 0.04 for khusinol 10 and $30 \mu\text{M}$, respectively ($n=4$). A known blocker of VDCC, nifedipine ($10 \mu\text{M}$), when added to the tissue and incubated for 25 min, completely abolished the contraction response by CaCl_2 . Rotundifolone, an oxygenated sesquiterpene, also induced vasorelaxation by inhibiting voltage-dependent Ca^{2+} channels and intracellular Ca^{2+} release selectively due to inositol 1,4,5-triphosphate activation in the rat aorta.

Analysis of the docking results showed that the binding of khusinol at the active site of the selected target was chiefly driven by hydrogen binding, with nearly similar or higher binding energy, confirming the effectiveness of khusinol as a therapeutic agent. The protein-ligand interaction showed that the hydrogen bond is crucial in providing stability to the complex. Similarly, other interactions, such as Van der Waals interactions, alkyl interactions, pi-alkyl interactions, etc., are also vital players in determining the stability and orientation of ligands within the protein binding pocket. Moreover, these results have predicted that khusinol binds actively to the active site residues of the selected targets.



Dr. CS Chanotiya & his team

Dr. Prasanta Kumar Rout डॉ. पी.के. राउत

Scale-up process on purification of Ricinoleic acid from Castor oil and biotransformation of Ricinoleic acid to (+)-gamma-Decalactone with compiling the safety aspects



India has monopoly in castor oil production in the world, and it is composed of 80-85% of ricinoleic acid. This ricinoleic acid is an anti-nutritional fatty acid, and coming under the non-edible category. However, this fatty acid has a high industrial impact, and it is used as substrate for the production of a number of commodity products. Therefore, a novel crystallization process has been developed for the enrichment of the ricinoleic acid (~97%) from castor oil through a two-step urea-crystallisation process. First, the castor oil has been hydrolysed to free fatty

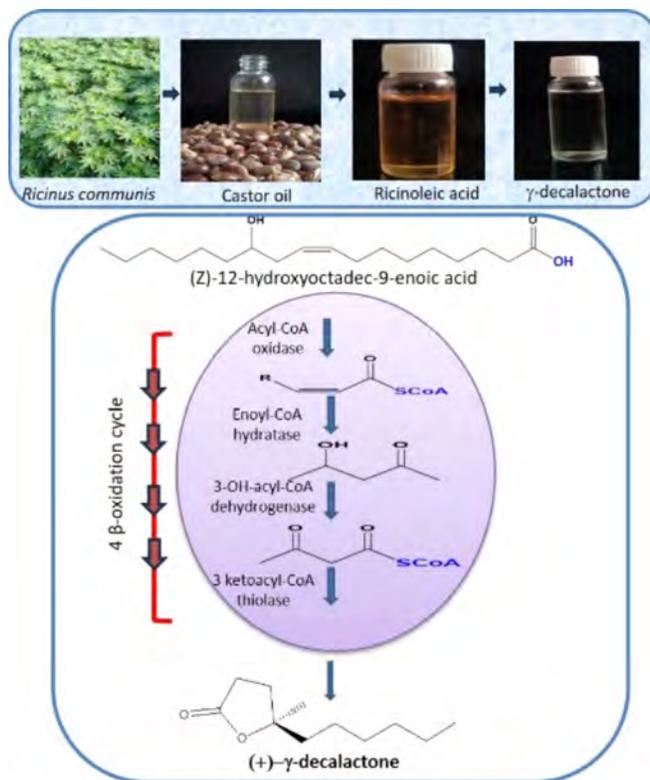


Fig.: Scheme for production of (+)-gamma-decalactone from ricinoleic acid through *beta*-oxidation pathway

acids (FFAs) using 4% NaOH aqueous solution, at optimized conditions for producing FFAs are found to be 80°C, 200 rpm agitation, and 1:5 oil-aqueous ratios in 4 h. Then, the ricinoleic acid is selectively isolated from FFAs through the urea-crystallization method at optimized conditions as the urea to ethanol ratio 1:10, urea to FFAs ratio 1:1, crystallization temperature 10°C, the crystallization period 120 min, the reflux temperature 70°C, and the reflux time 30 min.

The above purified ricinoleic acid is used for bio-transformation to (+)-*gamma*-decalactone (GDL), applying yeast culture. The lactones have found particular attention in food industries as flavouring agents. The *gamma*-decalactone possesses a peach-like odour, and is listed as GRAS-recognised chemical. In the present process, more than 88% molar conversion to (+)-*gamma*-decalactone is attained through bio-transformation. This biotransformation process has been scaled up using 10 L bioreactor. The process conditions at 28 °C, 200 rpm, 40% oxygen supply have optimized the 88% yield of (+)-*gamma*-decalactone in 66h fermentation period. The biotransformation process from ricinoleic acid to (+)-*gamma*-decalactone is attained in *in situ* 4-steps *b*-oxidation pathways. In enantiomeric analysis, it is also reported that (+)-*gamma*-decalactone having better odour profile as compared to its mirror image structure (-)-*gamma*-

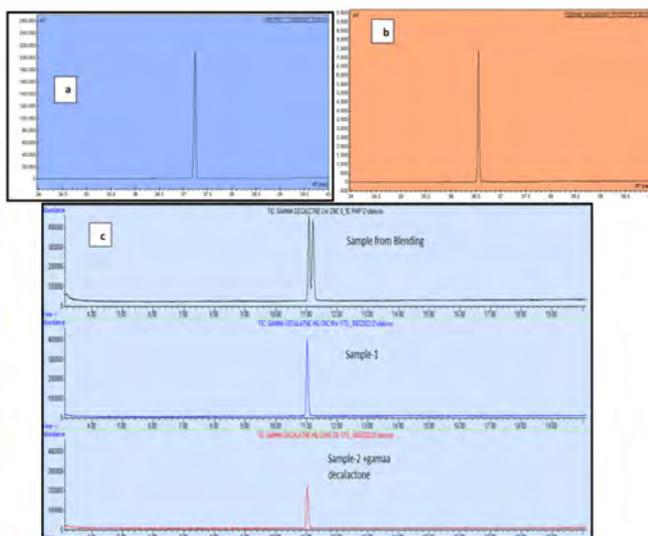


Fig.: Chromatograms (a) GC-FID for purity, (b) Chiral-GC-FID, (c) TIC of Chiral-GC-MS.

decalactone. Further, the reaction mixture was purified using a novel Ca-Mg-Al-Si composite to obtain 99% pure (+)-*gamma*-decalactone [*Journal of Biotechnology*, 2024].

The purified (+)-GDL is enantiomerically pure with positive specific rotation (+42.6°), and 100% biobased. There is no anti-nutritional compound detected in the finished product (+)-GDL, and it is free from live cells and residual solvents. Furthermore, the *in-vivo* oral toxicity study in the rodent model showed that the (+)-GDL as acceptable and harmless.

Synergistic catalysis by Al-B doped Pd/AC for selective conversion of Pulegone-enriched essential oil to Thymol-rich oil

The selective semi-synthesis of thymol from pulegone, a carcinogenic monoterpene, is crucial for regulatory compliance in nutraceutical, pharmaceutical, and flavour industries. A novel 2.5%Al-1.5%B-3%Pd/AC composite was developed as well as validated Al³⁺-B interactions to facilitate cyclohexane ring dehydrogenation, and Pd active sites for selective hydrogenation of C=C and C=O groups. The catalyst achieved a high thymol yield of 98.5% under moderate conditions (70 °C, 30 psi H₂, 60 min), and exhibited excellent stability, along with maintaining over 97% activity after five regeneration cycles. Structural analyses confirmed the catalyst's robustness with minimal Pd sintering observed after reuse. Scale-up experiments using *Mentha arvensis*

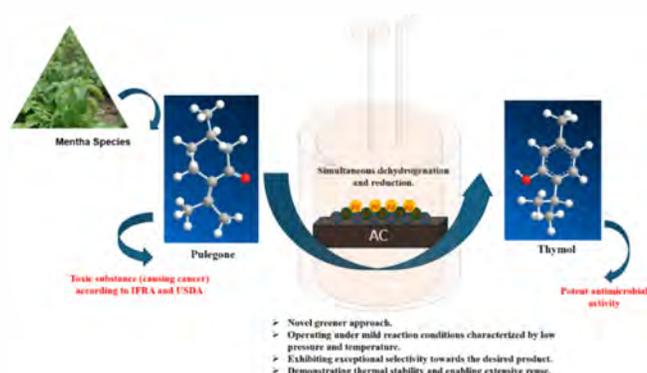


Fig.: Schematic representation of pulegone conversion to thymol over 2.5%Al-1.5%B-3%Pd/AC catalyst.

Synthesis of novel 1-ethoxy carbonyl-3,5-bis (Vanillin)-4-piperidone analogues as potential anti-cancer agents

Vanillin is a naturally derived aromatic aldehyde widely utilized as a versatile building block in synthetic chemistry. Vanillin and its analogues have been extensively studied for their broad spectrum of pharmacological properties, including antimicrobial, antioxidant, and anticancer activities, underscoring their relevance in pharmaceutical and industrial applications. Similarly, 4-piperidone, a six-membered heterocyclic compound, has attracted considerable interest as a scaffold in medicinal chemistry. Its cyclic amide structure allows for extensive derivatization, giving rise to analogues with notable anticancer, antimicrobial, and analgesic properties. The combination of vanillin and 4-piperidone into a single molecular framework represents a compelling approach in drug discovery and advanced material design. The resulting hybrids contain dual pharmacophores

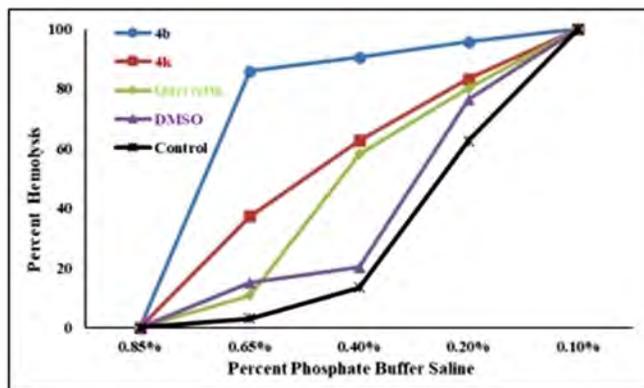


Fig.: Erythrocyte osmotic fragility curve of vanillin-4-piperidone analogues, dimethyl sulphoxide (DMSO).

that potentially exhibit improved pharmacokinetics, increased bioactivity, and enhanced selectivity. In the present study, a novel series of 1-ethoxycarbonyl-3,5-bis (benzyl/alkyl vanillin)-4-piperidone analogues (3 and 4a to 4m) were designed, synthesized and characterized by NMR and HR-MS spectral data. Among the synthesized analogues, compounds 3 and 4k exhibited potent and selective cytotoxicity against cancer cell lines SKBR3, HepG2, and DU145, with minimal toxicity toward normal HEK-293

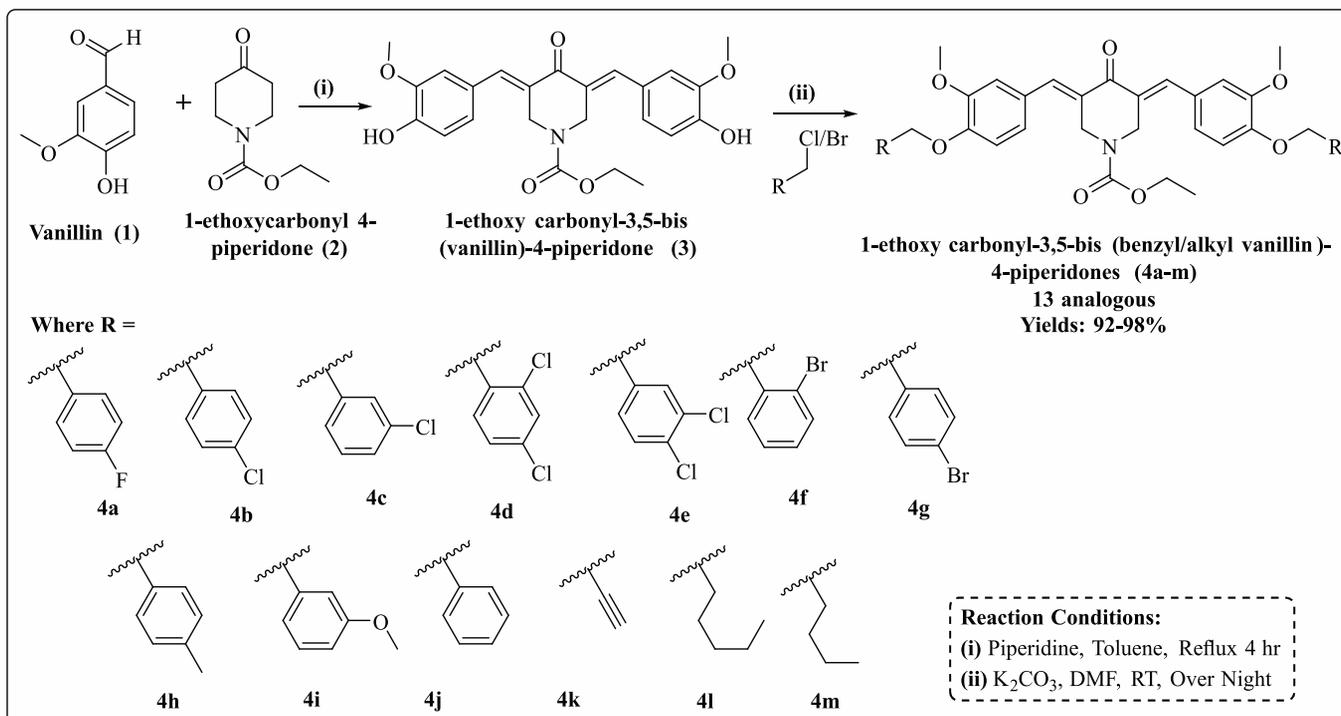


Fig.: Synthesis of novel 1-ethoxy carbonyl-3,5-bis (benzyl/alkyl vanillin)-4-piperidone analogues.

Table: *In vitro* cytotoxicity activity of **4k** on normal and cancer cells *in vitro*.

Com- pound	Anti-Cancer Activity [Cell Lines (IC ₅₀ μM)]				
	HEK-293	SKBR3	HEPG2	DU145	CHO-K1
1	127.3 ± 8.2	96.5 ± 2.4	391.3 ± 37.9	21.3 ± 0.8	ND
3	20.5 ± 4.9	2.97 ± 0.4	48.4 ± 5.5	4.4 ± 0.8	ND
4a	56.1 ± 1.1	57.7 ± 6.5	104.6 ± 1.9	72.4 ± 0.2	ND
4b	53.7 ± 3.2	74.6 ± 6.6	112.2 ± 7.5	10.6 ± 0.05	ND
4c	264.6 ± 17.7	90.1 ± 3.1	131.6 ± 8.1	38.3 ± 7.7	ND
4d	45.2 ± 8.5	68.8 ± 5.4	108.9 ± 13.3	70.8 ± 4.2	ND
4e	56.7 ± 12.9	66.8 ± 7.3	74.8 ± 3.2	45.7 ± 2.5	ND
4f	51 ± 6.5	82.9 ± 6.9	71.05 ± 3.8	47.8 ± 3.5	ND
4g	97.3 ± 11.7	85 ± 6.6	18.2 ± 0.3	85.64 ± 6.8	ND
4h	95.4 ± 6.6	89.4 ± 9.2	42.4 ± 6.1	104.07 ± 11.2	ND
4i	258.2 ± 14	53.3 ± 8.7	185.9 ± 10.9	28.09 ± 6.3	ND
4j	147.5 ± 16.6	37.3 ± 7.3	85.6 ± 2.6	45.7 ± 9.5	ND
4k	11.5 ± 2.5	127.3 ± 11.7	2.27 ± 1.2	5.01 ± 6.1	13.5 ± 1.9
4l	72.9 ± 8.6	148.2 ± 17.5	129.3 ± 8.2	92.78 ± 5.5	ND
4m	125.6 ± 2.8	56.2 ± 6.9	77.5 ± 6.4	88.5 ± 8.6	ND
Doxoru- bicin	6.12 ± 0.5	0.45 ± 0.52	0.7 ± 0.56	2.5 ± 1.42	-
Mitomy- cin-C	---	---	---	---	13.1 ± 0.68

CHO K1- Chinese hamster ovary cell line; HEK-293- Human embryonic kidney cell line (Normal cell line); SKBR3- Human breast cancer cell line; HepG2- Human hepatoblastoma cancer cell line; DU145- Human prostate cancer cell line; ND= Not done.

cells. Additionally, compound **4k** demonstrated strong erythrocyte membrane-stabilising potential in osmotic fragility assays, comparable to quercetin highlighting it as a promising anticancer lead.

Quantitative analysis of Vasicine and Vasicinone in *Adhatoda vasica* Nees using RP-HPLC: distribution and solvent extraction efficiency

A RP-HPLC protocol was developed for the simultaneous quantification of bitter quinazoline alkaloids vasicine and vasicinone from *Adhatoda vasica* and studied the distribution of these markers in different parts of the plant, along with the best extraction method for their recovery. The highest abundance of vasicine was observed in the leaves (0.7332%), then in the stems and roots, whereas vasicinone was present only in the leaves (0.0436%)

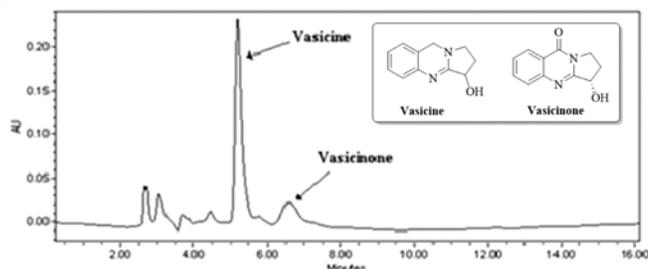


Fig.: HPLC chromatogram of *A. vasica* methanol extract.

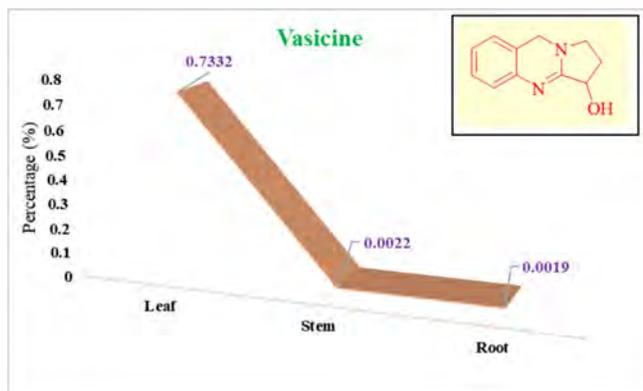


Fig.: Determination of vasicine in different parts of *A. vasica*.

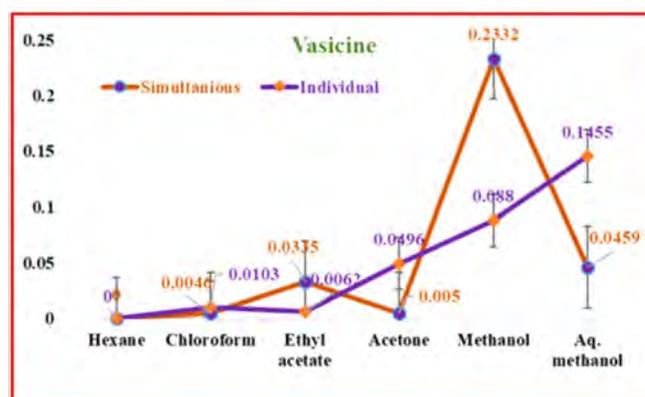
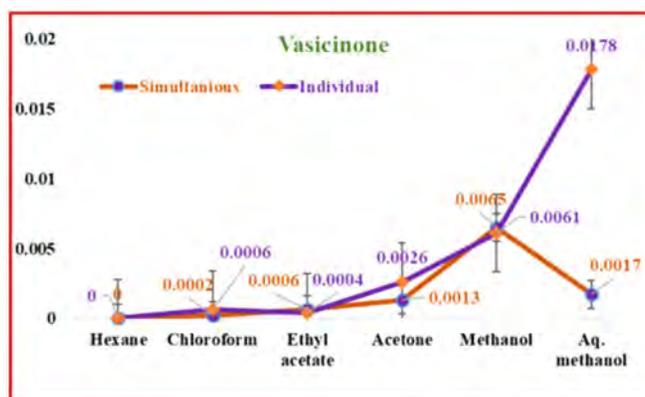


Fig.: Variations of marker compounds in different extracts.

and was absent in the stems and roots. Methanol was identified as the most effective solvent for the extraction of vasicine in successive extraction,

whereas 30% aq. methanol is recommended for the extraction of vasicinone in the individual solvent extraction method.



Dr. KVN Satya Srinivas & his team

Dr. Atul Gupta डॉ. अतुल गुप्ता

Value addition of Eugenol, a prominent phenyl propanoid from the essential oil of *Ocimum* species



Eugenol (**1**) is a phenylpropanoid abundantly present in *Ocimum* species and clove. It is a low-value aroma molecule with distinct functional characteristics. Eugenol is one of the versatile molecules that can serve as a starting material for a number of biologically important compounds, including its positional isomer Isoeugenol (**2**), and dimerised compounds (other lignans) such as α -Diisoeugenol (**3**), β -Diisoeugenol (**4**), γ -Diisoeugenol (**5**), δ -Diisoeugenol (**6**), and Biseugenol (**7**). α -Diisoeugenol is known to have diverse biological activities such as anti-inflammatory, anti-oxidant, etc.

Chemically, diisoeugenol possesses an indane core. The indane ring system plays a crucial role in the biological activity of such compounds. Many naturally occurring molecules, such as asarone dimer

(**8**) isolated from the essential oil of *Acarus calamus* or pallidol (**9**), a resveratrol dimer, from *Cissus pallida*, are widely studied bioactive phytochemicals with diverse pharmacological activity against various diseases. Owing to its aforementioned properties in pharmaceuticals, we devised an efficient, eco-friendly transformation of eugenol (**1**) extracted from *Syzygium aromaticum* (L.) Merr. and L.M. Perry, leaf/bud oil, *Ocimum tenuiflorum* cv. CIM-Ayu, *Ocimum gratissimum* (Clocimum) to synthesize diisoeugenol in the presence of green solvent.

In this study, we devised a chemical transformation for dimerization of eugenol and other similar phenylpropanoids via [3+2] cycloaddition in the presence of a simple base, utilising green solvent. This simple one-step transformation was achieved at moderate to good yield (Scheme 1). This method was also utilised for other substituted phenylpropanoids, and we got a similar product. Most of the dimerization techniques reported in the literature involve the use of a toxic and volatile halogenated solvent (CH_2Cl_2 , CHCl_3) and hazardous reagents like H_2SO_4 , CF_3COOH or other complex and expensive reagents, including

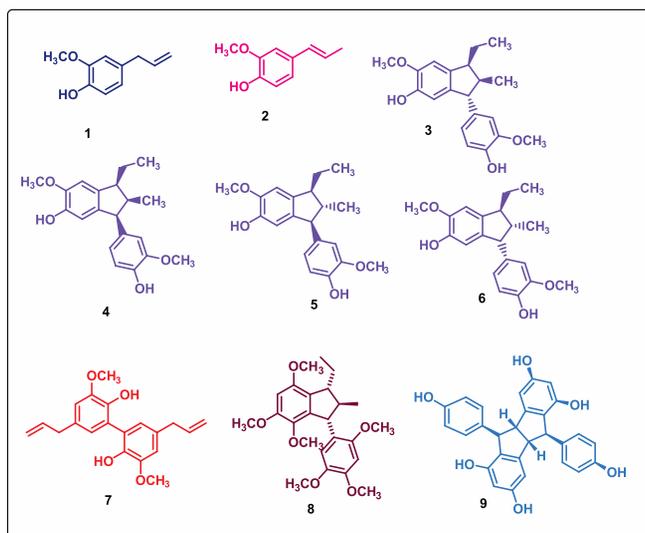
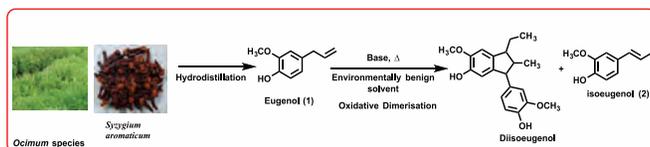


Fig.: Structures of naturally occurring diversified phenyl propanoid dimmers.

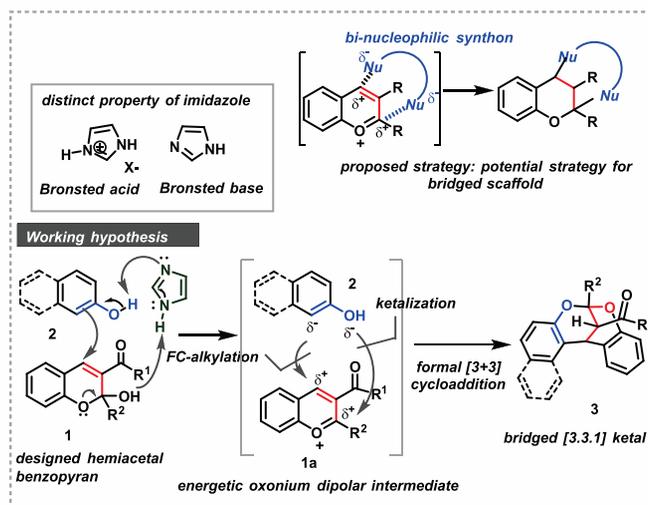


Scheme 1: Chemical process for the synthesis of diisoeugenol.

Au and Ag. Thus, this method presents a green, efficient, and cost-effective synthesis of diisoeugenol from low-value aroma molecules like eugenol and eugenol-rich essential oils, aligning with principles of sustainable chemistry. The newly established chemical methodology offers the synthesis of pharmacologically important diisoeugenol in good yield under environmentally benign conditions. The establishment of the general applicability of this chemical process to other phenyl propanoids is in progress.

Imidazole-catalysed construction of bridged bicyclo [3.3.1] ketals via formal [3+3]-cycloaddition of naphthols and 2-hydroxyl chromene derivatives

[3+3]-Cycloaddition reaction has bloomed into a sustainable synthetic transformation for constructing six-membered heterocyclic compounds using appropriate and compatible reactive/stable dipoles.

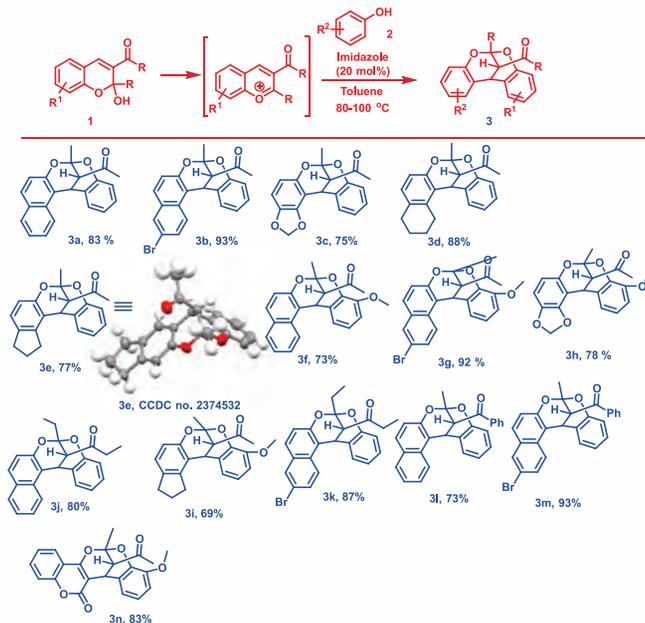


Scheme 2: Concept and mechanism of the reaction.

Imidazole and its derivatives are sustainable organocatalysts with great potential due to basicity, nucleophilicity, and the Brønsted acidity of their salts. In this study, due to distinguish reactivity (nucleophilic and the Brønsted acidity of their salts, Scheme 2) and catalytic potential, we intended to tap the reactivity profile of imidazole for the [3+3] cycloaddition reaction between benzopyran-derived hemiacetals (**1**) and naphthols (**2**). Naphthol has two intrinsic nucleophilic (C and O) centres, which can undergo reaction with reactive oxonium chroman intermediate (**1a**) that leads to the construction of bridged [3.3.1] nonane scaffolds (**3**) via sequential Friedel-Crafts alkylation followed by stereoselective ketalization shown in Scheme 2.

Finding the optimum results with imidazole for the synthesis of intriguing bridged bicycle [3.3.1] nonane, the substrate scope was investigated for various substituted phenols. 5-Bromonaphthol (**2b**) gave the corresponding bridged [3.3.1] nonane (**3b**) in 93% yield. Substituted phenols, such as benzo[d][1,3]-dioxol-5-ol (**2c**), tetrahydro-2-naphthol (**2d**) and 2,3-dihydro-indenol (**2e**) also worked well to give corresponding bridged bicycle [3.3.1] nonanes **3c-3e** in very good yields (75-88%), Scheme 3.

The scope for cyclic hemiacetals-derived hemiacetal was also explored to generalize the chemical methodology. Electron-rich, methoxy-substituted



Scheme 3: Synthesis of bridged bicycle [3.3.1] nonanes.

hemiacetals afforded corresponding bridged bicycle [3.3.1] nonanes (**3f-3i**) in good yields (69-92%) with 2-naphthol, 5-bromonaphthol, and 2,3-dihydroindeno[1,2-b]furan, respectively. Ethyl ketone and benzoyl-derived hemiacetals led to the formation of products **3j-3m** in 73-93% yields. The above standard condition was compatible with 4-hydroxycoumarin to furnish the corresponding product **3n** in 83% yield. The proposed reaction pathway follows a formal [3+3] cycloaddition of phenols and an oxonium dipolar intermediate. The reaction is efficient regarding scalability, environmentally benign conditions, resulted the products in good to excellent yields.



Dr. Atul Gupta & his team

Er. Ashween D Nannaware इंजी. अश्विन डी. नन्नावरे

Design, development and demonstration of decentralized mobile solar distillation unit at Farmer's field of Barabanki, Uttar Pradesh



This is a new decentralized solar distillation unit having a compact system, movable technology, where the scattered farmers in hilly areas can easily carry it to their field and can distil the aromatic crops for essential oil. Environment-friendly decentralized mobile solar distillation technology provides a much more efficient method of producing steam compared to other means using fossil fuels. A new patented design decentralized mobile solar distillation unit was successfully field demonstrated to various farmers on 11th June 2024 at Barabanki district of Uttar Pradesh [*Sustainable Energy Technologies and Assessments*, 2024, 69, 103895].



Installation and commissioning of 500kg capacity centralized solar hybrid aroma distillation unit at farmer's field in the Nagpur region

We have designed, developed and installed a centralized hybrid solar distillation unit (500kg capacity) for essential oil extraction in the Nagpur region and is having immense potential in rural India for agricultural and industrial sector development. This new solar distillation technology has a high degree of innovation with an integrated concept of using renewable solar energy to assist the Nagpur farmer's nucleus groups cultivating aromatic crops and end beneficiaries with the objective to develop sustainable agribusinesses. Using this new centralized solar hybrid distillation technology (500kg), Nagpur farmers cultivating aromatic plants will get high-purity essential oil with enhanced oil yield, which will facilitate them with high income generation. This centralized solar hybrid distillation technology will help the Nagpur farmers cluster to reduce the current energy needs during distillation operation, and also make efforts towards the environment-related agenda set by the government. In addition, it will directly improve the economic condition of Nagpur



farmers and provide an opportunity for employment generation. This centralized solar hybrid distillation technology innovative approach has helped to introduce the agriculture industry to the various uses of solar energy in a very simple and effective way.

Design and development of new adsorption system for reducing the emission of harmful gases into the atmosphere during aromatic distillation operation

The promotion and cultivation of high-value aromatic crops for essential oil production is an employment-generating activity, which has empowered the rural area with increase in income generation. Commercial distillation units for aromatic crops typically utilize substantial quantities of wood biomass, resulting in the emission of different harmful gases into the atmosphere and raising significant environmental issues. As atmospheric carbon dioxide (CO₂) levels continue to rise due to fossil fuel combustion and industrial activities, the urgency to adopt sustainable CO₂ reduction strategies becomes critical. Our study offers a thorough examination of the incorporation of renewable solar energy systems as a pivotal strategy to transform the distillation processes of aromatic crops, with the objective of reducing atmospheric CO₂ emissions. In this study, a new lab-scale adsorption system has been designed and developed to effectively trap and reduce the CO₂, SO₂, NO₂ and other gases emitted into the atmosphere [Patent draft is in progress].



Dr. Ashween D Nanaware & his team

Dr. Hariom Gupta डॉ. हरीओम गुप्ता

NMR analysis of essential oils and evaluation of characteristic markers in *Cymbopogon* species



This study aimed to explore the chemical composition and the bioactivity of essential oils from *Cymbopogon distans* (CDA-01), *Cymbopogon flexuosus* (CF), and *Cymbopogon martinii* (CM) due to the growing interest as natural antimicrobial agents and mosquito repellents. 1D and 2D-NMR analysis was used to identify and confirm the characteristic chemical markers such as neral, geranial, geranyl acetate, and geraniol with unique compositions in each oils: CDA-01 had a balanced mix of geranyl acetate (21.2%), geranial (19.7%), and geraniol (16.4%); CF was dominated with geranial (40.0%) and neral (30.5%); and CM having mainly geraniol (75.5%) as illustrated by NMR and GC analysis. It provided a detailed chemical profile crucial for evaluating their potential as natural solutions for microbial infections and mosquito control.

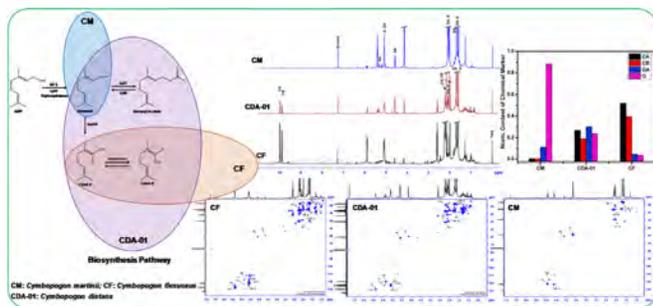


Fig.: ¹H-NMR study for the characteristic marker constituents of *Cymbopogon martinii* (CM), *Cymbopogon distans* (CDA-01), and *Cymbopogon flexuosus* (CF) essential oils: evaluation of normalized relative content of CA: citral A, CB: citral B, G: geraniol, and GA: geranyl acetate determined by NMR and representative biosynthesis pathway.

DFT-simulated Mg²⁺ and Ca²⁺-containing silicates, aluminates and aluminosilicates along with their deprotonation and dimerization reactions in solution

Geopolymers made from industrial and agricultural byproducts (e.g., fly ash, rice husk ash, and banana peel ash) offer a sustainable alternative to cement with minimal CO₂ emissions. Geopolymers are gaining attention for their environmental and economic benefits. A study using Density Functional Theory (DFT) simulations was examined to derive and compare the equilibrated geometries of fundamental monomers, dimers, and their initial key reactions (deprotonation and dimerization) with Mg²⁺ and Ca²⁺ as counter-cations. Molecular interactions (electrostatic, ion-dipole and hydrogen bonding) have been observed in the clusters. The feasibility of the deprotonation and dimerization reactions with Mg²⁺ and Ca²⁺ as counter-cations has been predicted on the basis of the Gibbs energy of the reaction. So, this study helps to predict the species that will be highly populated or not formed in the solution phase during geopolymerization.

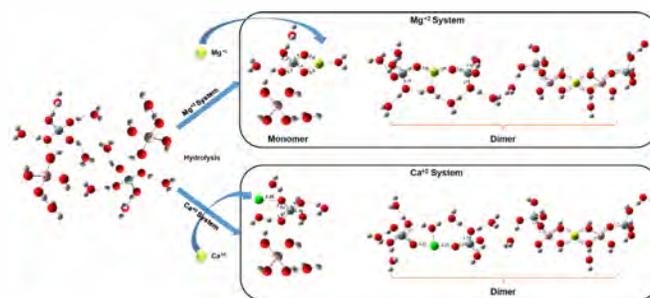


Fig.: Schematic representation of molecular interaction and formation of dimerizations obtained from the DFT simulations to describe the role of bi-ionic cations (Ca²⁺ and Mg²⁺).

Computational insights for K⁺ versus Na⁺-containing aluminosilicate species and their initial key reactions at experimentally relevant pH

Geopolymers are typically synthesized using sodium or potassium-based activators, supplying Na⁺ or K⁺ ions to the framework. While some studies suggest K-based geopolymers offer higher compressive strength than Na-based ones, a detailed comparison of the underlying chemical species and their initial reactions with these cations is lacking. This computational study uses DFT to compare the optimized geometries of silicate and aluminate

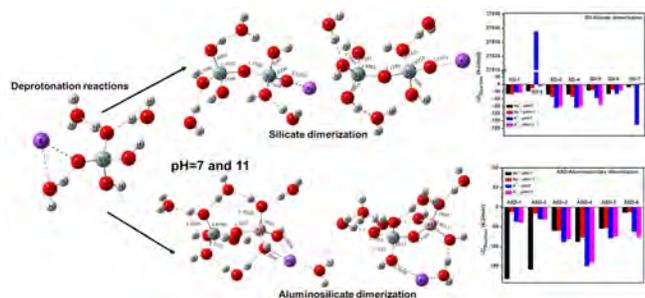


Fig.: Schematic illustration of molecular interactions and dimer formation, as revealed by DFT simulations conducted on a monoionic cation system under two different pH conditions.

monomers and dimers with Na^+ and K^+ , focusing on their deprotonation and dimerization reactions at pH 11.



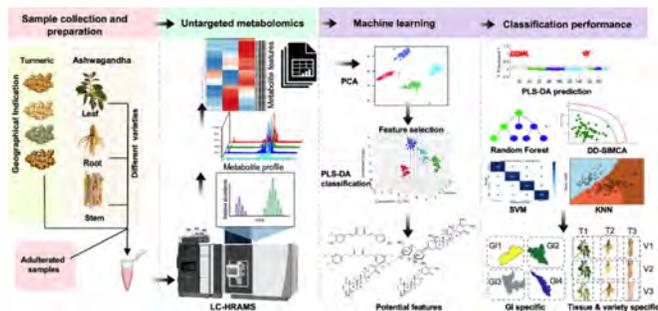
Dr. Hariom Gupta & his team

Dr. Ratnasekhar CH डॉ. रत्नशेखर सीएच

Machine learning-guided Orbitrap-HRMS-based metabolomic fingerprinting for geographical origin, variety and tissue-specific authentication, and adulteration detection of medicinal herbs: Ashwagandha and Turmeric Study



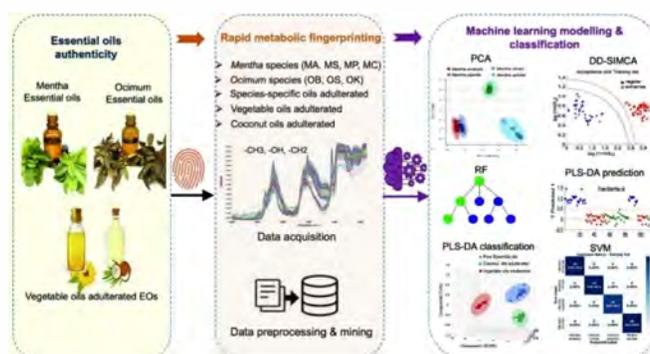
The rising demand for herbs in the food and nutraceutical industries underscores their functional



benefits, but issues such as geographical origin (GO) mislabeling and tissue- or variety-specific adulteration threaten quality and safety. This study used LC-Orbitrap-MS-based untargeted metabolomics with machine learning to authenticate turmeric (*Curcuma longa*) and ashwagandha (*Withania somnifera*). Four GO-specific turmeric samples, three tissue- and variety-specific ashwagandha samples, and adulterated market samples were analysed. Machine learning identified biomarkers and built robust classification models, achieving 98% specificity and accuracy. Findings highlight metabolomics-ML integration as a powerful tool for authenticity, traceability, and food safety in global markets [*Food Chemistry* 2025].

Rapid metabolic fingerprinting meets machine learning models to identify authenticity of essential oils

Essential oils (EOs) are increasingly valued for antibacterial, preservative, and flavour-enhancing properties, yet their application in food systems is constrained by adulteration with cheaper oils. This study developed a rapid, cost-effective, and



non-destructive approach for EO authentication using Fourier transform near-infrared (FT-NIR) spectroscopy coupled with machine learning. Four *Mentha* and three *Ocimum* species were analysed, including market samples adulterated with vegetable oils. The integrated system achieved outstanding performance, with Q^2 , R^2 , accuracy, sensitivity, and specificity all exceeding 0.98. These results establish FT-NIR with machine learning as a robust solution for EO authenticity and food industry quality assurance [Food Chemistry 2025].



Dr. Ratnasekhar CH & his team

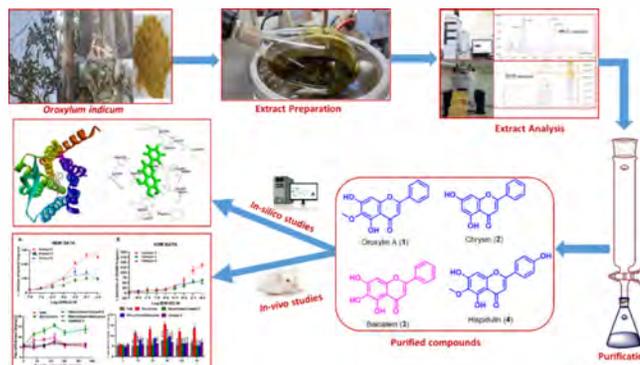
Dr. Kapil Dev डॉ. कपिल देव

Phytochemical investigation of *Oroxylum indicum* and opioid receptor modulator activity



Oroxylum indicum (L.) Kurz belongs to the family Bignoniaceae. It is a medium-sized tree that grows in tropical and subtropical regions of Asia. It is called as “Shyonak” or “Trumpet” tree in India. Traditionally, the plant is useful in the treatment of various diseases. It possesses several biological activities such as anti-microbial, anticancer, anti-inflammatory and anti-arthritis, etc. It is a very important ingredient of several Ayurvedic formulations, especially Dashmool.

The opioid receptors play a pivotal role in the treatment of several neuropsychiatric and neurological disorders. Here, we performed activity-



guided isolation of compounds for opioid receptor modulator activity. We evaluated the bioactivity of hydroalcoholic extract, enriched fractions, and the isolated compounds from *O. indicum* stem bark by measuring the effect of compounds on the reversal of agonist-mediated cAMP inhibition in transiently transfected HEK293T cells with KOR, MOR, or DOR. The crude hydro-alcoholic extract of *O. indicum* stem bark on KOR and found potent antagonist activity. Hence, to determine the constituents present in the extract that are responsible for the KOR antagonist activity of the crude extract, we first performed polarity-guided fractionation of the hydroalcoholic extract in subfractions F1, F2, F3, and F4 and then again determined the enrichment or loss of KOR antagonist activity by using these fractions. We found that the *n*-butanol fraction (F3) possesses the KOR antagonist activity, while other fractions did not exhibit any opioid receptor modulation activity. The active fraction yielded four flavonoid classes of compounds: Oroxylin A (1), Chrysin (2), Baicalein (3), and Hispidulin (4).

Out of all four compounds, three were found to have antagonistic effects on MOR and KOR with varying EC₅₀.

Among all three active constituents, compound 3 has shown the highest E_{max} at the MOR and KOR, but EC₅₀ was found to be in the range of 1-5 μM. Compound 3 showed significant inverse agonist activity at both MOR and KOR as the cAMP level increased than forskolin alone.

To further determine the compound 3 crosses, the blood-brain barrier and exhibit *in vivo* activity,

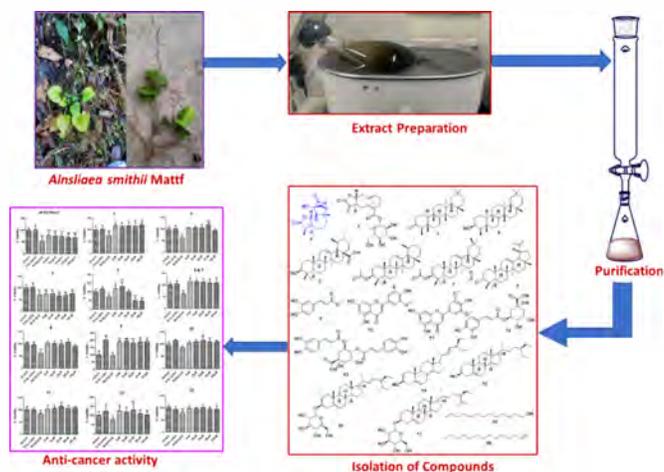
we evaluated the anti-analgesic effect of the most efficacious compound **3** at 20mg/kg dose in mice using the Hargreaves method that measures heat-induced nociception. We measured the antinociceptive effect of MOR agonist morphine and KOR agonist U50488 for 90 minutes after single dosing via the intraperitoneal route. An acute dose of morphine (10 mg/kg, s.c.) increases paw withdrawal latency time from 5 seconds to the maximum 15.7 seconds in a time-dependent manner. An acute dose of **3** (20mg/kg, *i.p.*) as well as naloxone (20mg/kg, *i.p.*) blocks the morphine-induced antinociceptive effects, which is reflected in the paw withdrawal latency decrease to 8.3s and 9.6s, respectively. Similarly, an acute dose of KOR agonist U50488 (5mg/kg, *i.p.*) also increased the paw withdrawal latency from 5 seconds to 16.9s at 15 minutes and stayed the same till 90 minutes, suggesting a lasting antinociceptive response by the KOR agonist. The compound **3** and the KOR-selective antagonist norBNI significantly blocked the U50488-induced antinociception. Notably, the paw withdrawal latency decreased from 16.9 to 8.8s and 9.4s by compound **3** and norBNI, respectively. As expected, there was no effect of compound **3** alone in the Hargreaves test. These results indicate that baicalein (**3**) isolated from *O. indicum* stem bark acts as a dual MOR and KOR antagonist. The *in silico* studies also supported our study that compound **3** binds with MOR and KOR. These results highlight the antinociceptive mechanism of *O. indicum* extracts and formulations. Furthermore, our data indicates that baicalein (**3**) could be used as the template for further synthesis of novel and selective opioid receptor modulators [Natural Product Research, 2024].

Isolation of a new sesquiterpene lactone from *Ainsliaea smithii* and cytotoxic activity against the A549 cancer cell line

Ainsliaea smithii Matff is a pseudo-shrub belonging to the genus *Ainsliaea* and the Compositae family. The genus *Ainsliaea* contains about 70 species. Majorly, they are distributed in South Asia; however, some of

them are Indigenous to India and distributed in the eastern to the western regions of the Sub-Himalayas. The *Ainsliaea* species have been reported to be used as traditional medicine by the North Indian population for gastric and several other problems. It has also been documented in traditional Chinese medicine to treat various diseases. Previous phytochemical investigations of the genus led to the isolation of sesquiterpenoids, triterpenoids, and phenolics with diverse biological activities like anti-inflammatory, cytotoxicity, and NO production activity.

In the current study, we have carried out an extensive phytochemical study on the whole plant of *A. smithii*, which is the first report for the isolation and characterisation of compounds from this species. The extensive phytochemical investigation led to the isolation of a new sesquiterpene lactone ainslialide (**1**), and eighteen (**2-19**) known compounds were isolated from aq. methanolic extract of *Ainsliaea smithii*. All the isolated compounds were structurally characterised by analysis of spectroscopic data (1D and 2D NMR, and HR-ESI-MS) and comparison with previously reported literature for known compounds. Compounds (**2-13**) and aq. methanolic extract were evaluated for its cytotoxic activity against the A549 cancer cell line. Compounds **4** (*epi*-friedelanol), **5** (ursolic acid) and aq. methanolic extract showed activity against A549 with an IC_{50} 0.44, 51.25 μ M, and 31.86 μ g/ml, respectively [Natural Product Research, 2025].





Dr. Kapil Dev & his team

Dr. V S Pragadheesh डॉ. वी एस प्रगाधीश

Comprehensive analysis of the chemical compositions, chiral profile, and physical properties of *Myristica fragrans* fruit essential oils and oleoresins



The fruit of *Myristica fragrans* produces two valuable spices: nutmeg (seed) and mace (aril), which are used worldwide for their distinct flavour and therapeutic properties. Essential oils (EO) and oleoresins were obtained by hydro-distillation and maceration, respectively, from the rind, mace, seed coat, and seed of *M. fragrans* fruits and the compositional variation was studied using GC and GC-MS. The enantiomeric distribution of compounds in the EO and oleoresins was investigated by enantioselective GC with the 2,3-diethyl-6-*tert*-butyldimethylsilyl- β -cyclodextrin capillary column. Distinct chemical profiles across different fruit parts of *M. fragrans* were observed, with sabinene as the major compound in seed and mace EO, terpinen-4-ol in rind EO and myristic acid in the seed coat EO. Interestingly, myristicin was observed as the major compound in rind and mace oleoresins. This is the first report on the comparative chiral GC analysis of different parts of *M. fragrans* fruits. Results showed that (+)-enantiomers of α -thujene, sabinene, and β -phellandrene were significantly abundant in all the analysed EO and oleoresins. Physical properties of the EO, *viz.*, optical rotation, specific gravity, and refractive index, were

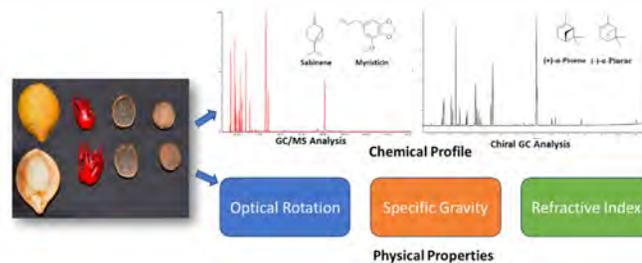


Fig.: Chemical compositions, physical properties and chiral Profile of *Myristica fragrans* essential oil.

also reported. This study on compositional variation, enantiomeric distribution and physical properties could be helpful in the authentication of *M. fragrans* essential oils and to identify the potential applications in the pharmaceutical and food industries.

Chemical variation and post-harvest processing of *Clerodendrum phlomidis* L.f. essential oils from different locations in southern India

Clerodendrum phlomidis L.f. is a medicinal shrub found across dry terrains in tropical or sub-tropical regions. Essential oils (EO) from four different accessions at separate locations in southern India were extracted by hydro-distillation. GC and GC-MS analyses of the EO showed (*E*)-caryophyllene as the major compound in all the samples, ranging from 26.42 to 53.41%. α -Humulene, linalool, phytol, and caryophyllene oxide were the other major compounds found in the EO of *C. phlomidis*. Post-harvest processing of *C. phlomidis* was optimized at different shade drying

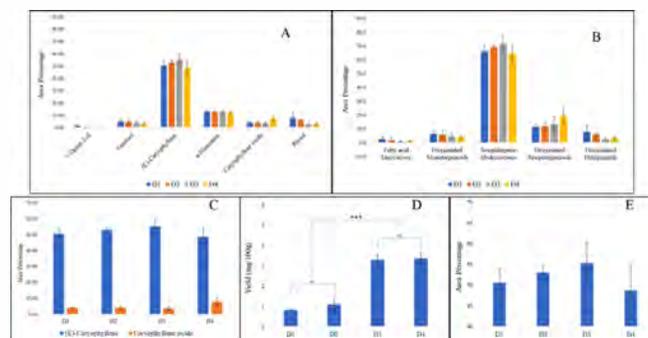


Fig.: The effect of shade drying on (A) percentage of the major compounds, (B) different types of volatile compounds, (C) percentage of (*E*)-caryophyllene and caryophyllene oxide, (D) yield of EO of CpC and (E) percentage of (*E*)-caryophyllene in the EO of CpC. *** $p < 0.0001$, ns- not significant.

Phytochemistry

duration to study the EO yield and percentage of (*E*)-caryophyllene. Seven days of shade drying provides maximum yield of EO and (*E*)-caryophyllene content. The major compound, (*E*)-caryophyllene, was also confirmed by NMR analysis of the essential oil. (*E*)-Caryophyllene is a plant secondary metabolite with several biological properties, and this is the first report on the chemical composition of the (*E*)-caryophyllene-rich chemotype of *C. phlomidis*.



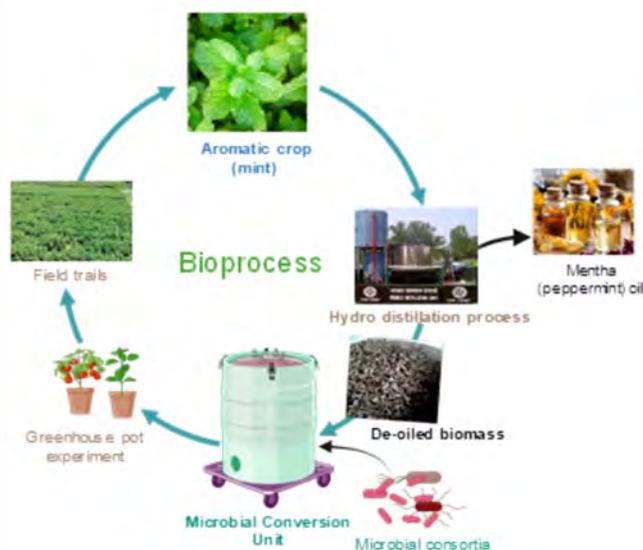
Dr. VS Pragadheesh & his team

Dr. Sanjeet Mehariya डॉ. संजीत मेहरिया

Utilization of hydro-distillation waste of aromatic crops for the production of bio-stimulation



India is one of the leading producers and exporters of peppermint (*Mentha*) oil, contributing 80% of total *Mentha* oil production, globally, with 35,150 tonnes of *Mentha* oil produced from 348,680 hectares of area under *Mentha* cultivation. According to a study by Fortune, the global peppermint oil market is valued at around USD 482.9 million (2024) and is projected to grow at a compound annual growth rate (CAGR) of 9.4%; it is expected to reach USD 994.1 million by 2032. Moreover, during the extraction of *Mentha* oil by the water-distillation process, about 98% the solid biomass (3.4 MT/year) is spent, and a considerable amount of spent water (hydrosol and wastewater) is generated, which is dumped in the fields, reducing soil fertility and affecting soil microbes. Therefore, our group is focusing on the utilisation of the residual biomass as



feedstock for fertilisers or bio-stimulant production by various native microorganisms. Considering these wastes as feedstock for bio-stimulant production can provide a low-cost, environmentally sustainable alternative to chemical fertilisers, which will help *Mentha*-producing farmers to become self-sufficient for bio-stimulant production.

The following are the environmental and economic benefits of using hydro-distillation waste for bio-stimulant production:

- Generating additional sources of income for farmers and distillers.
- Promoting sustainable agriculture by reducing the use of chemical fertilizers.
- Integrating bio-fertilizer production with distillation units, thereby creating rural employment.



Dr. Sanjeet Mehariya & his team

Bio-Prospection & Product Development

HIGHLIGHTS

The Bio-Prospection & Product Development Division is actively involved in the pharmacological evaluation of plant leads, their molecular mechanisms, and the development of standardized herbal formulations for human and animal health in AYUSH, Phytopharmaceutical, Nutraceutical, and Cosmeceutical modes, employing *in silico*, *in vitro*, and *in vivo* studies. Focus areas include Psoriasis, pain and inflammation, Cardiovascular diseases, Diabetes, liver diseases, cancer, Immunopharmacology, Infectious diseases, Toxicity studies, Nanomedicine, and drug delivery of bioactives from medicinal and aromatic plants.

Promising compounds are subsequently subjected to comprehensive mechanistic investigations employing a wide array of experimental approaches to elucidate their mode of action and identify cellular targets. To ensure translational relevance and safety, lead formulations are further validated through *in vivo* toxicity studies, thereby integrating efficacy, mechanism, and biosafety into a coherent pipeline suitable for therapeutic and topical applications.

Finally, suitable herbal formulations are developed and subjected to chemical characterization, safety evaluations and stability studies for shelf life.

Core R&D Facilities:

Central Animal House (CAH) facility: CAH facility establishment is registered with Committee for Control and Supervision of Experiments on Animals (CCSEA), Ministry of Fisheries, Animal Husbandry and Dairying (MoFAH & D), Government of India (Registration no: 400/GO/ReBi/01/CCSEA). CAH facility provides high-quality, ethically-maintained laboratory animals (mice, rats, rabbits) for biomedical research related to Medicinal and Aromatic Plants (MAPs)-derived leads. CAH facility ensuring the proper housing, health monitoring, breeding, and experiments on small animals under the supervision of veterinarians and an Institutional Animal Ethics Committee (IAEC).

Herbal Medicinal Product Facility: HMP Facility is equipped with the set-up and instruments required for lab-scale preparation of various pharmaceutical formulations including cream, gel, syrup, suspension, emulsion, granules, tablets, capsules and liquid preparations. This facility is also enriched with high speed homogenizer, laboratory reactor, various stirrers, particle size analyser, sonicator and rotary evaporator required for preparation of nano-formulations.



Scientists of Bio-prospection and Product Development Division

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



R&D Output:

Plant leads:

During the year (2024-2025), significant progress was achieved in establishing advanced multi-target therapeutic strategies addressing both cancer and infectious diseases. Asiatic acid was identified as a potent inhibitor of non-small cell lung cancer (NSCLC), where it effectively suppressed COX-2-mediated PI3K/AKT/mTOR signaling. In another study, 3,5,7-trihydroxy-2-phenylchromen-4-one (THF) exhibited robust anticancer efficacy in both lung and skin cancer models. THF exerted its effects through inhibition of 5-lipoxygenase (5-LOX), induction of oxidative stress, cell cycle arrest, and significant tumor suppression in *in vivo* models.

Our research also advanced the understanding of molecular regulators in cancer biology. Comprehensive investigations highlighted the therapeutic potential of microRNAs and phytochemicals in modulating miRNA-mediated regulatory networks during carcinogenesis. Complementing this, diosmetin, a dietary flavone, emerged as a promising modulator of multiple oncogenic signaling pathways implicated in cancer progression.

Palmarosa essential oil demonstrated strong antimicrobial activity against dandruff-associated pathogens by elevating intracellular reactive oxygen species (ROS) levels and modulating microbial efflux pump mechanisms, thereby inhibiting microbial growth and survival.

Naringin and chloroquine combination was found a promising drug-like candidate effective to mitigate the chloroquine-resistant parasite-induced malaria pathogenesis by attenuating the inflammatory response. Dehydroepiandrosterone (DHEA), a circulating steroid hormone precursor, produced potent vasorelaxation in rat aorta and mesenteric arteries through blockade of L-type voltage-dependent calcium channels.

Other studies established Vindoline as a key component of *Catharanthus roseus* leaf juice extract prepared through an Ayurveda-based method for ameliorating insulin-resistant type 2 diabetes and neuroinflammation and acetylcholinesterase inhibition potentials of acyclic monoterpenoids

isolated from *Cymbopogon distans* (Nees ex Steud.) Will. Watson.

Technology/Product Development:

In a significant scientific breakthrough, an innovative, eco-friendly solution to combat mosquito-borne diseases was developed. The new technology uses biodegradable polymer beads entrapping food grade essential oil to eliminate mosquito larvae from stagnant water sources, offering a safer and sustainable alternative to conventional chemical larvicides. CSIR-CIMAP filed the patent of the technology in India, the USA, Brazil, South Africa, and published the study in an international journal. This technology is also licensed to the industry for commercialization.

In another technology, we explored enzyme-based nanomaterial synthesis as a sustainable, eco-friendly, and green approach for developing functional nanomaterials with biomedical applications. This strategy aligns with our efforts to design innovative nanoformulations, exemplified by the vetiver root cellulose nanofiber-based Amphotericin B system, which enhanced antifungal efficacy while ensuring sustained drug release and reduced toxicity.

Other Important Output:

The Bio-Prospection & Product Development Division has published 15 articles, filed 3 patents, and is working on 5 different mission projects. The division has 04 ongoing GAP/CNP/SSP projects. The total number of Ph. D. students in the division are 30, and 05 students have been awarded Ph. D. in the year 2024-25.

Dr. Suaib Luqman, Senior Principal Scientist featured in the list of top 2% Most Influential Scientists (Single Year) in 2024 by Stanford University.

Dr. D.U. Bawankule and Dr. N. P. Yadav conducted training programs for skill development, namely (1) Residential training on "Pre-Clinical Development of Medicinal and Aromatic Plant-based Leads", (2) 5-day training Program (residential) on Herbal Drug Development Technologies.

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

Dr. D. Saikia डॉ. डी. सैकिया

In Vivo Studies on Coumarinolignoid Cliv-92 for its Effect on Rifampicin-Induced Hepatic Damage



Drug-induced hepatotoxicity is a major concern and is caused by all classes of medications, indicating a key area of research. Antitubercular drugs have a beneficial effect but cause hepatotoxicity on prolonged use.

The present work was aimed to investigate the role of rifampicin-induced hepatic damage and the effect of Cliv-92 on rifampicin-induced alteration in rats.

Male Wistar Rats were administered with rifampicin, Cliv-92, and Silymarin (standard drug) orally in 0.5% carboxymethyl cellulose (CMC) suspension, in doses of 100 mg/kg, once daily for fourteen days, one hour before the administration of rifampicin. Control animals were treated with 0.5% CMC. On the 14th

day, 1hr after the last drug administration, tissue was collected, homogenized, and various parameters, viz. SOD, CAT, GPX, and cytochromes, were estimated from rat liver supernatant and compared with the control group. Blood serum parameters were also measured. Simultaneously, antioxidant activity and *in silico* studies were performed. The constituent isoforms of Cliv-92 and Silymarin and their metabolites were analyzed for different pharmacokinetic characteristics. Silymarin was used as a standard drug.

The result of the study suggests that the hepatoprotective potential of Cliv-92 is due to its antioxidant property and inhibitory effect on hepatoproteins, cytochromes (CPY450). An *in-silico* finding validates the safety profile of Cliv-92, its metabolites, and the standard drug silymarin and also explains that the drug is non-mutagenic.

Conclusion: The result of this study indicated that both Cliv-92 and silymarin could be used to avoid drug-induced overload and hepatic damage.

Table : Effect of Cliv-92 (100 mg/kg) and Silymarin (100 mg/kg) on antitubercular drug Rifampicin (100 mg/kg) induced hepatotoxicity in mice.

Treatment Group	SOD (U/ml)	GPX (nmol/min/ml)	Catalase (nmol/min/ml)
Control	34.95±0.74	130.91±0.001	447.31±15.40
Rifampicin	27.80*±2.81	77.08*±0.012	304.40*±13.28
Rifampicin+Cliv-92	33.58#±03.93	125.98 ^a ±0.005	428.45**±57.10
Rifampicin+Silymarin	31.78**±0.74	126.49 ^a ±0.002	436.15**±27.09
Cliv-92	32.38#±01.27	118.85 ^a ±0.007	379.04±06.10
Silymarin	33.72#±03.44	115.51 ^a ±0.005	384.35±13.54

N=6, values are mean±SEM, '*' exhibit significant (p<0.001) changes from control, '#' exhibit significant (p<0.01), '^a' (p<0.001) and '**' changes (p<0.05) in compared to rifampicin.

Table . Effect of Cliv-92 (100 mg/kg) and Silymarin (100 mg/kg) on antitubercular drug Rifampicin (100 mg/kg) on biochemical parameters.

Markers	Control	Rifampicin	Rifampicin+Cliv-92	Rifampicin+Silymarin
SGOT (U/L)	22.55±01.76	35.61**±01.95	23.39#±03.43	24.73#±03.50
SGPT (U/L)	24.09±05.16	35.50**±06.55	28.51#±04.99	25.89#±03.64
ALKP (U/L)	104.02±18.80	151.48*±07.59	118.03#±06.89	112.23#±05.42
Haemoglobin (g/dl)	12.87±0.321	12.83±0.379	12.90±0.469	13.88±01.19

Triglycerides (mg/dl)	181.83±35.47	157.933±18.16	190.393±28.75	177.43±055.70
Total Protein (g/dl)	13.70±01.11	12.77±0.362	11.716±02.43	12.58±01.26
Creatinine (mg/dl)	02.26±0.399	01.44±0.528	0.933±0.266	01.06±0.266
Total Bilirubin(mg/dl)	0.184±0.059	0.346*±0.022	0.295±0.032	0.247±0.048
Cholestrol (mg/dl)	124.32±11.05	114.56±03.08	143.135±4.87	122.92±13.36
Direct Bilirubin (mg/dl)	0.152±0.025	0.276**±0.014	0.236±0.016	0.252±0.021

N=6, values are mean±SEM, '**' exhibit significant (p<0.05), '***' (p<0.01), changes in comparison to control, '#' exhibit significant (p<0.05) changes in comparison to rifampicin.

Dr. Anirban Pal डा. अर्निबन पाल

Andrographis paniculata Ethanolic Extract Restores Gut Homeostasis by Modulating Inflammation and Immune Responses



Gut immunity is pivotal for overall health, as it maintains a delicate balance between tolerance to food antigens and the microbiota while providing defense against pathogens. Disruption of this balance by gut inflammation and infections leads to various diseases. *Andrographis paniculata*, a plant employed in traditional medicine, is recognized for its anti-inflammatory and immune-modulating properties, making it a strong candidate for addressing gut-related disorders. The manuscript investigates the therapeutic efficacy of ethanolic extract of *Andrographis paniculata* (ApEtOH), extracted from leaves and characterized by HPLC for bioactive compounds. The anti-inflammatory activity was assessed using a

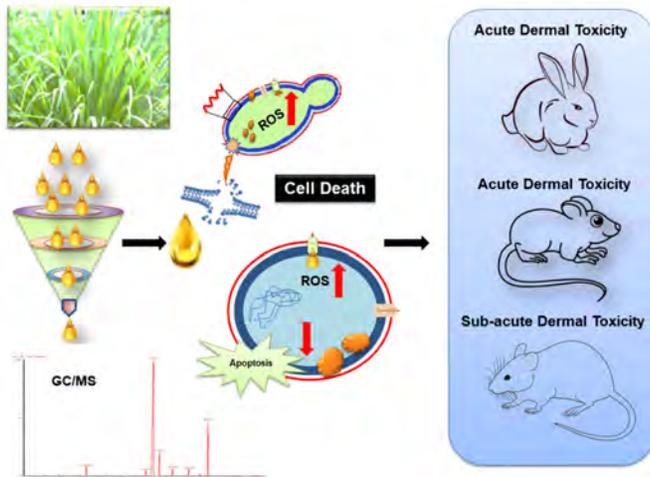
Caco-2/RAW264.7 co-culture inflammation model, and gene expression of chemokines was quantified in *Salmonella* Typhimurium-infected Caco-2 cells. In vivo studies in BALB/c mice treated with ApEtOH at various doses evaluated the impact on bacterial load, immune responses, and inflammation. The results revealed that ApEtOH significantly suppressed chemokines RANTES, MCP-1, and ENA-78 and reduced TNF- α and IL-6 in vitro. In vivo, ApEtOH lowered bacterial colonization in the spleen, decreased systemic infection markers, and restored intestinal equilibrium. ApEtOH also normalised IgA levels, elevated IgG, reduced TNF- α and IL-10, and promoted the expression of mucin (MUC-2) and lysozyme (LYZ-1), both essential for epithelial integrity and antimicrobial defence. Overall, ApEtOH demonstrates substantial therapeutic potential for gut health by minimising bacterial colonisation, modulating inflammation, and supporting both innate and adaptive immunity, establishing itself as a promising natural remedy for microbial-induced gastrointestinal disorders and restoration of gut homeostasis.



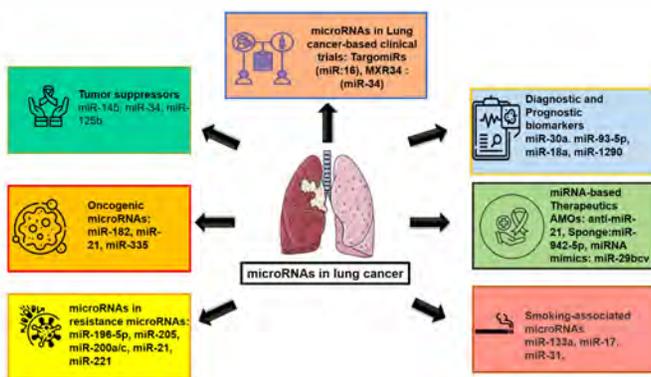
Dr. Anirban Pal & his team

Dr. Suaib Luqman डॉ. शोएब लुकमान

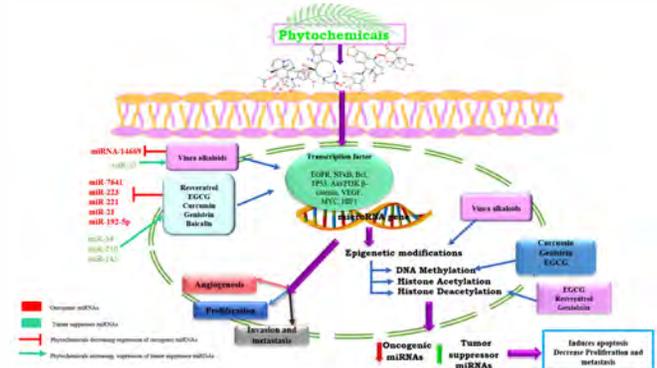
Palmarosa essential oil suppresses the growth of dandruff-related microbes by enhancing reactive oxygen species (ROS) production and regulating efflux pump activity (Microbial Pathogenesis, 2025)



MicroRNAs in Lung Oncogenesis: Diagnostic Biomarkers, Mechanisms of Drug Resistance, and Emerging Therapeutic Strategies (International Journal of Biological Macromolecules, 2025)



Therapeutic Potential of Phytochemicals and microRNAs in Regulating miRNA Expression During Carcinogenesis (Biochemical and Biophysical Research Communications, 2025)



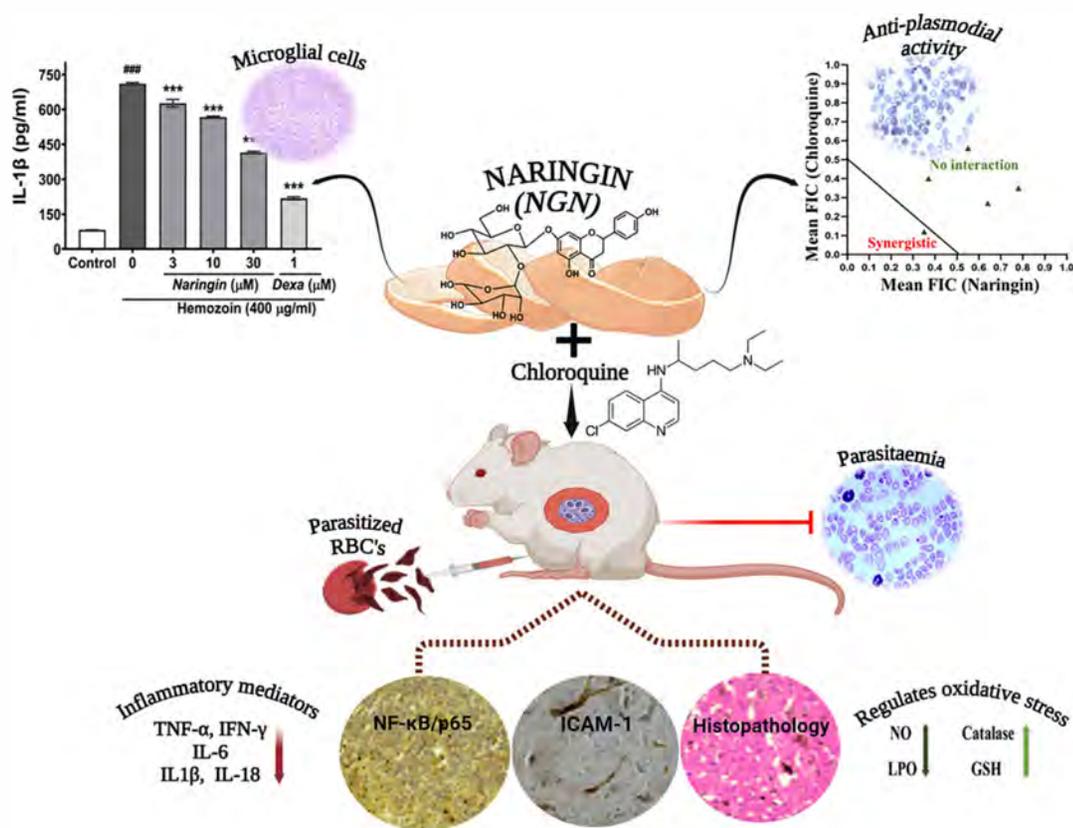
Dr. Suaib Luqman & his team

Dr. DU Bawankule डॉ. डी.यू. बावनकुले

Naringin and chloroquine combination mitigates chloroquine-resistant parasite-induced malaria pathogenesis by attenuating the inflammatory response



Malaria, characterised by inflammation and multi-organ complications, needs novel chemotherapeutics due to the rise of drug-resistant malaria parasites, which is a serious health issue. Naringin (NGN), a flavanone glycoside, has a broad spectrum of pharmacological activities; however, its effect against malaria, both alone and in combination, has not been thoroughly investigated. The purpose of this study was to assess the pharmacological efficacy of NGN alone and in combination with chloroquine (CQ) against a Plasmodium strain resistant to CQ and to elucidate its potential mode of action. Results of this study demonstrated that NGN alone and in combination with CQ displayed anti-plasmodial activity against the K1 strain of Plasmodium, a chloroquine-resistant laboratory strain of the Plasmodium falciparum parasite. NGN treatment also significantly reduced



mechanism study revealed that oral treatment of NGN alone and in combination with CQ significantly reduced the pro-inflammatory cytokines (TNF- α , IL-1 α , IL-18, IFN- α , and IL-6) when compared to vehicle-treated infected mice. This was supported by the overexpression of inflammation-regulatory genes (TGF β , Nrf2, HO-1, and iNOS) and the downregulation of inflammation-stimulating genes (NF- κ B, NLRP3, and caspase-1). Histopathological analysis also

the elevation of pro-inflammatory cytokines in synthetic hemozoin-stimulated microglial cells. Further, in-vivo anti-malarial efficacy study against the CQ-resistant *Plasmodium yoelii nigeriensis* N67 strain in mice demonstrated that oral treatment of NGN alone and in combination with CQ significantly reduced parasitemia in mice, resulting in a survival period of up to 13 days. The brain and liver tissues of experimental mice were used for molecular mechanism study with special emphasis on the inflammatory signalling pathway. Molecular

demonstrated the potential of NGN to restore liver and brain tissues to normal. The substantial decrease in the expression and production of ICAM-1 protein in the brain tissue implies the beneficial effects of NGN, pointing towards its potential for mitigating brain pathology. These findings suggest that the NGN is a promising drug-like candidate for the management of CQ-resistant parasite-induced malaria pathogenesis for adjunctive therapy in combination with standard antimalarial drugs.



Dr. DU Bawankule & his team

Dr. Daya Nandan Mani डॉ. दया नन्दन मणि

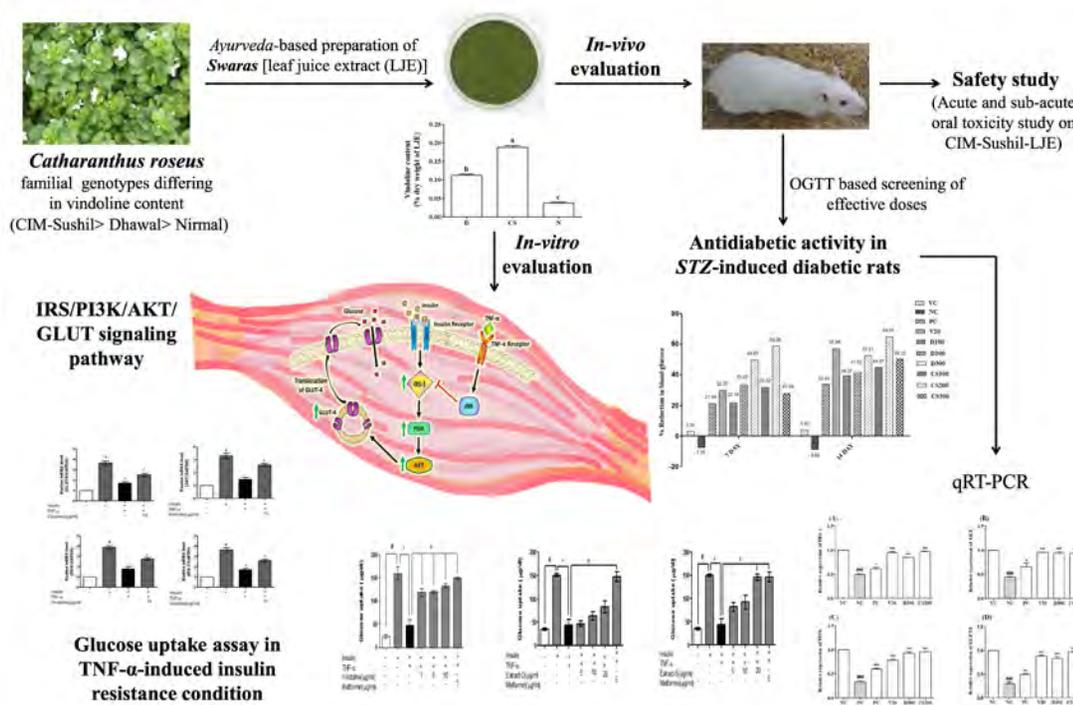
Vindoline is a key component of Catharanthus roseus leaf juice extract prepared



Catharanthus roseus leaves have been traditionally described to possess potent antidiabetic activity and

doses (D100, D200, D300, CS100, CS200, CS300) in streptozotocin-induced diabetic rats indicated highest blood glucose depletion in D300 (52.51%) and CS200 (64.55%) together with V20 (56.96%) on the 14th day. CS-LJE was found to be safe up to 2000 mg/kg BW. The role of LJE/vindoline in maintaining glucose homeostasis in liver was found to be mediated through the expression of insulin pathway genes (IRS-1, PI3K, AKT, GLUT2). TNF- α -induced insulin

resistance in L6 skeletal muscle cells was used to analyze the effect of LJE/vindoline through glucose uptake assay and expression analysis of insulin pathway genes (IRS-1, PI3K, AKT, GLUT4). The results indicated that the antidiabetic effect of LJE/ vindoline is mediated through activation of IRS/ PI3K/AKT/GLUT signaling pathway.



some leaf-specific alkaloids, including vindoline, have been studied for their antidiabetic potential. The aim of the present study was to validate the antidiabetic property of the plant with special reference to vindoline. An Ayurveda-based method was used to prepare the Swaras [leaf juice extract (LJE)] of three familial *C. roseus* genotypes differing in their vindoline content [CIM-Sushil (CS) > Dhawal (D) > Nirmal (N)]. In vivo experiments using LJE were performed in Charles Foster rats, whereby metformin (M100, 100 mg/kg BW) and vindoline (V20, 20 mg/kg BW) were used for comparison. OGTT-based screening for LJE doses (N100, N300, N500, D100, D200, D300, CS100, CS200, CS300 mg/kg BW) was carried out. Further analysis of the effective



Dr. Daya Nandan Mani & his team

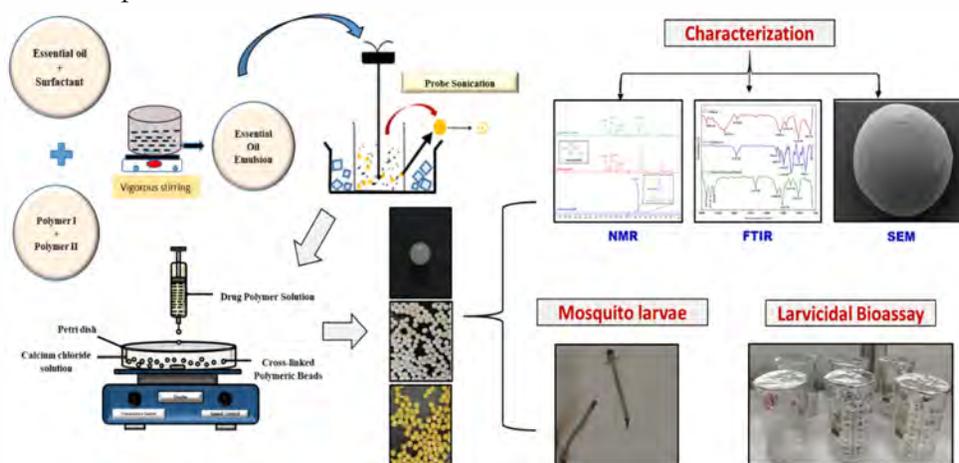
Dr. NP Yadav डॉ. एन.पी. यादव

Development of fennel oil loaded alginate polymeric beads for mosquito larvicidal activity



In the present work, alginate-HPMC polymeric beads containing fennel oil were prepared and evaluated for larvicidal activity against *Aedes aegypti*, *Anopheles stephensi*, and wild mosquito larvae.

This study was carried out by emulsifying fennel oil in an aqueous sodium alginate solution blended with HPMC and the fabrication of beads was then followed by an ionotropic gelation method using CaCl_2 as a cross-linker. The alginate emulsion was characterized based on the oil droplet size, polydispersity index, and viscosity. The prepared beads were characterized by NMR, FTIR and SEM for the



confirmation of fennel oil entrapment in alginate beads and surface topographical study. The beads were further evaluated for loading capacity and *in-vitro* drug release. The *in-vivo* larvicidal bioassay showed that the fennel oil-loaded alginate beads represented 100% mortality rate of *Aedes aegypti*, *Anopheles stephensi*, and wild mosquito larvae within 24 hours. These results depicted that the fennel oil-loaded alginate beads presented good entrapment efficiency, extended release, and suitable larvicidal activity. The developed product has been patented

in India, USA, Brazil and South Africa and the technology is licensed to Industry.



Dr. NP Yadav & his team

Dr. Debabrata Chanda डॉ. देबब्रत चंदा

Assessing deoiled plants biomass of lemongrass and palmarosa as novel feed resources under *in vitro* conditions



The feasibility of newer feed resources was explored for sustainable livestock production addressing food security, climate change, and greenhouse gas emissions concerns. The current study aimed to evaluate the nutritional value of lemongrass and palmarosa grass residues after their essential oils are extracted, which are otherwise discarded as wastes and contribute to environmental pollution. The study was undertaken as a joint collaborative research work between CSIR-CIMAP Lucknow and ICAR-NDRI Karnal. Chemical composition, *in vitro* gas production, *in vitro* dry matter degradability (IVDMD), *in vitro* organic matter degradability (IVOMD), and methane production parameters were analyzed for the graded levels of lemongrass and palmarosa grass residues replacing wheat straw up to 50% in the total mixed ration (TMR). *In vitro* total gas production, IVDMD, IVOMD, and

methane production did not differ among the graded inclusion levels of lemongrass residues. In case of palmarosa grass residues, IVOMD was highest at the 20% inclusion level however no significant changes were observed ($p > 0.05$). IVDMD and gas production did not differ among the treatments. Methane share was found to be lowest at the 50% inclusion level as compared to the other treatments but no discernible differences were observed ($p > 0.05$). The partitioning factor and microbial biomass production similar among the treatments. These results demonstrate that after the extraction of essential oils, the leftover biomass residues or spent grass can potentially be incorporated in the cattle feed, alleviating dry fodder shortages to some extent and may help achieve sustainability in the livestock production system and reduce its environmental impacts.

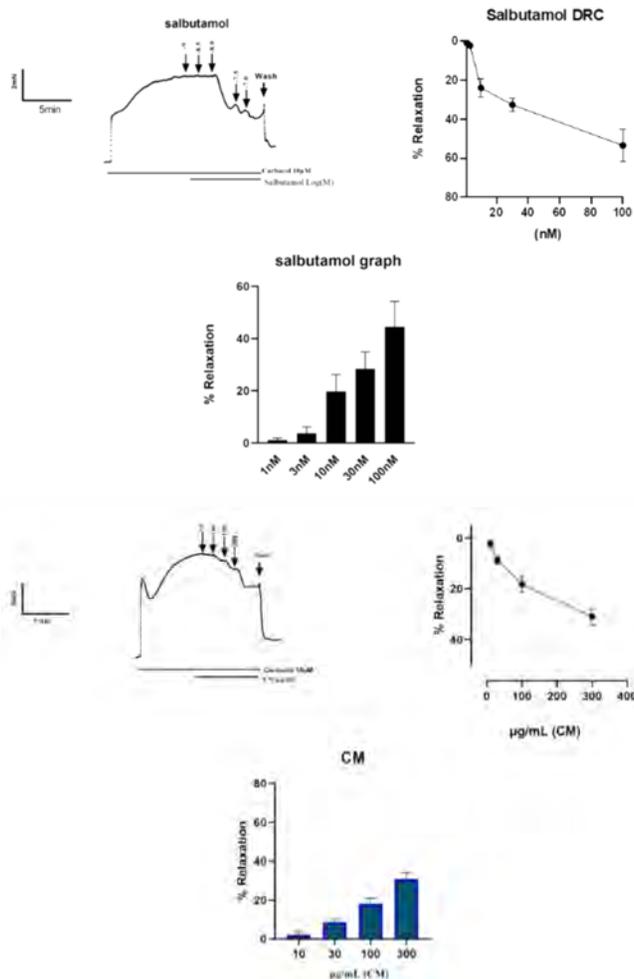
Bronchodilatory potential of novel medicinal lead *Capparis moonii* (CM) Wight in Swiss albino mice

Bioactive fraction from *Capparis moonii* (CM) Wight, commonly called Rudanti, in *ex-vivo* studies have demonstrated the concentration-dependent bronchodilation potential of on isolated murine bronchial ring tissue. The present study signifies

Table 1. Chemical composition of lemongrass and palmarosa grass residues in comparison to wheat straw

	Lemongrass residues		Palmarosa grass residues		Wheat straw
	L1	L2	P1	P2	
DM %	98.65 ^a ± 0.13	98.78 ^a ± 0.14	98.78 ^a ± 0.10	98.49 ^a ± 0.09	90.48 ^b ± 0.41
CP %	3.64 ± 0.74	3.50 ± 0.18	4.15 ± 0.13	4.72 ± 0.18	2.92 ± 0.09
EE %	1.88 ^{ab} ± 0.04	2.06 ^a ± 0.025	2.02 ^a ± 0.04	1.70 ^b ± 0.05	1.91 ^{ab} ± 0.09
NDF %	79.77 ^a ± 1.02	78.02 ^a ± 0.74	77.30 ^a ± 0.52	77.04 ^a ± 1.18	71.56 ^b ± 1.07
ADF %	39.90 ^b ± 0.52	46.71 ^a ± 1.12	48.66 ^a ± 1.18	47.07 ^a ± 1.31	42.75 ^{ab} ± 1.42
ADL %	8.45 ^{bc} ± 0.44	9.61 ^b ± 0.24	12.13 ^a ± 0.14	11.30 ^a ± 0.41	7.49 ^c ± 0.30
HC %	39.86 ^a ± 0.49	31.31 ^b ± 0.37	27.20 ^d ± 0.66	29.97 ^{bc} ± 0.33	28.81 ^{cd} ± 0.48
Cellulose%	38.31 ± 0.55	37.64 ± 1.32	38.53 ± 1.11	39.92 ± 1.03	38.50 ± 0.62
TA %	3.10 ± 0.43	5.73 ± 1.28	6.75 ± 0.54	6.14 ± 1.19	8.96 ± 0.16

DM = Dry matter; CP = Crude protein; EE = Ether extract; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; ADL = Acid detergent lignin; HC = Hemicellulose; TA = Total ash



traditional claim of their role in the management of respiratory.



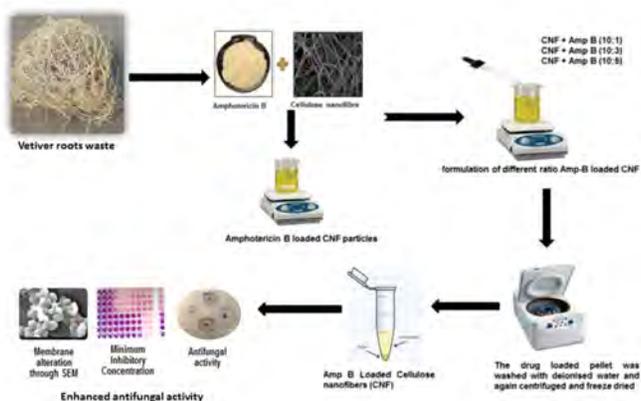
Dr. D. Chanda & his team

Dr. Abha Meena डॉ. आभा मीणा

Novel nanoformulation for enhanced amphotericin B efficacy and sustained release using vetiver root cellulose nanofibers against *Candida albicans*



The formidable antifungal agent, Amphotericin B, is well-known for its potency; however, its clinical application has been significantly limited due to toxicity and poor solubility. This study aims to address these challenges by developing and evaluating a novel nano-cellulose-based formulation of Amphotericin B to enhance its efficacy. Amphotericin B was encapsulated within cellulose nanofibers at varying ratios to optimize formulation parameters, including drug concentration, particle size, zeta potential, and entrapment efficiency. Notably, a composition ratio of 10:1 of cellulose nanofibers to Amphotericin B achieved an impressive encapsulation efficiency of 96.64%. Subsequent physicochemical characterizations employing techniques such as FTIR, DLS, XRD, and SEM provided insights into structural attributes and interactions within formulation. Controlled and extended-release profiles were observed at various physiological pH levels, with the Korsmeyer-Peppas model showing the highest correlation, indicating predominant drug diffusion. Importantly, nanoformulation demonstrated non-toxicity to A431 cells and human erythrocytes up to a maximum concentration of 20 µg/ml, as corroborated by MTT and hemolysis assays. Furthermore, antimicrobial susceptibility and efficacy assessments, conducted using agar disc diffusion and broth micro-dilution methods, revealed enhanced inhibition of *Candida albicans* growth. The nanoformulation produced a larger diameter of the inhibition zone (DIZ) of 19.66 mm compared to a DIZ of 16.33 mm for Amphotericin B alone. Impressively, the nanoformulation exhibited a minimum inhibitory concentration (MIC) of 25 µg/ml against *Candida albicans*, underscoring its heightened efficacy. Additionally, the formulation's

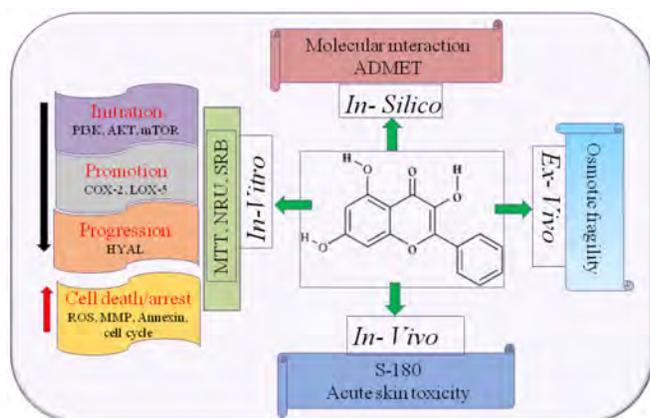


ability to improve the targetability and bioavailability of Amphotericin B holds promise for enhancing its antifungal effectiveness while reducing associated toxicity.

THF induce apoptosis by downregulating initiation, promotion and progression phase biomarkers in skin and lung carcinoma

3,5,7-Trihydroxy-2-phenylchromen-4-one (THF) possesses a diverse range of pharmacological activities. Evidence suggests that THF exerts anticancer activity by distinct mechanisms of action. This study explores the anticancer potential of THF in human lung (A549) and skin (A431) cancer cells by employing different antiproliferative assays. 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide, neutral red uptake, sulphorhodamine B, and cell motility assays were used to confirm the anticancer potential of

THF. Cell target-based and quantitative reverse transcription polymerase chain reaction (qRT-PCR) assays were used to explore the effect of THF on the initiation, promotion and progression phase biomarkers of carcinogenesis. THF suppresses the activity of lipoxygenase-5 up to ~40% in both A549 and A431 cells and up to ~50% hyaluronidase activity in A549 cells. qRT-PCR assay reveals that THF inhibits the activity of phosphatidylinositol-3 kinase/protein kinase B/mammalian target of rapamycin in both cell lines, which is responsible for the initiation of cancer. It also arrests the G2/M phase of the cell cycle in A431 cells and increases the sub-diploid population in both A549 and A431 cell lines which leads to cell death. Annexin V-FITC assay confirmed that THF induces apoptosis and necrosis in A431 and A549 cell lines. Further investigation revealed that THF not only enhances reactive oxygen species production but also modulates mitochondrial membrane potential in both cell lines. It significantly inhibits S-180 tumour formation at 5 and 10 mg/kg bw, *i.p.* dose. An acute skin toxicity study on mice showed that erythema and edema scores are within the acceptable range, besides acceptable drug-likeness properties and non-toxic effects on human erythrocytes. Conclusively, THF showed potent anticancer activity on skin and lung carcinoma cell lines, suppressed the level of the biomarkers and inhibited tumour growth in mice.



Dr. Abha Meena & her team

Dr. M. Gover Antoniraj डॉ. एम. गोवर एंटोनीराज

Synthesis and characterization of self-healing hydrogel

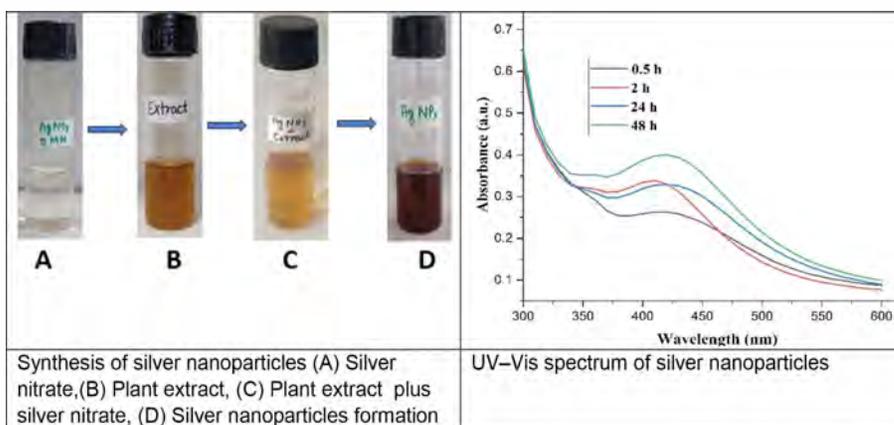


The derivatives of pectin and methoxy polyethylene glycol (mPEG) polymers can form a self-healing hydrogel, which can enhance the retention of phytomolecules at the disease site. Pectin conjugated with dopamine using carbodiimide & N-Hydroxy succinimide mediated acid-amine coupling reaction for enhanced adhesiveness in the physiological membranes, and substituted with hydrazine for self-healing linkage formation with aldehyde substituted polymers. Methoxy poly(ethylene glycol) was oxidised to an aldehyde derivative using Dess-Martin periodinane. The ^1H NMR spectrum reveals a peak corresponding to the methoxy protons of pectin at 3.6 ppm, as well as proton peaks for D-galacturonic acid at 4.1 ppm and 5.31 ppm. The pectin-hydrazide exhibited all the peaks characteristic of pectin, and the disappearance of the methoxy proton peak at 3.6 ppm indicates the conjugation of hydrazine to pectin. The NMR spectrum of dopamine-pectin-hydrazine shows an additional peak between 6.78-6.94 ppm, alongside the pectin-hydrazine peak, suggesting that dopamine has substituted into the pectin-hydrazine structure. Self-healing hydrogel with nanoemulsion cell line study is progressing, and based on the results, this delivery system will be evaluated for its effectiveness in treating diabetic wounds.

Plant extract-mediated synthesis of silver nanoparticles for antimicrobial activity

Green synthesis of metal nanoparticles in the presence of plant extracts (rich in bioactive compounds: flavonoids, terpenoids, phenolics, and essential oils) is a safer and reliable approach. The phytochemicals

can reduce metal ions to form nanostructures and stabilize these structures. *Cymbopogon flexuosus*-Neema (CFN) and *Cymbopogon pendulus*-Chirharit (CPC) mediated synthesized nanoparticles' were studied for antimicrobial activity. The result indicates that nanoparticle samples of 2, 24 & 48 h have higher microbial inhibition against *Escherichia coli*, *Candida albicans* & MRSA *Staphylococcus aureus* than silver nitrate. The minimum inhibitory concentration (MIC) analysis reveals nanoparticles possess better antimicrobial activity against *Candida albicans* (0.0031 mg/mL). CFN, CPC, and MC nanoparticles (MIC of 0.0625 mg/mL) show effective inhibition of Gram-positive bacteria *Staphylococcus aureus*.



Also, CFN, CPC nanoparticles effectively inhibited *L. monocytogenes* microbes. The antimicrobial assay indicates better inhibition activity of nanoparticles than silver nitrate, and further study is progressing to check the nanoparticles' extended applications in the effective treatment of microbial diseases.



Dr. M. Gover Antoniraj & his team

Plant Biotechnology

HIGHLIGHTS

The plant biotechnology group is working on improving the metabolite content and/or composition in various plants, characterization of genes for facilitating the production of high-on-demand Phyto-molecules from heterologous systems, development of plant varieties with better resistant

to biotic and abiotic stresses, and standardization of in-vitro regeneration and genetic transformation protocols for MAPs. Under CSIR mission project “genome editing for crop improvement” genome-edited plants of tomato, which reduces SGA content has been developed further genome edited tomato



Members of Plant Biotechnology Division

Upper Panel (L to R) : Dr. Pradipto Mukhopadhyay, Dr. Vikrant Gupta, Dr. Laiq-ur Rahman, Dr. Prabodh Kumar Trivedi, Mr. Basant Kumar Dubey, Dr. Ashutosh Kumar Shukla, Dr. Sanjeet Kumar Verma, Dr. Sumit Ghosh

Lower Panel (L to R) : Dr. Prema G. Vasudev, Dr. Sailendra Singh, Dr. Ashish Sharma, Dr. Isha Sharma, Dr. Swati Tyagi, Dr. Sunita Singh Dhawan, Ms. Pooja Singh and Dr. Rakesh Shukla

Individual Photographs: Dr. Dinesh A. Nagegowda, Dr. Venkat Rao DK, Dr. Muktinath Mishra and Neelam Prabha Negi



Plant Biotechnology

plants with improved flavonoid content are being developed. Under the same project genome edited plants for five MAPs are being developed to improve the yield of desirable phytomolecules. Putative genome-edited lines have been developed and are being analysed further. The scientists from the group have characterized many important genes such as CrPMEs and CrZIP for vindoline accumulation in *Catharanthus*, PsSAD from *Papaver somniferum*, *Ocimum* UGTs for 7-O glycosylation of apigenin, and CYPs and UGTs for triterpenoid biosynthesis in *Terminalia arjuna*. The scientists of the group have also done genetic engineering to improve bacoside content in *Bacopa monnieri*. The scientists are also involved in the development of fungal resistant and

chilling tolerant MAP varieties like *Palargonium graveolens* and *Ocimum* sp. using tissue culture and other molecular techniques. The group is also involved in genome sequencing of MAPs like *Cymbopogon flexuosus* in addition to identification of genes and peptides related to flowering trichome and root development and biosynthesis of important metabolites in various MAPs. During this period the group has published 21 publications with average impact factor of 3.8 and also involved in release of one plant variety. There were 04 CSIR projects and 13 GAP projects. Five students have received award for posters and oral presentation in the national and international conferences.

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

Dissecting miPEP858a: The C-Terminal Domain Unlocks miRNA Regulation and Flavonoid Biosynthesis



MicroRNAs (miRNAs) are central regulators of gene expression and are generally processed from primary transcripts (pri-miRNAs). Recent discoveries have revealed that certain pri-miRNAs also encode small peptides, termed miRNA-encoded peptides (miPEPs), which modulate miRNA activity. Despite their importance, the molecular mechanisms governing miPEP function, particularly the functional domains or critical amino acid residues, remain poorly understood. In this study, group demonstrate that the pri-miR858a-derived peptide, miPEP858a, directly interacts with the promoter of the *MIR858* gene in *Arabidopsis thaliana*. Importantly, group identified the C-terminal region of miPEP858a, consisting of 14 amino acids, as essential for its regulatory function. Using a combination of DNA-protein interaction assays, including yeast one-hybrid, chromatin immunoprecipitation (ChIP-qPCR), electrophoretic mobility shift assay (EMSA), and promoter-reporter analyses, group established

that miPEP858a binds to a specific region within the *MIR858* promoter. Exogenous application of a synthetic peptide corresponding to the C-terminal region was sufficient to enhance *MIR858* expression and induce phenotypic effects comparable to those observed with the full-length miPEP858a. Moreover, the truncated C-terminal peptide successfully complemented mutant plants lacking endogenous miPEP858a, confirming its role in regulating *MIR858* expression and downstream genes associated with flavonoid biosynthesis and plant development (Figure). Collectively, findings indicate that the full-length miPEP858a is not required for biological activity, and that the C-terminal region alone is sufficient to modulate miRNA expression. This research not only provides a framework for dissecting functional domains in other miPEPs but also highlights the potential of minimal synthetic peptides as cost-effective tools for improving agronomic traits in crop plants without reliance on complex biotechnological interventions.

From Light to Defence: SIHY5-Dependent Regulation of Anti-Nutritional and Protective Metabolites in Tomato

Tomato is one of the most widely consumed fruit crops worldwide, valued for its rich nutrient content and as a model for metabolic engineering. In addition to beneficial metabolites, tomatoes also produce cholesterol-derived steroidal glycoalkaloids (SGAs), which play important roles in pathogen defence but are toxic to humans and considered anti-nutritional compounds. Although several transcription factors have been implicated in regulating SGA biosynthesis, the influence of light and its associated regulators in this process remains unexplored in tomato. In this study, group demonstrate that SGA biosynthesis is regulated by light through the tomato ELONGATED HYPOCOTYL 5 homolog (SIHY5), which binds to light-responsive G-box elements in the promoters of structural and regulatory genes. Functional analysis revealed that SIHY5 complements *Arabidopsis thaliana* and *Nicotiana tabacum hy5* mutants at molecular, morphological, and biochemical levels. Using CRISPR/Cas9-generated knockout mutants

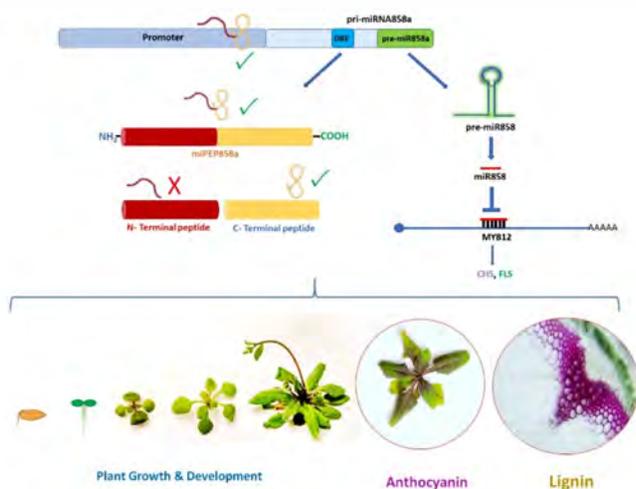


Fig.: Model of the study showing the C-terminus region of miPEP858a can enhance the expression of precursor and mature miR858a similar to full-length miPEP858a providing evidence regarding the importance of amino acids present at the C-terminus end.

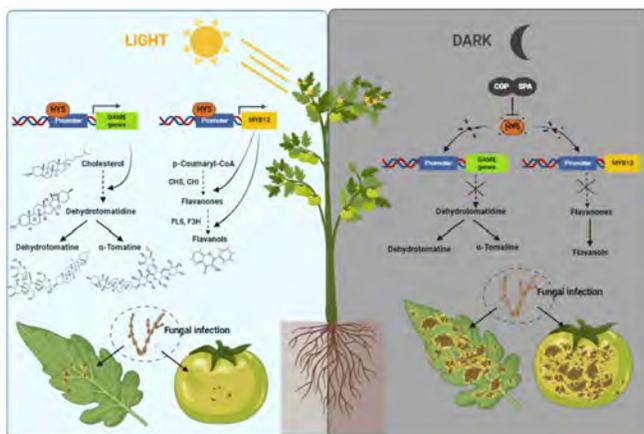


Fig.: Proposed working model showing the role of SIHY5 in SGA and flavonol accumulation and biotic stress resistance in tomato.

(*slhy5^{CR}*), study shows that disruption of SIHY5 leads to the down-regulation of SGA and phenylpropanoid pathway genes, resulting in a significant reduction in SGAs (α -tomatine and dehydrotomatine) and flavonol accumulation. In contrast, SIHY5 overexpression (*SIHY5OX*) plants exhibited elevated levels of these metabolites. Importantly, the enhanced accumulation of SGAs and flavonols in *SIHY5OX* lines conferred tolerance against *Alternaria solani*, whereas *slhy5^{CR}* mutants displayed increased susceptibility to infection. Together, these findings establish SIHY5 as a key regulator linking light signaling to the coordinated biosynthesis of SGAs and flavonoids, thereby contributing to biotic stress resistance in tomato (Figure).

HY5 Orchestrates the Crosstalk Between Primary and Secondary Metabolism in Tobacco

HY5 (ELONGATED HYPOCOTYL 5), a bZIP transcription factor, is a central regulator of light-mediated plant growth and physiology, with well-established roles in secondary metabolism. However, its influence on primary metabolic pathways, including photosynthesis and central carbon metabolism, remains poorly understood. In this study, group investigated the functional role of HY5 in *Nicotiana tabacum* using wild-type (WT), HY5-overexpressing (*NtHY5OX*), and CRISPR/Cas9-mediated HY5 knockout (*NtHY5^{CR}*) lines. Integrated

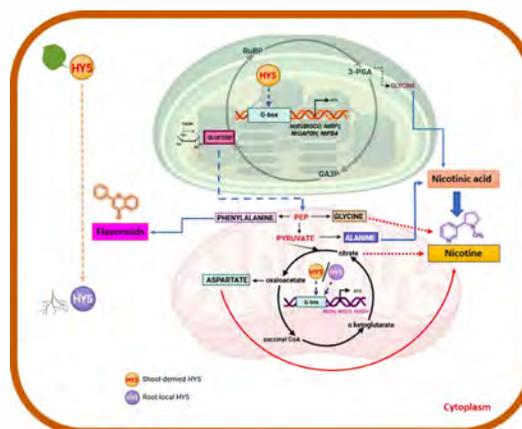


Fig.: The proposed working model illustrating the integrated cross talk between NtHY5 with primary metabolites in governing nicotine biosynthesis.

transcriptome profiling of leaves and roots, combined with LC/MS- and GC/MS-based metabolite analyses, revealed that *NtHY5OX* plants exhibited strong upregulation of genes associated with the Calvin cycle, tricarboxylic acid (TCA) cycle, flavonoid biosynthesis, and nicotine metabolism. Consistently, metabolite profiling indicated increased accumulation of amino acids, lipids, phenolic compounds, and organic acids, suggesting enhanced flux toward both primary and secondary metabolic pathways. In contrast, *NtHY5^{CR}* mutants showed downregulation of these pathways and reduced metabolite levels. KEGG pathway analysis further established a clear link between HY5 activity and the integration of central carbon metabolism with specialized metabolite biosynthesis. Collectively, these findings uncover a previously underappreciated role of HY5 in coordinating primary metabolic networks with secondary metabolism, providing new insights for targeted metabolic engineering of tobacco and other economically important crops.



Dr. Prabodh K. Trivedi & his team

Dr. Laiq-ur Rahman डॉ. लईक-उर-रहमान

Development of Resilient Somaclonal Variant of Geranium 'CIM-Sangam' with High Oil Yield and Low Citronellol: Geraniol Ratio for Cultivation in the North Indian Plains



Geranium (*Pelargonium graveolens*), a perennial and multi-harvest aromatic herb belonging to the Geraniaceae family, is renowned for its erect and branched growth habit. Its essential oil, prized for its therapeutic and commercial value, primarily contains citronellol and geraniol as major constituents, alongside several important minor compounds. Existing commercial varieties are inadequate in oil yield, stress resilience, and adaptation to the northern Indian plains, especially due to fungal susceptibility and post-rainy season propagule scarcity. To address these limitations, the somaclonal variation method was initiated at CSIR-CIMAP in 2020 using the CIMAP-24 (Chinese) line to develop genetically improved clone, CIMAP-K24, which was registered as the new variety 'CIM-Sangam' of *P. graveolens* for commercial application. The developed clone has superior agronomic traits, including strong stems, a high Leaf: Stem ratio of 2.46, oil content of 0.12%, abundant branching, and substantial biomass. The distinctive feature of the clone is enhanced tolerance to fungal infections and biotic stress, particularly during the rainy season, which leads to adaptation in the agro-climatic conditions of northern Indian plains. The developed variety has two main essential oil chemical constituents, Citronellol: Geraniol (C: G)



Fig.: Molecular Profile of CIM-Sangam



Fig.: View of CIM-Sangam

ratio (<2) to meet high oil quality for improved Indian economy. The minor constituents 6, 9-guaiadiene and 10-epi- γ -eudesmol are present in a concentration of 3.36% and 0.19%, respectively. Altogether, the clone can produce impressive oil yields of 65.0 kg/ha in the first harvest and 32.64 kg/ha in the second harvest. These features make CIM-Sangam a promising variety for sustainable geranium cultivation and essential oil production in the northern plains of India.



Dr. Laiq-ur-Rahman and his team

Dr. Dinesh A Nagegowda डॉ. दिनेश ए नागेगौड़ा

Specific ROP-GTPase regulatory proteins control anticancer alkaloid biosynthesis in *Catharanthus roseus*



Rho of plant (ROP)-GTPase regulatory proteins (RGRPs) are well studied for their roles in plant morphogenesis, development, and immunity; however, their involvement in specialized metabolism has remained unexplored. In this study, we demonstrate that specific RGRPs regulate monoterpene indole alkaloid (MIA) biosynthesis through interactions with distinct ROPs in Madagascar periwinkle (*Catharanthus roseus*). Among the five guanine nucleotide exchange factors (GEFs), four GTPase-activating proteins (GAPs), and two GDP dissociation inhibitors (GDIs) encoded by *C. roseus* genome, only CrGEF1, CrGAP1, and CrGDI2 showed specific interactions with CrROP3 and CrROP5. These RGRPs exhibited distinct cytosolic and/or membrane localization patterns, and their transcripts were predominantly expressed in aerial tissues. Functional analyses revealed that CrGEF1 positively regulates MIA biosynthesis, as its gene silencing resulted in reduced alkaloid accumulation, whereas overexpression enhanced it. By contrast, CrGAP1 and CrGDI2 act as negative regulators, as their silencing increased MIA levels while overexpression suppressed them. Interestingly, truncated forms of these RGRPs were still able to interact with CrROP3 or CrROP5 but failed to influence MIA production, highlighting the importance of their intact domains for regulatory function. Collectively, our findings uncover a regulatory mechanism in which distinct RGRPs coordinate with specific ROPs to modulate transcription factor activity and fine-tune MIA biosynthesis in *C. roseus*. The characterized genes function as master regulators of alkaloid biosynthesis in *C. roseus*, and hence could be utilized for crop improvement through metabolic engineering or genome editing.

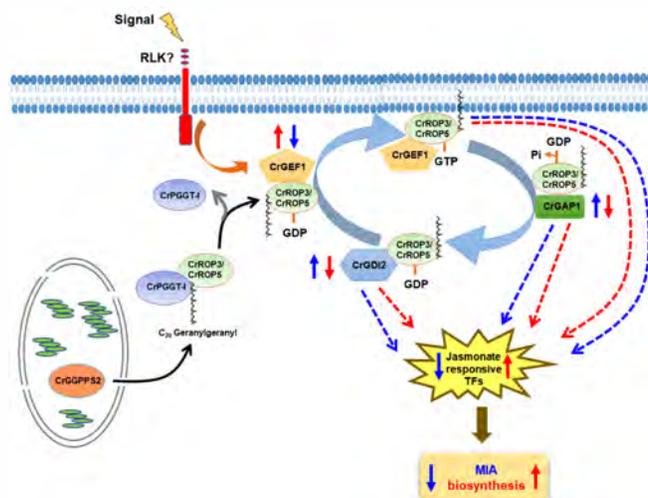


Fig.: Proposed model of ROP/RGRP-mediated modulation of MIA biosynthesis in *C. roseus*.

Distinct enzymatic routes for geraniol production: role of dual-localized geraniol synthase and cytosolic geranyl pyrophosphatase in lemongrass

Geraniol, a major constituent of many essential oils and precursor for geraniol-derived aldehydes and acetates, is produced in plants either through terpene synthase (geraniol synthase) or a non-canonical TPS-independent route involving a Nudix hydrolase and an unknown pyrophosphatase. Here, we identify a geraniol synthase (*Cymbopogon flexuosus* geraniol synthase; CfGES) that converts geranyl pyrophosphate (GPP) to geraniol, as well as a previously unreported geranylpyrophosphatase (CfG(P)Pase) that acts on both GPP and geranyl monophosphate (GP), albeit with different efficiencies, to generate geraniol. Virus-induced gene silencing of CfGES or CfG(P)Pase resulted in a substantial reduction in geraniol and its immediate product citral in lemongrass leaves. Conversely, transient overexpression of CfGES or CfG(P)Pase resulted in enhanced production of geraniol and citral in lemon balm (*Melissa officinalis*) leaves, as well as geraniol, citronellol, and citral in rose (*Rosa damascena*) flower petals. Subcellular localization studies revealed that

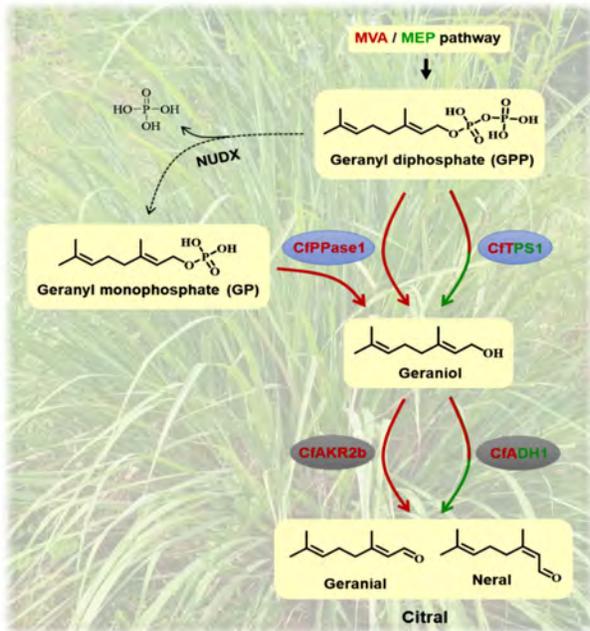


Fig.: Overview of geraniol formation required for citral biosynthesis in lemongrass.

while CfGES exhibited dual cytosolic/plastidial localization, CfG(P)Pase was localized to the cytosol. This localization pattern was further supported by the significantly higher geraniol-forming activity observed in the purified cytosolic protein fraction compared to the chloroplast fraction. Our study uncovers the missing step in cytosolic geraniol formation via a TPS-independent non-canonical route and demonstrates that geraniol, required for citral production in lemongrass, is synthesized by cytosolic CfG(P)Pase and cytosol-/plastid-localized CfGES. This knowledge has implications for crop improvement of aromatic grasses and metabolic engineering for production of geraniol-derived essential oils.



Dr. Dinesh A Nagegowda and his team

Dr. Vikrant Gupta डॉ. विक्रान्त गुप्ता

Investigations on biomass development-related gene homolog(s) in *Withania somnifera*



Withania somnifera L. (Ashwagandha) is known to produce withanolides (triterpenoid steroidal lactones) of economic and medicinal value. 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.

The T₃ transgenic tobacco lines ectopically expressing *W. somnifera WsSHR*, were subjected to biochemical analyses and compared with the control plants. The transgenic plants showed more lignin content as compared to the control plants. The enhanced lignin levels in tobacco overexpression lines suggest that the target gene may contribute to lignin biosynthesis by activating essential enzymes in the phenylpropanoid pathway. The proline content was also found to be significantly increased in all the transgenic tobacco lines when compared with wild-type control. The increased proline levels in the overexpression lines indicate that the target gene may play a role in pathways related to stress response. Proline is recognized as an osmoprotectant and a metabolite

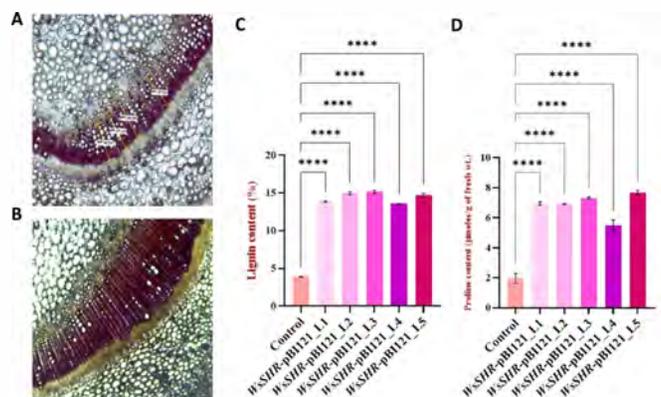


Fig.: Biochemical analyses of tobacco transgenic plants ectopically expressing *WsSHR*. (A) Lignin in WT control plant, (B) Lignin in transgenic tobacco line, (C) Lignin content assay, and (D) Proline content estimation

which is associated with stress, accumulating in plants under drought, salinity, and oxidative stress. Furthermore, there was a notable rise in glucose content in all the *WsSHR* expressing transgenic tobacco lines. It suggests that the overexpression of the target gene may improve carbon metabolism by enhancing sugar synthesis pathways or promoting the breakdown of cellulose and starch.

Artemisinin biosynthesis modulation by Genome Editing

To manipulate the artemisinin biosynthesis in *Artemisia annua*, few genes were previously identified that have common precursors or diverging points for diverse/different secondary compound(s) biosynthetic pathways. From these overlapping pathways, gene(s) including $\hat{\alpha}$ -caryophyllene synthase (*CPS/QHS1*), dihydroartemisinic aldehyde reductase (*RED1*) and lupeol synthase (*LS*) were selected as targets 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 containing specific sgRNAs (pKSE401 vector) for all the target genes (*AaQHS1*, *AaRED1* and *AaLS*) were independently transformed into *Artemisia annua* via *Agrobacterium*-

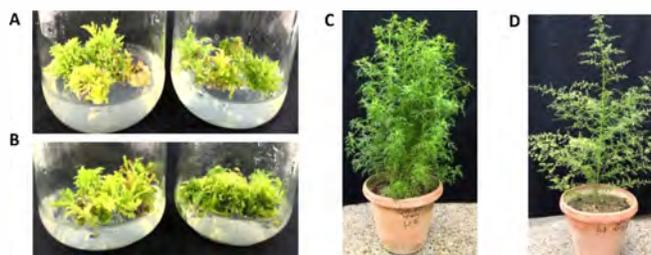


Fig.: Transformation and regeneration of *A. annua* using *pKSE401-AaQHS1* (A,C) and *pKSE401-AaRED1* (B,D) sgRNA construct. Picture of representative plants transferred to pots are shown

mediated *in vitro* transformation-regeneration protocol developed earlier in the laboratory. After transformation and regeneration, 11, 12, and 21 regenerated/elongated shoots (transformants) in the case of *pKSE401-AaQHS1*, *pKSE401-AaRED1*, and *pKSE401-AaLS*, respectively, were transferred to rooting media for root initiation. Out of them, 7, 1, and 1 rooted plantlet for *pKSE401-AaQHS1*, *pKSE401-AaRED1*, and *pKSE401-AaLS*, respectively, were transferred to pots and grown in glass house conditions. Confirmation of putative transgenics (transformants) through cas9-specific PCR is being carried out for confirming the insertion of the cassette in the plant genome. Subsequently, gene-specific PCR amplification and sequencing will be carried out for confirmation of genome-edited lines. Different stages of regeneration, rooting stage and plantlets in pots are shown in the pictures below.



Dr. Vikrant Gupta and his team

Dr. Sunita Singh Dhawan डॉ. सुनीता सिंह धवन

Genetic diversification and metabolite regulation of *Mentha spicata* to develop elite accession using biotechnological and genomics tools



Mentha spicata L. (spearmint) is a medicinally significant herb valued for its essential oil and presence of bioactive compounds Carvone and Limonene. Morphological traits were evaluated along with phytochemical profiles to assess variations induced by gamma irradiation. Trichomes, essential for the plant's essential oil were quantified and analyzed using Scanning Electron Microscopy (SEM). Gamma irradiation-induced variations in trichome density were observed. A significant advancement was achieved in the development and selection of elite accessions in *Mentha spicata* L. through gamma irradiation-induced mutagenesis. Various doses of gamma irradiation were applied to five varieties (NA, NK, MS, CM, and AK), and their germination responses were systematically recorded. To assess genetic polymorphism, SCoT (Start Codon Targeted) primers were employed. These molecular tools highlighted distinct genetic changes, underscoring the mutagenic effects of gamma radiation. Polymorphism analysis revealed a high level of genetic variability, which is essential for

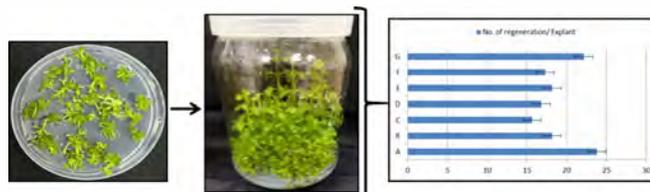


Fig.: Development of efficient regeneration protocols for *M. spicata* hybrid variety Neerkalka

selecting promising lines with improved agronomic and phytochemical traits. *In vitro* regeneration studies optimized growth hormone combinations and identified the most efficient regeneration media, particularly effective for the hybrid variety *Neerkalka*. Furthermore, SCOT (Start Codon Targeted) marker analysis was employed for molecular profiling of induced variants, providing insight into genomic alterations. Total 17 accessions were selected on the basis of yield potential (Herbage, Essential Oil Yield) All selections were in field trials along with check varieties for further analysis. This study serves as a foundation for further research into the genetic and morphological enhancement of aromatic plants through irradiation and molecular marker technologies.

Development and selection of elite accessions in *M. arvensis* L for enhanced yield traits

The investigations in *Mentha arvensis* L (Menthol Mint), with an aim to identify elite lines through comprehensive experimental evaluation integrating

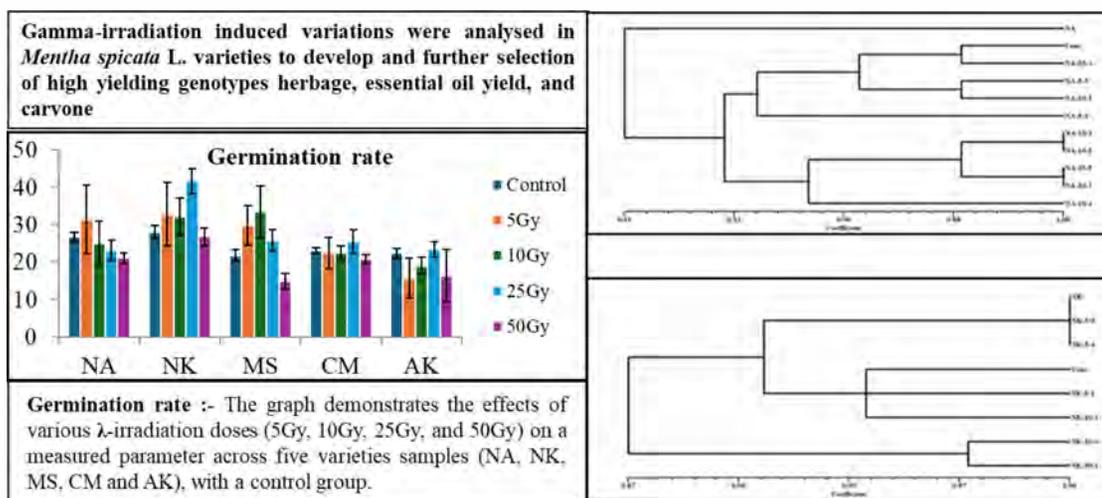


Fig.: Analysis of *Mentha spicata* accessions for germination and genetic relatedness by SCoT analysis

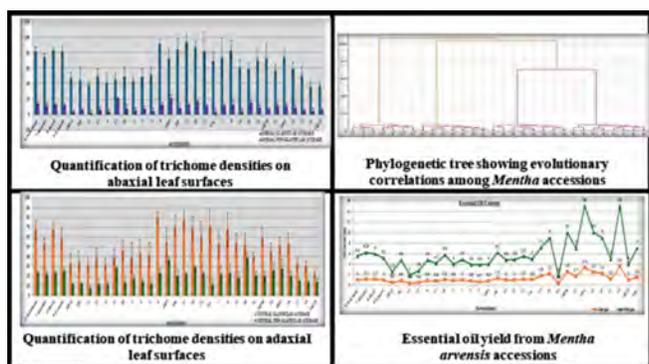


Fig.: Comprehensive evaluation for various selection parameters in *Mentha arvensis*



morphological, biochemical, and molecular markers. Trichome analysis was performed on both abaxial and adaxial leaf surfaces across multiple accessions. Quantitative assessments revealed significant variations in trichome density, which is an important

trait due to its strong correlation with essential oil biosynthesis. SEM was employed to visualize trichome architecture, comparing control and treated variants. Molecular profiling using SCOT primers was carried out to assess DNA polymorphism. The phylogenetic tree constructed from SCOT data further elucidated the evolutionary relationships and genetic divergence, providing insight into population structure and lineage segregation. Additionally, the oil yield from various accessions was systematically recorded, with certain lines exhibiting superior performance over standard varieties. These multi-dimensional evaluations culminated in the

identification and selection of four elite *Mentha arvensis* accessions. These genotypes demonstrated promising agronomic traits, enhanced oil yield, and desirable genetic characteristics, qualifying them for advanced field trials and potential commercial cultivation.



Dr. Sunita Singh Dhawan and her team

Dr. Sumit Ghosh डॉ. सुमित घोष

Identification and functional characterization of the cytochrome P450 enzymes involved in oleanane triterpenoid biosynthesis in arjuna tree



Triterpenoids, bearing a basic C30-isoprenoid skeleton, make a major group of natural products with various physiological functions in plants. Several triterpenoids and their derivatives were recognized as medicinal compounds due to diverse bioactivities. Arjuna [*Terminalia arjuna* (Roxburgh) Wight and Arnott] tree bark contains highly-oxygenated β -amyrin-derived oleanane triterpenoids such as arjunic acid, arjungenin, arjunolic acid, which have

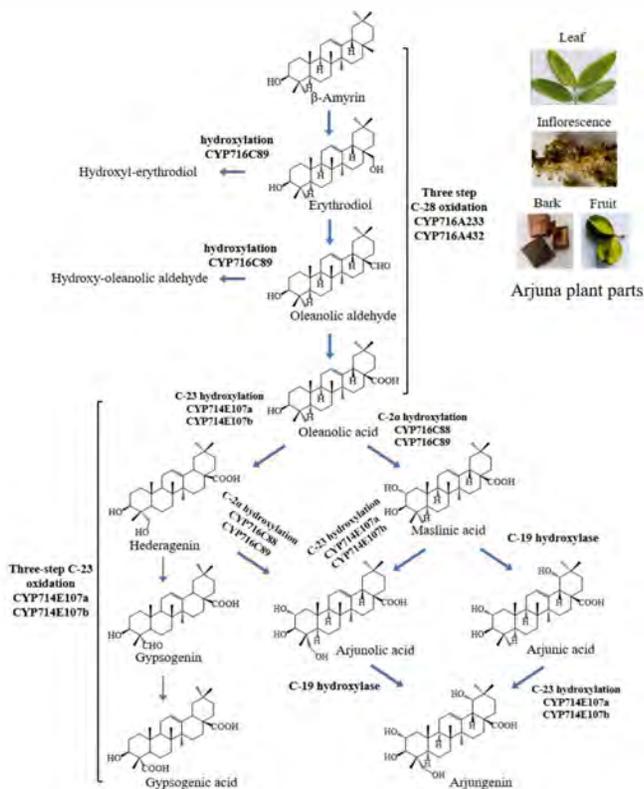


Fig.: The proposed roles of arjuna P450s in triterpenoid biosynthesis. The functions of P450s in triterpenoid pathway were proposed based on biochemical characterization of the enzymes in the present study. Thin arrows represent minor activity of the corresponding P450s.

shown cardioprotective roles. However, biosynthetic routes and enzymes of arjuna triterpenoids were not yet characterized. Earlier, our group identified and characterized a β -amyirin synthase (TaOSC1) of the arjuna triterpenoid pathway. However, the cytochrome P450 monooxygenases (P450s) catalyzing sequential C-2 α , C-19, C-23 and C-28 hydroxylation/oxidation of β -amyirin scaffold to form bioactive triterpenoids (e.g., arjunic acid, arjungenin and arjunolic acid) in arjuna were not yet identified and functionally characterized. Moreover, the sequential steps of β -amyirin hydroxylation/oxidation in the arjuna triterpenoid pathway were not yet established. In the present work, we have identified P450s and cognate cytochrome P450 reductases (CPRs) from arjuna transcriptome data. Furthermore, based on the results of *in vitro* and *in vivo* P450 assays and

triterpenoid pathway reconstruction in *Saccharomyces cerevisiae* and *Nicotiana benthamiana*, we confirmed the function of P450s in catalyzing C-2 α , C-23 and C-28 hydroxylation/oxidation of β -amyirin scaffold, and finally proposed the biosynthetic routes of medicinal triterpenoids found in arjuna bark.

In vitro and *in vivo* assays identified two each of C-28 oxidases (CYP716A233 and CYP716A432), C-2 α hydroxylases (CYP716C88 and CYP716C89), C-23 hydroxylases/oxidases (CYP714E107a and CYP714E107b) and cognate CPRs (TaCPR1-2), which catalyzed successive C-28, C-2 α and C-23 hydroxylation/oxidation of β -amyirin-derived oleanane scaffolds, leading to the formation of arjunolic acid and arjungenin. P450 activity using oleanane substrates found a greater substrate promiscuity of C-2 α and C-23 hydroxylases/oxidases than P450s having C-28 oxidase activity. CYP716A233 and CYP716A432 catalyzed β -amyirin/erythrodiol C-28 oxidation to form oleanolic acid. C-2 α hydroxylases (CYP716C88 and CYP716C89) converted oleanolic acid and hederagenin to maslinic acid and arjunolic acid, respectively. CYP716C89 also hydroxylated erythrodiol and oleanolic aldehyde. However, CYP714E107a and CYP714E107b catalyzed oleanolic acid/maslinic acid/arjunic acid C-23 hydroxylation to produce hederagenin, arjunolic acid and arjungenin, and hederagenin C-23 oxidation to form gypsogenin and gypsogenic acid, but at a decreased rate than oleanolic acid C-23 hydroxylation. Taken together, P450 substrate selectivity suggested that C-28 oxidation is the first P450-catalyzed oxidative modification in the arjuna triterpenoid biosynthetic pathway. However, the pathway might branch thereafter through C-2 α /C-23 hydroxylation of oleanolic acid. Moreover, triterpenoid pathway reconstruction in *S. cerevisiae* and *N. benthamiana* found the use of arjuna P450s in the heterologous production of cardioprotective compounds. Overall, these results provided new insights into the substrate range of P450s and established the biosynthetic routes of triterpenoids in arjuna (Plant Journal, 2024).



Dr. Sumit Ghosh & his team

Dr. Ashutosh K Shukla डॉ. आशुतोष कु. शुक्ला

Transcriptomic insight into zinc dependency of vindoline accumulation in *Catharanthus roseus* leaves: relevance and potential role of a *CrZIP*



The leaf-localized *Catharanthus roseus* alkaloid, vindoline, is the major impediment precursor in the production of scanty and expensive anticancer bisindoles, vinblastine and vincristine. Earlier studies have hinted toward the role of micronutrients in its accumulation. Here, the effect of various micronutrients on the leaf vindoline content was analyzed. Foliar application of zinc (Zn, 100 ppm) was found to be most effective for enhancing the vindoline content. Comparison of leaf samples of Zn-treated and control plants was performed using paired-end transcriptome sequencing and promising candidates among the differentially expressed genes were identified. A zinc-regulated, iron-regulated transporter-like proteins (ZIP) family member, which was found to be upregulated in Zn-treated samples, was taken up for functional characterization. Complementation of the *zrt1/zrt2* yeast mutant (ZHY3) by *CrZIP* suggested that it encodes a functional Zn transporter. VIGS and transient overexpression of *CrZIP* in *C. roseus* showed

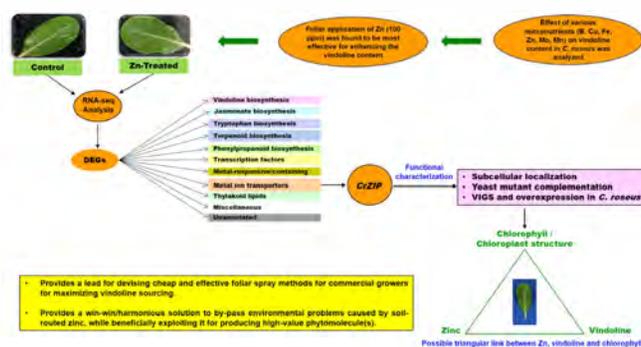


Fig.: Overview of the study.

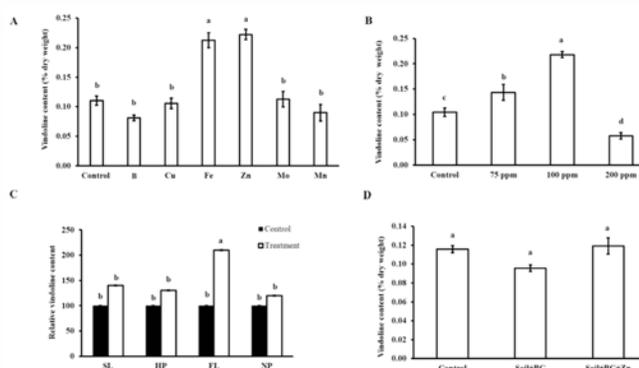


Fig.: Effect of micronutrients on vindoline accumulation in *Catharanthus roseus* leaves. **A** Effect of foliar application of various micronutrients (100 ppm) on vindoline content. **B** Effect of foliar application of different concentrations of Zn on the vindoline content. **C** Relative vindoline content under different modes of Zn treatment (100 ppm), whereby each treated sample is compared with its respective control. SL: soil treatment with Zn salt; HP: hydroponics treatment with Zn salt; FL: foliar spray treatment with Zn salt; NP: foliar spray treatment with ZnO nanoparticles. **D** Effect of biochar (BC) application (4% of soil) with Zn (100 ppm) through soil route.

a direct relationship between its expression and vindoline content. GFP fusion-based subcellular localization indicated chloroplast localization of *CrZIP*. Previously, vindoline biosynthesis has been reported to be dependent on intact chloroplasts. The chloroplast localization of *CrZIP* and its direct relationship with vindoline content in this study identifies the possible role of *CrZIP*, in modulating zinc-induced vindoline accumulation in the plant. (Plant Cell Reports 2025).

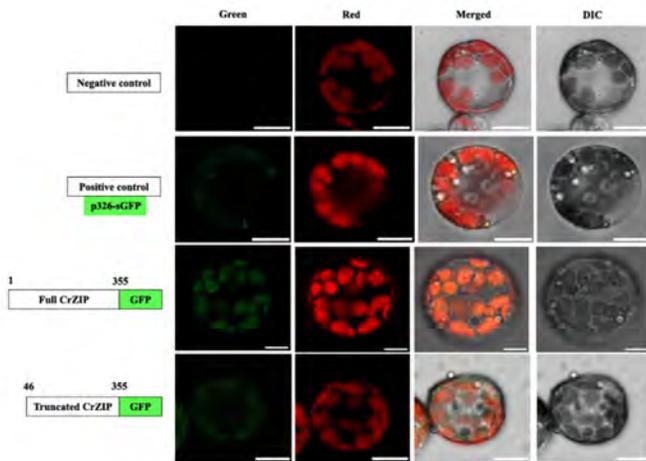


Fig.: Experimental subcellular localization of CrZIP protein using confocal laser scanning microscopy. The left panel depicts the name of the GFP fusion construct with the numbers on top denoting amino acid positions and the right panel depicts the corresponding transient expression of the GFP fusion protein in *Catharanthus roseus* leaf protoplasts. The truncated version of CrZIP lacks the 45 amino acids from the N terminal including the predicted signal / transit peptide and has an introduced start codon (ATG). GFP fluorescence is indicated in green and chlorophyll autofluorescence in red. The “Merged” column indicates combined GFP fluorescence and chlorophyll autofluorescence, whereas the “DIC” column indicates the differential interference contrast images of the intact protoplasts. For each construct, result of one of the two independent transformations is presented. Scale bars = 10 μ m.

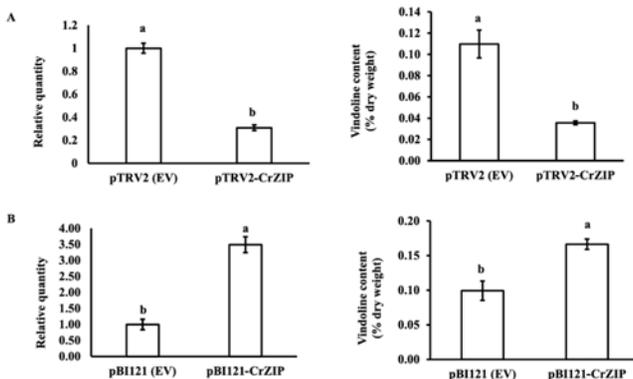


Fig.: Analysis of agro-infiltrated *Catharanthus roseus* plants for CrZIP gene expression and vindoline content (% dry weight basis) in leaves. **A** With pTRV2-CrZIP (VIGS construct). **B** With pBI121-CrZIP (overexpression construct). For qRT-PCR, in both cases, the empty vector (EV) control sample was used as calibrator and *C. roseus* cyclophilin was used as the endogenous gene.

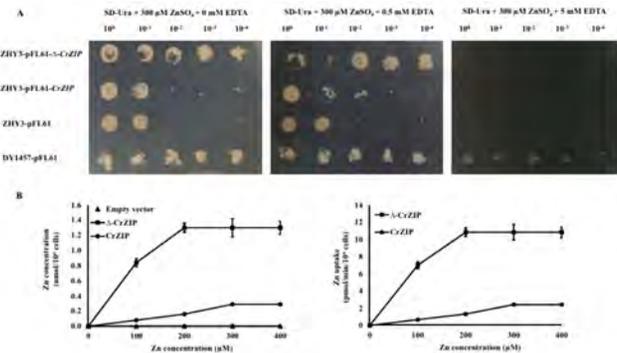


Fig.: Complementation of yeast mutant defective in Zn uptake by CrZIP. **A** Drop-spotting assays using the Zn uptake-defective double mutant ZHY3 and its wild-type strain DY1457. The pFL61-CrZIP and pFL61- Δ -CrZIP constructs were transformed into the ZHY3 strain for analyzing mutant complementation. ZHY3 strain (harboring pFL61 empty vector) and DY1457 strain (harboring pFL61 empty vector) were used as negative and positive controls, respectively. A series of Zn-limited conditions were induced by supplementing SD Ura medium with 300 μ M ZnSO₄ and 0 mM / 0.5 mM / 5.0 mM EDTA (a Zn chelator). 5 μ l drops of serial dilutions of yeast cells (OD₆₀₀ of 1, 0.1, 0.01, 0.001 and 0.0001) were spotted and allowed to grow for 3–5 days at 30 °C. **B** Zn uptake assay in ZHY3 cells expressing CrZIP. The left image denotes Zn concentration in ZHY3 cells expressing the empty vector (pFL-61), CrZIP or Δ -CrZIP. The right image denotes uptake kinetics of Zn mediated by CrZIP or Δ -CrZIP in yeast cells. Zn accumulation was determined by exposing yeast cells to varying Zn concentrations at 30 °C for 120 min. Zn uptake was calculated by deducting Zn accumulation in the yeast cells carrying the empty vector from the Zn accumulation in yeast cells expressing CrZIP or Δ -CrZIP. Δ -CrZIP denotes a truncated version lacking the chloroplast transit peptide.

Mining and functional characterization of a flavonoid glucosyltransferase (*OtUGT*) involved in 7-O-glucosylation of apigenin in *Ocimum tenuiflorum*

The genome data of *Ocimum tenuiflorum* (CIM-Ayu) were utilized for mining novel flavonoid biosynthesis-related gene(s). The search using the unannotated gene sequences yielded an uncharacterized flavonoid glucosyltransferase gene (*OtUGT*), which was selected for characterization. Its bioinformatics-based analysis predicted it to be an *OtUGT*. qRT-PCR analysis of this *OtUGT* indicated

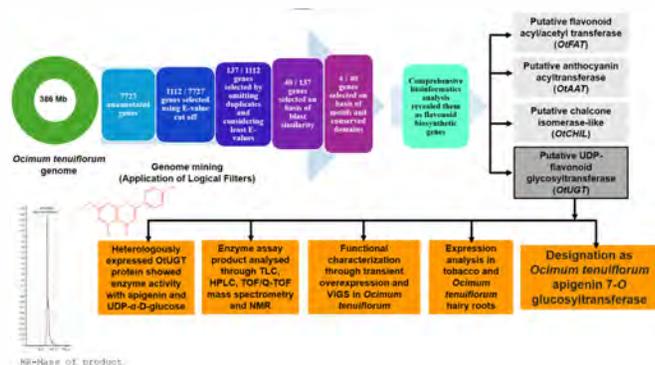


Fig.: Overview of the study.

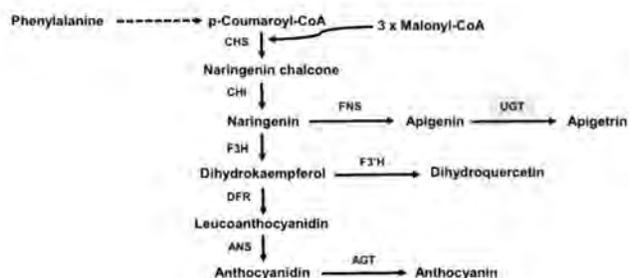


Fig.: A simplified schematic representation of apigenin biosynthesis in *Ocimum tenuiflorum*. The UGT found to be responsible for glucosylating apigenin to apigetrin in this study (OtUGT) is shown in the shaded box.

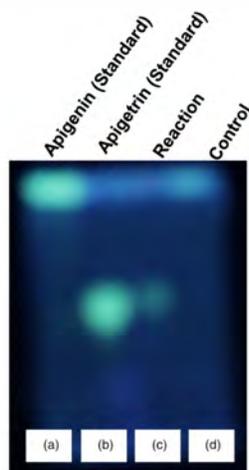


Fig.: Thin layer chromatography visualization of assay product on Silica Gel 60 F₂₅₄ plates (Merck).

its highest expression in *O. tenuiflorum* in comparison to other *Ocimum* species. In *O. tenuiflorum*, its expression was highest in the leaf tissue compared to the trichome, stem, flower, and root. The gene expression was found to be sensitive to MeJA and light. Heterologous expression of the OtUGT protein was induced in BL21(DE3) strain of *Escherichia coli*.

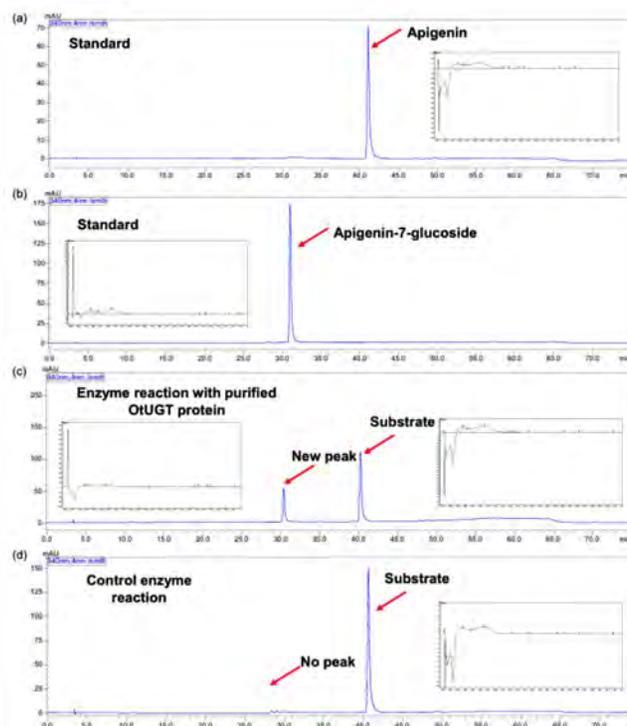


Fig.: High performance liquid chromatography analysis of enzyme activity carried out with the purified OtUGT protein.

Sample(s)	Molecular formula	Monoisotopic mass (m/z)
Positive reaction with apigenin	C ₂₁ H ₂₀ O ₁₀	431.09843
Control	C ₁₅ H ₁₀ O ₅	269.04557
Apigenin Standard	C ₁₅ H ₁₀ O ₅	269.04575
Apigenin-7-glucoside standard	C ₂₁ H ₂₀ O ₁₀	431.09756

Fig.: Identification of assay product, control reaction product, and standards through LC-QTOF-MS analysis.

The purified recombinant protein was used for assay with different flavonoid and sugar donor substrates, whereby it showed activity only with apigenin and UDP- α -D-glucose. The product formed was apigenin 7-O-glucoside (apigetrin), which was confirmed through TLC, HPLC, LC-QTOF mass spectrometry, and NMR analyses. Transient overexpression and VIGS of *OtUGT* in *O. tenuiflorum* were appropriately reflected in terms of alterations in apigetrin levels in the plant. Apigetrin content increased by up to 2.5-fold in transgenic *Nicotiana tabacum* lines generated by transformation with *Agrobacterium*

tumefaciens carrying the pBI121-*OtUGT* construct. Hairy roots generated from leaf explants of *O. tenuiflorum* through transformation with *A. rhizogenes* carrying the pBI121-*OtUGT* construct were not found to be advantageous in terms of apigenin content. Since apigenin possesses high medicinal value, elucidation of its biosynthesis in *O. tenuiflorum* will enable its economical production through optimization in the plant or heterologous systems in the future. (Plant Journal, 2025).



Dr. Ashutosh K Shukla & his team

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

A structural bioinformatics study on aromatic ring interactions in the binding of natural product scaffolds to protein kinases:



Aromatic rings play an important role in numerous molecular phenomena such as protein folding, enzyme catalysis, crystal engineering, drug-receptor interaction etc, because of their ability for form directional interaction with each other. In continuation with our previous work on the analysis of binding interactions of natural product scaffold pyrazolopyrimidine with receptor proteins (Verma et. al., *J. Chem. Inofrm. Mod.* 2023), a structural bioinformatics study was undertaken on the ligand-bound protein kinases. In this study, the 3-D

structures of ligand-bound human protein kinases available in the Protein Data Bank (PDB) and Kinase Ligand Interaction Fingerprint (KLIF) database were analysed in detail. The PDB contains crystal structures for all the five major classes of protein kinases, namely, Serine/Threonine kinase, Tyrosine kinase, dual-specific kinase, Histidine specific kinase and Aspartic acid/Glutamic acid kinase. The analysis showed that maximum number of high-resolution (0.5-2.0 Å) crystal structures are available for Serine Threonine kinases (1456), followed by tyrosine kinases (824). In Serine/Threonine kinase family, highest number of examples are available for Cyclin-dependent kinase 2 (CDK2; 270 entries), Casein kinase II alpha (CSNK2A1; 156 entries), and Mitogen-activated protein kinase (MAPK14; 103 entries). In the case of Tyrosine kinases, Ephrin type A receptor 2 (EPHA2; 63) and Bruton tyrosine kinase (BTK; 90), have the highest number of examples in the PDB. A detailed analysis of crystal structures of the above five selected enzyme classes showed that majority of the ligands contain heterocyclic ring scaffolds, commonly found in natural products. Furthermore, the analysis of binding interactions of ligands revealed that aromatic interactions with the kinases are present in more than 50% of the structures. These interactions are characterized by centroid... centroid distances ranging from 3.3 Å-5.9 Å between the ligand and the selected receptor protein, which is considered as strong to optimal range of interaction. Fig. shows representative examples of the aromatic ring interactions between ligand and aromatic

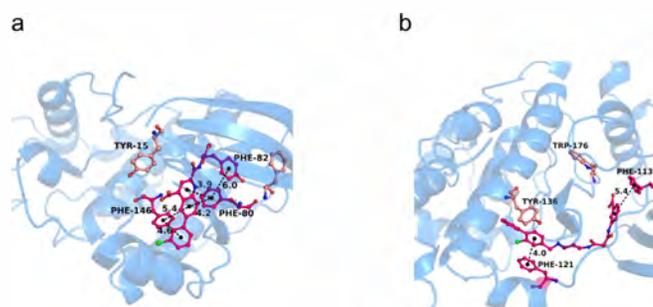


Fig.: Aromatic interactions shown as distance between centroid of the aromatic ring of the ligand and side chain of aromatic amino acid in (a) CDK2 (PDB Id: 4NJ3), and (b) CSNK2A1 (PDB: Id 5MO8).

amino acid side chains of the receptor. This study identified the key aromatic amino acids at the active site that contribute to the ligand-binding through aromatic interactions, and the average centroid... centroid distances for each of these interactions. This information will allow researchers for developing new strategies for kinase inhibitor design, and for obtaining more accurate prediction models in QSAR studies.



Dr. Prema G Vasudev and her team

Dr. Rakesh K. Shukla डॉ. राकेश कुमार शुक्ला

Engineering *Bacopa monnieri* for improved bacoside content and its neurological evaluation



Bacosides are triterpenoidal saponins with numerous pharmacological benefits. One of the significant drawbacks is the low availability of these bacosides. The bacoside pathway is not well elucidated, and there is no prior report of a metabolic engineering approach in this plant. In this study, we have over-expressed the active isoform of *Bacopa monnieri* squalene synthase (*BmSQS-1-OE*) and silenced the *B. monnieri* *G10H* (*BmG10H-1-KD*), the competitive metabolic pathway, to divert the flux towards triterpene biosynthesis. Absolute quantification of bacosides in these *BmSQS-1(OE)-BmG10H-1(KD)* lines has identified improved content of bacoside A3, bacopaside II, and bacoside A. Moreover, the engineered plant extract was also found to have better efficacy on locomotor activity, neuromuscular coordination, and social

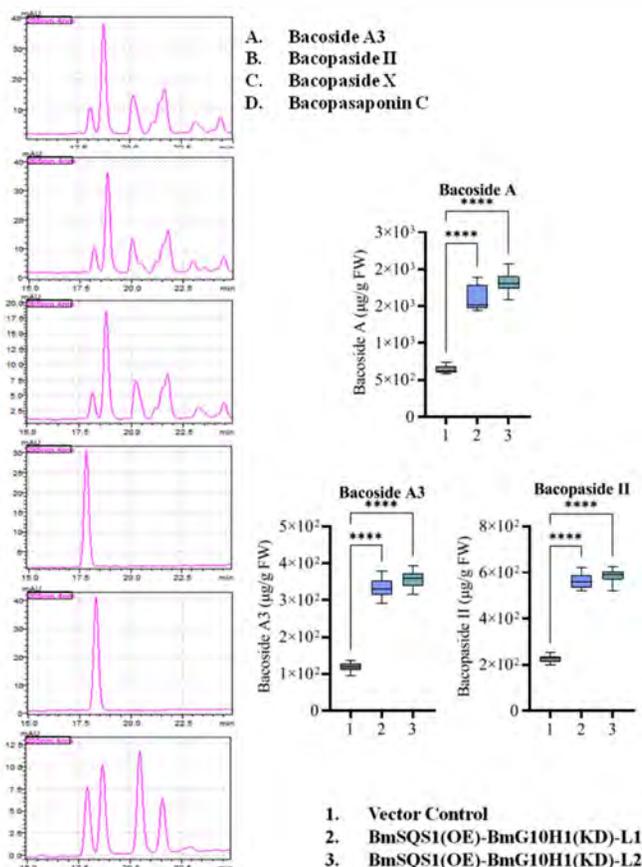


Fig.: Absolute quantification of bacoside content in *BmSQS1(OE)-BmG10H1(KD)* lines. Quantification of bacoside A, bacoside A3 and bacopaside II content (µg/g fresh weight) in two different co-transformed transgenic lines of *B. monnieri* was compared with the Vector control. HPLC chromatograms of (a) crude methanolic extract of *BmSQS1(OE)-BmG10H1(KD)* line 1 (b) crude methanolic extract of *BmSQS1(OE)-BmG10H1(KD)* line 2 (c) crude methanolic extract of vector control line (d) standard bacoside A3 (e) standard bacopaside II (f) bacoside A. Quantification of (g) bacoside A (h) bacoside A3 (i) Bacopaside-II content in two different co-transformed transgenic lines of *B. monnieri*. The experiments were performed in three independent biological and experimental replicates. Error bars indicate mean ± SD. ANOVA, *, P < 0.05; **, P < 0.01; ***, P < 0.001; ****, P < 0.0001.

interaction in a 6-hydroxydopamine (6-OHDA) induced rat model of Parkinson's disease (PD). Immunohistochemistry of the brain tissues indicates that an extract of enhanced bacoside contents reduces 6-OHDA-induced dopaminergic depletion, implying a potential utility in neurological disorders (Applied Microbiology and Biotechnology, 2025) .

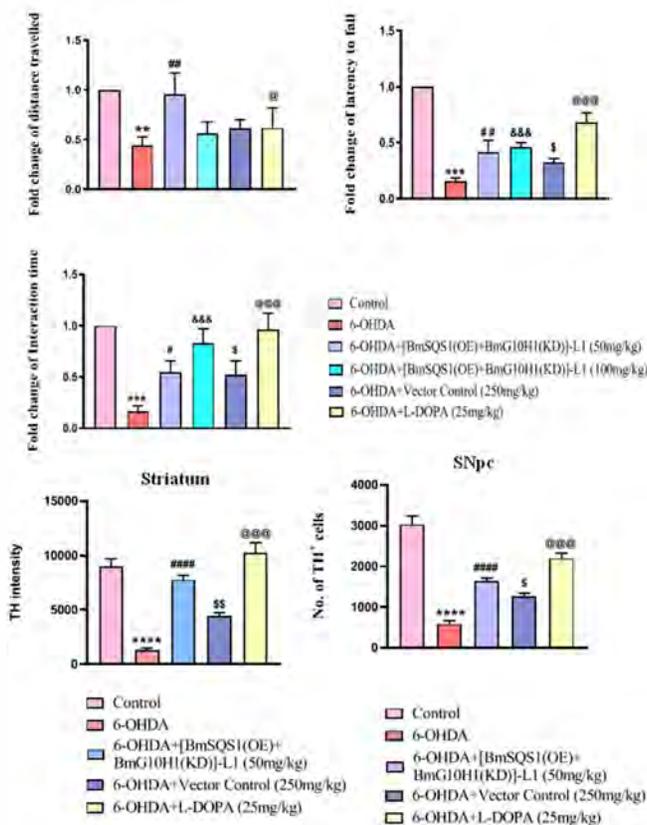


Fig.: Treatment with enhanced bacoside content improved locomotor activity, neuromuscular coordination, and sociability behaviour after 6-OHDA lesioning in rats. (a) The bar graph shows a fold change in the distance travelled in open field activity on the 21st day. (b) The bar graph shows the fold change of latency to fall on the 21st day during the assessment of neuromuscular coordination. (c) The bar graph shows the fold change in interaction time during the sociability test on the 21st day. Data are expressed as mean \pm SEM of n = 9-10 rats/group. Data were analysed by one-way ANOVA followed by Fisher's LSD test (* p <0.05, ** p <0.01, *** p <0.001, # p <0.05, ## p <0.01, ### p <0.001, & p <0.05, && p <0.01, &&& p <0.001, \$ p <0.05, \$\$ p <0.01, \$\$\$ p <0.001, @ p <0.05, @@ p <0.01, @@@ p <0.001) * =control vs 6-OHDA, # =6-OHDA vs 6-OHDA+BmSQS1(OE)-BmG10H1(KD)-L1 (50mg/kg) & =6-OHDA vs 6-OHDA+BmSQS1(OE)-BmG10H1(KD)-L1 (100mg/kg), \$ =6-OHDA vs 6-OHDA+Vector control (250 mg/kg), @ =6-OHDA vs 6-OHDA+L-DOPA (25 mg/kg). (d) The bar graph shows the number of TH⁺ cells in the striatum. (e) The bar graph shows the number of TH⁺ cells in the SNpc region. Data are expressed in \pm SEM of n=4 rats/group and analysed by one-way ANOVA followed by Tukey test.



Dr. Rakesh Kumar Shukla and his team

Dr. Pradipto Mukhopadhyay डॉ. पी. मुखोपाध्याय

Radial distribution of withanolides in tuberous roots of *Withania somnifera* is driven by a 24ISO isoform *Ws24ISO2*



Withania somnifera roots are in high demand for their withanolides, but the low content in the roots poses challenges in meeting market needs. We had reported that in the roots, 75-80% of the withanolides are concentrated outside the primary cambium (NLC), which represents only 25-30% of the total root biomass. This pattern results from the differential expression of a specific sterol reductase gene (*Ws24ISO2*) involved in withanolide biosynthesis. As *Ws24ISO* channels the sterol carbon structure towards withanolide biosynthesis, we performed an RISH assay for *Ws24ISO1* and *Ws24ISO2* (two isoforms of 24ISO in *W. somnifera* Cv. Chetak) to identify primary sites of withanolide biosynthesis in the transverse section of 145-day-old *W. somnifera* roots. Control probes yielded no signals (Fig. A, B, D), while antisense probes revealed specific signals in various cell types within the NLC region, including phellem, phellogen, phelloderm, and phloem parenchyma cells (Fig. C, E, F-I), with the strongest signal in phellogen and phelloderm. As expected *Ws24ISO2* had a stronger expression pattern. In the NLP region (cells inside vascular cambium), distinct signals appeared in some medullary ray cells. These

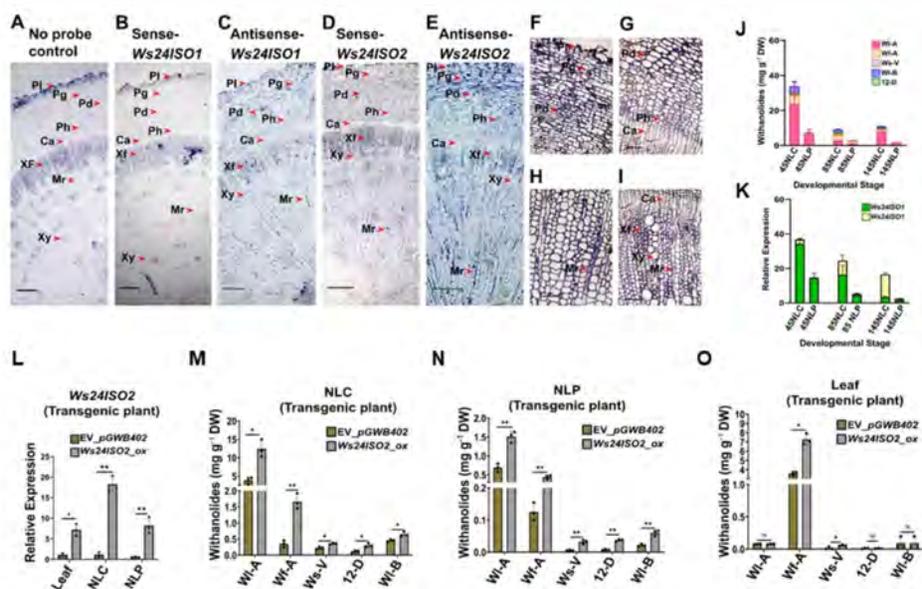


Fig.: (A-E) Stereo-microscope images showing the signals developed through RISH assays in T.S. of 145-day-old *W. somnifera* roots without using any probe. (F-I) Compound microscope images showing the signals developed through RISH assays in different radial regions of the root using the Antisense-*Ws24ISO2* probe. (J-K) Correlation between changes in withanolide accumulation and 24ISO1/2 expression. (L) qRT-based expression estimation of *Ws24ISO2* in *W. somnifera* stable transgenic lines. (M-O) Withanolide content in *Ws24ISO2* in stable transgenic lines in the NLC and NLP region of mature roots and in leaves.

results along with previous qRT-PCR and RNA-seq findings, unequivocally show that both *Ws24ISO1* and *Ws24ISO2* are integral to withanolide biosynthesis, with *Ws24ISO2* as a candidate responsible in radial distribution of withanolides. A similarity in withanolide biosynthesis and expression of *Ws24ISO* genes was also observed which also indicates *Ws24ISO2* as the major transcript in mature roots (Fig J-K). Stable overexpression of *Ws24ISO2* shows upregulation in the NLC, NLP and leaves (Fig. L) along with significant enhancement of withanolides in these regions (Fig. M-O). These findings suggest that the enrichment of *Ws24ISO2* in the NLC region plays a crucial role in the radial distribution of withanolides in mature roots.



Dr. Pradipto Mukhopadhyay and his Team

Dr. Mukti Nath Mishra डॉ. मुक्ति नाथ मिश्रा

Metabolic engineering to utilize high endogenous isoprenoid flux in *Azospirillum brasilense* for production of high-value terpenes



Terpenoids (terpene or isoprenoids) comprises the largest family of the metabolites with >60,000 structurally diverse compounds. A relatively small number of terpene compounds (carotenoids, bacterial hopanoids, sterols, ubiquinone, plastoquinone, gibberellins, etc.) are involved in the primary metabolism. However, most of the terpenes are not essential for survival and growth, and function as secondary metabolites, which provide survival benefits to the host plants by interacting with its biotic and abiotic environment. In addition to their endogenous roles in the plants, several terpenes possess commercially important activities such as pharmaceutical, anti-oxidant, flavouring, fragrance and biofuel. The ever-increasing commercial

applications have increased the demand of several terpenes, and limitations associated with their natural extraction and chemical synthesis have shifted the interest towards their heterologous production using engineered microbes. However, most of the engineered microbes lack the industrially potential yield. Since a high carotenoid yield reflects an equal high-flux through isoprenoid-pathway intermediates, my group is working to improve carotenoid-producing strains from *Azospirillum brasilense* Sp7, and explore the production of carotenoids as well as diversion of the flux towards other high-value terpenes. We have developed an industrially potential strain for carotenoid production, and currently involved in identification of the carotenoids produced by the engineered strain. We have developed *Azospirillum brasilense* strains for production of high-value sesquiterpenes (valencene, nootkatone and humulene), and currently working to improve the yield of the engineered strain by process optimization for large-scale production.

Dr. Sailendra Singh डॉ. शैलेन्द्र सिंह

Establishment of a genetic transformation protocol in *Ocimum sanctum* and *O. basilicum* for genome editing of beta-amyrin synthase for the enhancement of ursolic acid.



In vitro establishment of the targeted plant systems was done using seeds and nodal segments as explant sources. More than 95% seed germination was observed for both the *Ocimum* species. In parallel, nodal segments were also utilized for rapid multiplication of the selected plants.

Additionally, callus cultures from the *in vitro* established leaves of both the *Ocimum* species were also developed by optimizing different combinations and concentrations of plant growth regulators.

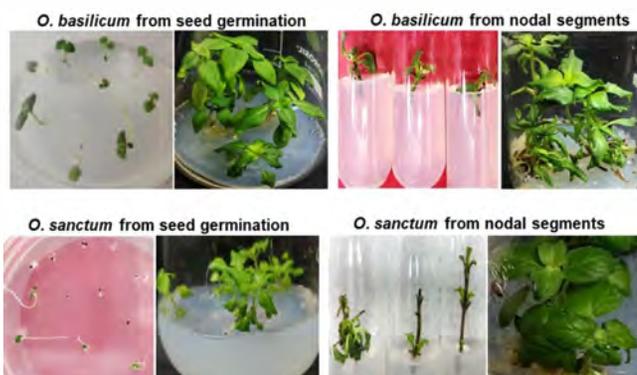


Fig. 1: *In vitro* establishment of both the targeted plant systems was done using seeds and nodal segments as explant sources.

***O. basilicum* callus**



***O. sanctum* callus**



Fig. 2: Development of callus cultures from the *in vitro* established leaves of both the *Ocimum* species.



Dr. Sailendra Singh and his Team

Dr. Ashish Sharma डॉ. आशीष शर्मा

Ocimum pri-microRNA-encoded peptides: regulatory role in secondary plant product biosynthesis



Nature offers a vast storehouse of medicinal plants that play a vital role in human health. Medicinal plants are rich in secondary metabolites like alkaloids, flavonoids, phenolics, tannins, saponins, and essential oils, which have therapeutic value. These bioactive compounds are widely used in the pharmaceutical industry for developing drugs, making medicinal plants essential for primary healthcare and modern medicine. *Ocimum* sp. L., commonly known as holy basil (Tulsi), is an herbaceous perennial plant belonging to the family Lamiaceae. It is considered one of the most important medicinal plants due to its

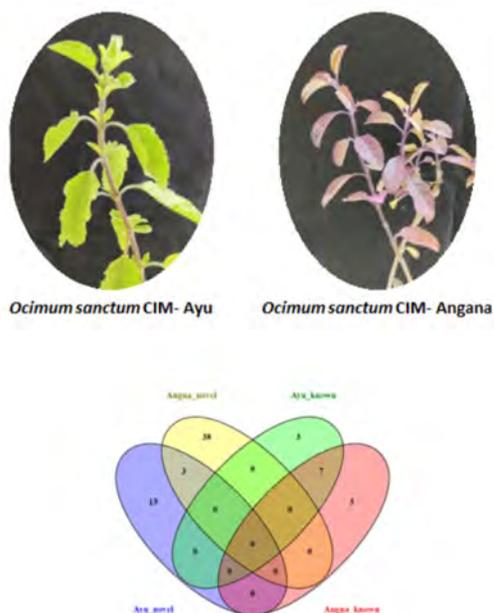


Fig.: Representative image of *Ocimum sanctum* sp. L. CIM Ayu and Angana. Venn diagram showing the distribution of known and novel miRNAs in two *Ocimum sanctum* cultivars (CIM-Angana and CIM-Ayu). The diagram represents the overlap and unique presence of miRNAs identified through small RNA sequencing. miRNAs are categorized into four groups: novel miRNAs in CIM-Angana (Angna_novel - yellow), novel miRNAs in CIM-Ayu (Ayu_novel - blue), known miRNAs in CIM-Angana (Angna_known - red), and known miRNAs in CIM-Ayu (Ayu_known - green).

rich content of secondary metabolites and essential oils, which are recommended for the treatment of various diseases. However, the molecular aspects of enhancing its medicinal properties have not yet been fully explored. Small molecules like small peptides, miRNA, miPEP, microProtein etc. have been identified and have proven their essential role in plant biology. However, they still need to be identified and characterised in MAPs.

Leaves from two different *Ocimum* species *Ocimum sanctum* CIM-Angana and *Ocimum sanctum* CIM-Ayu, commonly known as Shyama Tulsi and Rama Tulsi, respectively, were used for small RNA sequencing. The sequencing analysis identified 38 novel miRNAs in Angana and 15 in Ayu. Additionally, 36 miRNAs were found to be commonly expressed in both varieties, while 22 miRNAs were uniquely expressed in Ayu and 41 were unique to Angana. miRNAs associated with the regulation of secondary metabolites were selected for further investigation. To study these in more detail, the full-length primary miRNA transcripts will be developed using the 5' RACE. *In silico* genome-wide analysis will be conducted to identify open reading frames (ORFs) within these pri-miRNA sequences, which may encode putative miRNA-encoded peptides (miPEPs) for conserved miRNAs in *Ocimum*. The identified ORFs will be used in future molecular and physiological studies. Additionally, synthetic miPEPs will be applied in gene expression, phenotypic, and metabolite analysis experiments to better understand their functional roles.



Dr. Ashish Sharma and his team

Dr. Neelam Prabha Negi डॉ. नीलम प्रभा नेगी

Unravelling tissue culture and elicitor-driven strategies: A “biotechnological pathway” for conservation and metabolite enhancement in medicinal and aromatic plants



Medicinal and aromatic plants (MAPs) are invaluable sources of specialized metabolites with wide-ranging applications in pharmaceuticals, nutraceuticals, and traditional medicine. However, uncontrolled wild harvesting and ecological pressures have threatened their survival and created inconsistencies in the supply of quality raw material. Plant tissue culture (PTC), integrated with elicitor applications and molecular tools, provides a promising platform for both conservation and sustainable metabolite production. In our laboratory, we are developing and standardizing in vitro regeneration protocols for high-value and endangered MAPs, enabling large-scale propagation of genetically uniform and disease-free plants. Beyond conservation, we are establishing callus, suspension, adventitious, and hairy root cultures as renewable biofactories capable of reliably producing bioactive compounds under controlled conditions.

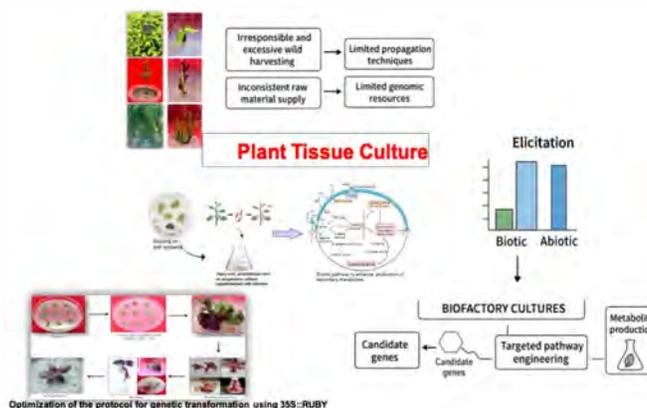


Fig.: Tissue culture and elicitor-driven strategies for conserving medicinal and aromatic plants and enhancing bioactive metabolite production along with biotic and abiotic elicitors and gene pathway engineering.

A key thrust of our work is the use of elicitors to stimulate plant defense pathways and enhance secondary metabolite biosynthesis. Both biotic (yeast extract, chitosan) and abiotic (jasmonic acid, salicylic acid, methyl jasmonate) elicitors are employed in our laboratory, leading to significant increases in alkaloids, terpenoids, phenolics, and saponins. Complementing these approaches, optimized transformation protocols allow functional validation of candidate genes and targeted pathway engineering, integrating molecular insights with biotechnological strategies to achieve sustainable and enhanced production of high-value plant metabolites.



Dr. Neelam Prabha Negi and her team

Dr. Swati Tyagi डॉ. स्वाती त्यागी

First haplotype-resolved genome assembly of citral-rich lemongrass *Cymbopogon flexuosus* var. Krishna



CSIR-CIMAP has prioritized developing genomic resources for key MAPs including *Cymbopogon flexuosus*, *C. martinii*, *Mentha arvensis*, *Chrysopogon zizanioides*, *Pelargonium graveolens*, *Ocimum basilicum*, *O. tenuiflorum*, *O. gratissimum*, *Mentha spicata*, and *Asparagus racemosus*. Within this framework, we targeted *C. flexuosus* var. Krishna—an elite cultivar valued for its high citral content (78–82%), yield stability, and wide adaptability—as a genomic model for the genus. India cultivates ~20,000 ha of lemongrass, providing sustainable livelihoods to smallholder farmers, with *Krishna* representing a primary contributor to essential oil exports. Importantly, natural populations of *Cymbopogon* exhibit considerable ploidy variation (diploid, tetraploid, and hexaploid races), highlighting the need for haplotype-level resolution to capture allelic diversity relevant for breeding. Using PacBio HiFi

sequencing and Omni-C chromatin capture, we generated the first chromosome-scale, haplotype-resolved genome of *C. flexuosus* var. Krishna. Assembly with Hifiasm and scaffolding via HapHiC yielded a 798 Mb genome with a scaffold N50 of 64.35 Mb, anchored to 10 pseudo-chromosomes representing 98% of the assembly. BUSCO analysis demonstrated near-complete gene space recovery (99.8% complete genes, embryophyta lineage). Only 38 gaps remain in the final assembly, underscoring its structural accuracy. Repeat annotation revealed that ~65% of the genome is composed of interspersed repeats, dominated by LTR-Gypsy retrotransposons (~26.4%). A total of 37,254 protein-coding genes were predicted using MAKER, integrating ab initio predictions (Augustus), transcript evidence (RNA-seq), and homology-based alignments (rice, maize, sorghum, *Arabidopsis*). Functional annotation through UniProt, eggNOG-mapper, Pfam, and InterPro databases assigned biological roles to >30,000 genes, including ~26,000 with KEGG orthology. Gene families involved in terpenoid biosynthesis were curated, providing the first comprehensive catalog of candidate enzymes for citral and monoterpene pathways.

Comparative transcriptome analysis reveals *ABI3VP3-WRKY25-STR1* regulatory module linking specialized metabolism with root development in *Rauvolfia serpentina*

In the present study, we conducted a meta-analysis of publicly available *Rauvolfia serpentina* transcriptome data from different plant tissues to investigate secondary metabolite biosynthesis and root system architecture regulatory network. Our analysis identifies key biosynthetic pathways and regulatory networks involved in metabolite production. Through co-expression analysis, we detect 2 distinct co-expression modules—*plum1* and *stealblue*, revealing coordinated gene expression patterns associated with secondary metabolism. Further hub gene detection identified three strongly correlated genes i.e., *STR1*, *ABI3VP1* and *WRKY25* involved in

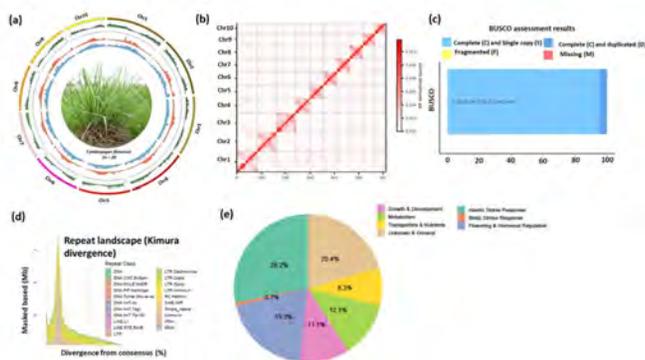


Fig.: Whole-genome assembly of lemongrass (*Cymbopogon flexuosus* var. Krishna). (a) Circos plot depicting the ten chromosomes, GC content, and distribution of repeat elements. (b) Hi-C contact map illustrating chromatin interactions and scaffold connectivity. (c) BUSCO analysis showing genome completeness based on conserved single-copy orthologues. (d) Repeat age distribution indicating the temporal dynamics of transposable elements. (e) Functional annotation of predicted genes, including GO terms and protein domains.

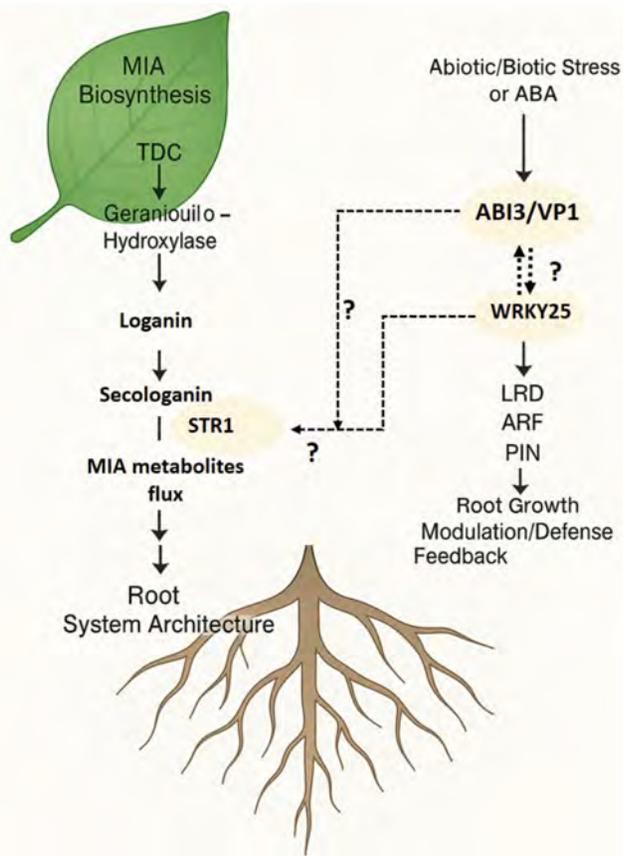


Fig.: Hypothetical model illustrating the transcriptional and metabolic crosstalk between monoterpene indole alkaloid (MIA) biosynthesis and root system architecture (RSA) regulation in *Rauvolfia serpentina*. Note: Dashed arrows indicate proposed or hypothesized regulatory influences that require experimental validation.

secondary metabolite biosynthesis and root system development. Based on the three candidate genes which have been identified during our study, we propose a mechanistic model in which the biosynthesis of MIAs is functionally interconnected with RSA remodelling via coordinated transcriptional regulation (Fig.). In response to elevated abscisic acid (ABA) levels or upon abiotic or biotic stress exposure, the ABA-responsive transcription factor *ABIVP3* becomes activated and initiates a signalling cascade by cross talking with *WRKY25*, a stress-associated transcription factor. *WRKY25*, in turn, might regulates genes involved in both secondary metabolism and root development. On the metabolic axis, this regulation activates downstream genes such as *G10H*, *Secologanin Synthase*, and *Strictosidine Synthase (SLS)*,

leading to the accumulation of strictosidine, a central MIA intermediate. Strictosidine is synthesized from the precursors tryptophan and secologanin through the action of Tryptophan Decarboxylase (TDC) and Geraniol 10-Hydroxylase (*G10H*), followed by a series of enzymatic steps (Fig.). This metabolite flux contributes not only to the production of MIAs but may also serve as a signalling or feedback molecule influencing root growth. Parallel to this, *WRKY25* and *ABIVP3* modulate root development genes such as *LATERAL ROOT DENSITY (LRD)*, *AUXIN RESPONSE FACTORS (ARF)*, and *PINFORMED (PIN)* auxin efflux carriers, facilitating stress-adaptive root remodelling. The model thus supports a functional crosstalk where stress signals modulate both metabolite production and root patterning, ensuring that metabolic defense and morphogenetic adaptation are tightly coupled. However, laboratory-level validation as mentioned above of these genes and their functional crosstalk is essential to substantiate this hypothesis and delineate the mechanistic underpinnings of this integrated regulatory network. This study provides a comprehensive list of candidate genes and regulatory elements for further functional validation, offering new insights into the tissue-specific biosynthesis of secondary metabolites in *R. serpentina*. Our findings also highlight the power of transcriptome meta-analysis in elucidating complex biosynthetic pathways, facilitating metabolic engineering efforts for enhanced production of valuable phytochemicals.



Dr. Swati Tyagi and her team

Crop Production and Protection

HIGHLIGHTS

The Crop Production and Protection Division at CSIR-CIMAP has a dedicated team of 15 scientists working across various aspects of agro-technology for Medicinal and Aromatic Plants. The division focuses on integrated pest management (IPM), integrated nutrient management (INM), disease and weed management, bio-herbicide efficacy of essential oils, and the mechanisation of medicinal and aromatic plants (MAPs). It also investigates energy and carbon budgeting in MAPs and the impact of nano-fertilizers on plant growth. The division plays a significant role in the CSIR-Aroma Mission, particularly in the development of agro-technologies and good agricultural practices (GAPs) aimed at enhancing MAP productivity, reducing cultivation costs, and minimising pesticide use.

One of the division's key initiatives is the deployment of innovative technologies and skill development programs for farmers, particularly at the village level, through CSIR-CIMAP's research centers in Lucknow, Pantnagar, Bengaluru, and Hyderabad. The division has also facilitated the distribution of high-quality planting material for MAP cultivation in various states, further supporting the expansion of MAP farming across India.

In terms of energy use, the division has found that mint essential oil production requires more energy than other herbs, with *Mentha citrata* being particularly energy-intensive. Notably, firewood accounts for 59% of the energy used in essential oil extraction. To address these concerns, the division has been working on optimizing processes to make MAP



Left to right: Dr. Anandakumar TM, Dr. Priyanka Suryavanshi, Dr. Santoshkumar C. Kedar, Dr. Rakesh Kumar, Dr. Rajesh Kumar Verma, Dr. Puja Khare, Dr. Akanksha Singh, Dr. Yugander Arra, Dr. Kishore Babu Bandamaravuri



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

production more sustainable and energy-efficient. In line with sustainability goals, the division has established India's first sustainable Aroma Cluster in Barabanki (Uttar Pradesh), promoting sustainable agricultural practices. This model integrates crop diversification, apiculture, mushroom production, and vermicomposting with hybrid processing units, which have the potential to increase rural incomes while minimizing waste and investment.

In research, the division has carried out numerous impactful studies, including the development of De-oiled Solid Waste-based Calcium and Phosphorus-enriched Biochar (CPB) for immobilizing harmful metals like arsenic, cadmium, and lead in soil. This process has shown promise in improving plant growth and enhancing soil health. The division also explored the insecticidal properties of essential oils derived from lemon peels and other plants, finding them effective in controlling pests such as the pulse beetle and aphids.

A significant achievement has been the identification of an alternate growing season (kharif) for menthol mint in the Bundelkhand region, leading to a 40-45% increase in essential oil production compared to the traditional summer season. This has enabled farmers in Chatarpur to produce 150-160 kg of menthol mint oil per hectare, a remarkable increase from the previous 100-110 kg per hectare in the traditional season. Under the CSIR Floriculture Mission Phase-II, the division has been working to mass-multiply pharma-based floral crops like marigold, rose, tuberose, and jasmine. This initiative has expanded the cultivation area for these high-value crops by over 250 hectares. In addition to floriculture, the division has been examining the impact of water stress on the growth of *Andrographis paniculata*, highlighting the benefits of deficit irrigation in increasing plant output.

The division has also been focused on integrated pest management for various crops, identifying and addressing fungal diseases in menthol mint, with interventions from plant pathologists. Additionally, bio-herbicide studies have demonstrated that essential oils from lemongrass, cinnamon, and Pimenta can effectively manage the noxious weed *Cyperus rotundus*, with lemongrass showing the highest growth inhibition. Further, the division has optimized agronomic practices for chamomile cultivation, including spacing, nutrient management, and hormone application, leading to high oil yield of

12.84 kg/ha. Likewise, research on oregano production has introduced new agro-technologies involving soil, vermicomposting, rooting hormones, and coco peat to increase yield and ensure sustainability in raw material production for the industry.

The division has also validated the effectiveness of nano-fertilizers in improving the growth and yield of *Ocimum basilicum* var. CIM-Saumya, showing significant improvements when using a combined application of nano-urea, nano-DAP, and humetsu. In another area of innovation, the division has developed efficient harvesting equipment for vetiver (*Vetiveria zizanioides*), improving the harvesting efficiency by 80% at optimal speed and rake angles.

Research on the impact of seaweed extract (SWE) on the growth and yield of Senna (*Cassia angustifolia*) and Kalmegh has shown that SWE significantly enhances germination, seedling growth, and overall plant health. Furthermore, SWE's application has proven highly effective in promoting germination and increasing the yield potential of these medicinal plants.

In molecular research, the division has identified 26 sugar transporters in lemongrass (*Cymbopogon citratus*) through whole-genome sequencing, contributing valuable insights into their role in plant development and stress tolerance. These findings are crucial for improving crop resilience and yield under variable environmental conditions. The division has also made significant contributions to scientific literature, publishing 52 peer-reviewed articles with a total impact factor of 140.6 in renowned journals such as Biomass and Bioenergy, Environmental Pollution, and International Bio-deterioration & Biodegradation etc. In recognition of the division's work, Dr. Puja Khare, Senior Principal Scientist, was honored as a Fellow of the National Environmental Science Academy (FNESA) and featured in the book *She is Women in Chemistry*. Dr. SG Eswara Reddy also filed a patent for a novel composition involving crude ethyl acetate leaf extract, contributing to pest management solutions.

Through these various initiatives, the Crop Production and Protection Division is advancing sustainable agricultural practices, enhancing productivity, and improving livelihoods for farmers across India. Its innovative research and technologies continue to have a significant impact on both the scientific community and the agricultural sector.

Dr. Rajesh Kumar Verma डॉ. राजेश कुमार वर्मा

Fostering economic and environmental resilience through sustainable agro-technology, honey production, beeswax candle and distillation waste based mushroom production in rural communities



Established India's first sustainable Aroma Cluster in Barabanki (Uttar Pradesh: *A composite study, GK magazine*) is a testament to CIMAP's commitment to promoting sustainable agricultural practices. By integrating innovative technologies and value-added processes, CIMAP aims to create a model for sustainable farming that can be replicated in other regions. This initiative not only enhances the livelihoods of farmers but also contributes to environmental conservation. Integration of crop diversification, apiculture, mushroom production, vermicomposting with hybrid processing units can boost the rural income with minimal investment and waste generation. The overall profit sharing percentage of cultivation of paddy, potato, menthol mint, beekeeping, mushroom and vermi production were 16.86%, 44.98%, 17.4%, 17.03%, 1.9%, and 1.6%, respectively.

Candle preparation using honeybee wax offers a sustainable and profitable alternative to petroleum-based paraffin candles. This study looks beyond the chemical properties and combustion emissions, as well as its lifecycle sustainability. Honeybee



Glimpse of Sustainable cluster

wax, a renewable and biodegradable by-product of apiculture, supports environmentally conscious production and aligns with global sustainability goals. This study examines the integration of honeybee wax candle production within a sustainable cluster framework, emphasizing resource efficiency, economic viability, and environmental conservation. In sustainable cluster models, beekeepers supply wax as a raw material, reducing waste and enhancing income from apiculture. Candle-making cooperatives employ energy efficient production techniques, lowering costs and enabling premium product pricing. Beeswax candles consistently achieve 30–50% higher profits in niche markets, contributing to increased profit margins.

Evaluation of on-farm energy input-output and economics of important essential oil-bearing Mint species

Mint species are grown worldwide and known for their medicinal and aromatic properties; however, studies on their energy assessments are very scarce. We have quantified the energy input-output relationship of herbs and essential oil production of different mint species (*M. arvensis*, *M. piperita*, *M. spicata*, *M. cardica* and *M. citrata*) which were commercially grown in subtropical regions of the India. The energy inputs and outputs were significantly varied with mints species. Results showed that mint's essential oil production used more energy than herbs, and *M. citrata* utilizes the highest energy in both cases. Firewood requirements for essential oil extraction account for the maximum (59%) energy input. Mint herbs and essential oil yields were recorded as 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. cardica* (herbs), and *M. arvensis* (essential oils), and required net calorific values were tested by automated advanced oxygen bomb calorimeter. Overall, *M. arvensis* showed the best results in energy production (0.07 kg MJ⁻¹), profitability (0.27), net return (17156.40 MJ ha⁻¹), and energy use efficacy (1.27) for mint herbs production. However, for

essential oil production *M. cardiaca* performed well. This study revealed that mint herbs production was more energy efficient than essential oils extraction although essential oil production is fiscally secure.



Dr. Rajesh Kumar Verma & team

Dr. Puja Khare डॉ. पूजा खरे

Impact of cultivating different *Ocimum* species on Bio-aerosol bacterial communities and functional genome at an agricultural Site

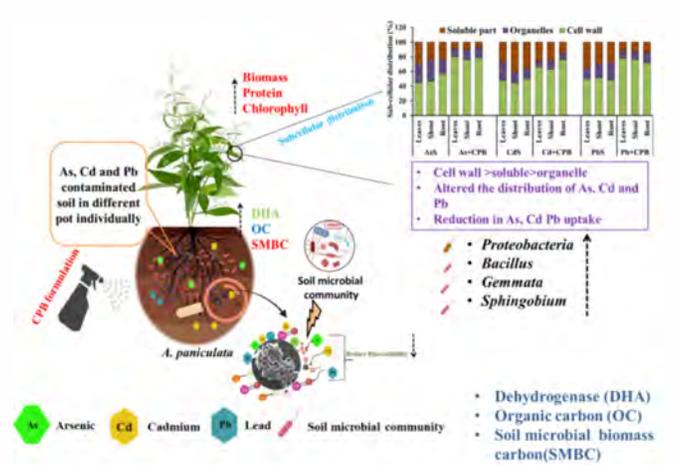
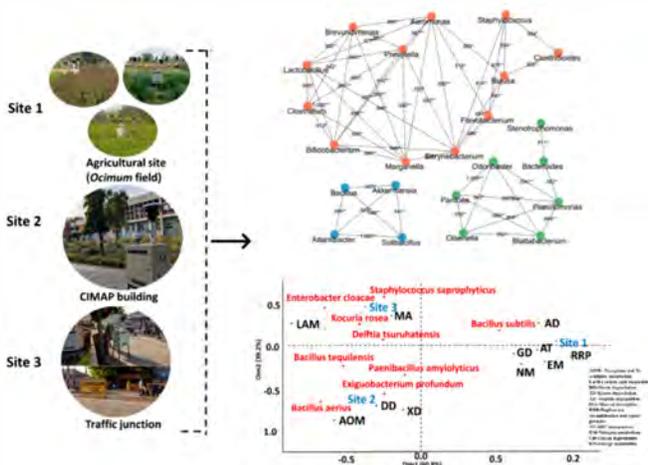


The bio-aerosol samples were collected from agricultural fields growing *Ocimum* [two varieties of *O. sanctum* (CIM-Aayu and CIM-Angana)] and *O.*

kilimandscharicum (Kapoor), nearby traffic junctions and suburban areas. The bacterial bio-aerosol was characterized at agricultural site of three *Ocimum* varieties. Distinct bacterial communities were observed different species/ varieties of *Ocimum*. The bio-aerosol community at *O. sanctum* (CIM-Ayu) site were different from other sites. The bacterial genera present in each sample exhibited limited inter-site correlation. Each site has differential cross-feeding and co-colonization of bacterial genera. [Environmental Pollution, 2024]

Adding mineral-enriched biochar to the rhizosphere reduces heavy metal toxicity on plants and soil microbes

Ca and P-enriched biochar formulation (CPB) was prepared and characterised. CPB effectively immobilised arsenic, Cd, and Pb in soil. CPB spray altered the subcellular distribution of As, Cd, and Pb in *A. paniculata*. CPB significantly reduced the uptake and translocation of As, Cd, and Pb in the plant. CPB increased the relative abundance of metal-immobilising microbes in soil. The study suggested that CPB formulation can be used as a potential solution to alleviate different metal uptake and toxicity of crops planted in contaminated soil, improve rhizospheric soil quality, and reconstruct the microbial community structure. [Journal of Environmental Chemical Engineering, 2024]





Dr. Puja Khare & team

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

Chemical profiling and insecticidal properties of essential oils from fresh and discarded lemon peels, *Citrus limon* against pulse beetle



The essential oil (EO) of *Citrus limon* fresh (LF) and lemon waste peel (LW) was extracted using the hydro

distillation method. A total of 17 chemical constituents (97.02-97.26%) were identified using GC, GC-MS, and NMR techniques. The major monoterpene hydrocarbons, including d-Limonene (52.42-54.17%), α -terpineol (16.82-21.15%), β -pinene (6.74-9.15%), and γ -terpinene (2.16-3.59%), were further identified using ^1H and ^{13}C NMR analysis. Further, extracted EOs, their synergistic combinations, and d-limonene were evaluated for fumigant toxicity, repellence, and ovipositional inhibitory (OI) potential without food and with food conditions against pulse beetle, *Callosobruchus chinensis* and *Callosobruchus maculatus*. The d-limonene was found to be most effective against *C. chinensis* and *C. maculatus* followed by LW oil in all the evaluated assays. EO of LW was found more effective against *C. chinensis* (LC_{50} = 2899.11 $\mu\text{l/L}$) without food after 96 h than lemon fresh. Among synergistic combinations, LW and LF at 3:1 ratio without food were reported to be more effective against *C. chinensis* (LC_{50} = 277.85 $\mu\text{l/L}$) and *C. maculatus* (LC_{50} = 322.38 $\mu\text{l/L}$) without food after 96 h. In the repellent assay, EO of LW also displayed

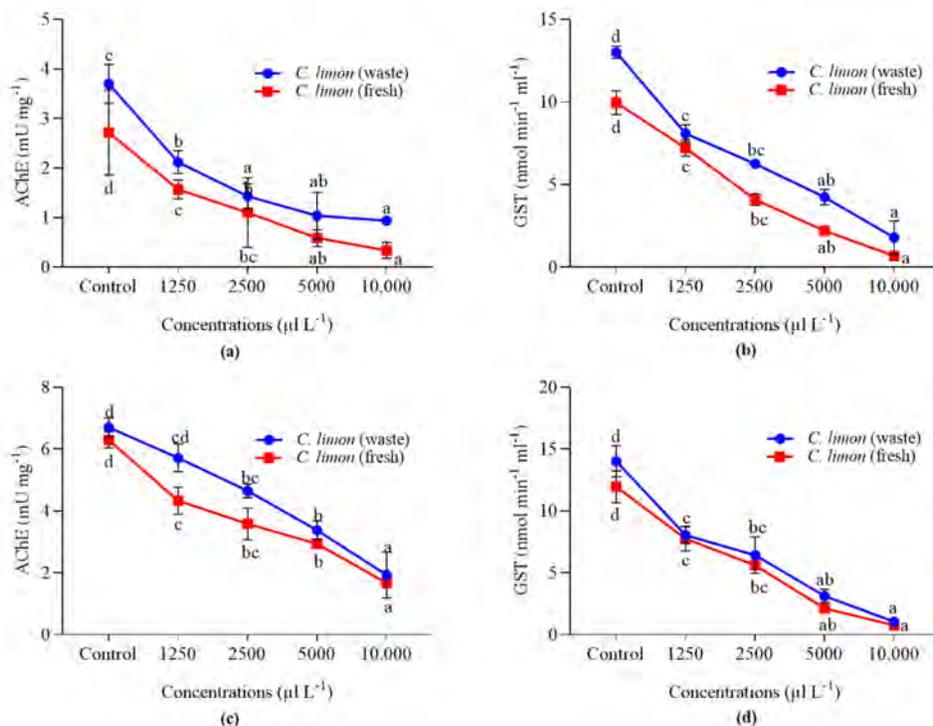


Fig.: Enzyme inhibition activities of essential oils (EOs). AChE inhibition in *C. chinensis* treated with *C. limon* waste and fresh (a); GST inhibition in *C. chinensis* treated with *C. limon* waste and fresh (b); AChE inhibition in *C. maculatus* treated with *C. limon* waste and fresh (c); GST inhibition in *C. chinensis* treated with *C. limon* waste and fresh (d). Mean (\pm SE) of three replications. Figures in the same letters do not differ significantly by Tukey's HSD ($p \geq 0.05$)

higher repellent to both species (RC_{50} =430.71 to 525.56 μ L). The EO of LW showed a higher OI (50.14%) against *C. chinensis* at a higher concentration after 24 h. EOs of LF and LW also inhibited glutathione-S-transferase (GST) and acetylcholine esterase (AChE) activity in *C. chinensis* and *C. maculatus* (Fig.).

Chemical profiling, insecticidal and enzyme inhibition activities of *Rosmarinus officinalis* and *Ocimum sanctum* against aphid, mealy bug and diamondback moth

The chemical composition and insecticidal activities of essential oils (EOs) were screened for their efficacy against aphid, *Aphis craccivora* (Hemiptera: Aphidiade), mealybug, *Planococcus lilacinus* (Hemiptera: Pseudococcidae), and diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae). GC and GC-MS analysis revealed that ocimene (36.4%) in the EO of *Rosmarinus officinalis* and β -caryophyllene (58.77 %) in *Ocimum sanctum* were major constituents. *R. officinalis* is most effective against *A. craccivora* and *P. lilacinus* (LD_{50} =0.97 and 2.02 μ L/insect, respectively) after 96 h. Similarly, *O. sanctum* was effective against *P. xylostella* (LD_{50} =3.92 μ L/insect). All combinations of EOs displayed toxicity (LD_{50} =0.11-0.14 μ L/insect), synergistic activity for *A. craccivora*, *P. lilacinus* and antagonistic activity to *P. xylostella*. Further RO+OS at 1:3 and 3:1 ratio also displayed high toxicity to *P. lilacinus* (LD_{50} =0.36-0.40 μ L/insect) and *P. xylostella* (LD_{50} =1.36-1.49 μ L/insect). EO of *R. officinalis* showed repellent (RC_{50} =2366.62 μ L/L) against *P. xylostella*, deterrent activity of *O. sanctum* against *A. craccivora* (88%) and synergistic action against *A. craccivora* (Co-toxicity coefficient (CTC) =640.67-1366.67) and *P. lilacinus* (CTC) =404-561.11). Both essential oils showed inhibition of acetylcholine esterase (AChE), glutathione-s-transferase (GST), carboxyl esterase (CES), and mixed function oxidase (MFO) in test insects (Fig.). The EO of *R. officinalis* and *O. sanctum* alone or their combination may be recommended for the control of target pests based on field bio-efficacy studies.

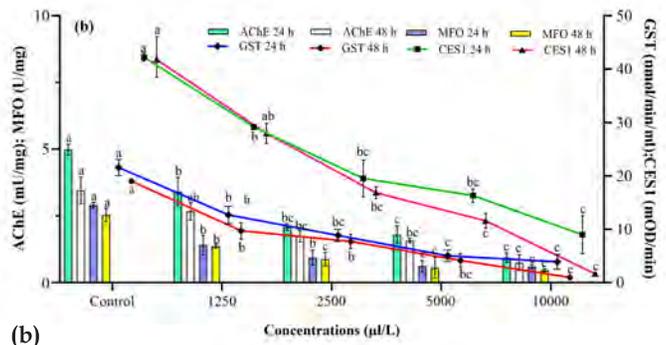
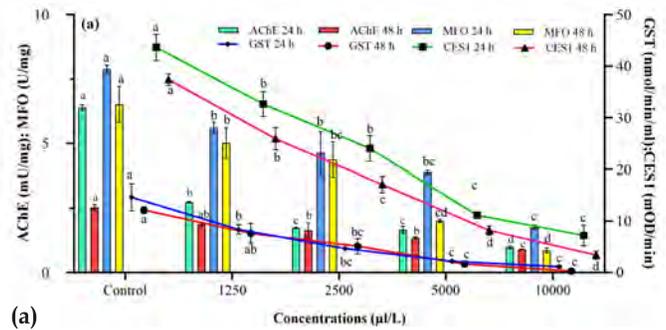


Fig.: Enzyme inhibition activities in *A. craccivora* treated with EO of *R. officinalis* (a) and *O. sanctum* (b); Error bars in the figure represent the standard error (\pm SE) of three replications; The same alphabetical letters in the figure do not differ significantly by Tukey's HSD test ($p \geq 0.05$)

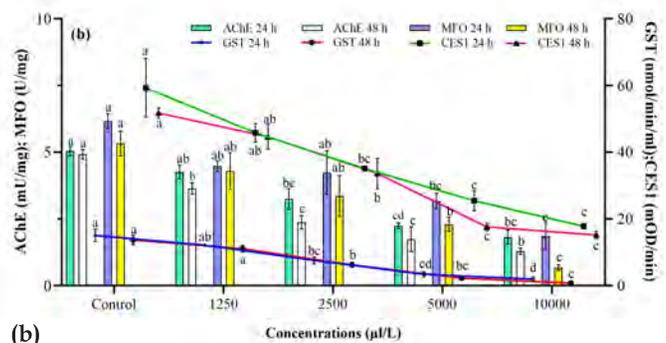
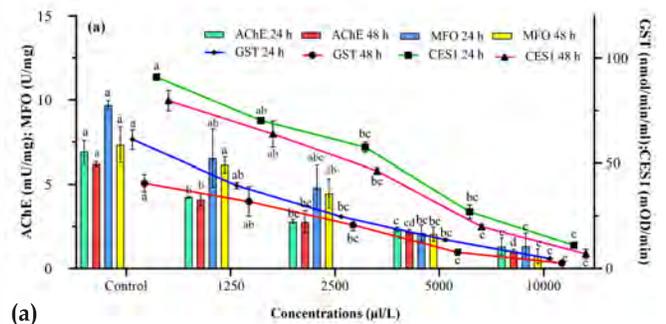


Fig.: Enzyme inhibition activities in *P. lilacinus* treated with EOs of *R. officinalis* (a) *O. sanctum* (b); Error bars in the figure represent the standard error (\pm SE) of three replications; The same alphabetical letters in the figure do not differ significantly by Tukey's HSD test ($p \geq 0.05$)



Dr. S.G. Eswara Reddy & team



Dr. R K Upadhyay डॉ. आर के उपाध्याय

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



The sustainable cluster developed for the menthol-mint cultivation in Kharif season in Bundelkhand region (Gundara (Neguwa) and Sewadi Villages, Tahsil- Maharajpur, Dist. Chhatarpur M.P.) and it's compared with existing cultivation practices. Total 19 farmers have cultivated the menthol mint crop in Kharif season in 12 acres of land and produced an essential oil of 150 to 160 kg ha⁻¹ through intervention of Kharif season mint technology of CSIR CIMAP *i.e.* approximately 40 - 45% higher as compared to existing practices (essential oil 100-110 kg ha⁻¹) in Chhatarpur.

After successful implementation of kharif season mint technology in Bundelkhand region, approximately 750 kg of menthol mint oil produced by farmers of Gundara & Sewadi cluster under Kharif Mint Technology with approximate monetary value of Rs. 7.5 lakhs from 12 acre land only within 4 month (kharif season). In overall the kharif season mint technology of CSIR-CIMAP showed excellent performance in Gundara & Sewadi cluster of Bundelkhand region (Maharajpur, Chhatarpur, Madhya Pradesh). CSIR-CIMAP also created facility for production of vermicompost in Gundara & Sewadi cluster towards making self-sustainable as well as reduces the dependency on chemical fertilizers.

Traditional method: Menthol mint crop cultivated by farmers during rainy season by using regenerates or plantlets after harvest of main crops. The main crop field also engaged after harvesting of main

Performance of Kharif Mint Technology over traditional method in Bundelkhand region

Parameters	Kharif Mint Technology (KMT)			Traditional Method
	CIM-Unnati	CIM Kranti	Average	Local variety
Plant height (cm)	70.00	75.00	72.50	44.00
No. of branches per plant	26.00	20.00	23.00	16.00
Fresh herb yield Q/ha	175.00	178.00	176.50	135.00
Oil content (%) Lab scale	1.40	0.95	1.18	0.87
Oil Yield kg ha ⁻¹ (Lab scale)	245.00	169.00	207.00	118.00
Oil Yield kg ha ⁻¹ (Farm scale)	177.00	132.00	155.00	105.00
Per cent performance over the traditional method (variety-wise with KMT)	68%	26%	47%	-

crops in May June to till August and it is also requires more weeding practices or agricultural practices for maintenance of plantlets *i.e.* major drawback of traditional method.

Evaluation of the agronomic traits, chlorophyll content and bioactive components of *Andrographis Paniculata* under various irrigation stresses:

The most crucial element in the area where abiotic stress is prevalent is irrigation. To assess the effects of various levels of stress on the development and bioactive components of *A. Paniculata*, a pot experiment with five stress treatments and three replications was carried out. Results demonstrated the statistical significance of water stress on plant growth metrics. Findings showed that reducing irrigation supply to 50% (T_3), deficit irrigation has significant effect on *A. paniculata*'s fresh weight, dry weight, leaf to stem ratio, leaf length and width all increased by 28.29%, 45.3%, 28.45%, 27.59% and 19.54%, respectively when compared to those of the control (T_1) experiment. With just a slight drop in growth metrics (plant height, fresh and dry weight, etc.), chlorophyll content, and relative water content of leaves, rain-fed irrigation had a substantial impact on plant survival. The plant in treatment T_5 underwent extreme drought stress conditions, and the highest decrease was seen there. In contrast to the chlorophyll content and RWC, which have fallen as the shortage of water has become worse, root length and root to shoot ratio has grown massively as stress levels go up with the highest increase in rain-fed irrigation (41.97 %). Maximum accumulation of active component andrographolide (2.46%) was found in treatment T_2 (Daily irrigation) with minor decrease in Neo-andrographolide (0.19%) and 14-deoxy-11, 12-didehydroandrographolide (0.16%) as compared to control. According to the findings, *A. paniculata* may be grown in arid and semiarid regions

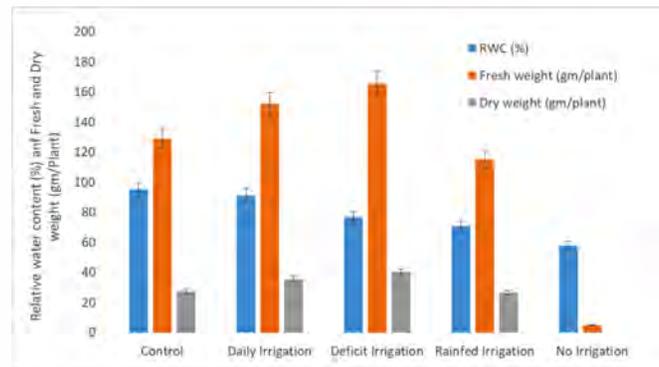
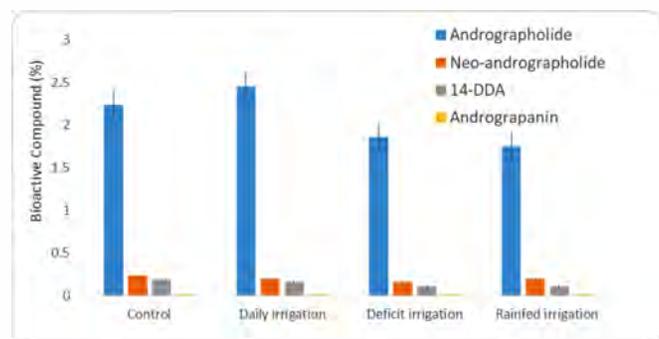


Fig.: Effects of different irrigation stress on relative water content (%), fresh and dry weight of *A. paniculata*



Effects of different irrigation stress on secondary metabolites of *A. paniculata*

as an alternative crop resistant to stress. In regions where water supply is very limited and irrigation management is subpar, deficit irrigation (T_3) may be a viable water saving strategy. This approach can help cut the overall cost of irrigation. In this study, each treatment showed measurable morphological and physiological impacts on plant attributes. Plants are challenged by water stress to evolve physiologic and biochemical defences and adaptive mechanisms. The findings show that the extreme water stress condition (T_5) has had an impact on the growth characteristics of *A. paniculata*, including plant height and yield, development of the leaves and roots, chlorophyll content, and leaf water content. By modifying the morphological features of the plant, such as reducing leaf growth and changing root function, deficit irrigation (T_3) has greatly increased the output of *A. paniculata*.

Table: Characteristic trait of *Andrographis paniculata* observed under different stress conditions

Treatment	Plant height (cm)	Fresh weight (gm/plant)	Dry weight (gm/plant)	Leaf- stem ratio	Leaf length (cm)	Leaf width (cm)
1(Control)	50.28 ± 0.36	129.16± 0.52	27.66± 1.2	1.23± 0.04	7.03± 0.09	3.07± 0.03
2(Daily Irrigation)	58.67± 0.88	152.27± 2.09	35.67± 0.33	1.46± 0.05	9.37± 0.09	4.27± 0.03
3(Deficit Irrigation)	61.00± 0.57	165.7± 1.64	40.19± 1.60	1.58± 0.04	8.97± 0.09	3.67± 0.17
4(Rainfed Irrigation)	45.67± 0.67	115.0± 1.73	26.66± 1.202	1.20± 0.02	6.42± 0.04	2.10± 0.06
5(No Irrigation)	14.00± 0.57	5.00± 0.577	0.16± 0.04	0.38± 0.06	3.47± 0.09	1.27± 0.03
C.D. (p < 0.01)	2.15**	4.66**	2.88**	0.14**	0.27**	0.23**
SEm ^(t)	0.71	1.54	0.95	0.04	0.09	0.08
C.V.(%)	2.67	2.35	6.30	6.60	2.22	4.63

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

Incidence of powdery mildew disease of mentha (var- CIM-Unnati)



Mentha crop var. CIM-Unnati and CIM-Kranti was grown by farmers in Lucknow, Barabanki, Sitapur and other adjoining areas were surveyed for incidence of powdery mildew disease. The powdery mildew incidence was found at Suratanj, Rampur and Israuli, fatehpur in Barabanki. Some other infected Mentha plants were collected, exhibit little leaf symptoms and yellowing and discoloration also found associated with Mentha plant at large area in Barabanki.



Fig. Field visit and survey of winter disease on Mentha crop in Barabanki

Survey of emerging fungal diseases on Mentha crop

On the request of farmer, a field visit was conducted on date- 02 May 2024 to the farmer field, at Akbarpur,



Fig. Field visit and survey of fungal diseases on Mentha crop in Sitapur.

Sariyya, Mahmoodabad, Sitapur. Mentha crop var. CIM-Unnati and CIM-Kranti was grown by the farmers. The infected Mentha plant shows wilting and produce wire like symptoms probably caused by fungus. The plants were completely or partial wilted. Initially infection appear on the upper portion of the plant and then spread downward. Typical die back symptoms were observed. Further some insects like snails are also causing damages to the Mentha

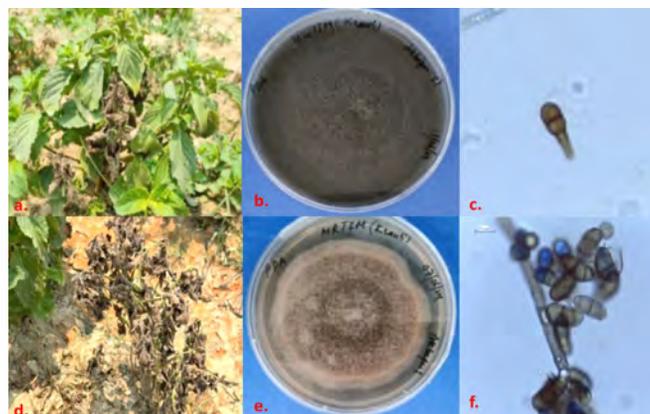


Fig. Dieback infected plants, the causative pathogen colony morphology on PDA and fungal spores.

crop was also observed. Infected plant samples were surface sterilized and plated on PDA plate for fungal growth. The plates were kept in incubator for 7 days at $26 \pm 2^\circ\text{C}$ for development of fungal colony. Microscopic slides were prepared through the spore suspension and morphology of fungal spores was observed. The spores identified as *Alternaria* spp. and *Curvularia* spp.



Dr. Kishore Babu Bandamaravuri & team

Dr. Jnanesha A C डॉ. ज्ञानेश ए सी

Augmenting root biomass productivity and reserpine level in *rauwolfia serpentina* (L.) benth. ex kurz by foliar application of seaweed extracts



Natural bio-stimulants like seaweed extracts (SWE) have significantly increased crop productivity. However, studies exploring the effect of SWE on medicinal plant productivity are scanty. The present study aimed to enhance the root biomass and reserpine content in *Rauwolfia serpentina* by foliar application of SWE. Using Randomized Block Design, a field experiment of *R. serpentina* was established and seven treatments of SWE (3 to 21%) were applied through foliar spray. Data on growth, above-ground biomass, and root biomass of mature harvested plants were recorded while dried roots were analyzed for physicochemical, total alkaloid, and

reserpine content. Among the treatments application of SWE at 6% demonstrated notably higher CD (13.20 cm) and plant spread (18.80 cm²) compared to other treatments, being comparable to SWE at 3% (CD: 12.67 cm, plant spread: 18.42 cm²). Similarly, lower SWE doses significantly improved fresh-weight root biomass by 18.16-39.17% and dry-weight root biomass by 16.53-58.23% compared to the control. Physicochemical and alkaloid content in the root was increased by lower SWE doses and found safe for drug application as per quality standards. SWE at 3% increased the reserpine content significantly by 111.11 to 137.77% over control which is a good finding for commercial drug production. Therefore, the present study recommends the foliar application of low doses of SWE (3-6%) for organic cultivation of economically important *R. serpentina* for better root biomass and reserpine production, which would be safer in use and support export trade in the root.

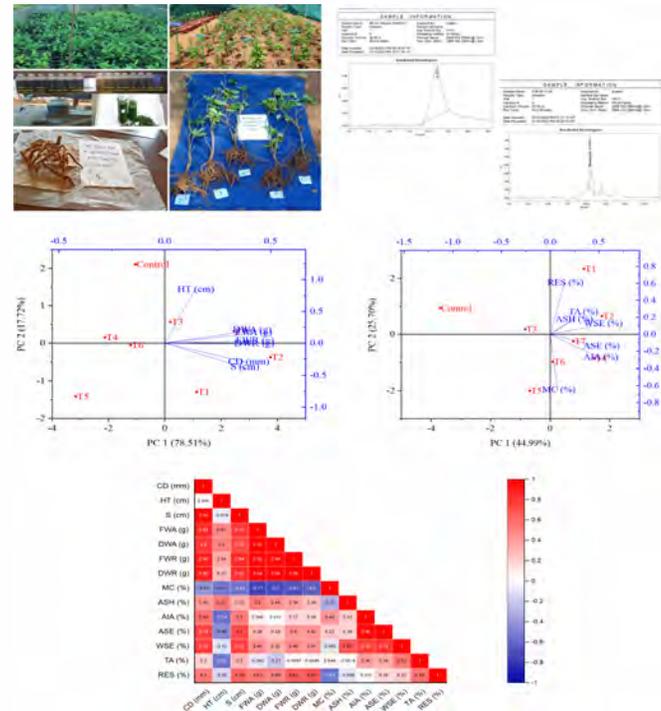


Fig.: PCA and Correlation between *Rauwolfia serpentina* (L.) Benth. ex Kurz growth, yield, and quality Parameters



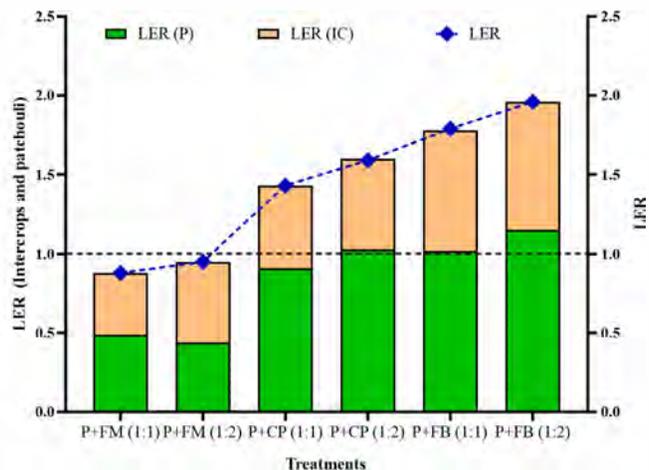
Dr. Jnanasha AC & team

Dr. Yogendra ND डॉ. योगेन्द्र एनडी

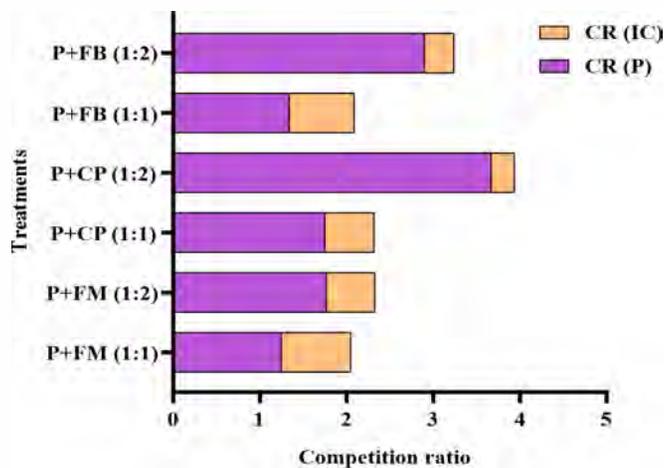
Resource use efficiency and system productivity of patchouli (*Pogostemon cablin* (Blanco) Benth) intercropping with food crops



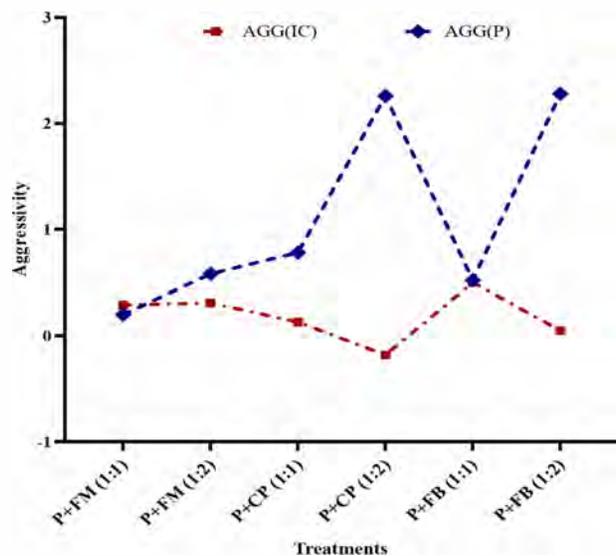
Intercropping, the practice of growing multiple crops together, improves resource efficiency by optimizing sunlight, water, and nutrient use. This approach enhances sustainability by reducing plant competition and fostering mutual benefits, often leading to higher yields. Field trials were carried out in 2022-23 and 2023-24 at CSIR-CIMAP, Research Centre, Bengaluru, to evaluate the biological and economic viability of intercropping systems (patchouli-finger millet, patchouli-cowpea and patchouli-field bean in 1:1 and 1:2 population density ratios and their corresponding sole crop) can improve patchouli productivity and economic viability. The results revealed better performance of patchouli with field bean in co-cultivation (1:2) compared to sole cropping. The combination of patchouli and field bean (1:2) yielded the highest PEY (115.38 L ha⁻¹), attributed to exceptional land utilisation efficiency (282.22%), along with a superior land equivalent ratio (1.96), land equivalent coefficient (0.93). Additionally, the ATER stood at 1.73, outperforming other cropping systems. The dominance of finger



LER of the intercropping system

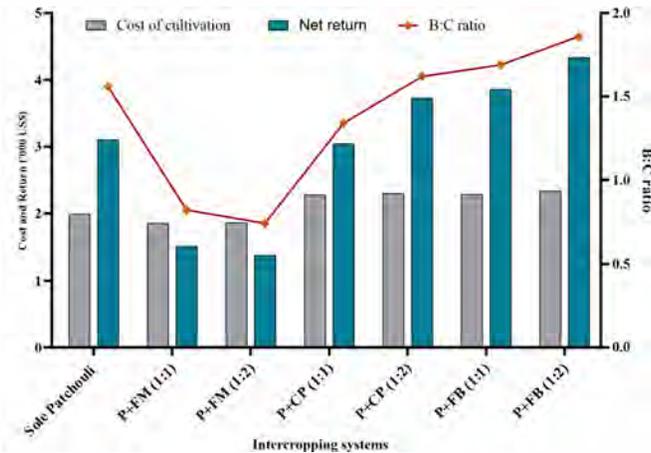


Competition ratio of the intercropping system



Aggressivity of the intercropping system

Note: P-Patchouli; FM- Finger millet; CP-Cowpea; FB-Field bean



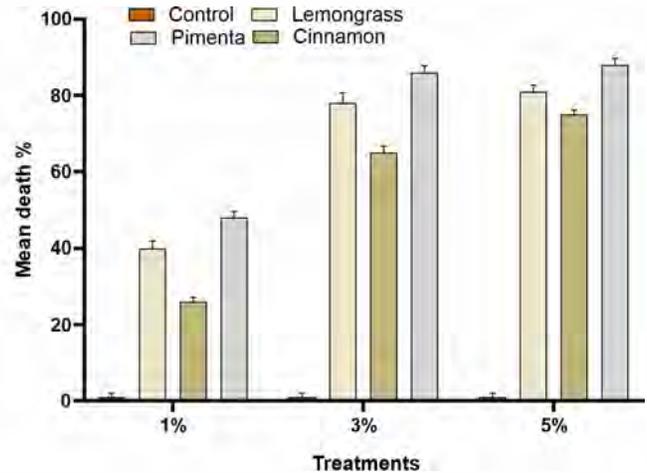
Cost-benefit analysis of crops in sole and intercropping systems.

Note: P-Patchouli; FM- Finger millet; CP-Cowpea; FB-Field bean

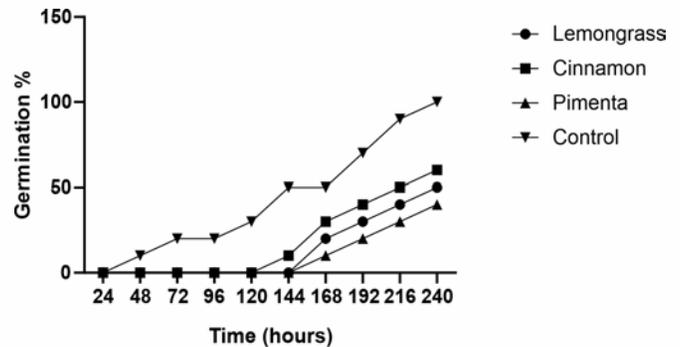
millet over patchouli is evident from the CR value of 1.25 and the A value of 0.2. Economic indices, including RVT (1.16), RNR (1.26), MAI (3260.62 US\$), REE (1.94), IA (143.89), cost-benefit ratio (1.86), and net returns (4156 US\$), were observed to be highest in the field bean intercropping system, closely followed by cowpea. The findings suggest that intercropping patchouli with field bean or cowpea enhances both biological performance and economic returns, which enhances farmer profits through improved resource utilisation efficiency. Intercropping medicinal and aromatic crops with food crops is an effective strategy for promoting sustainable farmer livelihoods and boosting the country's GDP. The global demand for essential oils continues to rise, offering significant economic opportunities for farmers and contributing to sustainable development.

Bioherbicidal efficacy of essential oils of medicinal and aromatic plants in managing *Cyperus Rotundus*- a noxious weed.

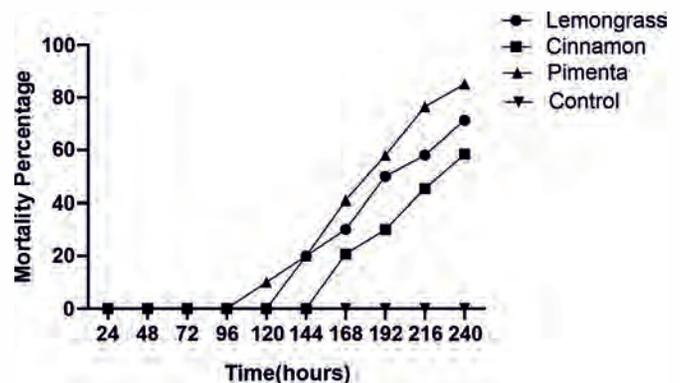
Cyperus Rotundus, a troublesome weed, poses significant challenges to crop production due to its competitive interference and resistance to various chemical herbicides. This study was designed with the objective of exploring the bio-herbicidal properties of



Effect of different essential oils at 3% Spray on Mortality percentage of *Cyperus rotundus*.



Mean Death Percentage of *Cyperus rotundus* due to spray application of essential oils at different concentrations



Timely effect of different essential oils at 3% rhizome dip on germination percentage of *Cyperus rotundus*.

different essential oils from medicinal and aromatic plants in controlling *Cyperus rotundus* as a sustainable approach to weed management. The investigation has been conducted at CSIR-Central Institute of Medicinal and Aromatic Plants Research Centre,

Bengaluru, India. The experiment was laid out in a completely randomised design (CRD), and the data were analysed using analysis of variance (ANOVA). Among 11 essential oils from MAPs tested at 5% (v/v) spray concentration, the essential oils of lemongrass, cinnamon and *Pimenta* exhibited the growth inhibition of *Cyperus*. Application of 3% *Pimenta* oil induced significant mortality of 85.14% compared to lemongrass (71.35%) and cinnamon (58.45%). Additionally, *Pimenta* (3%)

oil-treated rhizomes exhibited significantly lower germination rates (32.50%) and mean germination rates (0.120 per day) compared to lemongrass (45%, 0.129 per day) and cinnamon (56%, 0.134 per day). Evaluation of bioactive compounds revealed that eugenol from *Pimenta* oil induced a significant mean death percentage of 78%, followed by eugenol from cinnamon (72%), outperforming citral from lemongrass (52%). Furthermore, leaf anatomical analysis indicated the disruptions in cuticular wax, shrinkage of epidermal and hinge cells, and inward rolling of the leaf blade of essential oil-treated plants, evidencing the bio-herbicidal efficacy of essential oils. Overall, the findings suggest that 3% *Pimenta* essential oil shows potential in controlling *Cyperus Rotundus* with minimal or no adverse environmental effects.

Dr. Rakesh Kumar डॉ. राकेश कुमार

Application of micro-nutrients, hormone, and plant geometry to improve the quality of Chamomile (*Matricaria chamomilla* L.) flower yield



Chamomile (*Matricaria chamomilla* L.) is a medicinal and aromatic plant widely known for its therapeutic properties, including anti-inflammatory, antioxidant, and sedative effects. It is extensively cultivated for



Fig. Field view of Chamomile crop

its flowers, which are used in herbal teas, cosmetics, and pharmaceuticals. However, present experiments were planned to achieve maximum quality flower yield under optimal agronomic practices, including nutrient management, hormone application, and plant spacing. Experiments were conducted during 2024 - 2025 at the experimental farm of CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, in which three plant geometry (S₁: 30 × 30 cm; S₂: 45 × 30 cm; S₃: 45 × 45 cm) and four micronutrients [M₁: Zn (ZnSO₄ at the conc. of 0.5%); M₂: Fe (FeSO₄ at the conc. of 0.5%); M₃: Zn + Fe (ZnSO₄+FeSO₄ at the conc. of 0.5%+0.5%); M₄: Hormone (NAA) @150 ppm]. Results revealed that medium spacing (S₂: 30 cm× 45 cm) resulted in significantly greater plant height (85.41 cm), branch number (35.92) and leaf count (14,101) at harvest compared to the other geometry. The highest number of flowers plant⁻¹ (567.72) earliest flower initiation (40.56 days), and flower pickings were recorded under S₂ spacing. Interaction effects showed that S₁M₄ recorded the maximum dry flower yield (5797 kg ha⁻¹) followed by S₁M₃. The highest essential oil content (0.23%) and essential oil yield (11.48 kg ha⁻¹) were recorded under S₂. M₄ treatment yielded the highest essential oil output (10.35 kg ha⁻¹), while the S₂F₄ interaction led to the maximum oil yield of 12.84 kg ha⁻¹. The treatment combination S₂M₄ (30 cm × 45 cm + NAA) was the most economically profitable, with the highest net return (₹2,60,400 ha⁻¹) and B:C ratio (4.30).

Table. 1. Fresh flower yield (kg ha⁻¹), and essential oil yield (kg ha⁻¹) as affected by plant geometry and application of micronutrients and hormone in *Matricaria chamomilla*. L.

Spacing/ Micronutrients	Fresh flower yield (kg ha ⁻¹)					Essential Oil yield (kg ha ⁻¹)				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
S1	5363	5222	5654	5797	5509	9.82	9.56	10.35	10.64	10.09
S2	4960	4831	5122	5514	5107	10.18	10.98	11.92	12.84	11.48
S3	3574	3531	3607	3685	3599	7.14	7.25	7.41	7.58	7.34
Mean	4632	4528	4795	4999	4738	9.05	9.26	9.90	10.35	9.64
	SEm (±)			CD at 5%		SEm (±)			CD at 5%	
S	119			331		0.44			1.23	
M	51			108		0.22			0.46	
S×M	362			937		1.35			3.43	



Dr. Rakesh Kumar & team

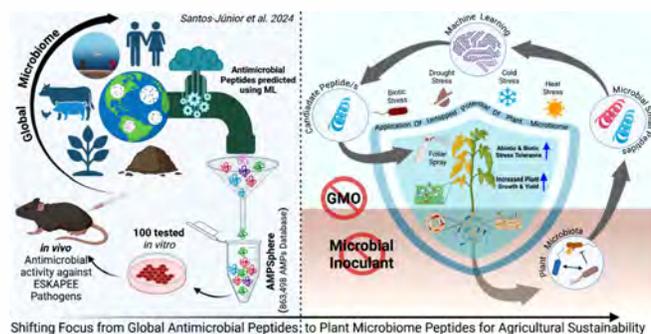
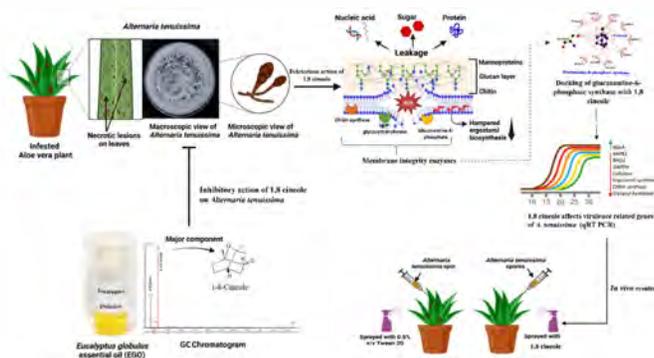
Dr. Akanksha Singh डॉ. आकांक्षा सिंह

Antifungal action of 1,8-cineole, a major component of *Eucalyptus globulus* essential oil against *Alternaria tenuissima* via overproduction of reactive oxygen species and downregulation of virulence and ergosterol biosynthetic genes



Aloe barbadensis popularly known as *Aloe vera* is an extensively cultivated medicinal herb that is significantly affected by phytopathogenic fungal infestations worldwide. Huge economic losses occur due to leaf spot disease caused by *Alternaria* spp. The use of different fungicides to manage this disease has harmful impacts on both the environment and the pharmacologically valuable components

of *Aloe vera*. In this study, the antifungal activities and mechanism of 1,8-cineole, a major component of *Eucalyptus globulus* essential oil (EGO) was investigated as the potential substitutes for synthetic fungicides against *Alternaria tenuissima*. 1,8-cineole at a minimum inhibitory concentration (MIC) of 5µL mL⁻¹ significantly reduced the ergosterol biosynthesis, along with weak cellular membrane, stunted germ tube development with hampered cell wall rigidity. At gene level, the elevated expression of NADPH oxidase A (*NoxA*) gene in fungus treated with 1,8-cineole resulted in an increased production of reactive oxygen species (ROS) that triggered cellular damage, leading to the successful mitigation of the phytopathogen. Furthermore, 1,8-cineole downregulated genes related with chitin synthase, ergosterol synthase, cellulase production, glycosyl hydrolase, RhO1 G protein (*Rho1*), cyclic AMP-dependent protein kinase subunit 1 (*AAPK1*), and glyceraldehyde-3-phosphate dehydrogenase (*GADPH*) which validated its detrimental effect on *A. tenuissima*. To further confirm the proposed antifungal mechanism, docking simulations were run between 1,8-cineole and a potential antifungal target glucosamine-6-phosphate synthase that revealed an efficient interaction with the designed protein model. Consequently, this research offers promising prospects for developing sustainable methods for safeguarding crops through the use of bioactive phyto compounds.



Unlocking microbial reservoirs for antimicrobial peptides and beyond

Antibiotic resistance has emerged as a significant global health concern that adversely affects both agricultural systems and human health. As bacteria evolve, traditional antibiotics become less effective, creating challenges for both medicine and agriculture. In farming, antibiotics are commonly used to protect crops and animals from infections, but the rise of antibiotic resistance poses serious risks. The increasing need for innovative antimicrobial agents highlights the urgent demand for new strategies to effectively combat resistant pathogens in both sectors. In the quest for novel interventions, antimicrobial peptides (AMPs) have surfaced as a promising novel category of antimicrobials. Endogenously synthesized by diverse organisms, including plants and microorganisms, AMPs present a wide-ranging spectrum of activity against bacteria, fungi, and viruses. Their distinctive mechanisms of action, frequently aimed at microbial membranes, mitigate the probability of resistance emergence, rendering them exceptionally appealing candidates for the management of harmful pathogens. AMPs, present in all life domains, are 10 to 100 amino acids long and produced via proteolysis, non-ribosomal synthesis, or genome encoding.

Recently, advances in computational techniques have accelerated the process of identifying novel antibiotics, including AMPs through machine learning, generic algorithms, and pattern recognition algorithms. Traditionally, the identification of new antibiotics or AMPs has relied heavily on the

experimental methods or bioinformatics tools, both of which require the prior identification of known targets. Nevertheless, these methodologies are frequently limited by small sample sizes and lack of environmental diversity. In the context of AMPs, we believe that the plant microbiome can be a great source for identifying environmentally safe, innovative “peptide-based biologicals” to combat harmful pests and pathogens infecting crops globally. This hypothesis is based on the observation that plant-associated microbiomes flourish in ecosystems rich in naturally occurring antibiotics and antimicrobials. We also propose that throughout evolutionary time, these microbiomes may have developed distinctive small peptides that enable them to outcompete other microbial communities in their ecological niches, thus augmenting their survival and reinforcing their symbiotic associations with the host plants. In addition, the global microbiome data can also be explored for searching small peptides including AMPs as “plant immunizers” and “growth promoters”. In addition, soil and microbiome data collected from sites affected by abiotic stressors, such as drought, temperature, and nutrient scarcity, may yield peptide-based “plant resiliencers” that could change the face and approach of combating the global climatic conditions in the future.



Dr. Akanksha Singh and team

Dr. Dipender Kumar डॉ. दीपेन्द्र कुमार

Individual and combined effect of different growing media on growth and establishment of new Indian Oregano (*Origanum vulgare* L.)



Owing to the medicinal attributes and appealing taste, the market of Oregano is being steadily increasing worldwide. Consequently, there is an immense need to enhance its production to meet this growing demand. For the cultivation of any plant, a suitable growth medium is essential, as it serves as a source and sink for essential nutrients required for plant growth and development. Recognising the importance of boosting Oregano production, research was performed to unveil the individual and combined performance of growth mediums, namely soil, vermicompost, rooting hormone, and coco-peat. The findings of the experiments revealed that all of the growth media effectively supported the plant's growth and establishment by providing necessary nutrients. However, it was observed that treatment T₇, which involved a combination of vermicompost and rooting hormone, had a particularly significant

positive impact on various agronomical attributes. This combination resulted in enhanced root and shoot growth, indicating that vermicompost primarily promotes the development of roots, shoots, and leaves, while rooting hormone positively influences root weight and overall plant development. As a result, this combination contributed to the establishment and growth of Oregano seedlings. By implementing these findings, farmers and cultivators can enhance the production of Oregano, meeting the rising demand and ensuring a sustainable supply of this valuable herb.

Evaluating the impact of irrigation methods and integrated nutrient management through different fertilizers sources on geranium production and oil quality

Rose fragrances geranium is a valuable crop with widespread applications in the fragrance, cosmetic, and flavour industries. Despite its global significance, India is experiencing a shortage in the production of geranium essential oil. Addressing this shortfall requires enhancing oil yields through improved agronomic practices, with a particular emphasis on refined nutrient and water management strategies. Traditional flood irrigation methods are inefficient,

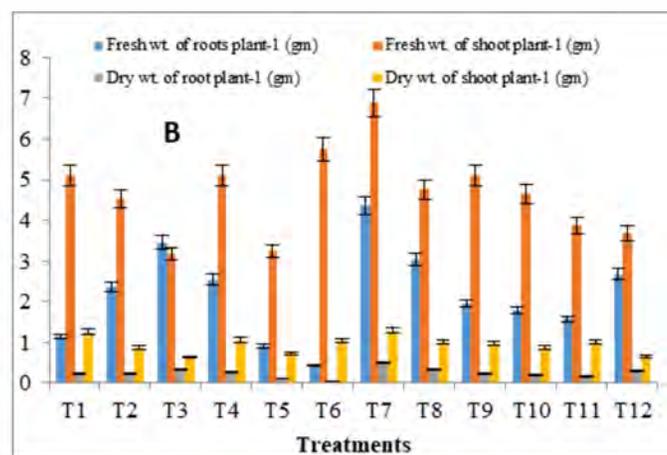
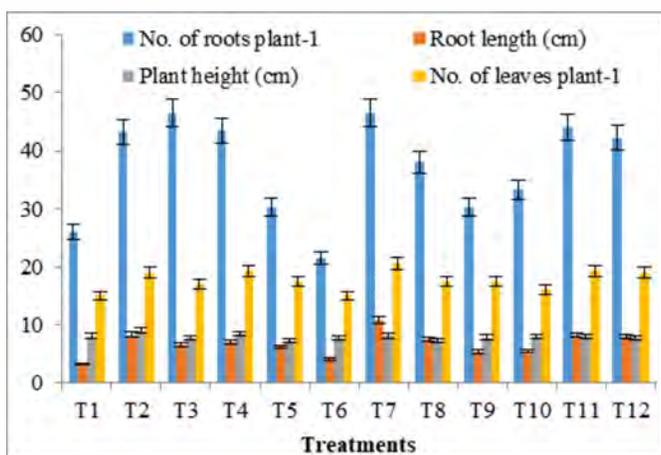


Figure: Effect of different growing media on growth and establishment of oregano cuttings

T₁: Only S; T₂: Only VC; T₃: Only CP; T₄: S+VC; T₅: S+CP; T₆: S+RH; T₇: VC+RH; T₈: CP+RH; T₉: S+VC+RH; T₁₀: S+CP+RH; T₁₁: S+VC+CP; T₁₂: S+VC+CP+RH

#VC: vermicompost; CP: cocopeat; RH: rooting hormone; S: soil

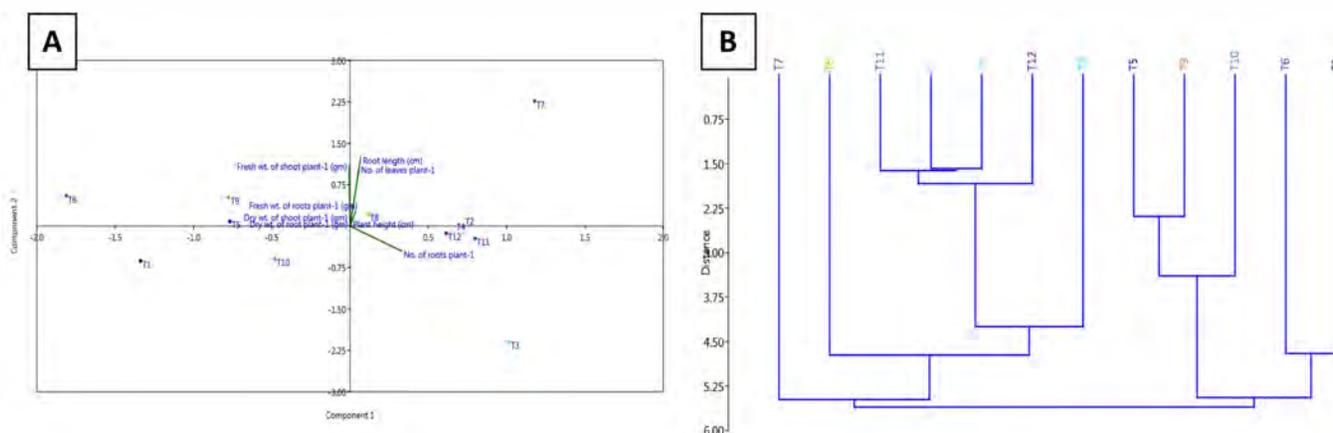


Figure: Relative performance assessment of various growth media through A) Principal component analysis B) Cluster analysis

Table 1: Effect of irrigation methods and nutrient management on growth attributes of Geranium

	Plant height (cm)		No. of Primary branches		Fresh weight/plant (g)	
	Drip	Flood	Drip	Flood	Drip	Flood
T ₁	53.67±2.1aA	55.00±1.7aA	9.67±0.33aA	10.33±0.33aB	0.34±0.01aA	0.36±0.02aA
T ₂	57.67±0.8bA	58.67±1.4bA	11.67±0.33bA	12.00±0.58bA	0.38±0.01abA	0.43±0.01bB
T ₃	59.00±1.7bcA	58.33±2.9abA	12.00±0.58bA	13.67±0.88cB	0.41±0.02bA	0.42±0.02bA
T ₄	60.33±1.2bcA	62.00±1.1bcA	12.33±0.33bA	13.67±1.20cB	0.53±0.02cA	0.63±0.03cB
T ₅	61.00±1.0bcA	63.33±1.2cA	14.33±0.88cA	14.33±0.33cdA	0.56±0.03cA	0.66±0.03cB
T ₆	62.00±2.0cA	63.67±1.7cdA	14.33±0.33cA	15.00±1.00dB	0.66±0.04dA	0.74±0.02dB
T ₇	63.67±1.4cA	67.00±2.6dA	15.67±0.33cdA	15.67±0.33dA	0.73±0.04eA	0.75±0.02dA
T ₈	64.33±1.2cA	68.00±2.5dA	16.67±0.33dA	17.33±0.33eB	0.75±0.03eA	0.77±0.02dA

Table 2: Effect of irrigation methods and nutrient management on yield attributes of Geranium

	Fresh herb yield (q/h)		Oil content (%)		Oil yield (kg/h)	
	Drip	Flood	Drip	Flood	Drip	Flood
T ₁	126.55±4.5aA	133.80±6.8aA	0.40±0.00aB	0.35±0.03A	16.87±0.6aA	15.48±0.5aA
T ₂	143.99±4.4bA	159.97±4.0bB	0.40±0.03aB	0.35±0.00aA	19.18±1.3aA	18.66±0.4aA
T ₃	151.91±7.8bA	158.11±6.3bA	0.50±0.03cA	0.50±0.00cA	25.46±2.7bA	26.35±1.0bA
T ₄	197.39±7.1cA	236.73±11.1cB	0.40±0.00aB	0.35±0.03aA	26.32±0.9bA	27.41±1.0bA
T ₅	210.77±9.5cA	248.98±10.0cB	0.45±0.03bA	0.50±0.03cB	31.60±2.3cA	41.30±0.7cB
T ₆	249.03±13.1dA	277.45±5.7dB	0.50±0.00cB	0.45±0.03bA	41.51±2.2dA	41.51±1.8cA
T ₇	275.15±16.5dA	281.38±9.0dA	0.50±0.03cA	0.50±0.03cA	45.57±1.0eA	46.72±1.2dA
T ₈	282.43±9.9dA	289.87±8.3dA	0.50±0.00cA	0.50±0.00cA	47.07±1.6eA	48.31±1.3dA

Where; T₁-control, T₂- vermicompost (VC), T₃- Farm yard manure (FYM), T₄-Recommended dose of fertilizer (RDF), T₅-VC+FYM, T₆-VC+RDF, T₇-FYM+RDF, T₈-VC+FYM+RDF

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

resulting in significant water losses and uneven distribution. In contrast, drip irrigation offers a more sustainable approach by conserving water and boosting crop yields. Additionally, the over-reliance on chemical fertilisers adversely affects soil health. Integrated nutrient management (INM), which uses organic and inorganic fertilisers simultaneously, has been demonstrated to enhance soil properties and increase crop yields more effectively than using either type of fertiliser alone. This study investigates how drip and flood irrigation systems influence the effectiveness of INM in geranium cultivation, aiming to provide insights for optimising production practices and improving both yield and quality. The current study revealed that Integrated Nutrient Management (INM) significantly outperforms single nutrient treatments or control in enhancing crop production and oil yield. Economically, the combination of Farm Yard Manure (FYM) and Recommended Dose of Fertiliser (RDF) (T_7) proves more advantageous compared to the combination of FYM, RDF, and Vermicompost (VC) (T_8), as there is no substantial difference in yield potential between them. Additionally, the study found that drip irrigation, with its superior water efficiency, achieves nearly equivalent crop production and oil yield compared to flood irrigation, even with reduced water input.



Dr. Dipender Kumar team

Dr. Priyanka Suryavanshi डॉ. प्रियंका सूर्यवंशी

Influence of nutrient management practices through microbial inoculants on productivity and soil quality of *Mentha arvensis*



A field experiment was conducted during the Zaid season 2024–25 at CSIR-CIMAP, Lucknow, to evaluate the impact of microbial inoculants and different fertilizer levels on *Mentha arvensis* (menthol mint). The study tested four levels of NPK fertilizers (0%, 50%, 75%, and 100% of the recommended dose, RDF), applied either alone or combined with a microbial consortium including *Azotobacter*, *Pseudomonas*, *Bacillus*, and Pusa VAM (arbuscular mycorrhizal fungi). The goal was to assess whether integrating

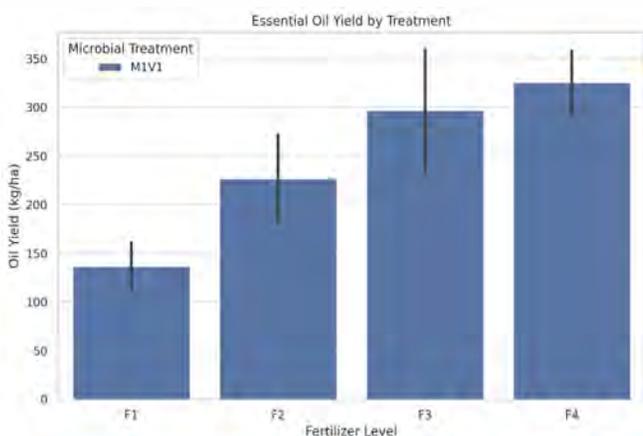
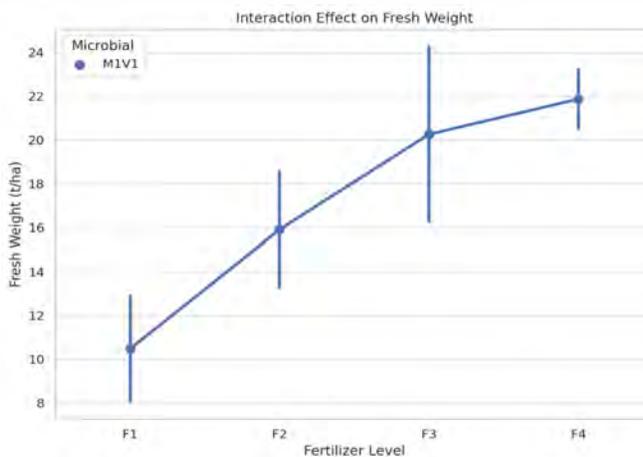




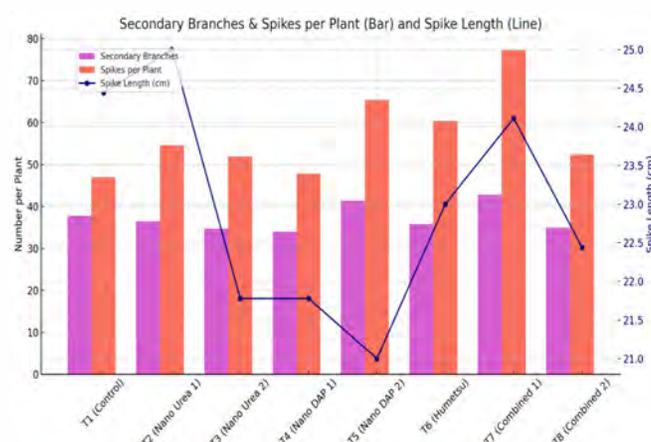
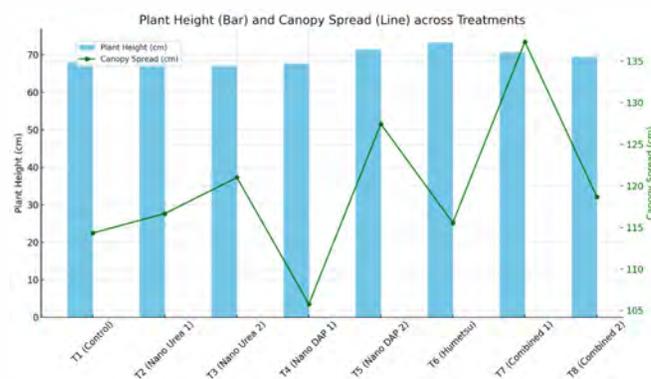
Fig.: Field photographs of the experiment

biofertilizers with reduced chemical fertilizers could maintain or enhance mint productivity and soil health. Fresh biomass yield improved significantly with increasing fertilizer application, from 10.5 t/ha at 0% RDF to 21.9 t/ha at 100% RDF. Microbial inoculation (M1V1) boosted yields across all fertilizer levels, with an average 19% increase compared to non-inoculated controls (M0V0). Notably, at 0% RDF, inoculated plots yielded 12.3 t/ha versus 8.6 t/ha in controls—a 42% increase. Even at 100% RDF, M1V1 plots slightly outperformed controls (22.8 vs. 20.9 t/ha), showing a consistent additive effect from microbial use regardless of fertilizer dose. Oil content in fresh herbage rose slightly with fertilizer input, from ~1.3% at 0% RDF to ~1.49% at 100% RDF ($p \approx 0.048$), peaking at 1.53% under 75% RDF. However, microbial inoculation did not significantly affect oil percentage (1.44% vs. 1.41%; $p = 0.38$). Oil yield, a function of both biomass and oil content, responded strongly to both fertilizer and microbial treatments. Fertilizer raised oil yield from ~136 kg/ha (0% RDF) to ~326 kg/ha (100% RDF). Microbial inoculation added a significant 23% increase overall (272 vs. 221 kg/ha; $p = 0.001$). At 75% RDF with inoculation, oil yield (~338 kg/ha) matched that of 100% RDF without

inoculation (~340 kg/ha), suggesting potential for 25% fertilizer savings without yield loss. Oil composition, especially menthol content, remained stable across treatments, with microbial inoculation having no negative effect on quality. Menthol levels stayed in the desirable $70 \pm 3\%$ range, confirming that biofertilizers can sustainably enhance yield while preserving essential oil quality.

Influence of Nano-fertilizers on growth, yield and soil quality of *Ocimum basilicum* var. CIM-Saumya

A field study was conducted during the Kharif season 2024–25 to evaluate the effect of foliar applications of nano-fertilizers and a humic acid-based biostimulant (Humetsu) on the growth and oil yield of *Ocimum basilicum* (Tulsi). The experiment included eight treatments, comprising nano urea, nano DAP, Humetsu, and their combinations at two concentration levels (4 ml/L and 6 ml/L), with the objective of identifying the most effective strategy for enhancing biomass and essential oil yield.



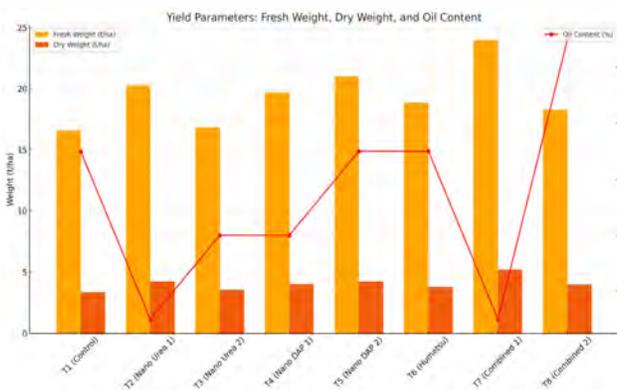
Among all treatments, T7 (a combination of nano urea conc.1 + nano DAP conc.1 + Humetsu) demonstrated the most robust plant growth and productivity. This treatment resulted in the widest canopy (137.3 cm), the highest number of secondary branches (42.8), and the maximum spike count per plant (77.2). Compared to the control (T1), T7 showed a 64% increase in spike number and an 18% increase over the best single-treatment (T5). These observations suggest a synergistic effect when nano-fertilizers and Humetsu are applied together at optimal concentrations. In terms of herbage yield, T7 again outperformed all other treatments, producing the highest fresh biomass of 24.0 t/ha and dry matter yield of 5.21 t/ha. This was a 45% improvement in fresh yield over the control (16.6 t/ha) and approximately 14% higher than the best-performing single treatment (T5 - nano DAP conc.2, 21.0 t/ha). The superior yield in T7 can be attributed to balanced nutrient supply (N and P) coupled with enhanced nutrient uptake and root development stimulated by Humetsu.

Humetsu alone (T6) also contributed to moderate growth improvement (18.9 t/ha), especially in plant height. However, without supplemental nitrogen or phosphorus, it did not significantly boost branching or spike formation. Among single treatments, T5 (nano DAP conc.2) provided the



Fig.: Pictures related to the experiment.

best morphological development and biomass, emphasizing the importance of phosphorus for Tulsi growth. In contrast, the higher dose of nano urea alone (T3) resulted in the lowest yield among treated plots, suggesting that excess nitrogen without balance can be counterproductive. In conclusion, the combination of nano urea, nano DAP, and Humetsu at lower concentrations (T7) proved to be the most effective strategy, significantly enhancing vegetative growth and yield. This integrated foliar approach offers a promising, efficient, and sustainable method to improve Tulsi cultivation.



Dr. Priyanka Suryavanshi & team

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

Discovery and description of a new species of larval parasitoid wasp, *Lemophagus larvivorus* sp. nov. (Hymenoptera: Ichneumonidae), parasitizing the asparagus beetle (*Crioceris nigroornata*), a major pest of shatavari (*Asparagus racemosus*)



The campoplegine genus *Lemophagus* is reported for the first time from India with the description of a new species, *Lemophagus larvivorus* sp. nov. (Hymenoptera: Ichneumonidae). The parasitoids were recovered from larvae of the chrysomelid beetle *Crioceris nigroornata*, a destructive pest of shatavari (*Asparagus racemosus*), an important medicinal plant widely used in ayurvedic formulations for its rejuvenating, adaptogenic, and immunomodulatory properties. The new species was compared with all known extant species, and its taxonomic validity is strongly supported by molecular evidence. A concatenated maximum likelihood phylogenetic tree based on COI + 28S gene fragments is presented, incorporating available molecular data from related species and confirming its distinct identity. The asparagus beetle is emerging as a major pest of Shatavari cultivation in India. Both adults and larvae feed on tender shoots, leaves, and growing tips, causing defoliation, drying of shoots, reduced biomass, and significant yield losses. Its infestation poses a serious threat to the sustainable production



Figure: *Lemophagus larvivorus* sp. nov. the newly described larval parasitoid of asparagus beetle

and quality of Shatavari, a crop of high economic and medicinal value. A natural parasitism rate of 12.5% by *L. larvivorus* was recorded in the study, suggesting its potential for future use in biological control after further research and field evaluations. This discovery also enriches the understanding of parasitoid diversity associated with medicinal crops and provides insights into ecological interactions within Shatavari agro-ecosystems. It underscores the importance of exploring native natural enemies for the development of integrated pest management (IPM) strategies in medicinal plants.

Natural mortality factors of *Helicoverpa armigera* in menthol mint (*Mentha arvensis*): Role of natural enemies in sustainable pest regulation

Menthol mint (*Mentha arvensis* L.) is one of the most important aromatic and medicinal crops cultivated in India, contributing significantly to the essential oil industry and rural livelihoods. However, its production is severely affected by *Helicoverpa armigera* (Lepidoptera: Noctuidae), a highly polyphagous and destructive pest. This insect causes substantial yield losses by feeding on buds, flowers, and developing capsules, posing a major challenge for sustainable menthol mint cultivation. To explore eco-friendly management options, an assessment was conducted to document the natural mortality factors of *H. armigera*, with a particular focus on natural enemies active in menthol mint ecosystems. A rich diversity of parasitoids was recorded, primarily belonging to Hymenoptera and Diptera. Among hymenopteran parasitoids, egg parasitoids such as *Trichogramma chilonis* were frequently encountered, playing a significant role in suppressing the pest before larval emergence. Larval parasitoids included *Campoletis chloridae* and *Cotesia* sp., which were observed parasitizing the early instar larvae of *H. armigera*. In addition, dipteran parasitoids, particularly tachinid flies, were also recorded, contributing to natural pest mortality at the larval and pupal stages. Predators of *H. armigera* were represented by a diverse assemblage of beneficial arthropods. Hymenopteran predators



Fig.: Asparagus beetle (*Crioceris nigroornata*) feeding on tender Shatavari (*Asparagus racemosus*) leaves

Fig.: Larvae of asparagus beetle damaging Shatavari shoots

(e.g., wasps) were commonly observed actively attacking larvae. Coleopteran predators (ladybird beetles, rove beetles ground beetles) fed on eggs and small caterpillars, while hemipteran predators like predatory stink bugs and reduvids preyed upon the larvae. Other important groups included lacewing (Neuroptera), earwig (Dermaptera), and spiders (Arachnida), all of which contributed collectively to the natural regulation *H. armigera* populations. The study highlights the crucial role of natural enemies in regulating *H. armigera* populations within menthol mint ecosystems. By conserving and enhancing these biological control agents, farmers can adopt **integrated pest management (IPM)** strategies that minimise reliance on chemical pesticides. Such approaches not only reduce production costs but also promote environmentally friendly and sustainable cultivation of menthol mint.



Fig.: Yellow paper wasp (*Polistes wattii*) preying on *Helicoverpa armigera*



Dr. Santoshkumar Kedar & Team

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

Development of vetiver (*Vetiveria Zizanioides*) root digging equipment and optimization of its operating parameters in the field condition



Vetiver (*Chrysopogon Zizanioides*) is an important aromatic crop producing potential essential oil from its roots, which has multiple uses in the medicinal, soap, cosmetics and perfumery industries. But harvesting these roots from the soil is a main challenging task as its roots grow more than 50 cm deep. Hence, this study has explored the development and performance evaluation of suitable digging equipment for harvesting vetiver roots. The developed digging equipment has been evaluated its performance at three levels of rake angle (15, 20,



Fig.: Vetiver root digging equipment in the field condition

Crop Production & Protection

25 degrees), three levels of forward speed (0.72, 1.2 and 1.8 km/h) and three levels of conveyor speed (0.55, 0.69 and 0.83 m/s). The recorded results show that the forward speed and rake angle of the digging equipment affect the performance parameters significantly. The maximum harvesting efficiency of digging equipment was observed as 80 % at a forward speed of 0.72 km/h with a conveyor speed of 0.83 m/s and a rake angle of 25 degrees. Furthermore, the fuel consumption increases with an increase in rake angle and forward speed, whereas no variation was observed with respect to a change in conveyor speed. Maximum soil separation efficiency (71 %) was observed at a lower forward speed of 0.72 km/h with a conveyor speed of 0.55 m/s and a rake angle of 15 degrees. The developed digger can harvest one hectare of vetiver roots in 50 hours.



Dr. Anandakumar T.M. & team

Dr. B. Shivanna डॉ. बी. शिवन्ना

Effect of different doses of sea weed extract on seed germination and growth of *Cassia angustifolia* (Senna).



The experiment was conducted at CSIR-CIMAP, Research Centre, Hyderabad, to evaluate the effect of different doses of seaweed extract (SWE) on germination, growth, and yield parameters of Senna (*Cassia angustifolia*). The study was laid out in a randomised complete block design (RCBD) with three replications to ensure robust statistical analysis.

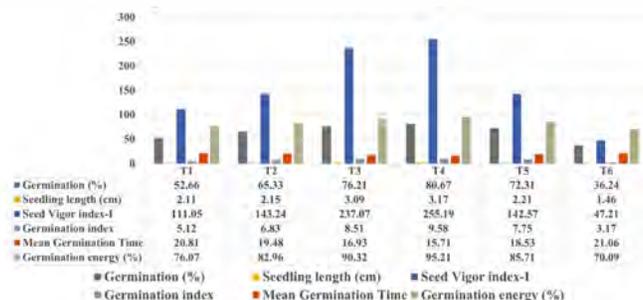


Fig.: Effect of foliar application of different dose of sea weed extractants on germination attributes of Senna (*Cassia Angustifolia*)

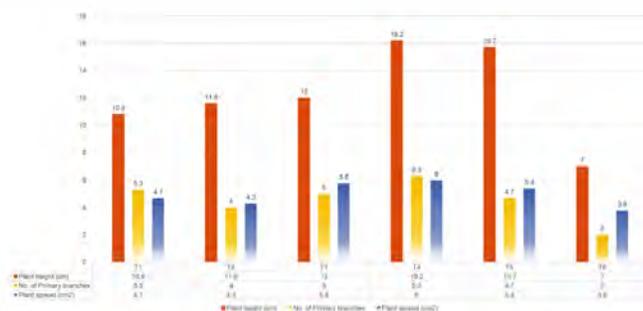


Fig.: Effect of foliar application of different dose of seaweed extractants on growth parameters of Senna

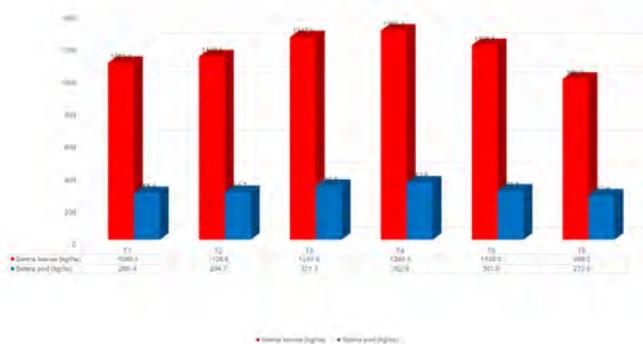


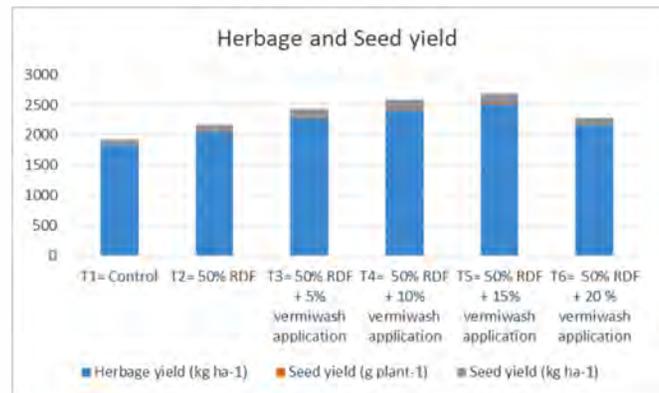
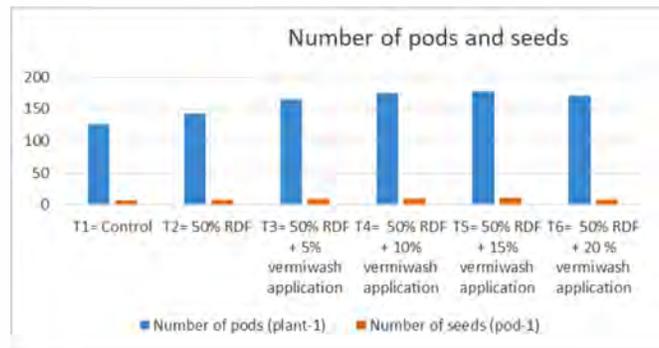
Fig.: Effect of foliar application of different dose of seaweed extractants on yield parameters of Senna

The treatments included six levels of seaweed extract: T₁: SWE @ 10%, T₂: SWE @ 8%, T₃: SWE @ 6%, T₄: SWE @ 4%, T₅: SWE @ 2%, and T₆: Control (no seaweed extract). The results revealed that the application of SWE @ 4% significantly enhanced germination parameters, achieving the highest germination percentage (80.67%), seedling length (3.17 cm), seed vigour index (255.19), germination index (9.58), and germination energy (95.21%), while recording the lowest mean germination time (15.71 days) among all treatments. These were closely followed by SWE @ 6%, which recorded corresponding values of 76.21%, 3.09 cm, 237.07, 8.51, 90.32%, and 16.93 days,

respectively. Similarly, SWE @ 4% also resulted in superior growth and yield attributes, including maximum plant height (15.7 cm), plant spread (5.3 cm), leaf yield (1028 kg/acre), and pod yield (282 kg/acre). The findings suggest that SWE at an optimal concentration of 4% is highly effective in promoting the germination, growth, and yield of Senna plants.

Evaluation of different levels of Vermiwash application on yield of Kalmeg (*Andrographis paniculata*).

The experiment was conducted at CSIR-CIMAP, Research Centre, Hyderabad, with the objective of evaluating the different levels of vermiwash application at the seedling and flowering stages on the growth and yield of Kalmeg. The study was laid out in a randomised complete block design (RCBD) with three replications. The treatments of the study are as follows: T₁ (control), T₂ (50% RDF), T₃ (50% RDF+ 5% vermiwash), T₄ (50% RDF + 10% vermiwash), T₅ (50% RDF + 15% vermiwash) and T₆ (50% RDF+ 20% vermiwash). The results revealed that the application of vermiwash significantly increased the growth and yield parameters. The maximum fresh weight and dry



weight was observed in T₅ followed by T₄. Similarly, the maximum herbage and seed yield was observed in T₅, followed by T₄. The application of 50%RDF + 15% vermiwash was found to significantly increase the growth and yield of kalmegh.

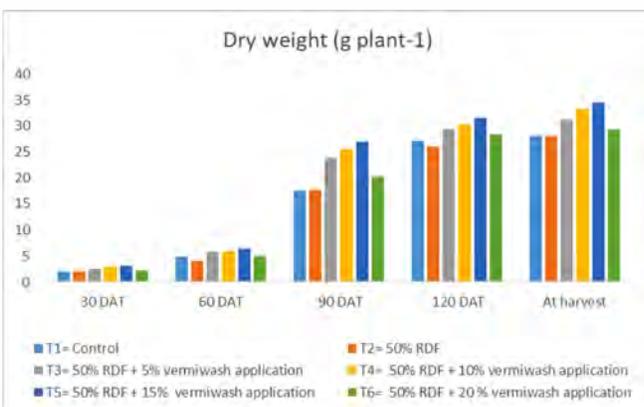
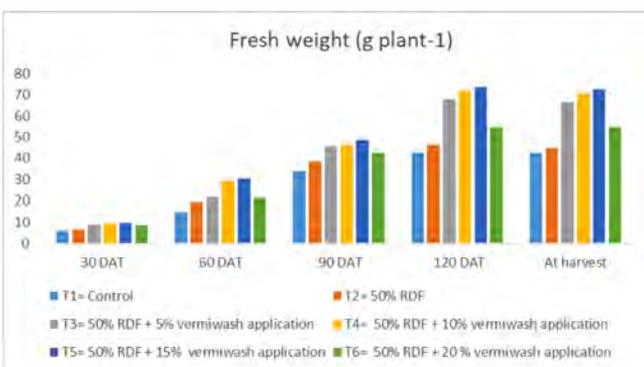
Dr. Yugander Arra डॉ. योगेन्द्र अर्रा

Molecular characterisation of Ashwagandha leaf spot disease



Ashwagandha (*Withania somnifera*) is a highly esteemed medicinal plant cultivated widely in India and other parts of the world for its therapeutic properties. Renowned for its role in traditional medicine. Ashwagandha is rich in pharmacologically active compounds, especially withanolides. However, the productivity and quality of withanolides are increasingly threatened by leaf spot disease caused by the *Alternaria alternata* fungal pathogen. This disease weakens plant health and reduces root yield and the biosynthesis of vital secondary metabolites, posing a serious challenge to commercial cultivation.

The present investigation was undertaken to isolate and identify the fungal pathogen responsible for



leaf spot in Ashwagandha, and to understand its interaction with the host. Leaf spot diseased leaf samples were collected from the field at CSIR-CIMAP, Lucknow, and six isolates were established from different varieties. These isolates exhibited significant morphological traits typical of *A. alternata*, including obclavate conidia with both transverse and longitudinal septa. These six isolates were also proven to be virulent by showing the typical leaf spot symptoms upon artificial inoculation with individual isolates on Ashwagandha cultivars (Fig.).

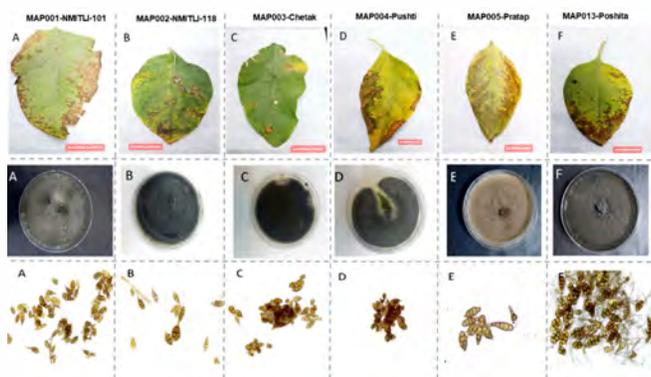


Fig.: Phenotypic characters of *A. alternata* isolates

Six *A. alternata* isolates were further sequenced using ITS-specific primers (ITS4 and ITS5) by Sanger sequencing. They were confirmed as *A. alternata*, which individually shared 88-100% sequence identity with *A. alternata* strains reported earlier. This study demonstrates that combining morphological and molecular tools provides a reliable approach to accurately diagnosing Ashwagandha leaf spot disease. The findings served as an initial step toward understanding the host-pathogen interaction at the molecular level to identify virulent/avirulent effector proteins from *A. alternata* by whole genome sequencing, which is in progress (Fig.2).

Identification of sugar transporters from *Cymbopogon flexuosus* (Lemongrass) and *Withania somnifera* (Ashwagandha)

Sugar transporters play a diverse role in plant development, grain filling, and disease resistance. To date, the role of sugar transporters of Lemongrass has not been reported. Therefore, functional characterisation of these sugar transporters,

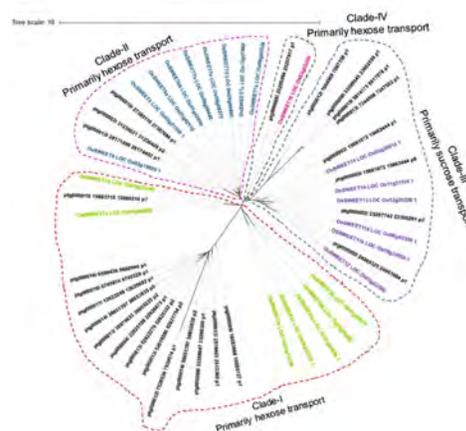


Fig.: Phylogeny of SWEET gene family members in *Cymbopogon flexuosus*, and rice (Os).

especially clade-III transporters, is very important to dissect the role during biotic stress. We analysed whole genome sequencing of Lemongrass (Krishna cultivar), and a total of 26 sugar transporters were identified that were mainly divided into SWEET transporters (9 proteins), STP/MST-like transporters (7 proteins), STP polyol transporters (5 proteins), Triose phosphate sugar transporters (4 proteins) and MFS like sugar transporters (1 protein) based on domain prediction and phylogenetic relationship compared to Rice, Arabidopsis and Maize, (Fig. 3).

The Ashwagandha transcriptome data were retrieved from the NR database and analysed to identify and determine the role of various sugar transporters from leaf tissues. Strikingly, the leaf transcriptome data revealed that Ashwagandha possesses multiple sugar transporters (Fig. 4). Validation of identified sugar transporters from Lemongrass and Ashwagandha are in progress.



Dr. Yugander Arra & team

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

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 Division

L to R: 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.



Plant Breeding & Genetic Resource Conservation

During this period, division has published 27 scientific papers in reputed journals. Division received one copyright of Herbal Health Garden. In this period, various CSIR (02) and 09 GAP/CNP/SSP (09) projects were going on in the division. Three Ph.D was awarded from the division. One of the scientists from the division, Dr. Birendra Kumar conferred with Dr Manmohan Attavar Gold Medal Award in Floriculture-2024 by Indian Academy of Horticultural Sciences, New Delhi, Global Scientist Award-2024 / Outstanding Scientist Award-2024 for outstanding contribution and recognition in the field of Genetics & Plant Breeding by Agriculture, Environment, Entrepreneur, and Technology Development Society (AEETDS), Lucknow, Life Time Achievement Award for outstanding contribution in the field of Genetics & Crop Improvement of medicinal and aromatic crops given by Glocal Environment and Social Association, New Delhi. He also received ISFGR Fellowship in PGR-2023, NABS Fellowship-2023 and NESAFellowship-2024. Dr Gunjan Tiwari received Young Scientist Award (2024) by National Environmental Science Academy (NESAA), New Delhi.

In a study, the nature and amount of variability and correlations were examined in the ten traits of twenty collections of clove basil was examined. The OC18, 14, and 16 genotypes performed best for these most economically substantial traits. As a result, it is recommended that these three genotypes be grown extensively throughout India. Another study, selection of stable genotype for qualitative productivity and rhoifolin content in the Ayurvedic herbal medicinal plant *Uraria picta* (Jacq.) Desv. ex DC was done. The genotypes UP-50, UP-49, and UP-47 were shown to be suitable for use in *U. picta* breeding programs to produce more steady lines with improved performance. A noble mutant of *Mentha piperita* that complements US-type peppermint oil, characterized by higher oil yield and improved oil quality, specifically targeting a menthofuran content of 36–46% and less than 5% menthofuran was developed during this period. Induced mutagenesis was achieved through gamma radiation, with seeds

from a menthofuran-rich variety CIM-Indus. Another study evaluated five candidate DNA barcode regions—three plastid (*matK*, *rbcL*, *trnH-psbA*) and two nuclear (*ITS*, *ITS2*)—to develop a reliable molecular authentication system for *Ocimum* species. Overall, *trnH-psbA* emerged as the most promising barcode for authenticating *Ocimum* species, though hybrid taxa remain unresolved, indicating the need for future development of more robust markers. During this period, development of functional mutant genetic screens and *Anacyclus pyrethrum* breeding line with high Pellitorin content (~1.2%) and fresh root yield was done. Also, CSIR-CIMAP as DUS Test center for Ashwagandha on Ashwagandha (*Withania somnifera* (L.) Dunal. received two entries of ashwagandha from PPVFRA, Government of India under DUS testing.

Another present study explored the phytocannabinoids and terpenes diversity in *Cannabis sativa* collected from different states of northern. During this period, Rhizome thickness influences the oil yield and oil constituents in *Homalomena aromatica* (Spreng.) Schott was studied. It concludes that the NR grade rhizomes are better for higher oil yield and also for high linalool and terpinene-4-ol content than the TR grade of *H. aromatica* rhizomes. Also, identification of pollen sources or paternal parent through molecular markers in citronella half-sib progenies was done. In addition, Induced mutagenesis in menthol mint (*Mentha arvensis* L.) using γ -radiation for the improvement of herb and essential oil yield was done. The integrative multivariate analysis of agro-chemical and genotypic traits in Indian catmint (*Nepeta cataria* L.) half-sib populations was also performed. The study highlights the rich genetic and chemical diversity within *N. cataria* half-sib populations and provides valuable insights for targeted selection, conservation, and breeding programs. The genetic diversity in Indian germplasm and breeding lines of Muskdana (*Abelmoschus moschatus* L.) was studied which lays the foundation for initiating focused breeding programs and developing improved cultivars for commercial cultivation.

Dr. Anil Kumar Gupta डॉ. अनिल कुमार गुप्ता

The genetic diversity and chemical profiling of clove basil collections



The nature and amount of variability and correlations were examined in the ten traits of twenty collections of clove basil. The 10 traits' correlation coefficients revealed that, at the genotypic and phenotypic levels, essential oil content (%) (EOC) and essential oil yield (ml) (EOY) had a strong and positive correlation. Both genetically and phenotypically, there was a positive correlation between the plant height (cm) (PH) and petiole leaf length (cm) (PLL). These characteristics were therefore determined to be useful selection criteria. There were also notable, positive, and significant associations between leaf length (cm) (LL) and inflorescence length (cm) (IL), leaf length (cm) (LL), and leaf width (cm) (LW). Additionally, significant and positive associations between EOY, LW, and IL were found. Except for one trait, leaf width (cm), which was medium (76.21%), all characteristics demonstrated high heritability in the broad sense (\hat{h}^2_b), ranging from 80.45% to 98.82%. On the other hand, all features ranging from 0.31% to 5.01% demonstrated the poor genetic advance of the study, except for two: medium plant height (24.39%) and high herb production per plant (g) of 88.99%. All other traits, on the other hand, ranged from 80.45% to 98.82%, except one medium trait, leaf width (cm), of 76.21%. Just one characteristic herb yield per plant

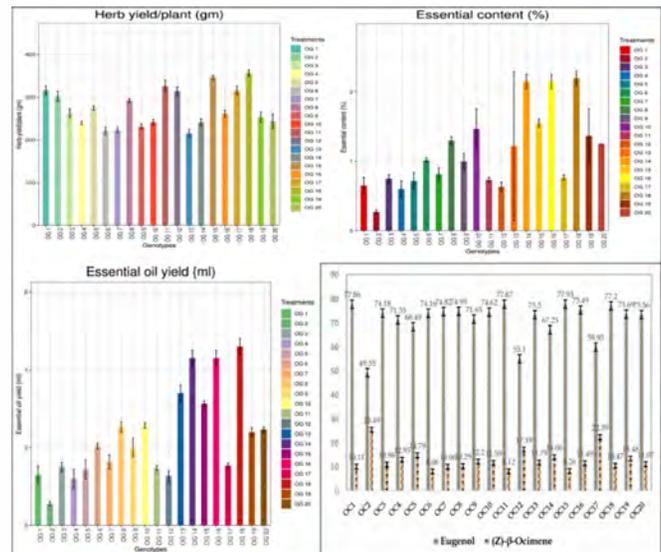


Fig. : Mean performance of different economic traits in the genotypes of *Ocimum*

(g) (HYPP) exhibited the maximum genetic advance and high heritability ($\hat{h}^2_b = 98.00$, $GA = 88.99\%$). The genotype OC2 was the lowest essential oil yielder, while the top five genotypes for high essential oil yielders were OC18, OC14, OC13, OC15, and OC10. For the essential oil content, the genotypes were ranked from top to lowest as follows: OC18 > OC14 > OC16 > OC13 > OC15, and OC2; for the eugenol content, the genotypes were OC15 > OC11 > OC1 > OC18 > OC16, and OC2. These traits showed high heritability (\hat{h}^2_b), significant genetic advance over the mean (GAM%), and favorable relationships. The OC18, 14, and 16 genotypes performed best for these most economically substantial traits. As a result, it is recommended that these three genotypes be grown extensively throughout India.



Dr. Anil Kumar Gupta & his team



Dr. Birendra Kumar डॉ. बीरेन्द्र कुमार

Selection of stable genotype for qualitative productivity and rhoifolin content in the Ayurvedic herbal medicinal plant *Uraria picta* (Jacq.) Desv. ex DC:



Uraria picta is a medicinally important leguminous plant widely recognized in Ayurveda for its therapeutic properties, particularly in tissue regeneration, wound healing, and anti-inflammatory applications. In order to identify better genotypes to facilitate breeding and realize its planned cultivation, a systematic study was conducted to investigate the changes in adaptation responsiveness of its 24 diverse genotypes of over 4 years. The regression coefficient (bi) and s^2di values were non-significant for numerous genotypes. One of the 24 genotypes studied, UP-50, was shown to be an appropriate and stable genotype for all variables except rhoifolin (%) in roots, where genotype UP-47 was the highest yielder over all 4 years and conditions. The present findings show that the parameters influencing

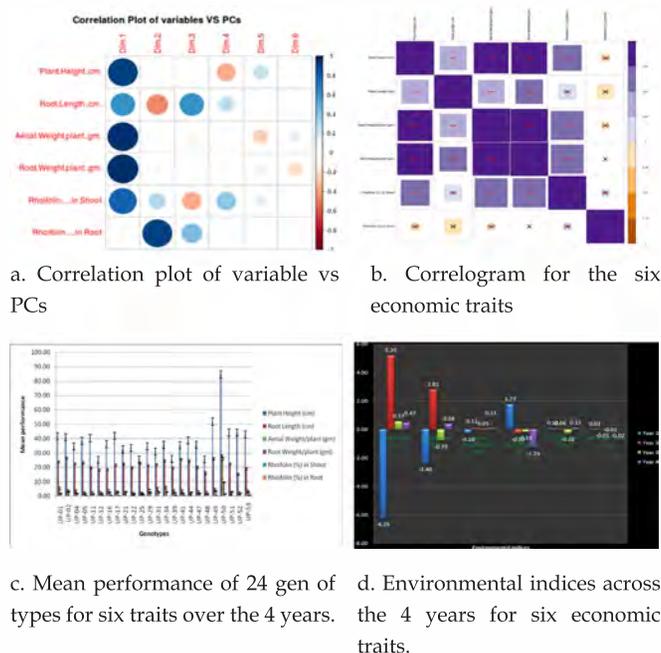


Fig.: (a-d). a. Correlation plot of variable vs PCs, b. Correlogram for the six economic traits ($P < 0.05$; X marked values = no significant), c. Means performance of 24 genotypes for the six traits, d. Environmental Indices across the four years for the six economic traits of *U. picta*

stability performance differ by genotype. To breed stable genotypes, it is important to consider all three stability indices (\bar{x} , b_i , and s^2di). The genotypes UP-50, UP-49, and UP-47 were shown to be suitable for use in *U. picta* breeding programs to produce more steady lines with improved performance. *The Nucleus*. <https://doi.org/10.1007/s13237-025-00545-2>. [Impact Factor: 2.60]

Unlocking the yield & quality potential of peppermint (*M. piperita* L.) for the study of genetic variability through Induced mutagenesis:

Mentha piperita L. commonly known as peppermint, is valued for its essential oil, which is rich in menthol and has various applications. However, challenges such as low oil yield and poor oil quality have limited the potential of peppermint cultivation. This study aimed to develop a noble

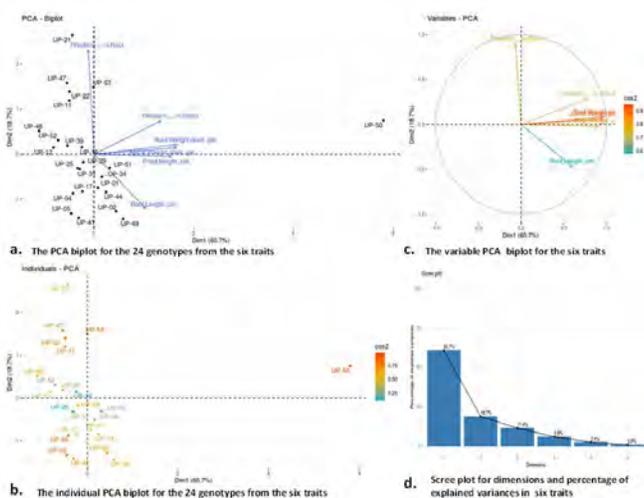
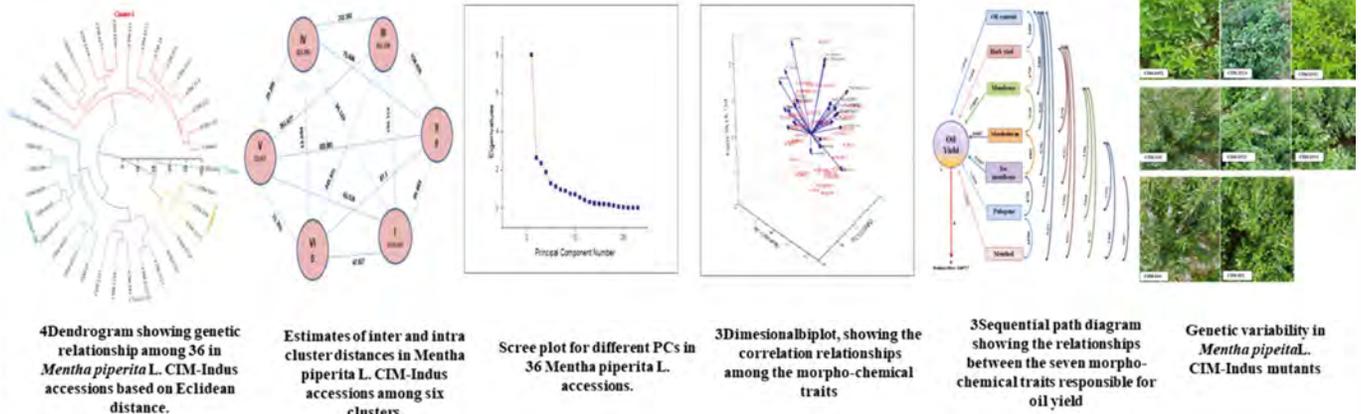


Fig. : (a-d). a. Principal component analysis generated biplot, b. The individual PCA biplot, c. The variable PCA generated biplot, d. Scree plot for dimensions and percentage of explained variances for the 24 genotypes from the six economic traits in *U. picta*



4Dendrogram showing genetic relationship among 36 in *Mentha piperita* L. CIM-Indus accessions based on Euclidean distance.

Estimates of inter and intra cluster distances in *Mentha piperita* L. CIM-Indus accessions among six clusters.

Scree plot for different PCs in 36 *Mentha piperita* L. accessions.

3Dimensional biplot, showing the correlation relationships among the morpho-chemical traits

3Sequential path diagram showing the relationships between the seven morpho-chemical traits responsible for oil yield

Genetic variability in *Mentha piperita* L. CIM-Indus mutants

mutant of *Mentha piperita* that complements US-type peppermint oil, characterized by higher oil yield and improved oil quality, specifically targeting a menthol content of 36–46% and less than 5% menthofuran. Induced mutagenesis was achieved through gamma radiation, with seeds from a menthofuran-rich variety CIM-Indus of *Mentha piperita* subjected to varying doses (10 Gy, 20 Gy, 30 Gy, 40 Gy, 50 Gy, 70 Gy, 90 Gy, and 110 Gy). A broad range of diversity was observed among the resulting mutant lines, leading to the selection of improved lines. Notably, CIM-I452 exhibited the highest oil yield along with substantial herb yield, followed by CIM-I332 and CIM-I324.

Lines CIM-I43, CIM-I44, CIM-I451, CIM-I32, CIM-I34, CIM-I332, and CIM-I452 were identified as menthol-rich, while CIM-I311 and CIM-I431 were menthofuran-rich. Additionally, CIM-I322 and CIM-I331 were recognized as limonene-rich lines. Because of the high menthol content and low amount of menthofuran, the mutant lines CIM-I452, CIM-I332, and CIM-I324 showed widely acceptance peppermint oil quality. These selected mutant lines exhibit promising mutant lines that may be utilised as parent lines for upcoming recombinant breeding or hybridization initiatives.



Dr. Birendra Kumar & his team

Dr. V. Sunderasan डॉ. वी. सुंदरेसन

Evaluation of the plastid and nuclear DNA barcodes in genus *Ocimum* towards quality assurance in the herbal industry



The genus *Ocimum* (Lamiaceae), commonly known as basil, holds immense medicinal and commercial importance but faces major challenges in species

authentication due to high morphological similarity, polyploidy, and frequent hybridization. These factors, along with the widespread trade of dried and powdered material, make traditional identification methods unreliable and prone to adulteration. Our study evaluated five candidate DNA barcode regions – three plastid (*matK*, *rbcl*, *trnH-psbA*) and two nuclear (*ITS*, *ITS2*) – to develop a reliable molecular authentication system for *Ocimum* species. Using 25 accessions representing seven species, we assessed the barcodes through PCR amplification, sequencing success, pairwise genetic distances, Wilcoxon tests, TaxonDNA analysis, and Neighbor-Joining (NJ)

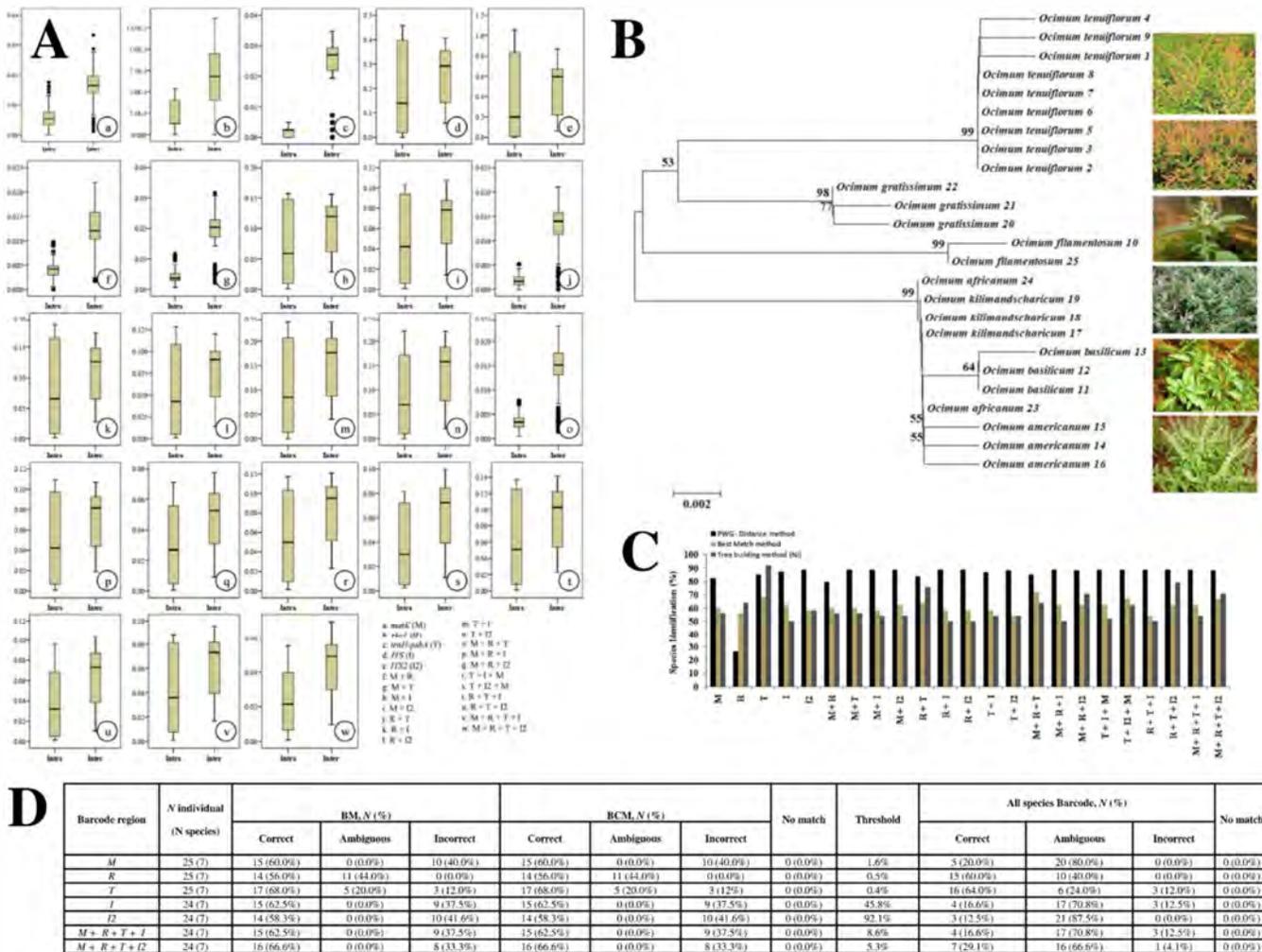


Fig.: A: Comparison of the distribution ranges of inter- and intra-specific distances using boxplots, B: Neighbor-joining tree for *Ocimum* using the *trnH-psbA* DNA barcode with the K2P distance model, C: Species discrimination rates using different approaches (PWG, Neighbour-joining, Best match). R, *rbcl*; M, *matK*; T, *trnH-psbA*; I, *ITS*; I2, *ITS2*, D: Identification success rates of all possible datasets using TAXONDNA program under 'best match' and 'best close match' and 'all species barcode' methods.

phylogenies. Results showed that all plastid markers amplified and sequenced with 100% success, while *ITS* regions had slightly lower sequencing efficiency. Among single loci, *trnH-psbA* exhibited the highest discriminatory power (92% resolution in NJ analysis) due to its low intra- and high interspecific divergence. Multi-locus combinations did not significantly improve species discrimination. Nuclear markers (*ITS*, *ITS2*) demonstrated high variability but were less consistent due to polyploidy and hybridization effects. Overall, *trnH-psbA* emerged as the most promising barcode for authenticating *Ocimum* species, though hybrid taxa remain unresolved, indicating the need for future development of more robust markers.



Dr. V Sunderensan & his team

Dr. Tripta Jhang डॉ. तृप्ता झंग

Development of functional mutant genetic screens and *Anacyclus pyrethrum* breeding line with high pellitorin content (~1.2%) and fresh root yield



Anacyclus pyrethrum (Asteraceae), is an indispensable medicinal plant of Ayurvedic, Unani, Siddha, Traditional Arabic and Islamic medicine (TAIM) explored for its local anaesthetic, anti-depressive, anticancer, sialagogue, antiviral bioactivities which is primarily imported in India. With an objective of breeding for high pellitorin and root yield, chemical mutagenized populations were subjected to recurrent selection from 2015-2025. The base population has 0.02% pellitorin content which has been enhanced to around 1.2mg/g and potential fresh root yield of 14.69t/ha and 6.614t/ha dry root yield as compared to the local check (0.2mg/ gm) with high dry root yield breeding line in *Anacyclus pyrethrum* (Akarkara)

for potential release as the variety for farmers and pharmaceutical industries (In House Divisional Activity under MLP02): Erect growth habit, a key domestication trait, in a natural procumbent, root crop, is a vital determinant for root productivity/ per unit area enhancement. An erect growth habit functional mutant in *Anacyclus pyrethrum* has developed whose inheritance and characterization studies are underway

CSIR-CIMAP as DUS Test center for Ashwagandha (*Withania somnifera* (L.) Dunal

As Ashwagandha DUS test guidelines are now gazette notified by the Government of India, plant varieties of Ashwagandha (*Withania somnifera* (L.) Dunal. are now open for registration at PPVFRA, Ministry of Agriculture and Farmers Welfare, Government of India. Under this, two entries of ashwagandha received from PPVFRA, Government of India are under DUS testing.

Also all national released Ashwagandha varieties in commerce using seed morphometric,



Fig. : DUS Test center for Ashwagandha (Entries tested two)

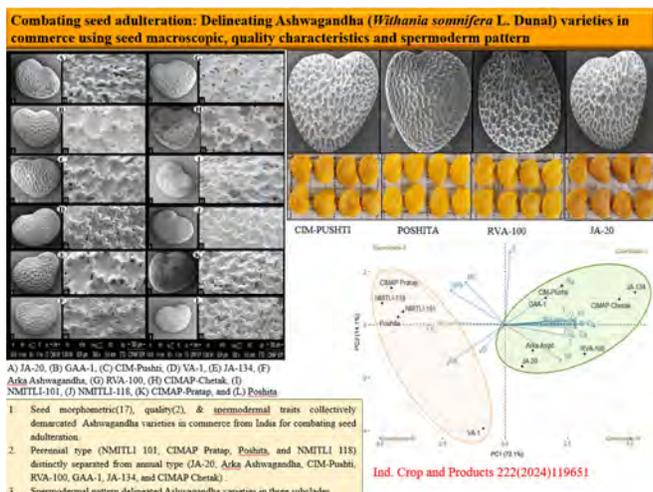


Fig. : Characterized all nationally released Ashwagandha varieties in commerce using seed morphometric, quality, and spermoderm pattern traits to combat malpractices of varietal seed adulteration.

To ensure the seed purity check by onsite parameters for the farmers, to confirm the targeted Ashwagandha Plant variety, all national released Ashwagandha varieties in commerce have been characterized using seed morphological quality, and spermoderm pattern traits to combat malpractices of varietal seed adulteration.



Dr. Tripta Jhang & her team

Dr. Channayya Hiremath डॉ. चैन्नय्या हिरेमथ

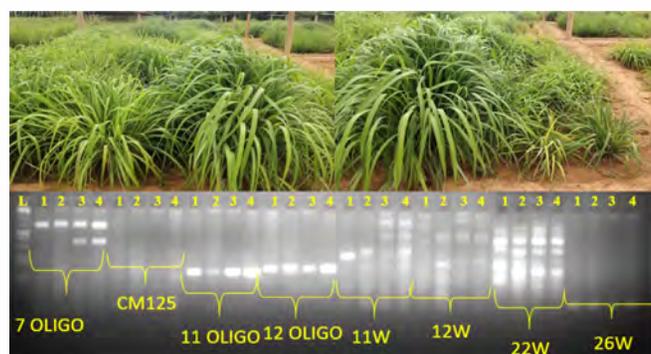
Identification of pollen sources or paternal parent through molecular markers in citronella half-sib progenies



Objectives:

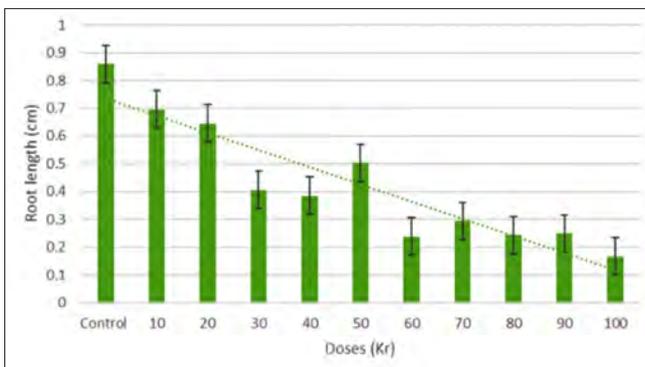
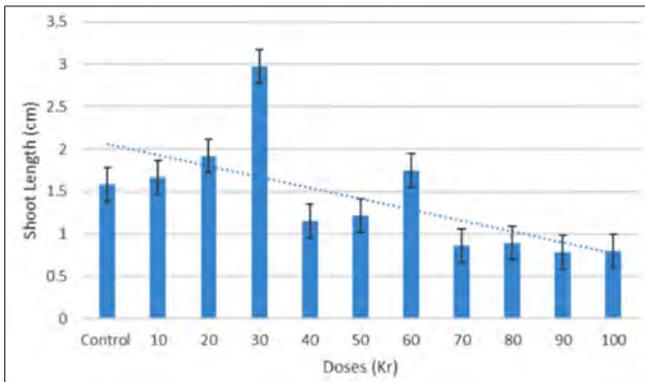
1. Development of disease tolerance and high yielding clones
2. Screening of SSR markers of *Cymbopogon winterianus* (28) and *Cymbopogon citratus* (17), *Cymbopogon flexuosus* (124).
3. Identification of male parents of high yielding clones
4. Total 60 half-sib progenies were selected

Species	Total primers	Primers amplified	Polymorphic primers
<i>C. flexuosus</i>	124	100	14
<i>C. winterianus</i>	28	28	4
<i>C. citratus</i>	17	17	2



Amplification pattern of SSR primers derived from *Cymbopogon flexuosus* and *Cymbopogon winterianus* in 4 genotypes of citronella (1- CIM-Jeeva, 2- Jal Pallavi 3- Medini 4- BIO 13)

Sl. No.	Clones	Oil (%)	Citronellal (%)	Geranyl Acetate (%)	Geraniol (%)	GC ratio
1.	B25 6-10	1.44	33.74	3.30	32.16	0.99
2.	B27 2-11	0.89	25.94	3.20	28.58	1.18
3.	B32 1-2	1.20	19.75	6.54	27.95	1.53
4.	B1 4-2	1.12	20.52	4.97	27.10	1.56
5.	B1 1-9	1.55	20.01	1.50	32.54	1.63



Lemongrass: Induced variability for identification of reduced flowering clones

The objective was to determine the LD₅₀ dose, which was identified to fall between 25 and 30 kr. Further by using LD₅₀ doses treated population will be screened for low flowering clones.



Dr. Channayya Hiremath & his team

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

Induced mutagenesis in menthol mint (*Mentha arvensis* L.) using γ -radiation for the improvement of herb and essential oil yield



Menthol mint (*Mentha arvensis* L.), a member of the Lamiaceae family, is a commercially significant aromatic and medicinal plant widely cultivated for its essential oil, particularly menthol. India is the leading producer and exporter of menthol mint oil, and the crop plays a vital role in the rural economy. Despite its economic importance, the crop's productivity, in terms of both herb yield and essential oil content, is often limited by a narrow genetic base, susceptibility to pests and diseases, and environmental stressors. Enhancing genetic variability is therefore crucial to developing superior cultivars with improved agronomic and industrial traits. Mutation breeding, particularly through physical mutagens like gamma radiation, has emerged as an effective approach for inducing genetic variability and improving traits in vegetatively propagated crops such as menthol mint. Gamma irradiation has been extensively utilized for its capacity to induce point mutations and generate novel phenotypic variations without altering the basic genetic makeup of the crop. Previous studies have demonstrated the successful application of induced mutagenesis in enhancing biomass, essential oil composition, and stress tolerance in various aromatic and medicinal plants. In the present study, three widely cultivated varieties of menthol mint (Kosi, CIM-Kranti, CIM-Unnati) were subjected to varying doses of gamma radiation to induce mutations aimed at improving herb yield and essential oil yield. The research focused on the identification, isolation, and advancement of putative mutant branches for future selection and evaluation, laying the groundwork for the development of elite mint genotypes through mutation breeding.

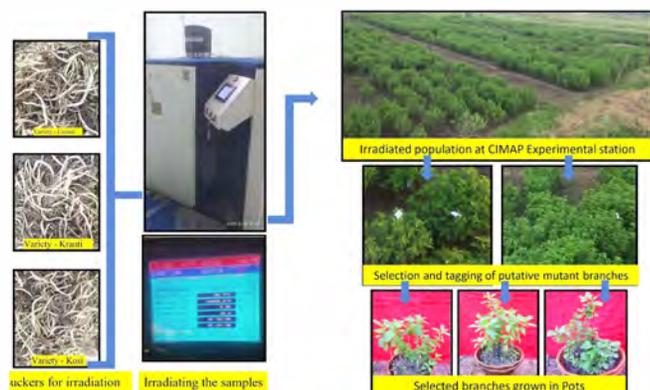


Fig. : Flow chart representing the induction of mutation through γ -radiation and selection and isolation of putative mutant branches for the development of elite mutant lines in menthol mint (*Mentha arvensis* L.).

Three commercially cultivated varieties of menthol mint (*Mentha arvensis* L.) namely Kosi, CIM-Kranti, CIM-Unnati were selected for the present study, based on their widespread adoption and agronomic performance. The irradiation was conducted at G.B. Pant University of Agriculture and Technology (GBPUAT), Pantnagar, India. The suckers of each variety were exposed to six doses of gamma radiation: 0.1 kGy, 0.2 kGy, 0.3 kGy, 0.4 kGy, 0.5 kGy, and 0.6 kGy. The experiment was laid out in a randomized complete block design (RCBD) with two replications at CSIR-Central Institute of Medicinal and Aromatic Plants, Pantnagar for each treatment-dose combination. Plants were closely monitored throughout the growing season for morphological and developmental variations. Putative mutant branches showing observable phenotypic deviations—such as alterations in growth habit, leaf morphology, pigmentation, branching pattern, and vigor—were identified through regular field observations. These branches were carefully tagged and recorded for further evaluation. For isolation and advancement, The identified mutant branches were excised from the mother plants and transplanted into pots under controlled conditions to facilitate their establishment and vegetative propagation. These isolated branches served as the initial (M_1V_1) generation, and were maintained for the development of clonal populations for subsequent generations (M_1V_2) aimed at assessing the stability and heritability of induced traits.

Dr Narendra Kumar डॉ. नरेन्द्र कुमार

Unveiling cannabinoids and terpenes Diversity in *cannabis sativa* L. from northern India for future breeding strategies



Cannabis sativa L. is an important medicinal plant with high commercial value. In recent years, the research interest in cannabidiol (CBD) and terpene-rich cannabis has been rapidly expanding due to their high therapeutic potential. The present study explored the phytocannabinoids and terpenes diversity in *Cannabis sativa* collected from different states of northern India. Our findings revealed that the cannabinoids and terpenes synthesize together in capitate stalked and capitate sessile glandular trichomes, whereas bulbous glands synthesize only terpenes. The North Indian *C. sativa* is mainly dominated by tetrahydrocannabinol (THC). The CBD-rich plant diversity is nominal (1.11%) in studied north Indian *C. Sativa*. The HP and HR populations represented only drug chemotype plants. Whereas the intermediate chemotype were found in UP, JK and UK populations. The analysis of variance (ANOVA) revealed significant variations in cannabinoids content. In the examined accessions, only one fibre chemotype (JK-3) representing a higher content of total CBD (1.36%) and a low content of total THC (0.25%) was recorded from the JK population. The essential oil profiling reveals (E)-caryophyllene (10.30-36.80%) as the major constituent, followed by α -humulene (0.50-15.29%) and α -bisabolol (0.00-16.40%) in the North Indian population. The analysis of variance (ANOVA) revealed significant variations in terpenes content among and within the five studied populations.

The principal component analysis (PCA) clearly discriminate three different chemotypes based on cannabinoid contents. This signifies that the studied accessions reveal a distinct pattern of chemical diversity based on their chemotypes. The correlation analysis between cannabinoids and terpenes indicates that α -pinene, β -pinene, and limonene

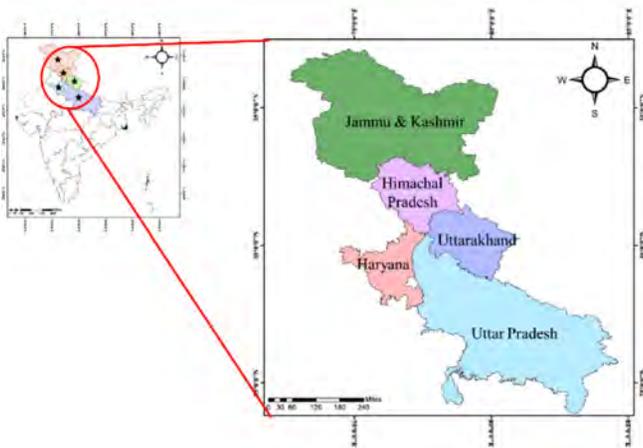
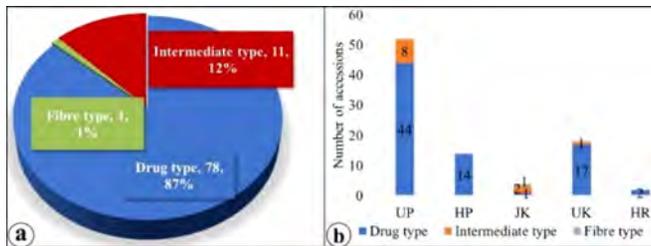


Fig.: Collection sites of *C. Sativa*



positively correlated with CBD content. Besides, other essential oil constituents also varied among the five studied populations. Similarly, α - and β -selinene correlate positively with tetrahydrocannabinolic acid (THCA) content. This study could help to identify the key cultivars from India and establish a consistent chemotype for future breeding programs. (*Chemistry & Biodiversity*, 2025)

Rhizome thickness influences the oil yield and oil constituents in *Homalomena aromatica* (Spreng.) Schott

Homalomena aromatica is an economically important essential oil-producing plant. The rhizome is a commercial source of essential oil useful for high-grade perfumery and therapeutic applications. The rhizomes are mainly collected from wild sources. The present study conducted the histochemical localization of oil-secreting idioblast and the variability in oil composition in commercial samples. The histochemical study revealed that essential oil is synthesized in oil cells and oil cavities distributed in



Fig. : Commercial rhizome samples of *Homelomena aromatica*. (a) rhizome thickness up to 10 mm; (b) rhizome thickness 10-20 mm; (c) rhizome thickness 20-30 mm (bar=10 mm).

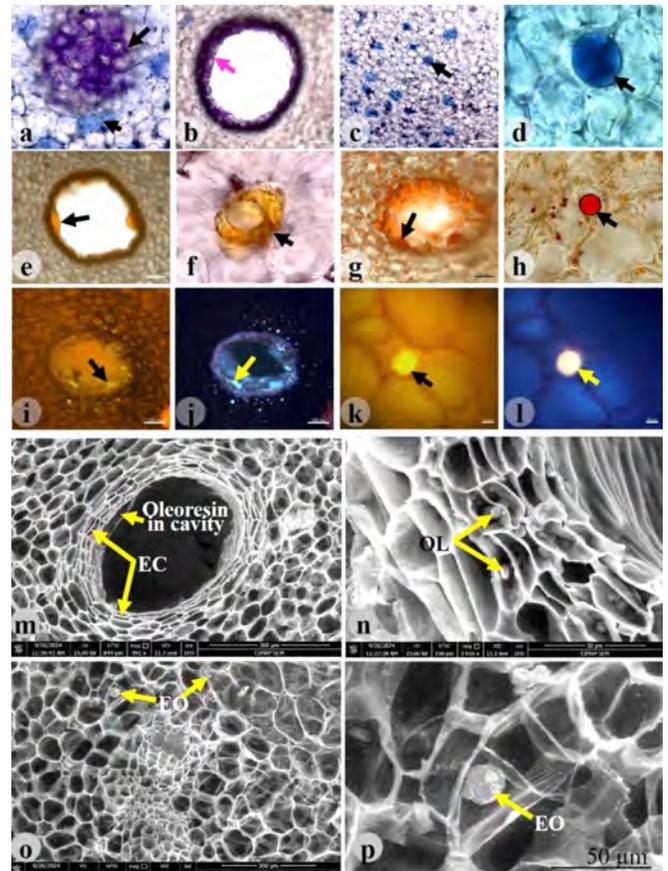


Fig. : Histochemical localization of essential oil in *Homelomena aromatica* rhizomes

the rhizome tissues. The larger oil cavities ($521 \pm 59.4 \mu\text{m}$ in size) synthesize essential oil and resin, whereas the smaller oil cells ($67.2 \pm 7.4 \mu\text{m}$ in size) synthesize only essential oil. The spatial distribution demonstrates that the oil cavities were densely present in the inner ground tissue region, whereas the oil cells were abundant in the cortex ($P < 0.05$). The different grades of commercial rhizome samples, i.e., thickness up to 10 mm (narrow rhizomes, NR), 10-20 mm (medium-sized rhizomes, MR) and 20-30 mm (thick rhizomes, TR) showed variation in distribution of fibre cells, fibre content and essential

oil yield & composition. The study demonstrated that the oil yield is negatively correlated with rhizome thickness, fibre content and density of fibre cells in rhizome tissues. The oil of *H. aromatica* is dominated by linalool (44.18-61.4%) followed by terpinene-4-ol (6.45-13.16%) in the rhizomes of different thicknesses. These major oil constituents also negatively correlate with rhizome thickness and significantly decrease in the TR samples. The heatmap cluster analysis

showed that NR and MR grade samples grouped together based on similar quantities of essential oil components. Whereas the oil components differently grouped the TR samples from NR and MR grade samples. The study concludes that the NR grade rhizomes are better for higher oil yield and also for high linalool and terpinene-4-ol content than the TR grade of *H. aromatica* rhizomes. (*Flavour and Fragrance Journal*, 2025)



Dr. Narendra Kumar and his team

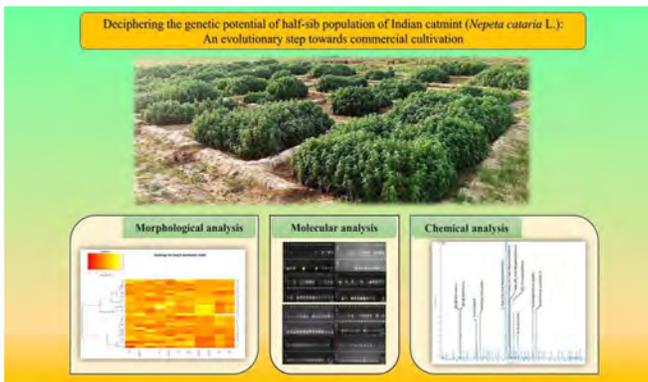
Dr Gunjan Tiwari डॉ. गुंजन तिवारी

Integrative multivariate analysis of agro-chemical and genotypic traits in Indian catmint (*Nepeta cataria* L.) half-sib populations

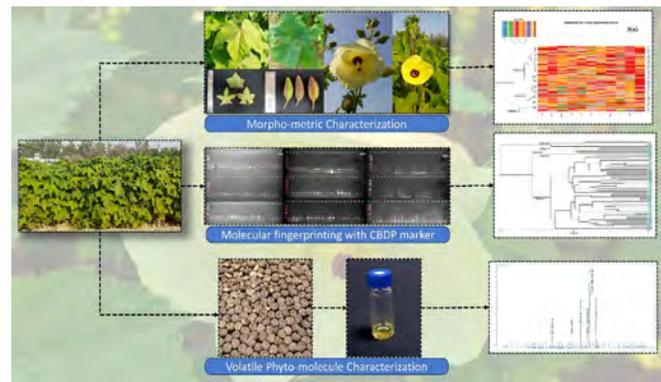


A comprehensive multivariate analysis was conducted on thirty half-sib populations of *Nepeta cataria* L., derived from natural populations with a focus on oil yield. The study addressed the existing gap in genetic, phenotypic, and chemical diversity data, which is critical for effective selection and breeding programs. Significant phenotypic diversity was recorded across eleven quantitative traits. Using Euclidean distance-based hierarchical clustering and principal component analysis (PCA), more than 50% variation was detected among the populations, which were grouped into three primary clusters,

with herb yield emerging as a key differentiator. Chemical profiling through GC and GC/MS identified eleven major phytochemicals. Notable variation in nepetalactone isomers was observed, particularly for cis-trans nepetalactone (73.45%–93.20%), resulting in three distinct chemical clusters with unique signatures. Molecular diversity analysis using 21 SCoT and 20 CBDP markers revealed high polymorphism and grouped the populations into three clusters. A Mantel test indicated weak correlation between agro-morphological, chemical, and molecular data, suggesting complex genetic-phenotypic interactions. The study highlights the rich genetic and chemical diversity within *N. cataria* half-sib populations and provides valuable insights for targeted selection, conservation, and breeding programs. The distinct clustering across agronomic, chemical, and molecular traits underscores the potential for developing improved cultivars. Future efforts will integrate these findings into breeding strategies to enhance commercial cultivation.



Source: Chaturvedi et al. (2025), Fitoterapia



Source: Pandey et al. (2025), Genetic Resources & Crop Evolution

Unlocking genetic diversity in Indian germplasm and breeding lines of Muskdana (*Abelmoschus moschatus* L.)

Muskdana is an aromatic and medicinal herb with high demand in the fragrance industry but limited research on its yield potential in India. To support its commercial cultivation, a study was undertaken to evaluate the genetic diversity of 61 genotypes, including breeding lines and germplasm collected from diverse eco-geographical regions of the country. Morphological, chemical, and molecular approaches were used to identify promising lines for targeted breeding. The study revealed significant variation among genotypes for most growth and yield traits. Oil content showed the highest genetic variability, followed by seed weight per plot and number of

Pods per plant. Both oil content and seed weight per plot exhibited high heritability and genetic advance, making them key economic traits for improvement. Chemical profiling of essential oils identified six major constituents, with 2E,6E-farnesyl acetate and Z-oxacycloheptadec-8-en-2-one as the most abundant. Cluster analysis based on morphological and chemical data grouped the genotypes into three clusters. In contrast, molecular analysis using 25 CDBP markers revealed higher allelic polymorphism and classified the genotypes into four distinct groups. However, no strong correlation was observed between molecular and agro-chemical clustering. The findings highlight the presence of substantial genetic variation in Indian muskdana, offering valuable opportunities for selecting superior parental combinations. This work lays the foundation for initiating focused breeding programs and developing improved cultivars for commercial cultivation.



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:

12 technologies related to scientifically develop herbal formulations have been transferred to MSMEs/ Start-ups for commercialization. 23 agreements were signed with different industries, and three projects were also received from different industries and government departments.

21 skill development training programs have been organized in different parts of the country under various projects. In these training programs, 857 farmers and entrepreneurs have participated. About 1605 farmers were made aware of the cultivation of medicinal and aromatic plants by organizing 34 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 17 training programs on making incense sticks from offered flowers. The programme was attended by 820 participants including 467 women during last one year.

Technology dissemination division was successfully organized institutional events, namely the Kisan Mela, CSIR Foundation Day, CIMAP Annual Day, National Technology Day, International Women's Day, CSIR-CIMAP Foundation day, Business meets and many more such kinds of activities for the image building of the institute.

More than 8327 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 exhibitions at various locations in the country. Three extension literature and three research articles were also published during the period.



Scientists of Technology Dissemination and Computational Biology Division

Upper Panel (L to R): Dr Sanjay Kumar, Dr R.K. Srivastava, Dr R.S. Sharma, Dr Rushikesh Nanasheh Bhise, Dr Sumya Pathak
Lower Panel (L to R): Dr Manoj Semwal, Dr Feroz Khan, Dr Bhaskar Shukla, Dr Aman Chandra Kaushik



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.

Scientists 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.

Technology Dissemination & Computational Biology

During the year 2024-2025 various studies to Assess Nitrogen Status in *Mentha arvensis*

Using UAV-based Hyperspectral Imaging. 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.

Department has developed Phyto ChemX1.0: chemoinformatics web server integrating 20 modules for drug discovery applications, Phyto Single Cell Atlas: an AI-powered web platform for single-cell RNA seq analysis in medicinal and aromatic plants. Seven-days Bioinformatics Skill Development Program (SDP) workshop at national level entitled "Plant's Transcriptome/RNA-Seq Data Analysis & Functional Annotation" held on Dec. 04-10, 2024, sponsored by CSIR, New Delhi and organized by CSIR-CIMAP, Lucknow in hybrid mode. Total 25 participants were trained.

Organized various lectures. educational tour of school students and competitions like quiz, sci-toons, extempore and creative writings under CSIR-JIGYASA Virtual lab 2.0 project for school students.

During this period, the Computational Biology Unit published 03 publications in high impact journals such as Current Topics in Industrial Crops and Products and Journal of Molecular Structure.

Human Resource Development

The HRD Cell co-ordinates academic activities related to the PhD and internship programmes at CSIR-CIMAP. During 2024-25, 58 PhD students were admitted to the AcSIR PhD program in January and August sessions. Currently CSIR-CIMAP has total 230 PhD students registered in AcSIR or JNU. In addition to this, 8 students who are registered



The HRD Cell organized an invited lecture for the scientific fraternity of CSIR-CIMAP, during 2024-25. Prof. Rajesh Viswanathan, IISER Tirupati talked on “Biomimetic Synthesis of Medicinal Agents Based on Microbes & Plants” on September 10, 2024

for PhD 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 94 M. Sc. or B. Tech. (Biotechnology) students from various colleges and universities during 2024-25.

CSIR-CIMAP had initiated the CIMAP Students Seminar (CSS) in 2024-25. The Second Seminar (CSS-2024) in this series was conducted on September 13, 2024, at the CIMAP Research Centre, Bengaluru. In CSS-2024, 14 students presented their research work and interacted with the invited expert Dr. Ritu Trivedi. The students were also taken on a field visit to CIMAP beneficiary farmers' fields near Mysuru.

Patent Cell:

The CIMAP Patent Cell collaborates with the CSIR-Innovation Protection Unit in New Delhi to protect and manage intellectual property generated through research in the areas of medicinal and aromatic plant varieties, agro-technology, bioactivities, chemical processes, and product formulations. During 2024-25, CSIR-CIMAP successfully filed 03 Indian patents. While 02 Patents Granted in US and India, respectively.

Project Monitoring and Evaluation (PME):

The CSIR-CIMAP PME Cell coordinates the planning of R&D activities and manages ongoing projects funded by the CSIR and various external funding agencies. PME Cell also plays a vital role in coordination between CSIR-CIMAP and CSIR-HQ, New Delhi. The PME Cell organises Lab Strategic Group (LSG) meetings for scientists to review the progress of ongoing projects and scrutinise projects before submission to various funding agencies. Coordinates the formulation and execution of new projects and contributes to the creation of data metrics for CSIR-CIMAP methodology. During 2024-25, a total of 31 projects, including 17 GAP, 1 CNP, 1 SSP, and 12 CSIR-funded projects from various agencies, were received and executed at CSIR-CIMAP.

Technology Dissemination Activities:

Sanjay Kumar, Ramesh Kumar Srivastava, Ram Suresh Sharma, Rushikesh N. Bhise, Sumya Pathak, R P Yadav, D.P. Mindala, Priyanka Singh, Manoj Kumar Yadav, Deepak Kumar Verma and Rajni Gautam

Skill Development Programmes:

In 2024-25, many skill development training and awareness programs have been organized in different parts of the country under various projects.

Table: 02-05 Days Skill Development Training Programme on Medicinal and Aromatic Plants Production Technology

Sr. No	Date	Place	No. of participant		Sponsored by
			Total	Women	
1	24-25 April 2024	Bahmara, Meghalaya	20	20	Aroma Mission-III
2	14-16 May, 2024	CIMAP Lucknow	40	03	SIDBI
3	27-31 May, 2024	CIMAP Lucknow	38	01	SSP-517, ATMA Maharashtra+HCP-0007
4	03-06 June 2024	CIMAP Lucknow	25	09	ATMA Sitamahri+ HCP-0007
5	10-14 June, 2024	CSIR-CIMAP, Lucknow	26	00	SSP-517, ATMA Maharashtra+HCP-0007
6	27-28 June, 2024	CSIR-CIMAP, Lucknow	43	41	Manipur+HCP-007
7	09-11 July, 2024	CSIR-CIMAP, Lucknow	33	07	SIDBI
8	23 August 2024	FRCER, Prayagraj	83	19	SIDBI+ Aroma Mission-III
9	10-12 September 2024	CSIR-NCL, Pune, Maharashtra	32	07	SIDBI
10	24-27 September 2024	CSIR-CIMAP, Lucknow	40	05	ATMA, Siwan, Bihar
11	14-18 October 2024	CSIR-CIMAP, Lucknow	40	00	ATMA, Sitamarhi, Bihar
12	18 October 2024	DRI, Arogyadham, Chitrakoot, Satna, Madhya Pradesh	55	15	SIDBI
13	12-14 November 2024	CSIR-CIMAP, Lucknow	40	00	ATMA, Rohtas, Bihar
14	02-04 December 2024	CSIR-CIMAP, Lucknow	40	05	CSIR-Aroma Mission-III
15	19 December 2024	Ramapur Rauli, Lakhimpur Kheri, (U.P.)	88	04	SIDBI+ Aroma Mission-III
16	20 December 2024	Bhagharpurwa, Ramia behar, Lakhimpur Kheri, (U.P.)	87	00	SIDBI+ Aroma Mission-III
17	16-20 December 2024	CSIR-CIMAP, Lucknow	20	07	MSME, ESDP Prog.
18	28 Jan to 01 Feb, 2025	CSIR-CIMAP, Lucknow	42	00	ATMA, Maharashtra
19	17-22 February, 2025	CSIR-CIMAP, Lucknow	24	01	ATMA, Maharashtra
20	03-08 March, 2025	CSIR-CIMAP, Lucknow	22	05	ATMA, Baran, Rajshtahn
21	18-20 March, 2025	CSIR-CIMAP, Lucknow	19	05	District Horticulture, Gaya, Bihar
		Total	857	154	



Views of Training Programmes



Views of Training Programmes



Views of Training Programmes



आर्थिक रूप से महत्वपूर्ण औषधीय एवं सस्य पौधों की खेती व प्राथमिक प्रसंस्करण पर **कौशल - सह - तकनीकी उन्नयन कार्यक्रम**
Date: 10-12 September, 2024

Views of Training Programmes

Awareness Programmes (2024-25), CSIR Aroma Mission-III
Table: One-Day Awareness Programme on Medicinal and Aromatic Plants Production Technology

Sr. No.	Date	Place	No. of Participants		Sponsored by
			Total	Women	
1	24-04-2024	Bahmara, Meghalaya	20	20	HCP-0007
2	08-05-2024	Siwan Sadar –Block Bihar	40	04	HCP-0007
3	09-05-2024	Village- Bangra Muja, Muzaffarpur Bihar	25	00	HCP-0007
4	10-05-2024	Village- Bhavanipur, Sangrampur District -East Champaran,Bihar	29	00	HCP-0007
5	23-05-2024	Village- Uchat ,Block-Mahabaleshwar District – Satara Maharashtra	45	01	HCP-0007
6	24-05-2024	Village- Lohaom ,Block-Khandala District – Satara Maharashtra	25	00	HCP-0007
7	29-05-2024	Village-Bhojadhee,Bundu Jharkhand	15	00	HCP-0007
8	30-05-2024	Village- Kapariya Hutar District – Khunti ,Jharkhand	27	17	HCP-0007
9	31-05-2024	Village- Patra ,Block-Pandwa District – Palamu Jharkhand	58	14	HCP-0007
10	13-06-2024	Aizawl, Mizoram	45	30	HCP-0007
11	19.06.2024	Ajara, Kolhapur, Maharashtra	10	02	HCP-0007
12	21.06.2024	Malegaon, Nashik, Maharashtra	90	60	HCP-0007
13	23.06.2024	Dare/Uchat (Mahabaleshwar), Satara, Maharashtra	45	01	HCP-0007
14	24.06.2024	Lohom, Satara, Maharashtra	25	00	HCP-0007
15	15-06-2024	Thenzawl, Mizoram	65	10	HCP-0007
16	28-06-2024	Rajnandgaon, Chhattisgarh	22	06	HCP-0007
17	16.07.2024	CSIR-CIMAP, Lucknow	53	05	MSME
18	19.07.2024	Village- Sareya Baduraha, Sangrampur District -East Champaran, Bihar	80	00	HCP-0007
19	20.07.2024	Agriculture office Muradpur, Dumra, District. Sitamarhi, Bihar	75	03	HCP-0007 + ATMA
20	22.07.2024	Mandan Bharti, Agricultural Collage Agwanpur, District -Saharsa, Bihar	70	09	HCP-0007
21	23.07.2024	Jhal, Bilaspur, Chhattisgarh	62	32	HCP-0007
22	26.07.2024	Kohkadi, Kondagaon (Bastar), Chhattisgarh	16	02	HCP-0007
23	05.09.2024	Ucchat, Mahabaleswar, MH	20	00	HCP-0007

Technology Dissemination & Computational Biology

24	04.10.2024	Jak, Barmer, Rajasthan	30	00	HCP-0007
25	13.11.2024	Pasighat, Arunanchal Pradesh	60	40	HCP-0007
26	26.11.2024	Anangpara Songsarek, Zikzak Block, South West Garo Hills, Meghalaya	65	15	Aroma Mission-III
27	27.11.2024	Vill-Watregre, Block Rongram, distt- West Garo Hills, Meghalaya	35	30	Aroma Mission-III
28	12.12.2024	Jhadol, Phalasia, Rajasthan	25	04	HCP-0007
29	19.12.2024	Ramapur Rauli, Lakhimpur Kheri, (U.P.)	88	04	SIDBI+ Aroma Mission-III
30	20.12.2024	Bhagharpurwa, Ramia behar, Lakhimpur Kheri, (U.P.)	87	00	SIDBI+ Aroma Mission-III
31	23.12.2024	District Baran, Agri. Department, Rajasthan	75	01	Aroma Mission-III
32	18.01.2025	Village-Devora, Post- Nindura, Fatehpur, Barabanki, Uttar Pradesh	68	15	Aroma Mission-III
33	24.01.2025	Kumbh, Prayagraj	62	12	Aroma Mission-III
34	24.02.2025	Village-Bahrauli, Barabanki, Uttar Pradesh	48	12	Aroma Mission-III
Total			1605	349	



Views of Awareness Programmes



Views of Awareness Programmes



Views of Awareness Programmes



Views of Awareness Programmes



Training programmes 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 organized 17 training programs on making incense sticks from offered flowers. The programme was attended by

820 participants including 467 women during the 2024-25.

The dates of such trainings along with number of participants are given in the Table no. 3 below. Based on the feedback received after training, many women out of these trainings have started making incense sticks and selling them in the local market.

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

Sr. No.	Date	Place	Total No. of Participants	No. of Participants Women	Sponsored by
1	27.05.2024	CSIR-CIMAP Campus, Lucknow	50	49	HCP-0007
2	07.06.2024	District Jail, Sitapur	40	38	HCP-0007

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3	21.06.2024	Malegaon, Maharashtra	85	55	HCP-0007
4	23.08.2024	FRCER, Prayagraj U.P.	83	19	HCP-0007
5	16.04.2024	Vill. - Kuajharana, Post - Harichandanpur, District - Keonjhar	54	40	HCP-0007
6	27-28 August 2024	Naraynpatna Block Office District - Koraput	65	45	HCP-0007
7	29-30 August 2024	Bandhugaon Block Office District - Koraput	70	55	HCP-0007
8	03.09.2024	KVK-2, Sandila, Hardoi	30	27	HCP-0007
9	23.10.2024	CSIR-CIMAP, CRC Bangalore	100	70	HCP-0007
10	06.11.2024	CSIR-CIMAP, Lucknow	30	10	HCP-0007
11	06.12.2024	Uttar Pradesh Sub Area (MUPSA), Lucknow	23	23	HCP-0007
12	28 Jan to 01 Feb, 2025	CSIR-CIMAP, Lucknow	42	00	Atma, Maharashtra
13	17-22 February, 2025	CSIR-CIMAP, Lucknow	24	01	Atma, Maharashtra
14	14.02.2025	District Jail Sitapur	35	20	HCP-0007
15	03-08 March, 2025	CSIR-CIMAP, Lucknow	22	05	Atma, Baran, Rajshthan
16	18-20 March, 2025	CSIR-CIMAP, Lucknow	19	05	District Horticulture, Gaya, Bihar
17	26.03.2025	CSIR-CIMAP, Lucknow in CIMAP Foundation Day Celebration - 2025	48	05	HCP-0007
Total			820	467	



Views of the Agarbatti Making Training Programme

Visitors:

More than 8327 visitor's comprising students, farmers, and government officials, visited CSIR-CIMAP and were apprised about cultivation, processing, and marketing of medicinal and aromatic plants.



Views of Visitors at CSIR-CIMAP



Views of Visitors at CSIR-CIMAP

CSIR-CIMAP Kisan Mela- 2025

The CSIR–Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow, organized a two-day Kisan Mela on 30–31 January 2025 at its campus, witnessing enthusiastic participation from farmers, scientists, industry representatives, and stakeholders across the country.

On the inaugural day, 30 January 2025, farmers from several states gathered for the event. Dr. G. N. Singh, Advisor to the Hon'ble Chief Minister of Uttar Pradesh and former Drug Controller General of India, attended as Chief Guest and lauded CSIR-CIMAP's significant role in promoting medicinal and aromatic plants (MAPs) and contributing to the enhancement of farmers' incomes. Dr. Vijay Bahadur Dwivedi,

Director of the Horticulture and Food Processing Department, Government of Uttar Pradesh, joined as Special Guest and encouraged farmers to diversify their cultivation by incorporating horticultural crops, while highlighting the state's financial assistance schemes.

On 31 January 2025, the second day of the Mela, Dr. Anil Prakash Joshi, Padma Bhushan and Padma Shri awardee, environmentalist, and founder of HESCO, Dehradun, attended as Chief Guest and praised the collaborative efforts of CSIR-CIMAP and other Lucknow-based CSIR laboratories towards farmer welfare. Dr. Ajit Kumar Shasany, Director of CSIR-NBRI, Lucknow, addressed the gathering as Special Guest and appreciated CSIR-CIMAP's contributions in MAP cultivation. Shri B. L. Meena, Chief Secretary

Technology Dissemination & Computational Biology

of the Horticulture and Food Processing Department, Government of Uttar Pradesh, also graced the occasion and commended CSIR-CIMAP's initiatives.

Dr. Prabodh Kumar Trivedi, Director of CSIR-CIMAP, welcomed the dignitaries and participants, emphasizing that the Mela aimed to disseminate advanced varieties, improved cultivation practices, and modern processing technologies developed by the institute. On this occasion, several publications were released, including "Aus-Gyanaya" (Kisan Mela booklet), a bulletin on Integrated Pest Management in Mentha, and guides on advanced agricultural techniques for tuberose and jasmine.

New improved varieties such as Tulsi (CIM-Saraswati) and Geranium (CIM-Sangam) were officially released, while planting material of mentha, geranium, and vetiver was distributed to progressive farmers. Collaborative efforts were furthered through an MoU between CSIR-CIMAP and M/s Shri Ananda Enterprises, Bangalore, for the procurement of aromatic oils under the Aroma

Mission, and a contract with M/s Artrista Creation Beauty Salon and Academy, Lucknow, for marketing herbal products like Clenzie (face wash), Herby Soft (shampoo), lip balm, and CIM-Kesh (hair oil).

The CIMAP Calendar 2025 was also unveiled during the event. Exhibitions showcased technologies from CSIR labs, with stalls set up by industries, voluntary organizations, and women empowerment initiatives. Women participants showed keen interest in demonstrations on incense stick and cone preparation using puja flowers. Live demonstrations featured the use of solar-powered distillation plants, cost-effective geranium propagation, herbal product preparation, and early mint cultivation techniques.

The Kisan Mela was actively attended by CSIR-CIMAP scientists, staff, researchers, farmers, and representatives from government departments and industries. The entire event was successfully coordinated by Dr. Sanjay Kumar and the Technology Dissemination Division.



Address by Director, CSIR-CIMAP



Address by Chief Guest on main event



Inaugural Address by Chief Guest



Address by Guest



Aus Gyanaya-2025 Release



Visit of Chief Guest in Exhibition area



Glimpse of Kisan Mela-2025



Glimpse of Kisan Mela-2025



Glimpse of Kisan Mela-2025



Glimpse of Kisan Mela-2025

Participation in national and state-level exhibitions:

During 2024–25, CSIR-CIMAP actively showcased its technologies and innovations in several national and state-level exhibitions, including the *Plants Growing Mela (Prayagraj)*, *Janjati Bhagidari Utsav* and *Krishi Bharat Expo (Lucknow)*, the *India International Science Festival (IIT Guwahati)*, and *State Flower and Vegetable Shows (Lucknow & Varanasi)*, among others. These participations attracted wide attention and motivated a large number of youth, women, and farmers to engage with CSIR-CIMAP's mission programs and technologies.

Table: Participation details of Technology Dissemination group on national and state level exhibition

Sl. No.	Date / Period	Exhibition / Expo	Place
1	15 Mar 2024	Plants Growing Mela – 2024, Prayagraj, U.P.	Prayagraj
2	24 Jun 2024	Curtain Raiser Event of <i>One Week One Theme</i>	New Delhi
3	15–20 Nov 2024	Janjati Bhagidari Utsav, organized by U.P. Lok evam Janjati Sanskriti Sansthan	Lucknow
4	15–18 Nov 2024	Krishi Bharat Expo, organized by CII AgroTech India	Lucknow
5	30 Nov – 03 Dec 2024	India International Science Festival 2024, organized by CSIR at IIT Guwahati	Guwahati
6	8–10 Feb 2025	State Flower and Vegetable Show – 2025 at Governor House	Lucknow
7	18–19 Feb 2025	Vendor Development Programme-cum-MSME Expo – 2025, organized by Ministry of MSME	Kanpur
8	22–24 Feb 2025	State Flower and Vegetable Show – 2025 at Company Bagh	Varanasi



Glimpse of CSIR-CIMAP participation in National Level Exhibition



Glimpse of CSIR-CIMAP participation in National Level Exhibition

Aromatic Crops: Current Indian Scenario and Development Priorities

India, with its rich biodiversity and diverse agro-climatic conditions, holds a unique position in the global trade of medicinal and aromatic plants (MAPs). This policy paper analyzes the current scenario and development priorities for aromatic crops in India,

highlighting their role in agriculture, trade, and rural livelihoods. The global essential oil market, valued at \$62 billion, is projected to touch \$5 trillion by 2050, offering India vast growth opportunities. Presently, India cultivates about 0.74 million hectares under aromatic and medicinal crops, yielding 0.64 million tonnes of raw material annually. Major oils such as menthol mint, lemongrass, palmarosa, citronella,

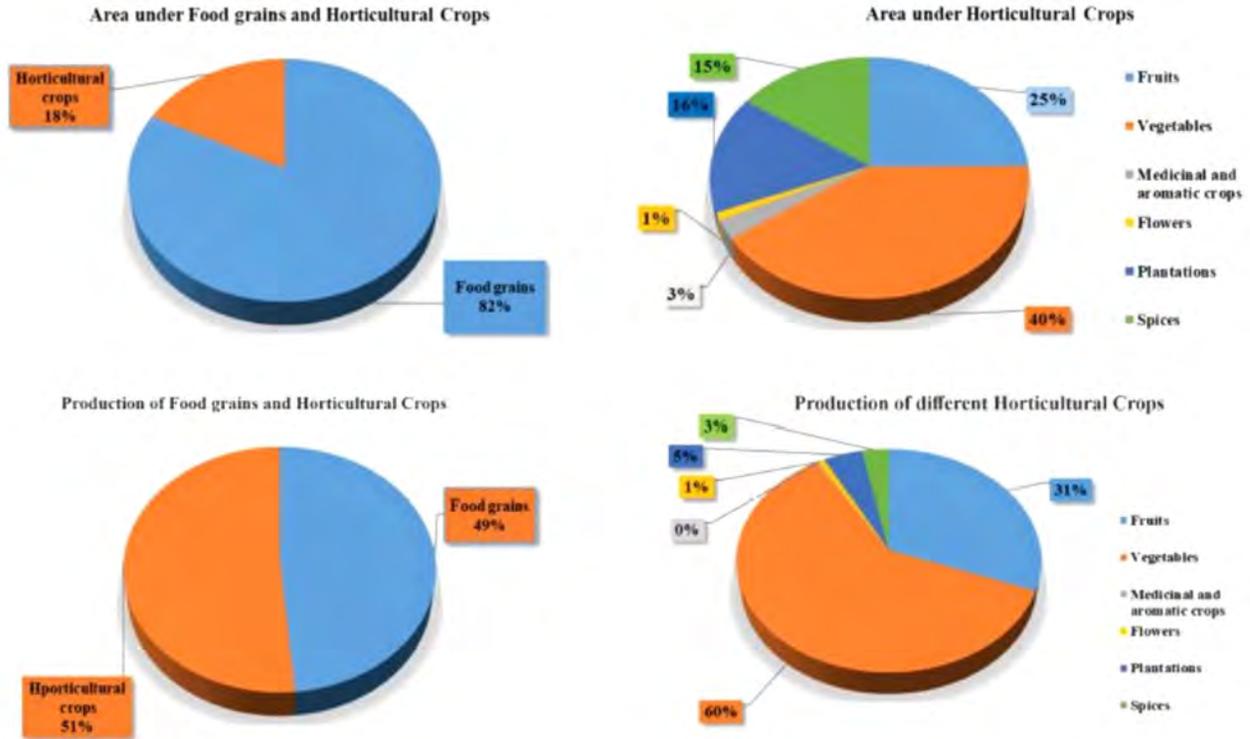


Fig. Area and Production of Various Crops in India

geranium, and davana form the backbone of exports, while imports of lavender, patchouli, and rose oils reflect existing gaps. Despite rising demand driven by pharmaceuticals, cosmetics, aromatherapy, and food industries, challenges persist in the form of inadequate post-harvest infrastructure, price volatility, global competition, and regulatory complexities. The paper identifies priority crops for export promotion and import substitution, alongside strategies for enhancing farmer income, utilizing marginal lands, and creating rural employment. It underscores the need for robust R&D, improved agro-technologies, sustainable cultivation practices, and supportive policy frameworks. Strengthening India’s aroma sector will not only boost economic

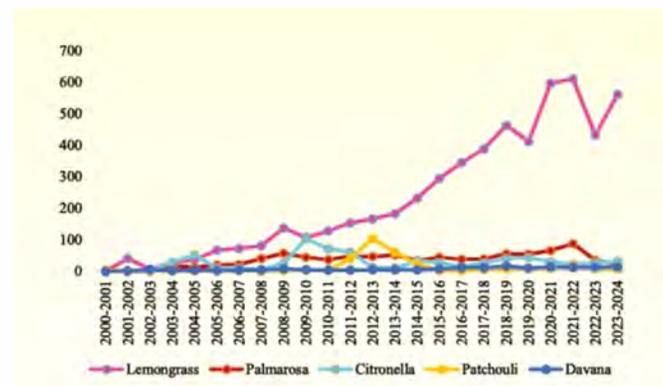


Fig. Export of Major Aromatic Oils (thousand kg)

returns but also position the country as a global leader in essential oils and natural products trade.

Dr. Sumya Pathak डॉ. सौम्या पाठक

Identifying Framework for Transformative pathways in Traditional Indian medicine: Strengthening patent regime, Strategies and Modulation of policy



Traditional Medicine (TM) comprises dynamic systems of knowledge, innovation, and validation; these systems offer crucial resources for addressing unmet health needs and fostering universal health coverage, but their potential has been constrained by historic under-investment in research, innovation ecosystems, and cross-sectoral collaborations. I am working on innovation strategies to globalise the traditional Indian system of medicine, developing a framework that involves comparative strategies on legal regulations (with reference to China, the EU, and the USA). In this context, we are working on analysing and innovating in the international market for traditional medicine to propose solutions that can help facilitate the internationalisation of TM in India and strengthen the patent regime for the future. We aim to cultivate a **Policy Research-Driven Ecosystem** for gathering evidence to create and complement a better TM ecosystem in India. We aim to leverage the synergies between academia, scientific communities, industries, and clinicians to effect positive change. Our work will create a roadmap for defining the technology impetus required to engage the critical stakeholders of the healthcare system, while also

supporting Sustainable Development Goal 3: good health and well-being.

Innovation Ecosystem for Research, Innovation and Entrepreneurship in India: Analysis of the Role of Actors

Research, Innovation and Entrepreneurship are interconnected activities performed by the innovation actors operating within the innovation ecosystem. Currently, the 'Innovation Ecosystem' for research, innovation, and entrepreneurship in India remains fragmented, despite the government's ongoing efforts and initiatives, which include establishing institutions and implementing policies. Although India is still lagging in creating the required ecosystem for innovation and in achieving an aspirational creative output. Therefore, to achieve a larger goal for Science, Technology, and Innovation advances, a need-based science-led innovation ecosystem that fosters a conducive environment for conducting research, innovation, and entrepreneurship is needed. The major focus of our research is to develop a better understanding of the interface between science, technology, and society, in order to drive Technological Innovations towards needs through the effective mobilisation of resources and the optimal utilisation of innovation system building activities. In this context, I am working on mapping and analysing the existing ecosystem's strengths and weaknesses/challenges for research, innovation and entrepreneurship by analysing the roles of innovation actors operating within the R&D ecosystem.



Technology Dissemination Team

Dr. Manoj Semwal डॉ. मनोज सेमवाल

Prediction of Biophysical Parameters (ChlM, LAI and NFI) in *Mentha arvensis* Using Multispectral UAV Data and Machine Learning



Accurate and timely assessment of crop biophysical parameters is critical for precision agriculture, as it enables early detection of stress, optimised input use and improved yield forecasting. In *Mentha arvensis*, key traits such as chlorophyll content (ChlM), Nitrogen Flavonol Index (NFI) and leaf area index (LAI) height are directly linked to plant vigour and productivity. This study deployed a high-throughput UAV-based multispectral imaging approach to estimate these parameters over farmers' fields in Babanpurva Village, Barabanki, Uttar Pradesh.

Multispectral data (Blue, Green, Red, Red Edge, NIR) were acquired using a Matrice 200 drone equipped with a MicaSense Altum sensor, providing large-area coverage at fine spatial resolution. Ground reference data from 150 sampling points, geolocated using DGPS, were collected for calibration and validation. High-resolution orthomosaics were processed with radiometric calibration and ground control points, and vegetation indices were derived for quantitative analysis.

Three machine-learning models, Random Forest, XGBoost, and Support Vector Regression, were trained on the combined spectral and ground datasets to predict ChlM, LAI, and NFI. Random Forest achieved the highest predictive accuracy for ChlM ($R^2 = 0.82$) and LAI ($R^2 = 0.84$). The results demonstrate that high-throughput UAV multispectral sensing, combined with machine-learning algorithms, can provide rapid, non-destructive, and spatially detailed estimates of essential biophysical parameters in *Mentha arvensis*, offering a scalable tool for precision crop management and decision-support.



Fig.: Methodology employed in the study

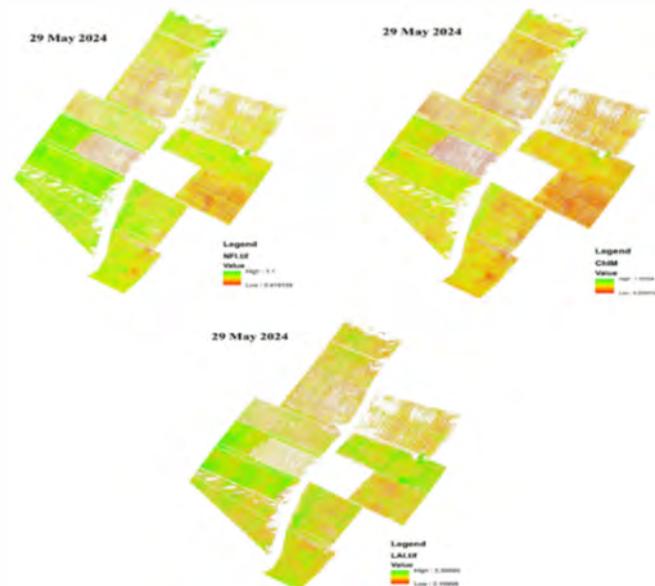


Fig.: Prediction map of NFI, leaf chlorophyll and LAI

Deep Learning and UAV Imagery for Site-Specific Detection of menthol mint and Weeds

Accurate detection of crops and weeds in agricultural fields is fundamental for precision agriculture and site-specific management. Mapping the spatial distribution and density of weeds alongside crop stands enables farmers and researchers to assess field heterogeneity, identify areas under stress, and determine site suitability for interventions such as



Fig.: Menthol mint plant and weed detected by developed model

targeted herbicide application, mechanical weeding, or variable-rate nutrient management. By quantifying not only the presence but also the abundance and growth patterns of weeds relative to crops, decision makers can optimize land preparation, adjust planting or irrigation schedules, and evaluate the long-term sustainability of specific sites. Integrating crop-weed detection into digital field monitoring systems thus supports more informed resource allocation, reduces input costs, and enhances both productivity and environmental stewardship.

In this study, deep learning-based object detection models were developed and evaluated to detect menthol mint plants and weeds from field imagery. Images were annotated with bounding boxes for both classes and exported in YOLO and COCO formats. Several object detection architectures, including YOLOv5, YOLOv7, YOLOv8n, and Faster R-CNN, were trained and tested. Result shows that YOLO models offered superior inference speed suitable for real-time deployment, and Faster R-CNN delivered good accuracy.

These findings underscore the potential of automated crop and weed detection to generate actionable

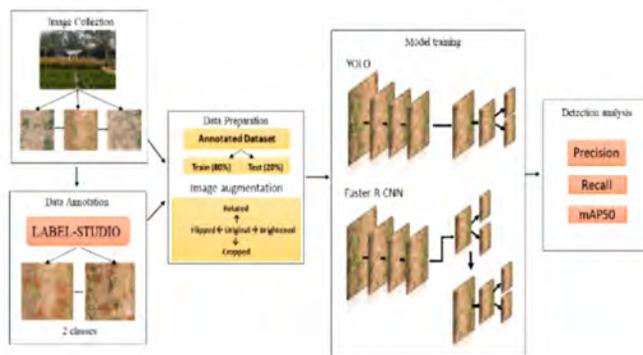


Fig.: Methodology for object detection

insights for site-specific management, enabling more precise resource allocation, reducing input costs, and ultimately enhancing both yield and oil quality in menthol mint cultivation.



Dr. Manoj Semwal & his team

Dr Feroz Khan डॉ. फिरोज खान

Developed a machine learning-based QSAR regression model, performed molecular docking & dynamics simulation on terpene derivatives for cytotoxicity prediction in MDA-MB231 triple-negative breast cancer cell line



Triple-negative breast cancer (TNBC) is the most aggressive cancer type that tests negative for progesterone, estrogen, and HER2 protein receptors. Therefore, TNBC is unlikely to respond either to

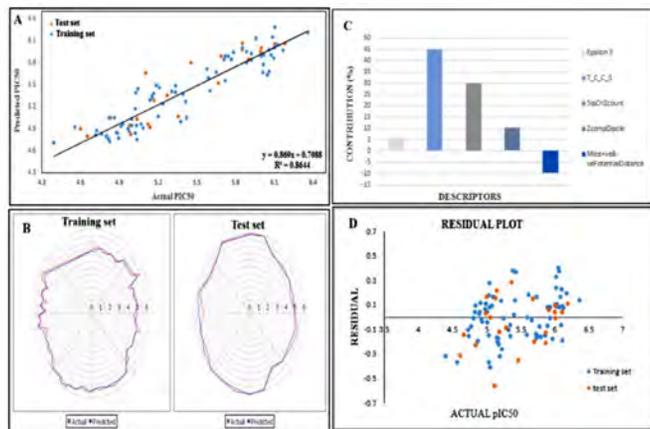


Fig.: (A): Regression plot between actual and predicted activity, (B): Radar Plot of Training set, and Test set indicating superimposition of predicted and actual values, (C): Contribution of molecular descriptors correlated with anticancer activity showing positive correlation with Epsilon3, T_T_C_5, SssCH2count, ZcompDipole, and negative correlation with Most +ve & -ve Potential Distance, and (D): Graph of residuals attained from the derived 2D-QSAR model.

drugs that target HER2 receptors or to hormonal therapy drugs. In the present study, 2D-QSAR model was developed to predict the inhibitory concentration (IC₅₀) of terpene derivatives against human breast cancer metastatic cell line MDA-MB231, using V-Life MDS v4.5, module. The model was developed using the forward stepwise multiple linear regression method, with a regression coefficient (r^2) of 0.86, and a cross-validated r^2 (q^2) of 0.8448. Molecular descriptors namely electronegativity (Epsilon-3), carbon atoms separated through five bond distances (T_C_C_5), Sum of Electrotopolgical state indices of -CH₂ group (SssCH₂count), Dipole moment of coordinate-z (Zcomp Dipole), and Distance between highest positive and negative electrostatic potential on van-der Waals surface area (Most +ve & -ve Potential Distance) were found to be the most potent contributing chemical descriptors for cytotoxicity against TNBC MDA-MB231 cell line. Additionally, binding affinities and interaction patterns revealed that the proposed compounds exhibit good binding affinities and substantial stability with c-Met-and β -tubulin receptors, as assessed by docking studies. Molecular dynamics simulations (100 ns) and binding free energy calculations were also performed

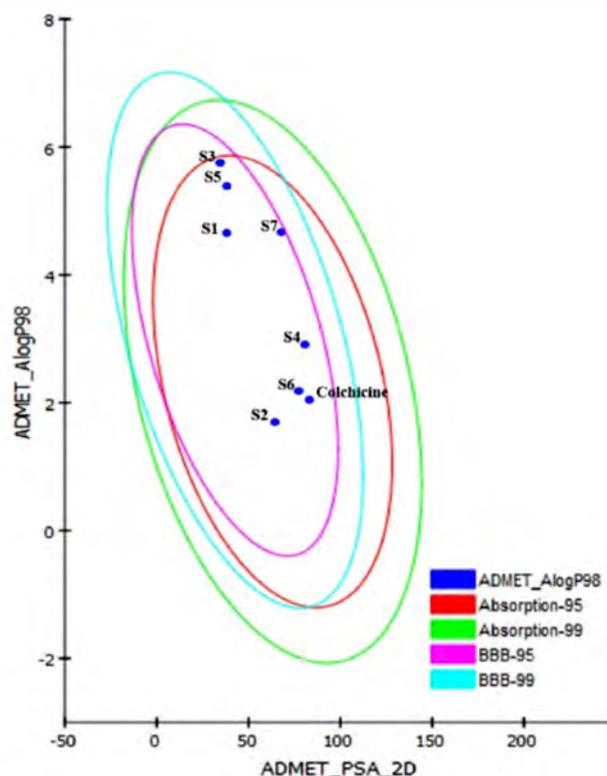


Fig. 2. A plot of polar surface area (PSA) versus AlogP.

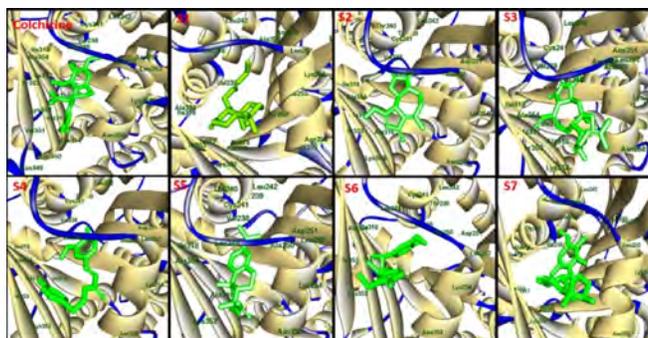


Fig.: Comparison of docking poses of Colchicine (control) and predicted hit compounds (S1 & S7) in terms of the binding pocket and binding site residues against anti-cancer receptor β -tubulin (PDB: 4O2B).

using the MMGBSA method. The pharmacokinetic and eADME/T analysis of predicted compounds were assessed through Discovery Studio software. These findings may be of immense importance in the optimization and development of dual inhibitory potent anti-cancer inhibitors against the MDA-MB231 TNBC cell line. Moreover, this novel QSAR based prediction model/method is implemented in R-package and software tool developed for virtual

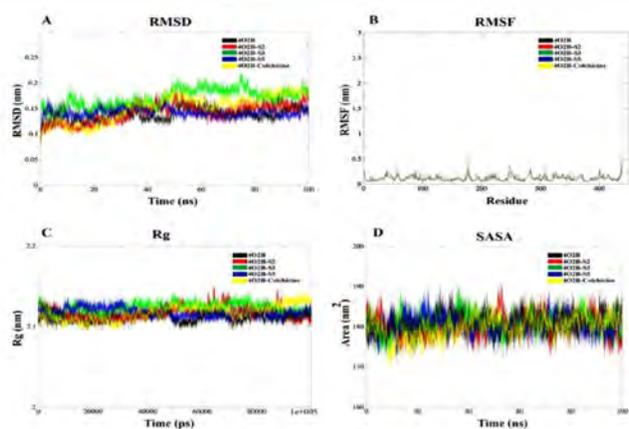


Fig.: Graphical Plots showing [A]: Root Mean Square Displacement (RMSD), [B]: Root Mean Square fluctuation (RMSF), [C]: Radius of gyration (Rg), and [D]: Solvent accessible surface area (SASA) backbone atoms of protein β -Tubulin (4O2B: black) and bounded ligands: 4O2B-S2 (red), 4O2B-S3 (green), 4O2B-S5 (blue), and 4O2B-Colchicine (yellow) complexes from initial structures throughout the 100 ns simulation as a function of time.

screening purposes and available online for download through the public repository GitHub (Fig. 1-4).

Developed Quantitative Structure-Property Relationship (QSPR) regression model to predict skin permeability (Kp) of Aroma molecules

In aroma therapy, human skin permeability property

e.g., skin permeability coefficient (K_p value) of aroma molecules (essential oils) play an important role. To predict the K_p value of aroma molecules, a supervised machine learning method based QSAR model developed by using forward multiple linear regression method. Results showed coefficient of determination (r^2) of 0.84 and a cross-validated regression coefficient (q^2) of 0.82, indicating strong predictive performance of developed QSPR model. Among the molecular descriptors analyzed, nO (number of oxygen atoms), ETA_BetaP_s (a measure of electronegative atom count of the molecule relative to molecular size), and M_i (mean first ionization potentials (scaled on carbon atom)) emerged as the most influential factors contributing to skin permeability. Through this model, a total of 339 sesquiterpene aroma compounds were screened for skin permeability. Through this, total 286 aroma compounds successfully cleared the Applicability Domain (AD) of model and predicted significant skin permeability. This model helps in prioritizing aroma molecules and offers valuable insights of aroma molecules action mechanism. This could assist the researchers in designing of focused aromatic plants/essential oil based herbal preparation (formulations/supplements) and aroma-therapy related skin lotions/oil for better permeability and bioactivity.



Dr. Feroz Khan & his team

Dr Bhaskar Shukla डॉ. भास्कर शुक्ला

Aroma-Mitra (Virtual Assistant of CSIR-Aroma App)



The CSIR Aroma mobile application has been augmented with Aroma-Mitra, a virtual assistant designed to facilitate interactive dissemination of information on aromatic crops. Aroma-Mitra enables farmers and other stakeholders to obtain accurate, context-specific information through natural language-based communication. By allowing users to pose queries and receive precise responses, the platform ensures an intuitive and engaging learning experience.

Key Features of Aroma-Mitra

- **AI-based platform:** Aroma-Mitra is built on an Artificial Intelligence (AI) and Natural Language Processing (NLP) framework to understand and respond to user queries in a human-like manner.
- **Bilingual-language support:** The chatbot can assist users in both English and Hindi.
- **Interactive User Experience:** The bot suggests quick-reply options for common queries. A typing indicator and bot avatar make the interaction natural and human-like. Works efficiently in areas with limited internet connectivity through optimized API responses.



- **Context-Specific Aromatic Crops Knowledge:** Provides information on cultivation practices, crop management, distillation processes, varieties, diseases, yield estimation, and market availability of aromatic crops. Reduces the knowledge gap by offering tailored answers rather than generic ones.
- **Decision-Support System:** Acts as a virtual aromatic crops guide, assisting in crop selection, cultivation planning, and disease management.
- **AI-Powered Continuous Learning:** The bot improves over time as more users interact, leveraging machine learning to dynamically.

Dr. Aman Chandra Kaushik डॉ. अमन चंद्र कौशिक



Artificial intelligence in the discovery and modification of biological elements in medicinal plants: Over the past years, I have conducted multiple scRNA-seq, RNA-seq, and ChIP-seq projects with a focus on plant-based medicine, secondary metabolism, and functional genomics using next-generation sequencing (NGS). My research emphasizes single-cell and systems-level analysis of medicinal and aromatic plants, integrating transcriptomics, epigenomics, and chemoinformatics to unravel regulatory networks, biomarker genes, and metabolic pathways that drive phytochemical biosynthesis.

PhytoSingleCellAtlas: Developed an AI-powered web platform for single-cell RNA-seq analysis in medicinal and aromatic plants, enabling biomarker discovery, cell-type annotation, and integration with spatial transcriptomics.

1. SmarTox: Developed an AI/ML-driven ethnopharmacovigilance platform for predicting the toxicity profiles of phytochemicals and synthetic drugs.
2. PhytoChemX1.0: Developed a chemoinformatics web server integrating 20 modules for drug discovery applications, including QSAR modeling,



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)	2500
Total Distillation Units Installed (number)	11
Total Varieties Developed (number)	01
Total Awareness/Training Programs (number)	87
Total Manpower Trained (number)	4679

Aroma Mission was conceptualized to popularize aromatic crops among farmers and enable the nation to compete in the global market. It recognizes the growing demand for aromatic crops and their products in various industries such as cosmetics, perfumery, pharmaceuticals, and culinary sectors. The mission aims to raise awareness among farmers about the potential benefits of growing aromatic crops, such as higher market value, 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. The mission, thus, recognizes the potential of aroma crops in terms of both economic value and environmental sustainability.

The Council of Scientific & Industrial Research (CSIR) has effectively 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 (2023-26), aiming at sustainable development along with entrepreneurship development. Ever since its inception, the mission has achieved significant success in revolutionizing the aroma industry through the application of scientific and technological

advancements by different laboratories under CSIR. CSIR-CIMAP, as the nodal laboratory, has effectively executed the mission's initiatives in cultivation, processing, value addition, and other related areas.



Plantation of geranium variety CIM-Bharat in farmers' fields under Aroma Mission at Sitapur district of Uttar Pradesh



A Chamomile seed was distributed to the farmers for the nursery bed at Kotia, Koraput, Odisha

During the second year of Aroma Mission Phase-III (2024-25), 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 2500 hectares of land with aromatic crops. Furthermore, to support and enable farmers in processing their crops, CSIR-CIMAP has also installed 11 distillation units.



A new aroma cluster has been selected for the cultivation of high-value aroma crops at Gangtok in Sikkim



Demonstration of drone technology during the FICCI International Fragrance Business Summit at Barabanki, Uttar Pradesh



Plantation of vetiver and lemongrass has been done in a sustainable cluster, Pathakpurva, Barabanki



CSIR-CIMAP team demonstrated the distillation process of lemongrass and addressed the processing issues.

Also, one high-yielding variety of Geranium (CIM-Sangam) has been released, providing farmers with improved varieties and agrotechnologies to enhance their yields and economic returns. CSIR-CIMAP has also organized numerous awareness, training, and skill development programs to enhance the knowledge

and skills of farmers involved in cultivating and processing aromatic crops. Over the past year, more than 87 programs were conducted, training over 4679 individuals, including 1245 women, highlighting the importance of gender inclusivity in agricultural and rural development initiatives. The institute, thus, strives to involve a large number of women in the

CSIR-Aroma Mission Phase-III

mission activities right from cultivation, processing, value addition to product development.



3-Day Skill Development and Training Program organized under the CSIR-Aroma Mission (HCP-0007) by the CSIR-CIMAP Research Centre, Hyderabad



250 kg SS Field Distillation Unit is installed for the CSIR-CIMAP beneficiary farmers under CSIR-Aroma Mission (Phase-III) at Pottal village, Tenkasi District, Tamil Nadu

Moreover, 05 MoUs have also been signed with various organizations/ NGOs/ Universities/ State Government/ FPOs, etc. in the year 2024-25. 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.



MOU signed in the presence of the Honorable Minister of Science and Technology, Dr. Jeetendra Singh, and DG CSIR, Dr. N. Kalaiselvi and Director, CSIR-CIMAP at New Delhi

CSIR-Floriculture Mission Phase-II

Floriculture Mission Phase II, significant progress has been made through various activities such as multiplying quality planting material's, developing & deploying agrotechnology and encouraging for development of value-added products to enhance economic and employment generation. So far, more than 23 lakh marigold saplings, 8 tonnes of tuberose bulbs, 1.4 lakh jasmine rooted plants, and 68,000 rose cuttings have been multiplied, distributed and expanding 125 hectares of floral cultivation acreage, and 2500 farmers family are employed in different floral activities. By this Floral Mission has created an opportunity among the small and marginal farmers, improving risk cover and multiplying income many folds.

Flower cultivation achieved an area of 125 ha against the proposed 116 ha target. Crop-wise, Average net

income from marigold, rose, tuberose and jasmine were ₹2.5–3.5 lakh/ha, ₹4.2–5.5 lakh/ha, ₹3.5–4.5 lakh/ha, and ₹4.5–5.5 lakh/ha, respectively. About 1,650 peoples were skilled through training/awareness programmes to enabling them for improved technologies and strengthen floriculture-based livelihoods.

Two major flower-based technologies were transferred to the industry. First one was the utilization of offered flowers for making incense sticks and fragrant cones, which was transferred to Kirti Divine Pvt. Ltd., Varanasi and the second was green chemistry based extraction process technology of Lutein from marigold (*Tagetes erecta*) flowers, transferred to Coromandal International Ltd., Cuddalore, Tamil Nadu.



Glimpse of Floriculture mission

CSIR-Phytopharmaceutical Mission (Phase III)

MMP075201 (Captive Cultivation of *Curcuma amada*)

Vertical - B (PI-Dr Ramesh Kumar Srivastava)

CSIR Phytopharmaceutical Mission III focused on developing drugs through the phytopharmaceutical route for both domestic and global markets. It aims to transform the perception of herbal medicines worldwide. CSIR, along with its specialized laboratories and collaborations with public and private enterprises, will deploy advanced technologies while ensuring environmental sustainability. By emphasizing captive cultivation and adhering to high quality standards, the mission strives to position India as a global leader in the phytopharmaceutical and botanical drug sector.

In the Phytopharmaceutical Mission Phase III, several key focus areas have been identified to address the challenges and gaps identified in Phase I. The mission aims to develop and disseminate scientific and technological advancements in the field of phytopharmaceuticals, with a strong emphasis on the restoration of natural populations and the captive cultivation of superior genotypes and cultivars.

S. No	Milestones proposed	Present status
1.	Collection, Identification and characterization of superior germplasm of <i>C. amada</i>	<ul style="list-style-type: none"> 5 kg rhizome of <i>C. amada</i> was given to Dr BS Sashidhar, Principal Scientist and PI at NIIST, Trivandrum for further analysis 42 Accessions of <i>Curcuma amada</i> collected from different states across the country and planted in the Research farms of CSIR-CIMAP and CRC, Pant Nagar.

2.	Development of Good Agriculture Practices and selection of promising chemotype	<ul style="list-style-type: none"> The collected accessions planted under development of Good Agriculture Practices and selection of chemotype is under process. The planted accessions were harvested and received more than 300 kg rhizome. This will be distributed for captive cultivation.
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Deliverables

- 5 kg rhizome of *C. amada* was given to Dr. BS Sashidhar, Principal Scientist and PI at NIIST, Trivandrum for further analysis and extraction
- 42 Accessions of *Curcuma amada* were collected from different states across the country and planted in the Research farms of CSIR-CIMAP and CRC, Pant Nagar for evaluation and development.
- Planted more than 95 kg rhizome of *Curcuma amada* for large scale multiplication of QPM and also used for development of Good Agro practices at CSIR-CIMAP Research Farm.
- Analysed each collected accessions for its active constituents presented in rhizome targeted towards the development of better chemotypes.
- After development of the elite chemotype of *C. amada*, improved QPM will be given to the famers with Good Agriculture Practices for re-initiation in native habitat.

Germplasm of *Curcuma amada* Collected and planted at CSIR-CIMAP

S.No.	Place	Date	Plant Part
1.	Mathura (U.P)	24/05/24	Rhizomes (Dried)
2.	Pantnagar (U.P)	24/05/24	Rhizomes
3.	Shergarh, Bareilly (U.P)	04/06/24	Rhizomes
4.	Marsanda, Sonbhadra (U.P)	06/06/24	Rhizomes
5.	Golaghat, Assam	07/06/24	Rhizomes
6.	Pasi Ghat , Arunachal Pradesh	07/06/24	Rhizomes
7.	Kamua, Sitapur, (U.P)	07/06/24	Rhizomes
8.	Mizoram	16/06/24	Rhizomes+ Plants
9.	Nashik, Mumbai, Maharashtra	22/06/24	Plants
10.	Raebareli (U.P)	25/06/24	Rhizomes
11.	Jhansi (U.P)	25/06/24	Rhizomes
12.	Araku Valley, Andhra Pradesh	28/06/24	Plants
13.	Kiloguada, ASR, Andhra Pradesh	28/06/24	Rhizomes
14.	Araku Valley, Andhra Pradesh	28/06/24	Rhizomes (Dried)
15.	Barwasagar, Jhansi (U.P)	05/07/24	Rhizomes (Dried)
16.	Kopi, Bihar	20/07/24	Plants
17.	Chalavara, Palakkad(Kerala)	06/08/24	Rhizomes
18.	Chalavara, Palakkad(Kerala)	06/08/24	Dried Rhizomes
19.	Chalavara, Palakkad(Kerala) 1	04/08/24	Plants
20.	Chalavara, Palakkad(Kerala) 2	04/08/24	Plants
21.	Chalavara, Palakkad(Kerala) 3	04/08/24	Plants
22.	Chalavara, Palakkad(Kerala) 4	04/08/24	Plants
23.	Chalavara, Palakkad(Kerala) 5	04/08/24	Rhizomes+ Plants
24.	Kunderhi, Potangi, Orissa	06/08/24	Rhizomes
25.	Podagada, Koraput, Orissa	02/08/24	Rhizomes
26.	Thiruvambadi, kerala	06/08/24	Rhizomes
27.	KVK, Mallappuram, kerala	05/06/24	Plants
28.	Simroll, Indore , MP	23/10/24	Plants & Rhizomes
29.	Phanda, Sehore, MP	24/10/24	Plants & Rhizomes
30.	Panna, MP	25/10/24	Dried Rhizomes
31.	Muallangthu, Aizwal , Mizoram	20/10/24	Rhizomes
32.	Calicut, Kerala	05/11/24	Rhizomes
33.	MRDC, Pantnagar, UK	06/11/24	Rhizomes
34.	Pacheykhani, Pakyong, Sikkim	19/11/24	Rhizomes
35.	Gangtok, Sikkim	27/11/24	Rhizomes
36.	Seorai, Ghazipur, UP	14/12/24	Rhizomes
37.	Kasargod, Kerala	07/02/25	Rhizomes
38.	Maniyat, Kasargod, Kerala	07/02/25	Rhizomes
39.	Kasargod, Kerala	07/02/25	Rhizomes
40.	Ahmedpur , Raebarelli, UP	21/02/25	Rhizomes
41.	Pakyong, Sikkim	11/03/25	Rhizomes
42.	Port Blair, Andaman & Nicobar	18/03/25	Rhizomes



Morphological analysis: -

Morphological analysis of *Curcuma amada*

- The morphological analysis of *Curcuma amada* showed significant variations in morphological traits
- The Pearson correlation showed a significant correlation in morphometric traits

Table 1: Analysis of variance (ANOVA) of morphometric characters of studied accessions of *C. amada*

Morphometric traits	Between population (df=11)	Within population (df=25)	Total (df=26)
Plant height (cm)	2823.65**	6827.59	35061.04
Number of leaves	121.05**	22.80	143.85
Leaves in main shoot	52.58*	26.40	78.98
Green leaves in main shoot	26.96	23.03	50.00
Dry leaves in main shoot	28.93	47.00	76.93
Leaves/plant	485.63*	1208.66	6084.29
Green leaves/plant	33.88 55*	481.30	2319.85
Dry leaves/plant	987.59	461.79	3650.29
Leaf length (cm)	6033.06**	1042.40	7075.55
Leaf width (cm)	2462.81*	238.09	150.67



Fig.1: *Curcuma amada*

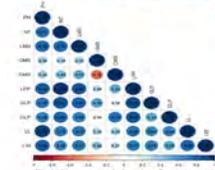


Fig.2: Pearson correlation plot of morphometric traits of the studied *C. amada* accessions

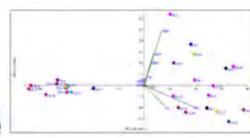


Fig.3: Principal component analysis of studied *C. amada* accessions based on the morphometric traits

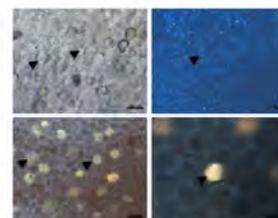
Chemical analysis: -

KEY FINDINGS

Studies on Morphological and anatomical description

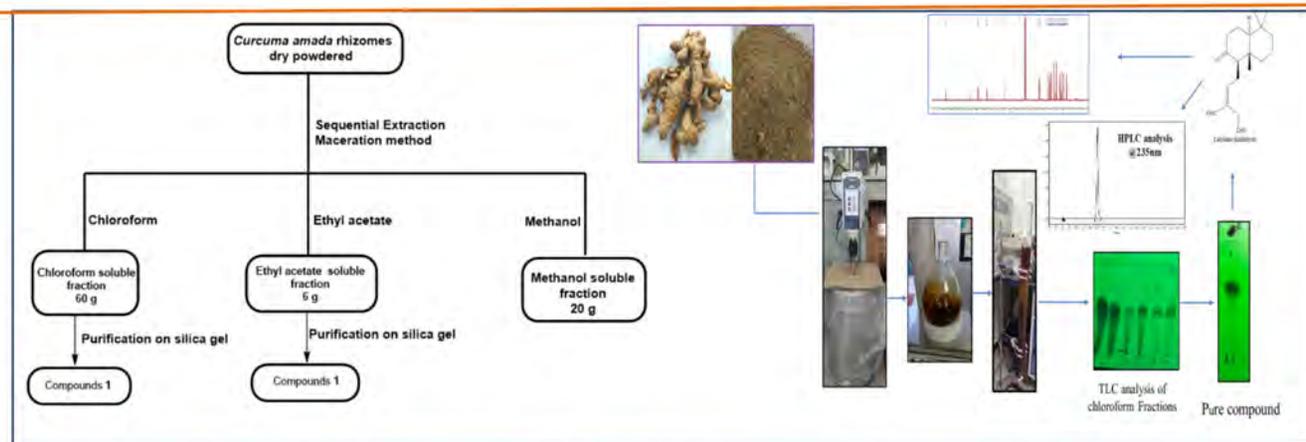


Morphological study of rhizome of *Curcuma amada* Roxb.



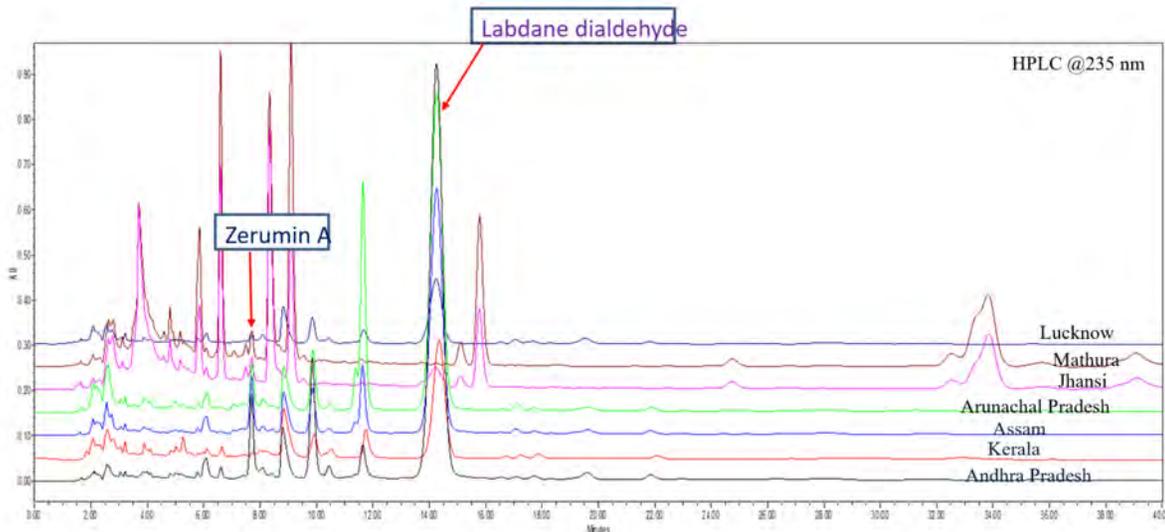
Anatomical study of *Curcuma amada* Roxb. Showing distribution of secondary Metabolites synthesizing cells (arrowhead)

Purification and identification of secondary metabolites from *Curcuma amada* rhizomes



- Fresh *C. amada* rhizomes (5.0 kg) were collected from CSIR-CIMAP, Lucknow Research Farm.
- Fresh rhizomes were dried under shade, and the material (1.1 kg) was powdered for further processing.
- The dried material (1.0 kg) was extracted sequentially with chloroform, ethyl acetate, and methanol to get corresponding extracts.
- HPLC analysis of chloroform extract and crude drug has been done.
- Further, the purification of chloroform extract for analytical marker compounds is in progress.

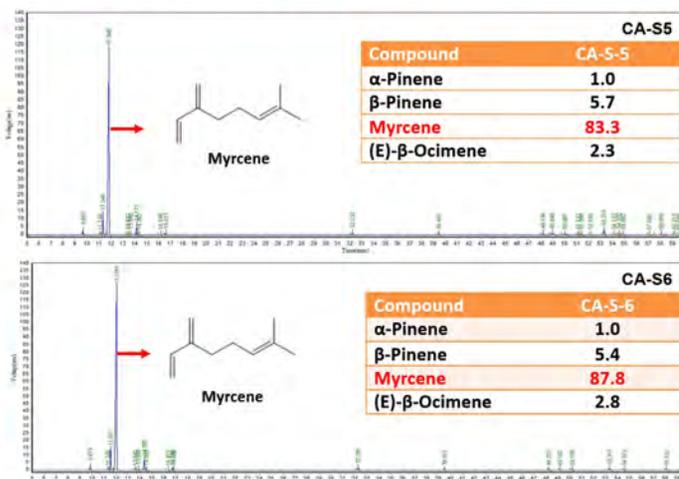
HPLC analysis of *Curcuma amada* rhizomes collected from different locations



Chemical analysis and physical properties of *Curcuma amada* essential oil



- Extraction of the essential oil from the rhizomes of two collections (CA-S5 and CA-S6) has been done.
- The physical properties of the oil have been determined.
- Chemical analysis of the essential oil done.



Essential oil yield and physical properties

Sample code	Essential oil (%) fresh rhizome	Refractive index (20°C)	Optical rotation (20°C)	Colour	Odour
CA-S5	0.8	1.4730	(-)-1.4°	Colourless	raw mango like
CA-S6	1.0	1.4709	(-)-1.4°	Colourless	raw mango like

IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP)

Online lecture series:

IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP) has initiated an online lecture series about medicinal and aromatic plants featuring monthly lectures by eminent professors, scientists, and industry experts from Member States and Dialogue Partners.

Online Presentation:

Title: 'A Review of Herbal Medicine Applications in the Treatment and Prevention of Type 2 Diabetes (T2D) in Iran'

Date: 23 October 2024

Speaker: Dr. Mohammad Reza Sanjabi, Director IORA-RCSTT, Tehran, Iran



International Conference:

An International Conference on Advances in Medicinal & Aromatic Plant Research in Context to Indian Ocean Region (Ensuring Trade, Sustainability and Global Transformation) "IORA-AMAR 2025" was organised by CSIR-Central Institute of medicinal & Aromatic Plants (CIMAP), Lucknow during February 4-6, 2025. The International Conference was focused on five key themes including Phytochemistry, Bioprospection and Product Development, Traditional Knowledge, Trade and Intellectual Property Rights (IPR), Plant Biochemistry and Biotechnology, and Plant Breeding and Crop Production. Delegates, keynote speakers, and participants from 12 IORA countries- including India, the United Kingdom, France, Iran, Mauritius, Mozambique, Madagascar, Bangladesh, Comoros,





the Philippines, Sri Lanka, South Africa, and Thailand joined the conference. The conference served as a platform for the exchange of ideas and research findings, promoting international collaboration and innovative approaches in the medicinal and aromatic plant sector, and strengthening networks among the participating countries. The rich international presence brought a vibrant energy to the conference, sparking meaningful conversations and building stronger connections across the Indian Ocean region. Participants engaged in meaningful discussions on making the medicinal and aromatic plant sector more sustainable, translating innovations into market, and addressing the challenges in research and development. These exchanges highlighted the value of working together to protect biodiversity, improve healthcare, and promote new trade opportunities. The conference became a space to share knowledge, inspire new ideas, and lay the groundwork for future collaborations.

International Training Program:

A Training program on “Prospects of Research, Development, Value-addition and Commercialization of Medicinal and Aromatic Plants Native to Indian Ocean Region” was organised by CSIR-CIMAP, Lucknow during February 7-11, 2025. The training program was primarily aimed at enhancing regional scientific and technological capabilities among IORA Member States and Dialogue Partners. It focused on exploring the potential of medicinal and aromatic plants (MAPs) native to the Indian Ocean region, highlighting advancements in scientific research,



sustainable cultivation practices, innovative value-addition techniques, and strategies for effective commercialization. Participants explored a diverse range of topics, including advanced DNA barcoding, bioactive compound identification, essential oil chemistry, novel product development, agrotechnologies for medicinal and aromatic plants, value-addition of MAPs, intellectual property rights, and trade opportunities, all through expert-led lectures, interactive sessions, hands-on demonstrations, and field visits. A total of sixteen delegates from IORA countries, including France, Iran, Mauritius, Mozambique, Madagascar, Comoros, the Philippines, Sri Lanka, South Africa, and Thailand, attended the training program.



Science & Technology



Variety Released

Linalool-rich inter-specific *Ocimum basilicum* × *O. kilimandscharicum* amphidiploid hybrid with perennial growth habit and cold tolerance suitable for aromatic plant-based cropping system

In order to extend the growing season vis-à-vis enhanced biomass production and perennial growth habit, efforts are made to realize interspecific hybrids, that could retain the desired oil quality of *O. basilicum*, vis-a-vis extended growth cycle of *O. kilimandscharicum* befitting dynamic cropping system. Realization of artificial interspecific hybrids between these two species, followed by experimental polyploidization and screening for essential oil quality and productivity have led to isolation of fertile interspecific hybrids that offer twin advantage of perennial growth habit, increased biomass and elite hybrid genotype with desirable oil quality, rich in high value Linalool component. The instant hybrid could fit in the standard Mint-Ocimum relay cropping system, as well as sole crop that could be cultivated round the year, thriving through monsoon and winter seasons in the plains, meeting the cultivator's choice. The developed amphidiploids promise cultivation in plains for Linalool-rich essential oil. The amphidiploids thus developed offer high seed fertility suitable for commercial cultivation, and promise productivity of ~180 litre Linalool (>60%,

reaching to >68% in winter harvest) rich essential oil from a six-month crop from two harvests per hectare over six months. Besides, its leaves contain medicinally valued micro-metabolites; Rutin=0.034 mg. and Gallic acid = 0.125 mg / g fresh weight.

Contributors

Dr. Umesh Chandra Lavania, Dr. Raj Kishori Lal , Dr. Yerramilli Vimala, Basant Kumar Dubey , Dr. Seshu Lavania, Dr. Chandan Singh Chanotia, Dr. Prabodh Kumar Trivedi , Dr. Ajit Kumar Shasany

Resilient Somaclonal Variant of Geranium 'CIMAP-K24' with High Oil Yield and Low Citronellol: Geraniol Ratio for Cultivation in the North Indian Plains

The national demand for geranium essential oil is ~200 tonnes per year whereas only 20 tonnes are produced in India and meets its requirement mainly by import. Perfumery industries need high yield, low C: G ratio, and fungal resistant/Tolerant Geranium variety. This creates an urgency to raise improved cultivars with all potential quality factors and high oil yield. The clone, developed for India's northern plains, stands out for its strong stem, high leaf-to-stem ratio, substantial biomass, and tolerance to fungi, especially during the rainy season. It yields 60–65 kg/ha of oil in a single harvest and





95–100 kg/ha in two harvests. The estimated gross returns range from ₹5,00,000–8,00,000, highlighting its economic potential. This clone demonstrates superior adaptability and performance for subtropical conditions.

Contributors

Dr Laiq Ur Rahman Zafar Iqbal Warsi, Kahkashan Khaton, Dr Akanksha Singh, Kajal Singh, Dr Sanjeet K. Verma, Dr Rajesh K Verma, Gazala Parween, Tanya Singh, Dr Zakir Husain, Dr Ramswaroop Verma, Dr Sudeep Tandon, Munmun Singh

Herbal Products Released

CIM-Larvishield: Novel Polymeric Beads formulation with Mosquito Larvicidal action

In a significant scientific breakthrough, researchers at the CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, have developed an innovative, eco-friendly solution to combat mosquito-borne diseases. The new technology uses biodegradable polymer beads entrapping food grade essential oil to eliminate mosquito larvae from stagnant water sources, offering a safer and sustainable alternative to conventional chemical larvicides.



The used essential oil is a widely recognized medicinal and culinary plant and has been known for its antimicrobial and insect-repellent properties for centuries. The essential oil derived from spice contains bioactive compounds that are highly effective against mosquito larvae. However, its direct application in water has been limited due to its rapid evaporation and insolubility in water.

Addressing this challenge, CSIR-CIMAP scientists have successfully encapsulated essential oil in

biodegradable polymeric beads approximately 1.2-2 mm in diameter. These beads gradually release the oil when placed in water, maintaining its larvicidal activity for days.

The technology is designed for practical use in everyday settings such as household water storage containers, garden ponds, birdbaths, overhead tanks, and summer coolers- common breeding grounds for mosquitoes. Laboratory trials have shown that adding these beads to stagnant water can kill existing mosquito larvae within 24 hours. The beads release the active compounds after coming in contact with water and continue to do so gradually over the extended period.

Importantly, the formulation is non-toxic, biodegradable, and environmentally friendly. Unlike conventional larvicides that may pose health hazards to children, pets, and aquatic organisms, fennel oil beads are safe and leave no harmful residues. This makes beads a promising tool in integrated mosquito management strategies, especially in urban and semi-urban areas where chemical usage is a growing concern.

Indian patent has been filed for the innovation and the technology has been licensed to an Indian company viz. Yauvanchakra Pvt. Ltd., Jaipur (India) for commercialization.



CIMAP Publications

राजभाषा पत्रिका 'औस विज्ञान'

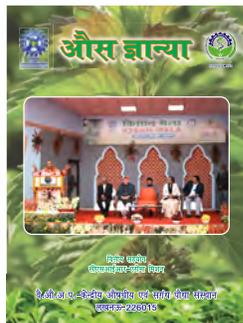
संस्थान द्वारा गृह राजभाषा पत्रिका 'औस विज्ञान' वर्ष 2025, अंक-8 का प्रकाशन हो चुका है। इस पत्रिका में संस्थान के विभिन्न वैज्ञानिकों, शोधार्थियों, प्रशासनिक, तकनीकी अधिकारियों, कर्मचारियों द्वारा सीमैप प्रयोगशाला में हो रहे शोध एवं विकास कार्यों को हिन्दी के माध्यम को प्रोत्साहित करने हेतु प्रस्तुत किया गया है। यह पत्रिका हमारे भावों की वाहिनी होने के साथ-साथ हमारी प्रगति को जन-जन तक पहुँचाने का सबल माध्यम है।



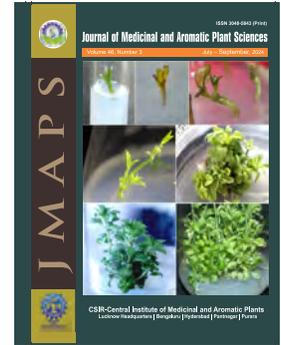
औषधीय एवं सगंध पौधों के अनुसंधान से होने वाले लाभ जनसाधारण तक पहुँचाने के लिये 'औस विज्ञान' तत्पर है। एक ओर जहाँ अनुसंधान व ज्ञान का लाभ सभी तक पहुँचाने में 'औस विज्ञान' जुटी है, वहीं हमारी मातृ भाषा का उपयोग वैज्ञानिक उपलब्धियों को यथार्थ में परिवर्तित कर पाना संभव हो पा रहा है। औस विज्ञान पिछले वर्ष से अधिक योगदान 'विज्ञान से सशक्त समाज' की परिकल्पना 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 में औषधीय एवं सगंध कृषि तकनीकियों एवं उनके प्रसंस्करण आधारित उद्योग तथा व्यापार संबंधी महत्वपूर्ण जानकारी को किसानों में 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 में 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 में महत्वपूर्ण भूमिका निभाना है। यह पुस्तिका हरसल लगभग 10000 से 15000 किसानों तक विभिन्न कार्यक्रमों के अंतर्गत पहुँचाई जाती है।



CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, has been successfully publishing an indexed, multidisciplinary, peer-reviewed scientific research journal entitled "Journal of Medicinal and Aromatic Plant Sciences" (JMAPS) since 1978. The journal is managed by reputed academicians and subject experts who serve on its Editorial Board and contribute their expertise to ensure high-quality and timely publication. JMAPS aims to publish the latest and most significant Original Research Articles, Review Articles, Short Communications, and Reports on New Variety Release of medicinal and aromatic plants. The journal follows a double-blind peer review process, wherein the identities of both authors and reviewers remain confidential throughout the review.



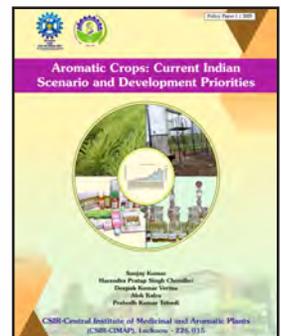
The journal is indexed/abstracted in several leading services, including: Medicinal and Aromatic Plants Abstracts (NISCAIR, India), Chemical Abstracts (USA), Plant Breeding Abstracts, Review of Aromatic and Medicinal Plants (CAB International, Wallingford, UK), and Biosis Preview (USA)

During the year 2024-25, JMAPS Volume 46 (Issues 1, 2, 3 & 4) was published. In which Vol. 46 (1 & 2), each issue included 2 Review Articles and 2 Original Research Articles; and Vol. 46 (3 & 4), each issue included 3 Review Articles and 2 Original Research Articles.

Policy Paper: 01

Aromatic Crops: Current Scenario and Development Priorities

India's rich biodiversity and agro-climatic diversity offer significant potential in the global aromatic crop sector. With 0.74 million hectares under cultivation, key exports like menthol mint and lemongrass drive growth in a global essential oil market projected to reach \$5 trillion by 2050. However, challenges such as post-harvest gaps, price volatility, and import dependence persist. This policy paper outlines development priorities including R&D, sustainable practices, and policy support to strengthen India's aroma sector, enhance farmer incomes, and boost global competitiveness.



S&T Activities

i) CSIR-CIMAP Foundation Day

CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) celebrated its 65th Foundation Day on Friday, 05 April 2024. On this occasion, Dr. Ajit

Kumar Shasany, Director, CSIR-NBRI, was the chief guest, Dr. Radha Rangarajan, Director, CSIR-CDRI was the guest of honor and Dr. Gopaljee Jha, Scientist-V, NIPGR was the special guest.



Invitation Card for Foundation Day 2024

Guest Speakers of the Programme.



The Glimpse of the Annual Day Program.

ii) National Technology Day

CSIR-Central Institute of Medicinal and Aromatic Plants celebrated the 25th National Technology Day at Lucknow on 15th May 2024. Dr. RM Sundaram, Director, ICAR-IIRR, was the Chief Guest, Dr.

Ashwariya Lakshmi, Staff Scientist VI, NIPGR, was the Guest of Honour and Dr. Hitendra Patel, Senior Principal Scientist, CCMB, was the Special Guest at the event.



Glimpse of National Technology Day-2024



Glimpse of National Technology Day-2024

iii) CSIR-CIMAP 46th Annual Day

CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow celebrated its 46th Annual Day today on 14th August, 2024 at its campus

in Lucknow. The program was inaugurated by Shri Brajesh Pathak, Hon'ble Deputy Chief Minister, Uttar Pradesh and the distinguished guests along with the Director of CSIR-CIMAP by lighting the lamp.



Invitation Card for CSIR-CIMAP Annual Day 2024



Felicitations of Guest Speakers



Science and Technology

Shri Brajesh Pathak, Hon'ble Deputy Chief Minister, Cabinet Minister, Medical Education, Medical and Health, Family Welfare and Mother and Child Welfare, Government of Uttar Pradesh, Chief Guest

of the function, congratulated the Director CSIR-CIMAP, Dr. Prabodh Kumar Trivedi, scientists, employees and researchers on the Annual Day.



A Glimpse of CSIR-CIMAP 46th Annual Day

iv) CSIR 83rd Foundation Day

CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP) celebrated CSIR Foundation Day on Friday, 27 September 2024 at Utsav Hall, CSIR-CIMAP, Lucknow. On this occasion, Major (Professor) Sanjay Kumar, Hindi Department & Associate NCC Officer, Ramlal Anand Mahavidyalaya, University of Delhi was chief guest, Dr. Ajit Kumar Shasany, Director, CSIR-NBRI was the guest of honor.



A Glimpse of 83rd CSIR Foundation Day



A Glimpse of 83rd CSIR Foundation Day

v) National Science Day

National Science Day 2025 was celebrated with great enthusiasm at the CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow. This year's theme for National Science Day celebration was "Empowering Indian Youth for Global Leadership in

Science and Innovation for Viksit Bharat."

The event was presided over by Dr. Prabodh Kumar Trivedi, Director, CSIR-CIMAP, and the Chief Guest for the function was Dr. Senjuti Sinharoy, Scientist-V, National Institute of Plant Genome Research, New Delhi.



Invitation Card



A Glimpse of National Science Day-2025



Felicitations of Chief Guest and Speaker

Trainings and awareness programs conducted by CSIR-CIMAP RC Bengaluru in Karnataka

As part of CSIR Aroma Mission-III, a three-day training programme on “Improved Production Technologies of Aromatic and Medicinal Plants & Aromatic Oils” was conducted from 7–9 August 2024 at the CSIR-CIMAP Research Centre, Bengaluru. A total of 19 trainees participated in this intensive programme, which provided hands-on exposure to cultivation practices, processing, and value addition.

In addition to this specialized training, several one-day awareness programmes were organized across Karnataka.

On August 20, 2024, a programme was held at KVK Suttur, Mysuru, with 50 participants. This was followed by another session at Thalur, Mysuru, on September 14, 2024, which attracted 60 participants. Subsequently, on October 28, 2024, a programme at KVK Mandya engaged 70 farmers. The largest gathering was at the CSIR-CIMAP Research Centre, Bengaluru, on October 23, 2024, where nearly 200 participants, including farmers and stakeholders, actively took part.

Together, these awareness and training programmes significantly contributed to promoting aromatic crops in Karnataka, equipping farmers with knowledge on advanced production technologies and strengthening livelihood opportunities through aromatic and medicinal plant cultivation.



Awareness program in KVK Suttur, Mysuru, Karnataka



Awareness program in Thaluru, Mysuru Karnataka

Trainings and awareness programs conducted by CSIR-CIMAP RC Bengaluru in Kerala

Under the CSIR Aroma Mission-III (HCP-0007), a series of one-day awareness programmes were organized across Kerala between December 2024 and March 2025 with the objective of promoting aromatic crops and enhancing livelihood opportunities. These programmes witnessed active participation from farmers, tribal communities, local residents, and other stakeholders, with attendance ranging from 30 to over 100 participants at each location.

The first programme was held at Valara in Idukki district on December 21, 2024, where around 30 participants took part in the sessions. This was followed by a major programme at the Daivakund Tribal Hamlet in Agali, Palakkad district on January 19, 2025, which drew nearly 95 participants, highlighting the strong interest among tribal farmers. Shortly after, on January 21, 2025, another programme was

conducted at Dinducomb in Kanthaloore Panchayat, Idukki district, with about 75 participants actively engaging in discussions on aromatic crop cultivation.

The mission expanded to Perumbavoor in Ernakulam district on January 23, 2025, where 100 participants attended, marking one of the largest gatherings in the series. Subsequently, on March 3, 2025, an awareness programme at Aralam Farm in Iritty, Kannur district brought together 35 participants, focusing on localized farming practices and aromatic plant promotion. The final programme in the series was





organized on March 5, 2025, at the Tropical Institute of Ecological Sciences (TIES), Vellore, Kottayam district, where around 85 participants took part, reflecting strong community involvement and institutional collaboration.

Collectively, these programmes played a significant role in spreading awareness about the potential of aromatic crops in Kerala, encouraging adoption of improved cultivation practices, and strengthening the livelihood base of farming and tribal communities across the state.

Trainings and awareness programs conducted by CSIR-CIMAP RC Bengaluru in Tamilnadu

Under the New Aroma Mission, several new beneficiary farmer clusters have been formed across Tamil Nadu. The Muthamalpuram cluster in Tenkasi, consisting of 3 beneficiary farmers, has taken up lemongrass cultivation in an area of 3.25 acres. Similarly, the Kallal cluster in Sivagangai with 3 farmers has also cultivated lemongrass over 3.25 acres. The Thirumangalam cluster in Madurai involves 2 farmers who are cultivating vetiver on 2.5 acres, while the Kottai cluster in Dharmapuri has 1 farmer engaged in lemongrass cultivation across 1.25 acres. In addition, the Kallanai cluster in Tiruchirapalli and the Thirukattupalli cluster in Thanjavur, with 2 and 3 farmers respectively, are focusing on vetiver cultivation over 2.5 acres each.

To create awareness and build farmer capacity, a series of awareness programs and field visits were organized. One-day awareness programs were conducted between May 29–31, 2024, at Vellimudi and Kadambarai tribal settlements of the Anamalai

Tiger Reserve, Pollachi taluk, Coimbatore district, benefiting 200 participants. Another program was held on October 7, 2024, at Nilakottai taluk of Dindigul district with 75 participants, followed by one on January 26, 2025, at Thirukkattupalli in Thanjavur district, attended by 50 farmers. A five-day training program was organized from February 24–28, 2025, at Ayya Nadar Janaki Ammal College (ANJA College), Sivakasi Taluk, Virudhunagar district, with 25 participants. In addition, a one-day interaction meeting and awareness programme on Tulsi cultivation, processing, value addition, and marketing was conducted for farmers of Nilakottai and nearby villages. On January 26, 2025, an awareness program on improved production technologies of aromatic plants and aromatic oils was also conducted at Thirukkattupalli, Thanjavur district.

Crop-wise, the area covered under vetiver (CIM-Samridhhi/Vridhi) includes 2.5 acres each in the Thirumangalam cluster of Madurai, the Kallanai cluster of Tiruchirapalli, and the Thirukattupalli cluster of Thanjavur, with 50,000 slips planted in each location, making up a total of 7.5 acres. Lemongrass (Krishna & CIM-Shikhar) has been cultivated in



several clusters: 1.25 acres in Muthamalpuram cluster, Tenkasi with 18,000 slips, 0.75 acres in Rajapalayam cluster, Virudhunagar with 10,000 slips, 1.5 acres in Kallal cluster, Sivagangai with 22,000 slips, 3.25 acres in Mookkanur cluster, Salem with 50,000 slips, and 1.25 acres in Kottai cluster, Dharmapuri with 20,000 slips. Together, lemongrass covers a

total area of 8 acres. Palmarosa (PRC-1) cultivation has been initiated in Narayanakuppam cluster, Thiruvannamalai and Mookkanur cluster, Salem, with 10 kg seed each covering 5 acres, contributing a total of 10 acres. Tulsi (CIM-Ayu) cultivation has been taken up in Nilakottai cluster, Dindigul district with 7 kg seed, covering 35 acres.

Quality planting material distribution under Aroma Mission by CSIR-CIMAP RC Bengaluru Centre

Under the CSIR Aroma Mission-III, significant quantities of planting material have been produced and supplied to farmers across different states to promote aromatic crop cultivation.

In Karnataka, farmers received 2.73 lakh slips of lemongrass, 0.20 lakh slips of vetiver, 0.10 lakh slips of geranium, 0.60 lakh slips of patchouli, and 13 kg of palmarosa seed material. In Tamil Nadu, the distribution included 1.20 lakh slips of lemongrass,

1.50 lakh slips of vetiver, 0.01 lakh slips of rosemary, 0.02 lakh slips of patchouli, along with 29 kg of palmarosa seed material. For Gujarat, 29 kg of palmarosa seeds and 0.90 lakh slips of citronella were supplied. In Kerala, 0.8 lakh slips of lemongrass were provided to farmers. Meanwhile, in Arunachal Pradesh, farmers benefitted from the supply of 0.8 lakh slips of patchouli.

This distribution of quality planting materials has played a key role in expanding the area under aromatic crops, supporting livelihood enhancement, and strengthening the supply chain of raw materials for the fragrance and flavour industry across multiple states.



Planting Material sent to Gujarat farmers under Aroma Mission-III

ONE DAY AWARENESS PROGRAMMES (APRIL 2024 - MARCH 2025)

1. The CSIR-CIMAP Research Centre, Hyderabad has successfully organized a one-day awareness program titled “Cultivation, Post-Harvest Management & Market Opportunities on MAPs” in collaboration with the Andhra Pradesh Medicinal and Aromatic Plants Board. This event took place on February 20, 2025, at the CLRC in Banavasi, Kurnool District, Andhra Pradesh, and attracted around 66 farmers from the surrounding area.



2. The CSIR-CIMAP Research Centre, Hyderabad, in collaboration with the Andhra Pradesh Medicinal and Aromatic Plants Board (APMAPB), Vijayawada, successfully organized a comprehensive one-day awareness program on February 25, 2025. This event took place at the RAAS-Krishi Vignan Kendram in



Chaitanyapuram, Karakambadi Panchayat, Renigunta Mandal, Andhra Pradesh, and was focused on the cultivation and marketing of various Medicinal and Aromatic Plants (MAPs), including Lemongrass, Palmarosa, Citronella, Tulsi, Vetiver, and Nannari. Around 70 farmers from the Tirupathi region participated actively, demonstrating a strong interest in the subject.

3. On 29th March 2025, the CSIR-CIMAP Research Centre, Hyderabad (CRCH), in collaboration with the Telangana State Medicinal Plant Board (TGMPB), organised a Buyer-Seller Meet cum Awareness Programme at National Research Institute on Unani Medicine and Skin Disorders, Hyderabad. The event focused on the marketing potential of Medicinal and Aromatic Plants (MAPs), attracting around 74 buyers and sellers from across the region for productive discussions. Distinguished speakers included the Deputy CEO of TGMPB, a Director from NRIUMSD, and experts including Dr Jnanesha A.C., CRCH and



Smt. Krishnaveni, Sri Konda Laxman Telangana State Horticulture University (SKLTSHU), and their team. Dr Jnanesha shared valuable insights on advanced cultivation techniques for key crops like Ashwagandha, Satavari, Lemongrass, and Palmarosa.

4. The CSIR-CIMAP Research Centre in Hyderabad organized a three-day skill development and training program from November 12 to 14, 2024, as part of the CSIR-Aroma Mission, Phase III. Approximately 40 participants attended the program, with representatives from Andhra



Pradesh (14), Telangana (22), Kerala (2), Maharashtra (1), and Puducherry (1). Among the participants, three were women. Dr. Prabodh Kumar Trivedi, Director of CSIR-CIMAP in Lucknow, as the Chief Guest, delivered the keynote address during the inaugural ceremony. He provided an overview of the current status of medicinal and aromatic crops, highlighted the achievements of the CSIR-Aroma Mission, and encouraged participants to consider cultivating medicinal and aromatic plants (MAPs) as alternative crops for dry and infertile lands.

5. The CSIR-CIMAP Research Centre, Hyderabad, organised a three-day skill development cum training program at the Centre on “Cultivation, Primary Processing, Quality and Marketing Aspects of Commercially Important Aromatic and Medicinal Crops” from **March 18 to 20, 2025**, under the CSIR-Aroma Mission Project (Phase III). Approximately 70 participants, including

53 men and 17 women, attended the program from nine states, primarily from Telangana, Andhra Pradesh, Odisha and Maharashtra. Dr. Prabodh Kumar Trivedi, Director of CSIR-CIMAP, Lucknow, inaugurated the program and, during his keynote address, encouraged the participants towards the cultivation of Medicinal and Aromatic Plants (MAPs). The technical sessions included presentations on production technologies for lemongrass, palmarosa, Ocimum species, vetiver, and rosemary, as well as nutrient management in MAP cultivation and essential oil production technologies. These sessions were led by Drs. Jnanesha AC, ND Yogendra, B Shivanna, and Er GD Kiran Babu.

6. CSIR-CIMAP Research Centre, Hyderabad, participated in the 3rd edition of the three-day KISAN Agri Show 2025 organised at Hitex City Exhibition Centre, Hyderabad from February 7th to 9th 2025, which is the most vibrant platform



and the largest Agri Show attended by more than 150 companies, emphasising groundbreaking agricultural products that bring together industry, professionals, policymakers and progressive farmers. CRC, Hyderabad, displayed CSIR-CIMAP's MAPs varieties, including Lemongrass, Palmarosa, Citronella, Vetiver, Ashwagandha, Senna, Kalmegh, different cultivars of Tulsi, along with CIMAP's herbal products, essential oils, distillation unit, posters on MAPs, processing technologies, CSIR-Aroma Mission activities, etc. The Centre has also distributed the literature on MAPs in the Telugu local language. There was a great response from the farming community and the other stakeholders on MAPs.

- On 3rd March 2025, the CSIR-CIMAP Research Centre, Hyderabad, in collaboration with the Andhra Pradesh Medicinal and Aromatic Plants Board (APMAPB), organized an inspiring



State Level Buyer-Seller Meet cum Awareness Program in Vijayawada, NTR Krishna District, AP, to forge vital market linkages for enhanced trade opportunities. The meeting focussed on the marketing potential of various Medicinal and Aromatic Plants (MAPs). Around 105 buyers and sellers of MAPs from across the region actively engaged in discussions.

An Integrated Vermicompost and Vermiwash Production System for Efficient Valorisation of Distilled Residue at CSIR-CIMAP Research Centre, Hyderabad.

The nutrient loss through leaching, lack of drainage, aeration, and delayed vermicomposting process are problems in the traditional pit method of vermicomposting. Hence, an integrated vermicompost and vermiwash production system with a controlled layering filtration system was designed for the effective valorisation of distilled residue at the CSIR-CIMAP Research Centre, Hyderabad. The integrated system is efficient in vermicomposting and nutrient recovery, and less labour demanding compared to the pit method. The produced vermicompost and vermiwash are used to meet the farm's requirement. The income is generated by selling to the medicinal plant home gardeners in cities and commercial cultivators of medicinal and aromatic plants.





CSIR-Jigyasa Student-Scientist Connect Program

The CSIR Jigyasa Project, launched in 2017, is a student-scientist connect program inspired by the vision of Scientific Social Responsibility (SSR). It supplements classroom learning with research-based experiences through CSIR laboratories across India. The CIMAP Jigyasa Team has successfully organized **68 activities from 01-04-2024 to 31-03-2025**. These activities encompassed **lectures by scientists in schools (both offline and online), educational tour of school students to CSIR-CIMAP, competitions like quiz, sci-toons, extempore and creative writing (both offline and online), career counselling sessions, demonstration sessions and brainstorming interactions**, thereby ensuring holistic exposure to scientific knowledge and its applications.

The following table shows different activities throughout the year:

S. No	Task/ Activity Name	Total Activities	No. of Students
1.	Visit of Scientist to schools /outreach program	24	789

2.	Popular lecture / demonstrations series at school	24	2823
3.	Visit of students to lab	14	767
4.	Summer vacation/ apprenticeship programs	02	30
5.	Micro Research Projects for students	03	75
6.	Webinar	01	101
Total		68	4585

The following table shows participating schools throughout the year:

S. No	School	No. of Activities
1.	Kendriya Vidyalaya (KVS)	20
2.	Jawahar Navodaya Vidyalaya (NVS)	04
3.	Private Schools	41
4.	State Government Schools	03
Total		68



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.



Renovation & up gradation of Golden Jubilee Auditorium at CSIR-CIMAP, Lucknow



Fabrication and Construction of Poly Houses at CSIR-CIMAP RC Pantnagar and Purara



Modification and up gradation of Existing glass house into Natural Light Plant Growth chamber at CSIR - CIMAP Lucknow.



Providing new AC plant with ducting for Golden Jubilee Auditorium



Renovation and up gradation of Vermicomposting Shed at CSIR - CIMAP, Lucknow



Up-gradation and SITC of 1600 kVA, 11/0.433 KV OLTC transformer with RTCC panel at CSIR-CIMAp, Lucknow



Others



Technology Transfer for Commercialization

In the year 2024-25, thirteen technologies were transferred to different MSMEs/Start-ups and entrepreneurs. Three projects were also received from different industries

Sl. No.	Name of Technology	Date	Name of Industry
1.	Incense Sticks and Fragrant Cones from Offered Flowers	2 nd May, 2024	Federation of Indian Chamber of Commerce and Industry (FICCI) FLO, Lucknow
2.	Incense Sticks and Fragrant Cones from Offered Flowers	15 th May, 2024	Saubhagya Foundation Trust, Lucknow
3.	Incense Sticks and Fragrant Cones from offered flowers/Geranium spent materials	15 th May, 2024	M/s Venkateshwara Cooperative Power & Agro Processing Ltd., Nashik
4.	Geranium Active Anti Dandruff Shampoo	24 th Jun, 2024	M/s Ecobhumi Bioagri Concepts Pvt. Ltd., Kolkata
5.	NAARI (Medicated Aromatic Sanitary Napkin)	12 th Jul, 2024	M/s SS Creations, Distt. - Tonk, Rajasthan
6.	CIM-Larvishield: Polymeric Beads Technology as Mosquito Larvicide	25 th Oct, 2024	M/s Yauvanchakra Private Limited, Jaipur
7.	Lutein (Green Extraction Technology from marigold)	25 th Oct, 2024	Coromandel International Limited, Secunderabad
8.	Relaxomap (Aromatherapy based pain relieving oil)	17 th Jan, 2025	M/s NYSA International, Gandhinagar
9.	Pain Chhoo Balm (Pain Balm)	17 th Jan, 2025	M/s NYSA International, Gandhinagar
10.	Painjaa (Non-staining pain relieving gel)	17 th Jan, 2025	M/s NYSA International, Gandhinagar
11.	NAARI* (Medicated Aromatic Sanitary Napkin)	17 th Jan, 2025	Nalanda Balvikas and Magasvargiya Mahila Vikas Mandal, Dhule, Maharashtra
12.	CIM-Sugandha (Herbal Soap)	18 th Mar, 2025	Sahaayak Nideshak Udyaan, Jila Udyaan Kaaryaalay, Gaya, Bihar
13.	Cleangerm- Floor Cleaner	18 th Mar, 2025	Sahaayak Nideshak Udyaan, Jila Udyaan Kaaryaalay, Gaya, Bihar



Glimpses of Technology Transferr by CSIR-CIMAP to various MSMEs, Start-ups and Entrepreneurs

MoUs /Agreements

Sl. No.	Title of MoUs/Agreement	Date of signing	Name of Institute/University/ Start-ups
1.	Market seeding for herbal products/formulation of Lip balm, Kleenze Lime, face wash, Kleenze Fruit face wash, Anti Dandruff Shampoo (Geramiun Active), Herbysoft Shampoo, CIM-Kesh Hair Oil, Painchoo	5-Apr-2024	M/s Nutri Planet Food Private Limited, Bengaluru
2.	Agreement for Providing Technical know-how with Quality Planting Material of Aromatic Crops and Development of Natural Perfume under CSIR-Aroma Mission-III	15-May-2024	Aromatic and Allied Chemicals, Bareilly
3.	MoU for Technology Transfer of herbal formulations developed by CSIR-CIMAP under separate Agreement to the Members of FICCI-FLO, Lucknow Chapter (MSME Unit)	21-May-2024	Federation of Indian Chamber of Commerce and Industry (FICCI) FLO, Lucknow
4.	MoU between CSIR-CIMAP and ICAR-CIARI for Research and Academic Collaboration	22-Jun-2024	ICAR-Central Island Agricultural Research Institute, Port Blair
5.	MoU for Providing Technical Know-how with Quality planting material of aromatic crops suitable for West Bengal under CSIR-Aroma Mission-III	24-Jun-2024	M/s Ecobhumi Bioagri Concepts Pvt. Ltd., Kolkata
6.	Market seeding Agreement for herbal products/formulation of Geranium Active Shampoo	28-Jun-2024	M/s Nirmal Nature, Gurugram
7.	Market seeding Agreement for herbal products/formulation of Relaxomap and Painchhoo	15-Jul-2024	Mandar Education and Research Foundation, Sonipat
8.	MoU for providing technical know-how with Quality planting material of aromatic crops suitable for Odisha state under CSIR-Aroma Mission-III	14-Aug-2024	M/s Bromhon Solutions Pvt. Ltd., Bhubaneswar, Odisha
9.	Collaborative agreement for botanical formulation from plant extracts and seed oil of <i>Triadica sebifera</i> (L.) small for the control of aphid, <i>Aphis craccivora</i> Kock	6-Sep-2024	Centre for Cellular and Molecular Platform, Bangalore and CSIR-Institute of Himalayan Bioresource Technology, Palampur, H.P.
10.	MoU for providing training/internships/workshops and seminars to students, researchers and faculty of HBTU	25-Oct-2024	Harcourt Butler Technical University (HBTU), Kanpur
11.	Market seeding Agreement for herbal products/formulation of Flomop and Mospray	8-Nov-2024	M/s Bromohon Solutions Private Limited, Bhubaneswar
12.	Agreement for Essential oil purchased from aroma beneficiaries under CSIR-Aroma Mission.	2-Dec-2024	Sri Ananda Enterprises, Bangalore

Technology Transfer for Commercialization

13.	Market seeding Agreement for herbal products/ formulation of Clean Germ	3-Dec-2024	M/s Om Sai Ram Traders, Kanpur, U.P.
14.	MoU for preparing common research programmes, industry oriented development program particularly in the area of medicinal and aromatic plants.	4-Dec-2024	Flora Fauna Science Foundation, U.P
15.	MoU with CSIR-CIMAP and PHSSF for preparing common research programmes, industry-oriented development program particularly in the area of MAPs	20-Dec-2024	Prof. HS Srivastava Foundation for Science and Society (PHSSF), Lucknow
16.	Agreement for Development and/or production of Bharatiya Nirdeshak Dravyas	4-Jan-2025	National Physical Laboratory, New Delhi
17.	MoU for Technology transfer for herbal formulation developed by CSIR-CIMAP under separate agreement	18-Jan-2025	Chamber for Advancement of Small and Medicum Businesses (CASMB), Mumbai
18.	Agreement for market seeding for herbal products of Face wash (Kleenzie), Shampoo (Herby Soft), Lipbalm and Hair Oil (CIMKESH)	30-Jan-2025	Astista Creation Beauty Salons & Academy, Lucknow
19.	MoU with CSIR-CIMAP and FFDC for Promoting the R&D work and skill development	4-Feb-2025	Fragrance and Flavour Development Centre (FFDC)
20.	MoU for Joint development of Cyber-physical systems (CPS), Establishment of CPS lab and AWaDH Spoke and Technology Transfer and commercialization and promoting entrepreneurship	4-Feb-2025	IIT Roper- Technology and Innovation Foundation (iHub-AWADH)
21.	MoU for Creating skill manpower for aroma and cosmetic industries through organization of two years Master in Science Course for Under Graduate Students.	4-Feb-2025	Fragrance and Flavour Development Centre (FFDC)
22.	Agreement for Market seeding for herbal products/ formulation of Relaxomap	28-Feb-2025	M/s Petal Drif, Lucknow
23.	MoU for Collaborative programs, industrial research and interdisciplinary research in the field of MAPs. Joint research works between students, faculty and staff of the institutions.	26-Mar-2025	Bihar Animal Sciences University, Patna



A View of MoU's Exchange

Technology Business Incubation Centre

Start-ups/Entrepreneurs/MSMEs utilized the pilot plant facility (TBIC) in the FY 2024-25

S. No.	Date	Name of MSMEs/Start-ups	Herbal Products/Technologies
1.	5 th Apr, 2024	M/s Nutri Planet Food Private Limited, Bengaluru	Lip balm, Kleenzie lime and fruit, Painchhoo, Herby soft, Geranium shampoo, CIM-Kesh
2.	28 th Jun, 2024	M/s Nirmal Nature, Gurugram, Haryana	Geranium Active (Anti Dandruff Shampoo)
3.	15 th Jul, 2024	M/s Mandar Education and Research Foundation, Sonipat	Relaxomap, Painchhoo
4.	5 th Dec, 2024	M/s Om Sai Ram Trader, Kanpur	Clean germ (Floor Mopping Liquid)
5.	5 th Mar, 2025	M/s Petal Drift, Lucknow	Relaxomap (Pain relieving oil)

Awards and Recognitions (2024-25)

सीएसआईआर-केंद्रीय औषधीय एवं सगंध पौधा संस्थान की राजभाषा पत्रिका 'औस विज्ञान' अंक-5, 2024 को नगर राजभाषा कार्यान्वयन समिति (कार्यालय-3) की बैठक (दिनांक 25 जून 2024) में प्रथम पुरस्कार से पुरस्कृत किया गया।



- Dr. Birendra Kumar, Chief Scientist, CSIR-CIMAP, has been elected as a Fellow of the Indian Society of Plant Genetic Resources, New Delhi, and National Academy of Biological Sciences, Chennai. He was also conferred with the Dr. Manmohan Attavar Gold Medal Award in Floriculture - 2024 and Life Time Achievement Award, for his outstanding contributions in Floriculture and Genetics & Crop Improvement of medicinal and aromatic crops. The awards were given by the Indian Academy of Horticultural Sciences and the Glocal Environment and Social Association, New Delhi, respectively.



- Dr. Dinesh A. Nagegowda, Chief Scientist, CSIR-CIMAP, has been elected as a Fellow of the Indian National Science Academy, New Delhi and Indian Academy of Sciences, Bangalore, India.



- Dr. Karuna Shanker, Chief Scientist, CSIR-CIMAP, has been elected as a Fellow of the National Environmental Science Academy (FNESA), New Delhi, India, and Uttar Pradesh Academy of Agricultural Sciences (UPAAS), Lucknow. He was also conferred with the Dr. P. D. Sethi Memorial National Annual HPTLC Award.



- Dr. Dnyaneshwar Umrao Bawankule, Senior Principal Scientist, CSIR-CIMAP, has been elected as a Fellow of the Indian Society of Veterinary Pharmacology and Toxicology (ISVPT), Gujarat, India.



- Dr. Chandan Singh Chanotiya, Senior Principal Scientist, CSIR-CIMAP, has been elected as a Fellow of the Royal Society of Chemistry (FRSC), London, UK.



- Dr. Puja Khare, Senior Principal Scientist, CSIR-CIMAP, has been elected as a Fellow of the National Environmental Science Academy of Agricultural Sciences (FNESA), New Delhi, India. She was also enlisted among 75 Women Scientists in a book entitled *She is Women in Chemistry*, and the book was published in collaboration with the Office of PSA and the Royal Society of Chemistry (RSC).



- Dr. Gunjan Tiwari, Senior Scientist, CSIR-CIMAP, conferred the Young Scientist Award - 2024 from National Environmental Science Academy (NESA), New Delhi, India.



- Dr. Santoshkumar C. Kedar, Senior Scientist, CSIR-CIMAP, received the Young Scientist Award-2024, by the Dr. B.V. David Foundation in the National Conference on Advances in Agricultural and Industrial Entomology on 17th November 2024, in Chennai, India. He also received Third prize in the 10th Photo contest organised by the Entomological Society of India, New Delhi, India.



Awards Conferred to the Research Scholars of the CSIR-CIMAP

- Ms. Anvesha Anyatama, student of Dr. Prabodh Kumar Trivedi, received the Best Poster Presentation award in the India International Science Festival-2024 (IISF-2024) at IIT, Guwahati, Assam, India.
- Ms. Disha Sharma, student of Dr. N.P. Yadav, was awarded Best Poster Award at International Conference on Advances in Medicinal & Aromatic Plant Research (IORA-AMAR-2025), organised by IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP), CSIR-CIMAP Lucknow from 4-6th February 2025.
- Mr. Manoj Kumar Yadav, student of Dr. N. P. Yadav, was awarded Gold medal for Young

Scientist by the Zoological Society of India (ZSI) during the 36th All India Congress of Zoology and International Conference held at Lucknow University, Lucknow (24- 26th April, 2025)

- Ms. Poonam Rani, student of Dr. Debabrata Chanda awarded the Young Pharmacologist award in the International Pharmacology Conference (IPC) & 54th Annual Conference of the Indian Pharmacological Society 2024 (IPSCON-2024) during 28-30th November 2024, at AIIMS, New Delhi, India.
- Ms. Shraddha Srivastava, student of Dr. Kapil Dev awarded the SFE-Young Researcher Award-2024; Prof. Peter Houghton Memorial Award in the International Conference on "Bioeconomy from Bioresources: Promoting Traditional Resources of NER for Viksit Bharat" & 11th Convention Society for Ethnopharmacology, Gangtok, Sikkim, India.
- Harsita Jangir, student of Dr. Tripta Jhang awarded the second prize in the poster presentation category for the poster *Combating seed adulteration: Annual and perennial varieties of Ashwagandha (Withania somnifera (L.) Dunal)* in the National Seminar on "ASHWAGANDHA: Nature's Answer to Modern Health Issues," on 17th January 2025 organised at Patanjali Research Foundation in collaboration with NMPB, Dehradun.
- Shakshi Balyan student of Dr. Tripta Jhang awarded the first prize for the presentation on Phenotypic Assessment of *Anacyclus pyrethrum* Under Field Conditions: Variability and Breeding Potential in the National symposium, at GBPAUT, Pantnagar, Uttarakhand, on 20-22nd December 2024.
- Ms. Poonam Kumari student of Dr. Akanksha Singh, received the best poster award in the National Conference on Expanding the Horizons of Microbial Research in Agriculture held at NBAIM, Mau on 14th June 2024.
- Mr. Ankur Katiyar, student of Dr. Kishore B. Bandamaravuri, awarded for the presentation at International Conference on Advances in Medicinal & Aromatic Plant Research (IORA-AMAR-2025), organised by IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP), CSIR-CIMAP Lucknow from 4-6th February 2025.

Glimpses of Events



A cleanliness drive initiative was taken on 5th May 2024 at CSIR- CIMAP residential colony



The Institute celebrated International Yoga Day on 21st June 2024



On the occasion of World Environment Day, the Director of CSIR-CIMAP launched the plantation campaign on 5th June 2024



The Institute celebrated the 78th Independence Day with enthusiasm and patriotism on 15th August 2024



A view of release of Annual Report CSIR-CIMAP



As a part of Swachhata Hi Seva and Swachh Bharat Campaign, a Swachhata Pledge was administered by the Director, on 19th September 2024



CSIR-CIMAP organised a Tree Plantation Drive Ek Ped Maa Ke Naam under Swachhata Hi Seva and Swachh Bharat campaign on 23rd September 2024



CSIR-CIMAP organised an Ayurveda Day on 24th October 2024



CSIR-CIMAP Lucknow successfully organised a Gram Sabha Awareness Programme on 23rd October, 2024 at Village Bambhaura, Uttar Pradesh



CSIR-CIMAP celebrated International Hindi Day on 10th January 2025



CSIR-CIMAP organized a wakathon on the occasion of Fit India freedom Run 5.0



CSIR-CIMAP celebrated Republic day on 26th January 2025

Glimpses of Events



CSIR-CIMAP organized International Conference on Advances in Medicinal Aromatic Plant Research in Context to the Indian Ocean Region (IORA-AMAR) from 04th to 06th February 2025



CSIR-CIMAP Resource Centre Pantnagar organized Kisan Mela on 10th February 2025 and showcased its technologies and products to the public



CSIR-CIMAP organized a lecture on Mental & Nutritional Wellbeing of Women on the occasion of International Women's day on 07th March 2025



CSIR-CIMAP organized a Walkathon Event for Women scientists, staff and students on the 4th of March 2025 to commemorate International women's day



CSIR-CIMAP Celebrated its 66th Foundation Day on 26th March 2025

CIMAP research finds new way to enhance nutritional quality of plants

Godhooli Sharma

godhooli.sharma@tifl.ve.com

LUCKNOW: A recent research by scientists at the Council for Scientific and Industrial Research - Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) has chanced upon ways to enhance the nutritional quality of plants.

Till now, if scientists wanted to over-express a gene in any plant, it had to be made a transgenic plant (one which is altered to achieve higher nutritional value). However, due to certain regulations imposed by the food safety authorities across the world, the transgenic plants are not directly accessible to the farmers and consumers.

Now through the new research, the scientists have found that the nutritional quality of plants can be enhanced using 'complementary peptides' (complementary form of a short protein found in plants). As part of this research, complementary peptides, when sprayed on the plant, enhanced its nutritional value and properties.

"This will enhance the protein accumulation in a plant without making it transgenic. We have worked with three pep-



When complementary peptides were sprayed on plants, their nutritional quality was found increased. SOURCED

ptides (short proteins found in plants) for proof of the concept. We tested it on thale cress, rose, grapes, tobacco and tomatoes and found the synthesis of molecules including -anthocyanin, flavonols and lignin," said a scientist Ashish Sharma.

Anthocyanin helps in prevention of inflammation, in protection against type II diabetes, cancer and heart disease. Flavonols have antioxidants, anti-cancer, anti-inflammatory and anti-viral properties while lignin is also rich in antioxidants and possesses anti-viral and anti-microbial properties.

"Thousands of peptides can be created from various proteins. If we know the function of a gene which we wish to

enhance in a plant this technique can be used," said Sharma.

Director CSIR-CIMAP, Prabhod Kumar Trivedi, who was also involved in the research said that the technique could be used on any plant with more than 10 amino acids conserved in it for protein.

"The technique is useful for any type of stress borne by a plant, including abiotic stress like salt and drought and biotic stress like insects and pathogens. To validate this technology, the team sprayed complementary peptides on plants and mutant plants developed by the team. The gene is not functional in mutant plants, so the complementary peptides did not show any difference on them," shared Trivedi.

When used on fruit plants like grapes and tomatoes, the nutritional values were found enhanced and when used on a white rose, there were certain changes in the colour of the flower.

In tobacco, the levels of flavonols and anthocyanin were found to have increased.

"This can be a gamechanger for the plant industry. A patent has been filed for the research," Trivedi added.

सीएसआईआर के स्थापना दिवस पर सम्मानित किए गए वैज्ञानिक



सीमैप में सीएसआईआर के स्थापना दिवस कार्यक्रम में जुटे वैज्ञानिक। -संवाद

संवाद न्यूज एजेंसी

लखनऊ। केंद्रीय औषधीय एवं सगंध पौधा संस्थान, भारतीय विप विज्ञान अनुसंधान संस्थान ने शुक्रवार को वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद (सीएसआईआर) का 83वां स्थापना दिवस मनाया। निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने सीमैप में 25 वर्ष पूरे करने वाले वैज्ञानिकों, समेत अन्य कर्मियों को सराहना कर उन्हें सम्मानित किया।

मुख्य अतिथि के तौर पर दिल्ली विवि के रामलाल आनंद महाविद्यालय के हिंदी विभाग एवं एएसोसिएट एनसोमैसि अधिकारी मेजर संजय कुमार ने कहा कि देश का भाग्य विद्यालयों, महाविद्यालयों

और सीमैप जैसे संस्थानों में निर्मित होता है। विशिष्ट अतिथि के तौर पर एनबीआरआई के निदेशक डॉ. अजीत कुमार शासनी ने सीमैप के प्रगति की सराहना की। हिंदी एवं स्वच्छता पखवाड़ा के तहत आयोजित विभिन्न प्रतियोगिताओं का पुस्तकार वितरण भी हुआ।

भारतीय विप विज्ञान अनुसंधान संस्थान ने भी सीएसआईआर का स्थापना दिवस मनाया। मुख्य अतिथि के तौर पर वाराणसी के कंजवेंटर ऑफ फारेस्ट (वन संरक्षक) डॉ. रवि कुमार सिंह ने आईआईटीआर की उपलब्धियों को तारीफ की। विशिष्ट अतिथि के तौर पर पदमश्री डॉ. विद्या विंदु सिंह ने कहा कि हिंदी भाषा हमारी धरोहर है, हमें इस पर गर्व होना चाहिए।

‘सीमैप जैसे संस्थानों में बनता है भारत का भाग्य’

सीएसआईआर-केंद्रीय औषधीय एवं सगंध पौधा संस्थान (सीमैप) ने शुक्रवार को उत्सव हॉल में सीएसआईआर के स्थापना दिवस के दौरान सीमैप के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने संस्थान में 25 वर्ष पूरे करने वाले वैज्ञानिकों, तकनीकी व प्रशासनिक कर्मचारियों के योगदान की सराहना की। मुख्य अतिथि दिल्ली यूनिवर्सिटी के रामलाल आनंद महाविद्यालय के मेजर (प्रफेसर) संजय कुमार ने कहा कि भारत का भाग्य विद्यालयों, महाविद्यालयों और सीएसआईआर-सीमैप जैसे संस्थानों में बनता है। उन्होंने सीएसआईआर-सीमैप के राजभाषा हिंदी के प्रति स्नेह और सम्मान की सराहना की। इस मौके पर सीमैप की वार्षिक रिपोर्ट और हिंदी पत्रिका औस-विज्ञान का विमोचन किया गया। वैज्ञानिकों और कर्मचारियों को सम्मानित किया गया। इस दौरान एनबीआरआई के निदेशक डॉ. अजीत कुमार शासनी ने बतौर विशिष्ट अतिथि मौजूद रहे।

लखनऊ (एसएनबी)। केंद्रीय औषधीय एवं सगंध पौधा संस्थान (सीमैप) एवं कृषि प्रौद्योगिकी प्रवर्धन अभिकरण (आत्मा), सीवान, बिहार के वित्तीय सहयोग में किसानों के लिए चार दिवसीय प्रशिक्षण कार्यक्रम का आयोजन किया गया, जिसमें बिहार के कृषकों को औषधीय एवं सगंध पौधों के उत्पादन, प्राथमिक प्रसंस्करण व विपणन की जानकारी दी गयी।

प्रशिक्षण कार्यक्रम का उद्घाटन करते हुए सीमैप के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने कहा कि सीमैप पिछले 60 वर्षों में औषधीय एवं सगंध पौधों की खेती में किसानों को प्रोत्साहित कर रहा है तथा नई-नई कृषि तकनीकों, पौध सामग्री एवं उन्नततकनीक प्रजातियाँ किसानों को उपलब्ध करा रहा है। इसके फलस्वरूप लाखों किसानों को प्रत्यक्ष तथा अप्रत्यक्ष रूप से लाभ पहुंचा है। किसानों द्वारा संस्थान की विकसित उन्नत प्रजातियों एवं तकनीकों को अपनाकर देश को मेधा तथा नीवृद्धाम के तेल के उत्पादन में विश्व में प्रथम बनाया है। हमें आशा है नती पूर्ण विषयवस्तु है कि आप लोग यहाँ से प्रशिक्षण प्राप्त कर अपने-अपने जिलों के किसानों को औषधीय एवं सगंध पौधों की खेती प्रति जागरूक करेंगे। इस तरह सभी लोग मिल कर कार्य करेंगे तो दूसरे सगंधीय तेलों जैसे खस, तुलसी,



सीमैप में प्रशिक्षण कार्यक्रम के दौरान कृषकों को साथ सीमैप के निदेशक डॉ. प्रबोध कुमार।

एरोमा मिशन के तहत सीमैप में चार दिवसीय प्रशिक्षण कार्यक्रम का शुभारंभ

पामारोज व अन्य सगंधीय तेलों में आत्मनिर्भरता के साथ निर्यात भी कर सकेंगे। प्रशिक्षण कार्यक्रम के तकनीकी सत्र में डॉ. संजय कुमार, डॉ. रमेश कुमार श्रीवास्तव, डॉ. राम सुरेश शर्मा, डॉ. संजय कुमार, डॉ. अमिल कुमार सिंह, डॉ. राजेश वर्मा एवं डॉ. चंद्रकिशोर मिश्र ने विभिन्न सगंध एवं औषधीय पौधों की खेती की उन्नत तकनीकियों को साझा किया गया। इस अवसर पर सीमैप के वैज्ञानिक, तकनीकी अधिकारी व शोधार्थी आदि उपस्थित रहे। डॉ. चंद्रकिशोर मिश्र ने प्रशिक्षण कार्यक्रम का संचालन तथा ब्यववाद ज़ाबित किया। कार्यक्रम में बिहार के विभिन्न जिलों से 42 किसानों ने भाग लिया।

‘टिकाऊ खेती’ ने बदल दी पूरे गांव की जिंदगी

सीमैप की मदद से बाराबंकी के बखनपुरवा गांव में किसानों ने सुगंधित पौधों की खेती से किया कमाल

विश्व चतुर्दशी

संसाधन विज्ञान अतिथि एवं सगंध पौधा संस्थान (सीमैप) के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने शुक्रवार को उत्सव हॉल में सीएसआईआर के स्थापना दिवस के दौरान सीमैप के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने संस्थान में 25 वर्ष पूरे करने वाले वैज्ञानिकों, तकनीकी व प्रशासनिक कर्मचारियों के योगदान की सराहना की। मुख्य अतिथि दिल्ली यूनिवर्सिटी के रामलाल आनंद महाविद्यालय के मेजर (प्रफेसर) संजय कुमार ने कहा कि भारत का भाग्य विद्यालयों, महाविद्यालयों और सीएसआईआर-सीमैप जैसे संस्थानों में बनता है। उन्होंने सीएसआईआर-सीमैप के राजभाषा हिंदी के प्रति स्नेह और सम्मान की सराहना की। इस मौके पर सीमैप की वार्षिक रिपोर्ट और हिंदी पत्रिका औस-विज्ञान का विमोचन किया गया। वैज्ञानिकों और कर्मचारियों को सम्मानित किया गया। इस दौरान एनबीआरआई के निदेशक डॉ. अजीत कुमार शासनी ने बतौर विशिष्ट अतिथि मौजूद रहे।



यूरोप के प्रतिनिधिमंडल ने किया गांव का दौरा, किसानों में हुआ संवाद
और नए तकनीकी पर्यावरण के परिचय दिये। सीमैप के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने कहा कि सीमैप पिछले 60 वर्षों में औषधीय एवं सगंध पौधों की खेती में किसानों को प्रोत्साहित कर रहा है तथा नई-नई कृषि तकनीकों, पौध सामग्री एवं उन्नततकनीक प्रजातियाँ किसानों को उपलब्ध करा रहा है। इसके फलस्वरूप लाखों किसानों को प्रत्यक्ष तथा अप्रत्यक्ष रूप से लाभ पहुंचा है। किसानों द्वारा संस्थान की विकसित उन्नत प्रजातियों एवं तकनीकों को अपनाकर देश को मेधा तथा नीवृद्धाम के तेल के उत्पादन में विश्व में प्रथम बनाया है। हमें आशा है नती पूर्ण विषयवस्तु है कि आप लोग यहाँ से प्रशिक्षण प्राप्त कर अपने-अपने जिलों के किसानों को औषधीय एवं सगंध पौधों की खेती प्रति जागरूक करेंगे। इस तरह सभी लोग मिल कर कार्य करेंगे तो दूसरे सगंधीय तेलों जैसे खस, तुलसी,

मेधा की खेती ने बदल दी किस्मत
संसाधन विज्ञान अतिथि एवं सगंध पौधा संस्थान (सीमैप) के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने शुक्रवार को उत्सव हॉल में सीएसआईआर के स्थापना दिवस के दौरान सीमैप के निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने संस्थान में 25 वर्ष पूरे करने वाले वैज्ञानिकों, तकनीकी व प्रशासनिक कर्मचारियों के योगदान की सराहना की। मुख्य अतिथि दिल्ली यूनिवर्सिटी के रामलाल आनंद महाविद्यालय के मेजर (प्रफेसर) संजय कुमार ने कहा कि भारत का भाग्य विद्यालयों, महाविद्यालयों और सीएसआईआर-सीमैप जैसे संस्थानों में बनता है। उन्होंने सीएसआईआर-सीमैप के राजभाषा हिंदी के प्रति स्नेह और सम्मान की सराहना की। इस मौके पर सीमैप की वार्षिक रिपोर्ट और हिंदी पत्रिका औस-विज्ञान का विमोचन किया गया। वैज्ञानिकों और कर्मचारियों को सम्मानित किया गया। इस दौरान एनबीआरआई के निदेशक डॉ. अजीत कुमार शासनी ने बतौर विशिष्ट अतिथि मौजूद रहे।



रोशनी संग सुगंध बिखरेगे दीये

एनबीटी, लखनऊ
कृषिगत विकास परियोजनाओं के तहत किसानों को नए फसल करने के लिए प्रेरित किया जा रहा है। रोशनी संग सुगंध बिखरेगे दीये कार्यक्रम के अंतर्गत किसानों को नए फसल करने के लिए प्रेरित किया जा रहा है।

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सीमैप संस्था द्वारा किसानों को दिया जानकारी कम लागत अधिक फायदा बताये उपाय

राजेन्द्र कुमार त्रिवेदी जिला संवाददाता
प्रणाम हिन्दुस्तान
रामसनेहीघाट बागवल्ली। सैरखानपुर के पूरे पाठक गांव में मेधा, तुलसी, लेमन ग्रास की खेती के लिए किसानों को सीमैप संस्था द्वारा जागरूक किया गया। जागरूकता कार्यक्रम के पश्चात खेतों में रोपाई की गई। लखनऊ में किसानों को जागरूक करने वाली संस्था सी एस आई आर सीमैप के सदस्यों ने पूरे पाठक मजरे सैरखानपुर गांव में एगोमा मिशन फेज 3 के अंतर्गत जागरूकता कार्यक्रम आयोजित किया। जिसमें किसानों को कम लागत में मेधा, तुलसी, लेमन ग्रास, खस की खेती करने की विधि बताया गया। अग्रिमेश ने बताया कि कम उपजाऊ खेत कम लागत में यह खेती हो जायेगी और इसकी पैदाई सैरखानपुर के पाठक पुरवा में लगी स्टील की टंकी में हो जाएगी। जागरूकता कार्यक्रम के पश्चात श्रेष्ठ द्विवेदी के खेतों में लेमन ग्रास की रोपाई भी की गई। इस अवसर पर वृधनाथ द्विवेदी, अग्रिमेश, गणप्रसाद, रामप्रकाश, गोविन्द, अरुण, अशोक आदि किसान उपस्थित रहे।



बिहार के किसानों को प्रशिक्षण

■ NBT रिपोर्ट, लखनऊ: सीएसआईआर-केन्द्रीय औषधीय व सगंध पौधा संस्थान (सीएसआईआर-सीमैप) की ओर से किसानों को तीन दिन प्रशिक्षण दिया जाएगा। मंगलवार से इसकी शुरुआत की गई। बिहार के गया जिले के पांच महिला के साथ 17 किसानों को इस प्रशिक्षण के लिए चयनित किया गया है। डॉ. प्रबोध कुमार त्रिवेदी ने बताया कि सीएसआईआर-सीमैप पिछले 60 वर्षों से औषधीय व सगंध पौधों की खेती में किसानों को प्रोत्साहित कर रहा है। तकनीकी सत्र में डॉ. संजय कुमार ने नीबूकास व रोशावास के उत्पादन की जानकारी दी। सत्र को डॉ. राम सुरेश शर्मा, डॉ. रमेश कुमार श्रीवास्तव और डॉ. राम स्वयंसेवक वर्मा ने भी प्रशिक्षण दिया।



औषधीय, पुष्पीय फसलों की खेती से आय बढ़ाएं

संजय, जामरग, माडा/भारतखंड: क्षेत्र के प्रधानमंत्री रामनाथ गौतम ने गुरुवार को पत्तोकरपुर व अरोगा मिशन के अंतर्गत सीमैप के निदेशक डा. प्रबोध कुमार त्रिवेदी के निदेशन में किसानों और ग्रामीण महिलाओं के लिए एक दिवसीय जागरूकता प्रशिक्षण कार्यक्रम का आयोजन किया गया। मुख्य अतिथि डा. कुमुद दुबे ने स्वावलंबन के विषय पर व्याख्यान दिया। इस दौरान सीमैप से आर. वैज्ञानिक व तकनीकी अधिकारियों द्वारा किसानों को उन्मत्तशील पुष्पीय, औषधीय व सुगन्धित फसलों की खेती की जानकारी दी गई। कृषि वैज्ञानिक डा. राजेश कुमार वर्मा ने पत्तोकरपुर के फसलों के बारे में और औषधीय व सगंध फसलों की जानकारी डा. अनिल कुमार सिंह ने दी। डा. रघुपाल सिंह ने किसानों के आप में बढ़ोतरी तथा फसल अवशेषों से मशरूम उत्पादन इकोफ्रेंडली कटलरी व चम्रो तन्पाद के विषय में बताया।



माडा में औषधीय खेती के लिए आयोजित एक दिवसीय प्रशिक्षण शिविर में मौजूद किसान

सौफ के तेल से बनी गोलियों से खत्म होंगे मच्छरों के लार्वा

सीमैप ने तैयार किया पॉलिमेरिक बीड प्रॉडक्ट
एनबीटी, लखनऊ: ड्यू और मल्लिकाने काले मच्छरों के लार्वा खत्म करने के लिए केटीप औषधीय एवं सगंध पौधा संस्थान (सीमैप) ने नया हार्बर प्रॉडक्ट तैयार किया है। इसे सौफ के तेल से बनाया गया है। वैज्ञानिकों को इसे तैयार करने में पांच सप्ताह लगे। यह पॉलिमेरिक बीड प्रॉडक्ट कुनैन को गोलियों की तरह इस्तेमाल किया जा सकेगा। इसे कुनैन, ममलो और फनी एजेंट करने वाले धरे-पीरॉ बोटस से खत्म निकाल कर देगा, जो मच्छर के लार्वा को खत्म कर देगा। संयोजन निदेशक डॉ. प्रबोध कुमार त्रिवेदी ने बताया कि आमतौर पर मच्छरों को रोकावक के साथ उपद्रव सिंथेटिक होते हैं। इनके सिंथेटिक से तैयार होने वाले प्रॉडक्ट सूक्ष्म होते हैं, लेकिन सूक्ष्म से बड़े लार्वा को हिलकाते होगे। ऐसे में यह प्रॉडक्ट बेहतरीन विकल्प होगे। वैज्ञानिक डॉ. नारायण प्रसाद शर्मा ने बताया कि बच्चे शिशु के बाद इन्हें सौफ का तेल इस्तेमाल किया जाये। इसमें मौजूद

कई और इलाकों में डेंगू की वस्तक



एनबीटी, लखनऊ: अब तक आठों सौ डेंगू में भी डेंगू ने दरमारा देरें मृत्यु कर दी है। खर के स्कार डेंगू में 5.4 नए मरीज सामने आए।

FRAGRANCE SUMMIT

The Federation of Indian Chambers of Commerce and Industry (FICCI) hosted the '3rd International Fragrance Summit 2024' at CSIR-CIMAP in Lucknow, under the 'CSIR One Week, One Theme' initiative. Collaborating with the Ministry of MSME, Bureau of Indian Standards, and industry partners, the summit focused on sustainable economic growth, emerging fragrance markets, and consumer safety standards. Dr Prabodh Kumar Trivedi highlighted CSIR-CIMAP's sustainable cluster model. Chief guest Avnish Kumar Awasthi emphasised the importance of fragrant crops for India's economy. MoUs were signed between FICCI, IFRA, and local universities, with technology transfers to several companies and the release of a short film on sustainable aroma clusters.

'किसानों की आय दोगुनी करने के लिए सीमैप प्रयासरत'

माई सिटी रिपोर्ट
लखनऊ: सीमैप छह दशकों से उद्योग जगत की गुणवत्तापूर्ण कच्चा माल उपलब्ध करा रहा है। औषधीय एवं सगंध पौधों की नई प्रजातियाँ, उन्नत कृषि व प्रसंस्करण तकनीकियों को विकसित कर किसानों तक पहुंचा रहा है। बुधवार को सीमैप के 66वें स्थापना दिवस समारोह में मुख्य अतिथि कृषि वैज्ञानिक भर्ती बोर्ड नई दिल्ली के अध्यक्ष डॉ. संजय कुमार ने ये बातें



सीमैप के 66वें स्थापना दिवस पर आयोजित कार्यक्रम में बोलीते डॉ. संजय कुमार

और लेमनग्रास के तेलों का निर्यातक बनने में महत्वपूर्ण भूमिका निभाई है। सीमैप किसानों की आय दोगुनी करने के लिए प्रयासरत है। समारोह में नीति दस्तावेज, स्वस्थ सौष्ठव और फाइटोकेमिकल्स के सर्वे जैसे दस्तावेजों, सॉफ्टवेयर व अनुसंधान आधारित उत्पादों का अनावरण किया गया। कार्यक्रम में वाइसचाइलड्रम फोटोग्राफी प्रतियोगिता के विजेताओं को सम्मानित किया गया। संयोजन डॉ. मुय्य पाठक व डॉ. संजय कुमार ने किया।

औषधीय पौधों की खेती के जानेंगे टिप्स

सीमैप में दो दिवसीय किसान मेला आज से, प्रदेश भर से जुटेंगे किसान
लखनऊ (एनबीटी) - केटीप औषधीय एवं सगंध पौधा संस्थान (सीमैप) में 30-31 जनवरी, 2025 के बीच दो दिवसीय किसान मेला-2025 का आयोजन किया जा रहा है। यह जागरूकता कार्यक्रम को संयोजन में एनबीटी, लखनऊ के अंतर्गत किसानों को नए फसल करने के लिए प्रेरित किया जा रहा है।

उद्योग विभाग के अंतर्गत किसानों को नए फसल करने के लिए प्रेरित किया जा रहा है।

उद्योग विभाग के अंतर्गत किसानों को नए फसल करने के लिए प्रेरित किया जा रहा है।



किसान मेला में जहाँ की जानेंगी तृतीया व अरेडिशन की टिप्स

Sponsored Projects

Externally Funded Projects

Sr. No.	Funding Agency	Project No.	Project Title	PI	Start Date	End Date	Total Cost (Rs. in Lakh)
1	Department of Science & Technology, Government of India (SEED)	GAP-533	Organization of training cum demonstration on agro-technology of novel spearmint variety CIM-Mohak developed by CSIR-CIMAP among the SC community of Badaun district of Uttar Pradesh for enhancement of socio-economic status.	Dr. Dipender Kumar	29.04.2024	28.04.2026	36.9524
2	Department of Biotechnology, (DBT) Ministry of Science & Technology, Government of India	GAP-534	Engineering yeast phospholipid metabolism for increased production of high value triterpene, Glycyrrhetic acid.	Dr. DK Venkata Rao	14.05.2024	13.05.2027	61.02798
3	Science & Engineering Research Board, DST	GAP-537	Investigation the role of <i>Pelargonium graveolens</i> root exudates on chemotactic response and colonization mechanism of <i>Pseudomonas oryzihabitans</i> CB24.	Dr. Akanksha Singh	29.07.2024	28.07.2027	18
4	DBT	GAP-538	Assessment of compatibility and immobilization of organophosphorus-degrading bacteria on biochar for rapid degradation of pesticides and soil remediation.	Dr. Puja Khare	25.09.2024	24.09.2027	55.0256
5	DBT	GAP-539	Core construction of genome wide association for unraveling genetic architecture of agro-chemical traits in medicinal plant opium poppy (<i>Papaver somniferum</i> L.).	Dr. Gunjan Tiwari	01.10.2024	30.09.2027	80.5664
6	Anusandhan National Research Foundation (ANRF), Science & Engineering Research Board (SERB)	GAP-540	Identification of Opioidergic Alkaloids from <i>Alstonia scholaris</i> in Search of Potent Analgesic Agents.	Dr. Kapil Dev	05.10.2024	04.10.2027	33.9256

Sponsored Projects



7	Council of Science & Technology, UP	GAP-541	Evaluation and optimization of seed-harvesting and storage for longevity in Indian Basil (<i>Ocimum basilicum</i> L.). (Project ID - 3444)	Dr. Rakesh Kumar	07.11.2024	06.11.2027	15.36
8	Anusandhan National Research Foundation (ANRF), Science & Engineering Research Board (SERB)	GAP-542	Systematics, biogeography and molecular phylogeny of Indian Pogostemon (Lamiaceae).	Dr. V Sundaresan	16.10.2024	15.10.2027	32.68166
9	Indian Council of Agricultural Research (ICAR), New Delhi, National Agricultural Science Fund (NASF)	GAP-543	Effects of abiotic and biotic factors on secondary metabolite profiles of <i>Rauwolfia serpentina</i> and <i>Tribulus terrestris</i> : Optimizing cultivation strategies in different agro-climatic regions of India	Dr. V Sundaresan	15.10.2024	14.10.2027	43.51778
10	Council of Science & Technology, UP	GAP-544	Biological control of <i>Helicoverpa armigera</i> for sustainable production of Menthol mint: Assessment of indigenous egg parasitoid, <i>Trichogramma chilonis</i> (Project ID-3931)	Dr. Santos Kumar C. Kedar	05.11.2024	04.11.2027	15.36
11	Ministry of Micro, Small and Medium Enterprises (MSME), Government of India, New Delhi	GAP-545	Entrepreneurship development in essential oil, natural fragrance and Aromatherapy.	Dr. Ramesh Kr. Srivastava	27.11.2024	31.03.2025	8
12	Council of Science & Technology, UP	GAP-546	Development of cardamom oil based in-situ gel for the mitigation of Oral Submucous Fibrosis.	Dr. Narayan Prasad Yadav	05.11.2024	04.11.2026	13
13	Department of Science & Technology (DST), Government of India (WISE KIRAN)	GAP-547	Functional characterization of NtMYB308 for regulatory role in phenylpropanoid biosynthesis in tobacco.	Dr. Nivedita Singh	23.12.2024	22.12.2027	15.4872
14	Department of Science & Technology (DST), Government of India (WISE KIRAN)	GAP-548	Biosynthetic pathway modulation for the enrichment of medicinal cannabinoids in Cannabis sativa hairy root.	Dr. Pallavi Pandey	23.12.2024	22.12.2027	43.46158

15	DBT	GAP-549	Characterization and stalking of multiple susceptible genes for a broad range of rice pathogens to engineer broad-spectrum resistance in south Indian mega rice varieties by genome editing.	Dr. Yugander Arra	23.12.2024	28.02.2027	83.16
16	Anusandhan National Research Foundation (ANRF), Science & Engineering Research Board (-SERB)	GAP-550	Integrative Plant Tissue Culture, Metabolite Profiling, Transcriptomic Analysis for Secondary Metabolite Biosynthesis in <i>Gaultheria fragrantissima</i> .	Dr. Neelam Prabha Negi	29.03.2025	28.03.2028	43.241
17	Ministry of AYUSH, National Medicinal Plant Board (NMPB)	GAP-551	Multiplication and Supply of Quality Planting Materials Selected MAPs for RCFC NR-1 Stakeholders)	Dr. Rajesh Kumar Verma	30.03.2025	29.3.2026	15
18	CSIR, New Delhi	FTT020501	Improved and feasible production of high-value terpenes through synthetic biology	Dr. Dinesh A, Nagegowda	01.04.2024	31.03.2026	189.8500
19	CSIR, New Delhi	FTT020502	CRM 1-Candidate Indian Certified Reference Materials (CRMs)/Bhartiya Nirdeshak Dravya (BND) of Phyto & Aroma Chemicals for Quality and Safety Assessment of Derived Products	Dr. Karuna Shanker	01.04.2024	31.03.2026	198.6800
20	CSIR, New Delhi	MMP075201	CSIR Phytopharmaceutical Mission Phase III	Dr. DU Bawankule & Dr. RK Srivastava	18.03.2024	31.03.2027	478.3300
21	CSIR, New Delhi	IHP024001	Induced genetic variation for high andrographolide and Sennoside content in highly therapeutic potential medicinal plants Kalmegh and Senna	Dr. Chanayya Hiremath	02.04.2024	31.03.2026	47.4000
22	CSIR, New Delhi	IHP024002	Elucidation of chemically mediated interaction in <i>Jasminum grandiflorum</i> -Thrips florum system employing analytical techniques, electroantennographic detection and behavioral assays	Dr. VS Pragadeesh	29.04.2024	31.03.2026	43.5000
23	CSIR, New Delhi	IHP024003	Genome-wide mining and characterization of microproteins from <i>Ocimum basilicum</i> using integrated omics approaches.	Dr. Prema G. Vasudeva	29.04.2024	31.03.2026	49.7000



Sponsored Projects

24	CSIR, New Delhi	IHP024004	Rapid metabolic fingerprinting combined with machine learning approach for the quality assessment of Indian medicinal herbs	Dr. Ratnasekhar C. H.	02.04.2024	31.03.2026	49.4000
25	CSIR, New Delhi	PPP240002	Pilot Plant Facility	Dr. Sumit Ghosh/ Dr. Karuna Shanker	06.05.2024	31.03.2026	1205.0000
26	CSIR, New Delhi	FBR020302	Functional analysis of terpene synthases involved in resin terpene biosynthesis in <i>Boswellia</i> tree	Dr. Sumit Ghosh	21.05.2024	31.03.2026	79.5000
27	CSIR, New Delhi	FBR020303	Understanding the role of UDP-glycosyltransferases in the jujubogenin-derived bacoside biosynthetic pathway in <i>Bacopa monnieri</i>	Dr. Rakesh Shukla	21.05.2024	31.03.2026	79.9740
28	CSIR, New Delhi	MMP025301	Genome-editing for crop improvement (GE-Crop)	Dr. Pradipto Mukhopadhyay	07.06.2024	31.03.2027	737.00
29	CSIR, New Delhi	FIR020301	Investigating the role of Type VI secretion system on the endophytic behavior of <i>Pseudomonas oryzae</i> CB24 in <i>Pelargonium graveolens</i>	Dr. Akanksha Singh	23.07.2024	31.03.2026	96.0000
30	Seva Trust, Chennai	CNP-535	Providing technical support to M/s Sewa Trust to support the project "Mint with purpose" on the processing aspects of Mint oils being cultivated in and around Moradabad & Gajraula district of U.P.	Dr. Sudeep Tandon	23.04.2024	22.04.2025	7.72875
31	Agricultural Technology Management Agency (ATMA)	SSP-536	Organization of training programme and exposure visit on cultivation, processing and marketing of aromatic and medicinal crops suitable for Bihar State.	Dr. Ram Suresh Sharma	19.07.2024	31.03.2026	9.6

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 2025)

Dr. Prabodh Kumar Trivedi Director

Chief Scientist

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
Dr. J Kotesch Kumar
Dr. Karuna Shanker

Senior Principal Scientist

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
Dr. V. Sunderesan
Dr. Ram Swaroop Verma
Dr. 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

Principal Scientist

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.E. 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
Dr. Akanksha Singh
Dr. Dipendra Kumar
Dr. (Mrs) Gunjan Tiwari
Dr. Kapil Dev
Dr. (Ms) Priyanka Suryavanshi
Dr. Bhise Rushikesh Nanasahab
Dr. Santosh Kumar Chandappa Kedar
Dr. V S Pragadheesh
Dr. Sumya Pathak
Dr. Shailendra Singh
Dr. Ratnashekhar C.H.
Dr. Anand Kumar T.M.
Dr. Isha Sharma

Scientist

Dr. B Shivanna
Dr. Ashish Sharma
Dr. Neelam Prabha Negi
Dr. M Gover Antoniraj



Staff Members

Dr. Swati Tyagi
Dr. Aman Chandra Kaushik
Dr. Sanjeet Mehariya
Dr. Yugander Arra

Group-III

Principal Technical Officer

Shri K Bhaskaran

Sr. Technical Officer (2)

Dr. Neerja Tiwari
Smt. Anju Kumari Yadav
Dr. Anil Kumar Singh
Shri Shiv Prakash
Dr. (Mrs.) Manju Singh
Dr. Rajendra Prasad Patel
Dr. Rakshpal Singh
Shri A.K. Tiwari
Shri Ram Pravesh
Dr. Devesh Shukla
Dr. Vipool Anand Thorat
Dr. Amit Chauhan
Dr. Anil Kumar Maurya
Mr. Pankaj Kumar Shukla

Sr. Technical Officer (1)

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
Mr. Anupam Singh
Mr. Vijaya H. M.
Mr. Sudarsan
Mr. Abhishek Maurya

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
Shri Manish Arya
Dr. Sanjeet Kumar Verma
Shri Deepak Kumar Verma
Dr (Mrs) Pooja Singh
Shri Sonveer Singh

Technical Assistant

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 Vinod Kumar
Shri Dharam Pal Singh

Sr. Technician (1)

Shri Kundan Narayan Wasnik
Shri Basant Kumar Dubey
Shri Yalla VVS Swamy
Shri Harendra Nath Pathak
Shri Hemraj Sharma
Shri Jitendra Kumar Verma

Technician (2)

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 Nurul Huda
Shri Lal Chand Prasad
Shri TP Suresh

Administrative Staff

Group-A (Gazetted)

Controller of Administration

Uttam Kumar Jha

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

Private Secretary

Miss Gaitry Sharda
Smt P Sabitha
Shri Srikar Ji Sinha
Shri Avadhesh Kumar

Group-B (Non-Gazetted)

Asstt. Section Officer (Gen)

Shri Sant Lal
Shri Kaushal Kishore
Shri Siddharth Shukla
Shri Ravi Prakash

Mrs. Sheela Yadav

Asstt. Section Officer (F&A)

Shri AL Sahoo
Shri Mohit Hitaishy

Asstt. Section Officer (S&P)

Shri Ajeet Verma
Shri Anil Kumar

Group-C Posts

Sr. Secretariat Asstt (Gen)

Shri Abdul Nadir Khan

Senior Secretariat Asstt. (F&A)

Ms. Sonali Kumari Yadav
Shri. Mohd. Shameem

Jr. Secretariat Asstt (S&P)

Shri Tula Singh

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 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. Sumya Pathak	Sr. Scientist	07-05-2024	CSIR-CIMAP,LKO
2.	Dr. Ashish Sharma	Scientist	12-07-2024	CSIR-CIMAP,LKO
3.	Dr. Neelam Prabha Negi	Scientist	18-07-2024	CSIR-CIMAP,LKO
4.	Shri Anupam Singh	STO(1)	23-07-2024	CRC-Purara
5.	Shri Vijaya H M	STO(1)	25-07-2024	CRC-Bengaluru
6.	Shri Sudarshan	STO(1)	25-07-2024	CSIR-CIMAP,LKO
7.	Dr. M. Gover Antoniraj	Scientist	05-08-2024	CSIR-CIMAP,LKO
8.	Shri Abhishek Kumar Maurya	STO(1)	07-08-2024	CSIR-CIMAP,LKO
9.	Shri Anil Kumar	ASO(S&P)	29-08-2024	CSIR-CIMAP,LKO
10.	Shri Mohit Hitaishy	ASO(F&A)	11-09-2024	CSIR-CIMAP,LKO
11.	Dr. Swati Tyagi	Scientist	29-10-2024	CSIR-CIMAP,LKO
12.	Dr. Aman Chandra Kaushik	Scientist	11-11-2024	CSIR-CIMAP,LKO
13.	Dr. Shailendra Singh	Sr. Scientist	09-12-2024	CSIR-CIMAP,LKO
14.	Dr. Sanjeet Mehariya	Scientist	09-12-2024	CSIR-CIMAP,LKO
15.	Dr. Yugander Arra	Scientist	23-12-2024	CSIR-CIMAP,LKO
16.	Shri Uttam Kumar Jha	COA	01-01-2025	CSIR-CIMAP,LKO
17.	Shri Avadhesh Kumar	PPS	10-01-2025	CSIR-CIMAP,LKO
18.	Dr. Isha Sharma	Sr. Scientist	04-03-2025	CSIR-CIMAP,LKO
19.	Ms. Reenu	ASO(Gen)	12-03-2025	CSIR-CIMAP,LKO
20.	Mr. Rohit	ASO(Gen)	18-03-2025	CSIR-CIMAP,LKO
21.	Ms. Renu	ASO(Gen)	18-03-2025	CSIR-CIMAP,LKO
22.	Ms. Manita	ASO(Gen)	21-03-2025	CSIR-CIMAP,LKO
23.	Mrs. Meghna Lohiya	ASO(Gen)	24-03-2025	CSIR-CIMAP,LKO
24.	Mr. Saurabh Singh	JSA(Gen)	27-03-2025	CSIR-CIMAP,LKO
25.	Mr. Zafar Alam	JSA(Gen)	27-03-2025	CSIR-CIMAP,LKO

Staff Superannuated

S.No.	Name	Designation	Date of Retirement	Posting
1.	Shri. Ram Lakhan	Sr. Technician(2)	30-04-2024	CSIR-CIMAP, LKO
2.	Shri. Subhash Kumar	Lab Assistant	30-04-2024	CRC-PANTNAGAR
3.	Shri. Shamiullah Khan	SO(S&P)	31-07-2024	CSIR-CIMAP, LKO
4.	Shri. Pawan Kumar Tiwari	Sr. Technician(2)	31-08-2024	CSIR-CIMAP, LKO
5.	Dr. Saudan Singh	Chief Scientist	31-08-2024	CSIR-CIMAP, LKO
6.	Shri. Bharat Singh	Lab Assistant	28-02-2025	CRC-PANTNAGAR

Superannuated Scientist

Dr. Saudan Singh

Dr. Saudan Singh has more than 33 years of research experience in the field of Agronomy with reference to development of agro-technologies for most of the Medicinal and Aromatic plants like Mints, Lemongrass, palmrosa, citronella, geranium, Kalmegh, serpagandha, brahmi, ashwgandha, safed musli, satawar, etc.



Dr. Singh's scientific ingenuity led to the development of novel agro-technologies for medicinal and aromatic plants, notably the Early Mint Technology, which has been widely adopted by farmers nationwide to enhance yield and economic returns. His pioneering, low-cost, farmer- and environment-friendly geranium protection method has reduced costs up to twentyfold for cultivators in the northern Indian plains.

Throughout his illustrious career, Dr. Singh authored 84 research articles in international peer-reviewed journals, 52 popular articles, 58 conference abstracts, and five book chapters, significantly advancing the scientific community's understanding of his field. He contributed extensively to practical agriculture, publishing 28 farm bulletins, securing two patents,

developing 19 crop varieties, and creating two innovative herbal products. His outreach has been remarkable, with 97 invited talks on television and radio and over 600 lectures delivered during institute training programs—an inspiration to countless learners and practitioners.

Equally impressive is Dr. Singh's commitment to mentorship, having guided nine PhD scholars and four MSc students through their dissertations. He represented the institute internationally, visiting Ukraine and Ethiopia to promote MAPs cultivation techniques and expand his expertise. His leadership roles as Head of the Division of Crop Production and Protection, Coordinator for Resource Centres, Professor at AcSIR, and Farm Manager for nearly a decade have left a profound impact on the institute's development. He also served as Coordinator for the CSIR-NET examination for six years, shaping countless scientific careers.

Dr. Singh's retirement marks the conclusion of an exceptional chapter and the beginning of another. His legacy will continue to inspire and influence generations of scientists, students, and farmers. Dr. Saudan Singh superannuated as a chief scientist on 31st August 2024 from CSIR-CIMAP.

Publications & Patents (2024-2025)

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3. Anyatama A, Datta T, Dwivedi S, Trivedi PK. Transcriptional junk: Waste or a key regulator in diverse biological processes? *Curr Opin Plant Biol*. 2024 Dec;82:102639. doi: 10.1016/j.pbi.2024.102639. Epub 2024 Sep 26. (IF:7.5).
4. Ashwini KV, Parveen S G, Hiremath C. (2024) Stable clone selection for oil and herb yield using GGE biplot model in climate-smart lemongrass. *Crop Breeding and Applied Biotechnology*. 24(4): e501324419.
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6. Bharath Kumar S, Prasanth P, Sreenivas M, Gouthami P, Sathish G, Jnanesha AC, Kumar SR, Gopal SV, Sravya K, Kumar A, Lal RK. (2025) Unveiling the influence of NPK, organic fertilizers, and plant growth enhancers on China aster (*Callistephus chinensis* L.) cv. 'Arka Kamini' seed yield. *Industrial Crops and Products*. 227: 120778. (IF:6.2)
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16. Das P, Anupama, Shukla AK, Khare P. (2024) Time series analysis of uptake and translocation of Cd and expression of transporter genes in nine *Andrographis paniculata* accessions. *Environmental Science and Pollution Research*. 31(57):65574-90.

17. Dikshit N, Syed N, Rout PK, Singhal RK, Indu I, Halli HM, Rana M, Ahmed S. (2025) Comparative evaluation of quantitative, and qualitative attributes of oat (*Avena sativa* L.) varieties grown in semi-arid India. *Discover Plants*.2(1):27.
18. Dwivedi GR, Pathak N, Tiwari N, Negi AS, Kumar A, Pal A, Sharma A, Darokar MP. (2024). Synergistic antibacterial activity of gallic acid based chalcone indl2 by inhibiting efflux pump transporters. *Chemistry & Biodiversity*. 21(4): e202301820. (IF: 2.5)
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23. Ghosh D, Kundu A, Chaudhary N, Gupta D, Dwivedi M, Verma RS, Shanker K, Kumar B, Kumar N. (2025) Unveiling Cannabinoids and Terpenes Diversity in *Cannabis sativa* L. From Northern India for Future Breeding Strategies. *Chemistry & Biodiversity*. 22(6): e202402278. (IF:2.6)
24. Ghosh D, Kundu A, Chaudhary N, Singh S, Shanker K, Kumar B, Kumar N. (2024) Morpho-anatomical, phytochemical, and molecular diversity of North-Indian *Cannabis sativa* L. germplasm for CBD-rich genotypes. *The Nucleus*.10:1-22. (IF:3.2)
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35. Jnanesha, AC, Venugopal S, Kumar SR, Kumar A, Bisht D, Chanotiya CS, Lal RK. (2024) Optimization of a new organic approach to natural bio stimulant (Jeevamrutha) for yield and quality management in Senna (*Cassia angustifolia* Vahl.): An agriculturally highly export-oriented crop. *Technology in Horticulture*. 4(1).
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2. Shasany AK, Yadav P, Rastogi S, Jaail SU, Bhakuni RS. Method for increasing viridiflorol content in tissues. US 12018264, Date: 25.06.2024.
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5. Yadav NP, Megha Ade M, Singh S, Sahoo D. Fennel oil-loaded polymeric bead formulation for insecticidal activity and process of preparation thereof. Application no. 0076NF2024. Date: 15.05.2024.



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Secretary (DARE) & DG,
Indian Council of Agriculture Research (ICAR)
Krishi Bhawan, New Delhi-110001

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Padam Bhushan,
Founder
Himalayan Environmental Studies and
Conservation Organisation (HESCO)
Dehradun, Uttarakhand-248001



Dr. Lal Hingorani
Director
Pharmanza (India) Pvt. Ltd.
70/11, G.I.D.C Estate Kansari
Khambha, Anand, Gujrat-388360



Dr. Alok K. Sinha
FNASc, FASc, FNA
JC Bose National Fellow
National Institute of Plant Genome Research,
Aruna Asaf Ali Marg
New Delhi -110 067



Dr. Chinnusamy Viswanathan
FNAAS
Joint Director (Research)
ICAR-Indian Agricultural Research Institute
New Delhi-110012

Agency Representative



Dr. Sanjay Kalia
Scientist F,
Department of Biotechnology,
6th - 8th Floor, Block-2,
4th - 5th Floor, Block-3,
CGO Complex, Lodhi Road
New Delhi - 110003

Sister Laboratory



Dr. Sudesh Kumar Yadav
Director,
CSIR-Institute of Himalayan Bioresource
Technology,
Palampur (Holta) Distt. Kangara (H.P.),
Palampur-176061

Director



Dr. Prabodh Kumar Trivedi
Director
CSIR-Central Institute of Medicinal & Aromatic
Plants,
P.O. CIMAP, Near Kukrail Picnic Spot
Lucknow-226015

DG's Representative



Dr. Vibha Malhotra Sawhney
Head,
Technology Management Directorate (TMD),
Vigyan Suchana Bhawan (CSIR-NIScPR Building)
14, Satsang Vihar Marg
New Delhi-110067

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CSIR-CIMAP, Lucknow



Dr. Sunita Singh Dhawan
Sr. Principal Scientist
CSIR-CIMAP, Lucknow



Dr. Akanksha Singh
Sr. Scientist
CSIR-CIMAP, Lucknow



Dr. Gunjan Tiwari
Sr. Scientist
CSIR-CIMAP, Lucknow



Dr. Rajendra Prasad Patel
Sr. Technical Officer (2)
CSIR-CIMAP, Lucknow



**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. Uttam Kumar Jha
CSIR-CIMAP
E-mail: coa.cimap@csir.res.in

Assistant Central Public Information Officer

Mr. Rahul Singh
CSIR-CIMAP
E-mail: rahulsingh01@csir.res.in

Dr. R K Srivastava
CSIR-CIMAP
E-mail: rksrivastava.cimap@csir.res.in

Appellate Authority

Dr. Karuna Shanker
CSIR-CIMAP
E-mail: kshanker.cimap@cimap.res.in

Transparency Officer

Dr. Sudeep Tandon
CSIR-CIMAP
E-Mail: standon.cimap@csir.res.in

Nodal Officer

Dr. Bhaskar Shukla
CSIR-CIMAP
E-mail: bhaskarshukla.cimap@csir.res.in



Budget at a Glance (As on 31 March 2025)

Name of Lab.	CSIR CIMAP		
	Final Allocation (` in lakhs)	Actual Expendi- ture (` 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	3577.087	3577.087	
2. Other Allowances			
a. Re-imburs. of Med.Exp./CGHS/Med.charges	100.875	100.875	
b. Overtime Allowance			
c. Honorarium	1.896	1.896	
d. Leave Travel Concession	25	25	
e. T.A. (India)	24.632	24.632	
f. T.A. (Foreign)			
g. Professional Update Allowance			
h. Total Other Allowances (a to g)	152.403	152.403	
3. Total Salaries (1+2h)	3729.49	3729.49	
4. P-04 Contingencies	546	546	
5. P-05 H.R.D.			
6. P-06 Lab. Maintenance	325.857	325.857	5.601
7. P-701 Staff Qrs. Maintenance	62.139	62.139	
8. P07 Chemical/Consum.& Other Res.Exp.	547.2	547.2	1.275
9. Total Revenue (3 to 8)	5210.686	5210.686	6.875
B. Capital			
a) P-50 Land Cost			
a) P-50 Land Cost			
b) (i) P-50 Works & Services/Elec. Installations (Lumpsum)	72.759	72.758	
b) (ii) P-50 Works & Services/Elec. Installations (Other)	56.07	56.07	

c) P-50 App. & Equip./Computer Equipments	747.403	747.403	5.03
d) P-50 Workshop Machinery			
e) P-50 Office Equipments			
f) P-50 Furniture & Fittings	14.79	14.79	
g) P-50 Library			0.077
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)	23.913	23.913	
m) (ii) P-702 Staff Qrs.(Construction) (Other)			
Total Capital (a to l)	914.936	914.935	5.108
Total A+B	6125.622	6125.621	11.983
C. Special Proj. FBR/NCP/FTC/FTT/RSP/HCP/HARIT/lab. project etc.			
1. Revenue			
(i) T. A. (India)	57	57	
(ii) T.A. (Foreign)			
(iii) Contingencies	135.15	135.15	
(iv) Maintenance	61.75	61.75	
(v) Chemical, Consum.& Other Res.Exp.	709.378	709.378	
(v) ORE	324.6	324.6	
(v) Tech HR	469.922	469.922	
Total Rev.(C1)	1757.8	1757.8	
2. Capital			
(i) Work's & Services	98.352	98.352	
(ii) Appartus & Equipment	351.402	351.402	
(iii) Other Capitals			
Total Capital(C2)	449.754	449.754	
C. Total allocation ; FBR/NCP/FTC/FTT/RSP/ HCP/HARIT/lab. project etc.	2207.554	2207.554	
Total National Labs. (A+B+C)	8333.176	8333.175	11.983
2. Others			
P-804 Pension & Other retirement benefits	2900	2900	
Grand Total	11233.176	11233.175	11.983



Ph.D. Awarded

1 st April 2024 to 31 st March 2025							
S. No	Name of Students	Supervisor/ Co-Supervisor	Batch	Enrollment	Thesis title (English)	Date of Viva	University
1.	Mr. Zakir Husain	Dr. L. Rahman	Jan 2018	CIM-AP/2018/012	Vanillin Production through Metabolic Engineering by Over expression of VpVAN gene in <i>Ocimum</i> Species	07-05-2024	JNU, New Delhi
2.	Seema Yadav	Dr. Ashutosh Shukla	Jan 2018	CIM-AP/18/014	Molecular studies on <i>Catharanthus roseus</i> for elucidating micronutrient dependency of vindoline accumulation	26-07-2024	JNU, New Delhi
3.	Ashutosh Joshi	Dr. Rakesh Kumar Shukla	Jan 2018	CIM-AP/18/010	Molecular and Functional Characterization of Methyl Jasmonate Inducible WRKY Transcription factor from <i>Ocimum sanctum</i>	31-07-2024	JNU, New Delhi
4.	Anuj Kumar	Dr. A.K. Gupta	Aug 2017	CIM-AP/17/006	Estimation of Genetic Component for Yield and Yield Related Traits through Diallel Cross Analysis in Indian Ginseng (<i>Withania somnifera</i> L. Dunal)	06-09-2024	JNU, New Delhi
5.	Naziya Sayed	Dr. P.K. Rout	Aug 2018	CIM-AP/18/018	Value addition of Indian underexplored vegetable oils for use as food and flavor	28-10-2024	JNU, New Delhi
6.	Ms. Riya Mehrotra	Dr. Rajesh Kumar Verma	Jan 2019	(CIM-AP/19/003)	“Deficiency evaluation, gene expression profiling and alleviation of iron chlorosis in aromatic plant lemongrass (<i>Cymbopogon flexuosus</i>)”	29-01-2025	JNU, New Delhi
7.	Mr. Aashish Kumar	Dr. Sumit Ghosh	Jan 2019	(CIM-AP/19/007)	Unraveling Key Enzyme(s) for Boswellic acid Biosynthesis in Salai Guggul (<i>Boswellia serrata</i> Roxb. ex Colebr)	27-02-2025	JNU, New Delhi
8.	Mr. Ashish Kumar	Dr. Anirban Pal	Jan 2017	CIM-AP/2017/012)	Prospecting medicinal plants to improve gut immunity	04-03-2025	JNU, New Delhi
9.	Mr. Waseem Raza	Dr. Abha Meena	Jan 2019	(CIM-AP/19/001)	Target based approach to explore anticancer potential of selected flavonoids	10-03-2025	JNU, New Delhi
10.	Monika Beniwal	Dr. D.U. Bawankule	Jan 2021	10BB21J10010	Therapeutic potential of selected taxoids from <i>taxus wallichiana</i> against insulin resistance: An <i>in-vitro</i> and <i>in-vivo</i> study”	24-05-2024	AcSIR

11.	Abdul Ma- zeed	Dr. Priyanka Suryavanshi	Aug 2020	10BB20A10003	Studies on plant-based bi- ostimulants and phospho- rus management practices in rose scented geranium (<i>Pelargonium graveo- lens</i> L'Herit ex Ait)"	28-05-2024	AcSIR
12.	Shahnaz Parveen	Dr. Suaib Luqman	Jan 2018	10BB18J10004	"Investigation on anticancer potential of selected alkaloids by employing molecular and cell target based studies"	13-06-2024	AcSIR
13.	Lothe Nikil Bhashkar	Dr. Rajesh Ku- mar Verma	Aug 2020	10BB20A10015	"Studies on the productivi- ty and economics of select- ed cultivars of geranium (<i>Pelargonium graveolens</i> L. Her.ex.Ait) in different regions of Maharashtra"	30-06-2024	AcSIR
14.	Jafar Mehdi	Dr. Anil Kumar Gupta, Supervi- sor and Dr. Nar- endra Kumar Co-Supervisor	Aug 2019	10BB19A10009	"Genetic variability, corre- lation and diversity studies in germplasm collections of Cannabis spp."	12-08-2024	AcSIR
15.	Kirti Verma	Dr. Saudan Singh Supe- visor and Dr. Rajesh Kumar Verma, Co-Su- pervisor	Jan 2021	10BB21J10018	"Evaluation of produc- tivity and profitability of Kalmegh [<i>Andrographis paniculata</i> (Burm.F) Wall ex.Nees] based co-cultiva- tion system"	17-09-2024	AcSIR
16.	Deepak Kumar	Dr. Prasanta Kumar Rout	Jan 2021	10CC21J10002	"Phytochemical investiga- tion of <i>Gymnema sylvestre</i> R. Br. to establish correlation in gymnemic acids and their derivatives with bio- activities"	26-09-2024	AcSIR
17.	Prasant Kumar	Dr. Prasanta Kumar Rout	Aug 2020	10CC20A10001	"Valorization of commer- cially important essential oils of <i>Poaceae</i> and <i>Lamiace- ae</i> families using heteroge- neous catalysts"	30-09-2024	AcSIR
18.	Swati Singh	Dr. Ram Swa- roop Verma, Su- pervisor and Dr. Rajendra Chandra Padalia Co-Supervisor	Jan 2020	10CC20J10011	"Chemical and biological investigations of less ex- plored aromatic plants: <i>Ar- temisia pallens</i> Wall. ex DC., <i>Ravenia spectabi- lis</i> Engl., <i>Cymbopogon distans</i> (Nees ex Steud.) W. Watson and <i>Cymbopogon martini</i> (Roxb.) W. Watson (var. <i>sofia</i>)"	18-10-2024	AcSIR
19.	Alka Kurmi	Dr. Dharmendra Saikia	Jan 2018	10BB18J10010	"Bioprospecting of plant derived bioactives against <i>Candida</i> ; an <i>in-vitro</i> and <i>in-vivo</i> study"	28-10-2024	AcSIR



Ph.D. Awarded

20.	Priyanka Prasad	Dr. Birendra Kumar	Aug 2018	10BB18A10004	"Genetic improvement of peppermint (<i>Mentha Piperita</i> L.) using gamma irradiation-induced variability for biomass, oil yield and quality attributes"	12-12-2024	AcSIR
21.	Nandini Pathak	Dr. Arvind Singh Negi	Jan 2020	10CC20J10013	"Development of dioscin, diosgenin and gallic acid based anticancer and antibacterial agent"	26-12-2024	AcSIR
22.	Ranu Yadav	Dr. Puja Khare	Jan 2019	10BB19J10010	"Studies on isolation and characterization of pesticide metabolizing rhizospheric microbes from aromatic crops grown in contaminated soil"	10-01-2025	AcSIR
23.	Deepayan Ghosh	Dr. Narendra Kumar	Aug 2021	10BB21A10011	"Morpho-anatomical, phytochemical and molecular investigation of <i>Cannabis sativa</i> L. for identification of CBD-rich genotype(s)"	07-02-2025	AcSIR
24.	Priyanka Gupta	Dr. Dinesh A Nagegowda	Aug 2019	10BB19A10007	"Understanding the molecular basis of essential oil biosynthesis in aromatic grasses (<i>Cymbopogon</i> sp.)"	07-02-2025	AcSIR
25.	Ms. Perminder Kaur	Dr. Saudan Singh Supervisor & Dr. Rakesh Kumar Co-Supervisor	Jan 2018	10BB18J10008	"Evaluation of productivity, quality and resource use efficiency of <i>Ocimum basilicum</i> L. under co-cultivation systems"	17-03-2025	AcSIR
26.	Ms. Shikha	Dr. Rakesh Kumar Shukla	Aug 2017	10BB17A10001	"Molecular characterization of transcripts involved in waterlogging-induced adventitious root formation in <i>Mentha arvensis</i> "	26-03-2025	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, CSIR-CIMAP 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)*

