

TRAINING REPORT

Prospects of Research, Development
Value addition and Commercialization of
Medicinal and Aromatic Plants native
to Indian Ocean Region

7-11 February 2025



Organized by
IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP),
CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow
P.O-CIMAP, Near Kukrail Picnic Spot Lucknow-226015, INDIA
www.cimap.res.in



TRAINING 2025

ICCMP, INDIA



Compiled By:

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विदेश मंत्रालय
MINISTRY OF
EXTERNAL AFFAIRS

7-11 February 2025

The training was financially supported by the Ministry of External Affairs, New Delhi (India)

Background and Training Objectives

The training program titled **“Prospects of Research, Development, Value Addition, and Commercialization of Medicinal and Aromatic Plants Native to the Indian Ocean Region”**, held on **7th February 2025** at the **CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow**, was organized under the framework of regional cooperation between India and **IORA Member States and Dialogue Partners**.

The program aimed to provide scientific and technological expertise in medicinal and aromatic plants (MAPs) to build capacity among IORA countries, many of which share similar biodiversity and traditional knowledge systems. The training sought to enhance understanding of MAP-based value chains through a holistic approach encompassing conservation, cultivation, phytochemical profiling, sustainable harvesting, advanced processing techniques, product formulation, and commercialization strategies.

Specific objectives included collaborative research, sharing best practices in MAP development, introducing quality standards and regulatory frameworks, and equipping participants with practical skills for value addition and enterprise development and joint technology project initiatives.

The main objectives of the training course were:

1) Capacity Building & Knowledge Sharing

- Strengthen the research and technical competencies of IORA Member State participants.
- Provide insights into advance tools and techniques for harmonization amongst the IORA countries.
- Assist developing states in enhancing their capabilities within existing mandates and resources.

2) Network Building/ Collaboration and Partnership

- Strengthen partnership and leadership, greater knowledge and engagement among Member States.
- Build a network of international cooperation within Indian Ocean Region connecting Government Officials/Institutes/Universities and private sector representatives, to exchange knowledge, ideas, and technologies.

3) Trade facilitation

- Promote international trade for the economic and social development of the Member States.
- Facilitate easier access to international markets for medicinal and aromatic plant products, allowing Member States to increase their export potential.

PARTICIPANTS PROFILE

S.No.	Name	Professional details and parent organization details
1.	Dr. Mohammad Reza Sanjabi	Director, IORA Regional Centre for Science and Technology Transfer (RCSTT), Tehran, Iran
2.	Fereshteh Moradi	Chief Coordinator, Indian Ocean Rim Association (IORA) Regional Centre for Science and Technology Transfer (RCSTT), Tehran, Iran
3.	Dr. Fadzureena binti Jamaludin	Research Officer, Forest Research Institute Malaysia (FRIM), 52109, Kepong, Selangor
4.	Prof. John Mellem	Professor, Department of Biotechnology and Food Science, Durban University of Technology, South Africa
5.	Dr. Juliao Armando	Teaching and Research, Centre of Research and Development in Ethnobotany (CIDE)
6.	Dr. Raquel Jose	Director, Centre of Research and Development in Ethnobotany, Maputo Province, Mozambique
7.	Dr. Filomeno Aboo Dibaliua	Professor, Centre of Research and Development in Ethnobotany, Maputo Province, Mozambique
8.	Dr. A. MANORAJ	Senior Scientist/ Head, Quality Assurance and Research laboratory. Bandaranaike Memorial Ayurveda Research Institute, Nawinna, Maharagama, Sri Lanka
9.	Dr. RAKOTOSAONA Rianasoambolanoro	Director of Centre National d'Application de Recherches Pharmaceutiques
10.	Prof. Ramadhoini	Research lecturer at the Faculty of Science and Technology, head of the biodiversity and ecosystem laboratory at the Comoros National Herbarium.
11.	Ms. Pattamapan Lomarat	Assistant Professor, Department of Food Chemistry, Faculty of Pharmacy, Mahidol University, Thailand
12.	Ms. Thanika Pathomwichaiwat	Assistant Professor, Department of Pharmaceutical Botany, Faculty of Pharmacy, Mahidol University, Thailand
13.	Ms. Wachiraporn Thong-on	Head of Research and Development Department, Abhaibhubejhr Hospital Foundation, Thailand

14. Miss Punika Nobnom

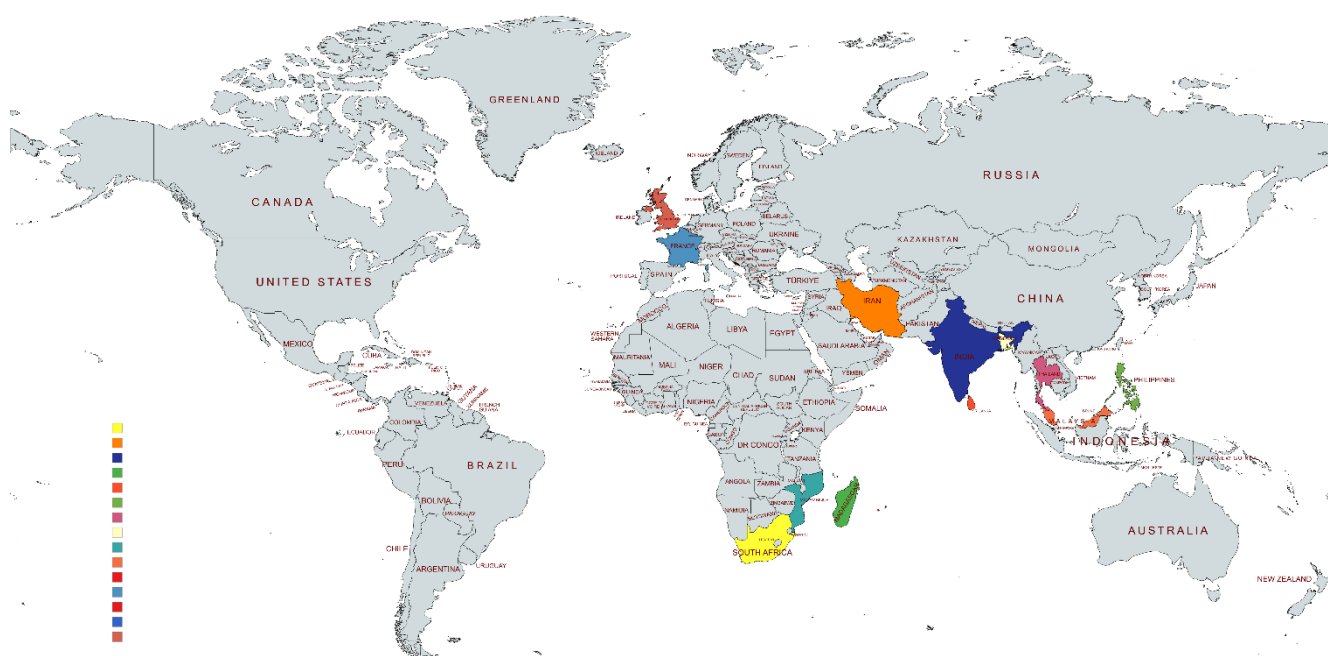
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15. Ms. Norrakamol Sookcharoen

Research and Development, Abhaibhubejhr Hospital
Foundation, Thailand

16. Dr. Vikash Halkhoree

Senior Ayurvedic Medical Officer, Ministry Of health
and Wellness, Mauritius



IORA Member States and Dialogue Partners participating in Training Program at CSIR- CIMAP, India



Resource Persons'

Sl. No.	Name	Designation	Specialization
1.	Dr. Sudeep Tandon	Chief Scientist	Processing and Upscaling
2.	Dr. Anil Kumar Gupta	Chief Scientist	Plant Breeding and Genetic Resource Conservation
3.	Dr. Laiq Ur Rahman	Chief Scientist	Tissue Culture and Plant Biotechnology
4.	Dr. Karuna Shanker	Chief Scientist	Analytical Chemistry
5.	Dr. Sunita Singh Dhawan	Senior Principal Scientist	Plant Biotechnology
6.	Dr. Rajesh Verma	Senior Principal Scientist	Crop Production & Protection
7.	Dr. Dnyaneshwar Umrao Bawankule	Senior Principal Scientist	Drug Discovery and Development
8.	Dr. Sanjay Kumar	Senior Principal Scientist	Technology Dissemination
9.	Dr. Manoj Semwal	Senior Principal Scientist	Precision Agriculture and AI
10.	Dr. V. Sunderasan	Senior Principal Scientist	Botany
11.	Dr. Ramswaroop Verma	Senior Principal Scientist	Chemistry
12.	Dr. Chandan S. Chanotiya	Senior Principal Scientist	Essential Oil Chemistry
13.	Dr. Ramesh Srivastava	Principal Scientist	Business Development
14.	Dr. Narendra Kumar	Senior Scientist	Botany and Herbarium

VENUE AND DATE

IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP)

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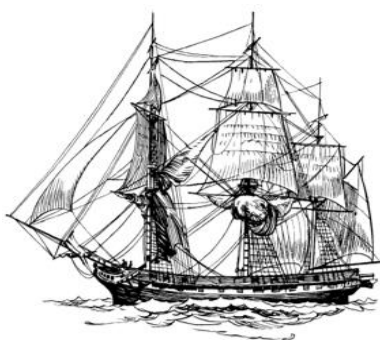
Inaugural Ceremony:

The inaugural session of the training program titled “Prospects of Research, Development, Value Addition, and Commercialization of Medicinal and Aromatic Plants Native to the Indian Ocean Region” was held at the CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) on 7th February 2025. Dr. Anirban Pal, Convener of the training program, formally welcomed the Director of CSIR-CIMAP - Dr. Prabodh K. Trivedi, the Director of IORA-RCSTT (Iran)- Dr. M. Sanjabi, participating Member States, and esteemed faculty members. He also provided a brief overview of the training schedule and the overall program structure.

Thereafter, Dr. Prabodh K. Trivedi, Director, CSIR- CIMAP addressed the gathering and highlighted the research activities and contribution of the institute in the area of Medicinal and Aromatic Plants (MAPs) in the last 60 years. Dr. Trivedi emphasized the importance of international collaboration and extended an open invitation to researchers and institutions from the Indian Ocean Region to engage in joint research projects, knowledge exchange, and technology development initiatives with CSIR-CIMAP. He expressed hope that such partnerships would foster regional cooperation and lead to sustainable growth and innovation in the MAP sector.

Dr. M. Sanjabi, Director of IORA-RCSTT, Tehran, Iran, delivered an address on strengthening the capacity of IORA Member States and Dialogue Partners. He emphasized the advancement of new technologies and highlighted the significance of cooperation, commercialization, and technology transfer among the member countries. Dr. Sanjabi also highlighted the importance of building strong networks among key stakeholders to foster collaboration and drive innovation across the region.

The Director of CSIR-CIMAP officially released the training manual during the inaugural ceremony, marking a significant milestone in the capacity-building program. As a gesture of appreciation, he also felicitated the participants by presenting them with mementos in recognition of their involvement and commitment. The inaugural session concluded with a heartfelt Vote of Thanks delivered by Dr. Anirban Pal, who acknowledged the contributions of all dignitaries, organizers, and participants, and expressed gratitude for their support in making the event a success.





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Addressing Challenges and the Future Roadmap for IORA Success (Focusing on the Strategic Importance of Medicinal Plants)

Ms. Feresteh Moradi, Tehran, Iran

Key Discussion Points:

- Strategic importance of medicinal plants in the Indian Ocean Rim Association (IORA) region.
- The role of IORA nations in promoting research, conservation, and sustainable utilization of medicinal and aromatic plants.
- Strengthening collaboration among IORA member countries to enhance knowledge sharing and technology transfer.
- Addressing challenges in the conservation, cultivation, and commercialization of medicinal plants.
- Future roadmap for enhancing the impact of medicinal plants on public health, local economies, and biodiversity conservation.

The session highlighted the strategic importance of the Indian Ocean Rim (IOR) region, emphasizing its rich biodiversity and the economic and ecological significance of medicinal and aromatic plants. It covered the key objectives of IORA in promoting sustainable economic development and the role of specialized agencies in advancing research and innovation in medicinal plants. Funding opportunities and financial support mechanisms available for medicinal plant research were discussed, along with the functions of the IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP) and its ongoing initiatives. The session concluded by stressing the urgent need for greater collaboration, policy support, and financial investment to drive sustainable development in the medicinal plant sector across the IORA region.

Strategic Importance of Indian Ocean Rim and the IORA Nations

- Overview of the Indian Ocean Rim region and its rich biodiversity.
- Economic and ecological significance of medicinal and aromatic plants in the region.

IORA Objectives and Specialized Agencies

- Overview of IORA's key objectives in promoting sustainable economic development.
- Role of specialized agencies in driving research and innovation in medicinal plants.

IORA Priority Areas and Financial Mechanism

- Funding opportunities and financial support mechanisms available for medicinal plant research.

IORA RCSTT's Coordination Centre on Medicinal Plants

- Functions and responsibilities of the IORA-RCSTT Coordination Centre on Medicinal Plants (ICCMP).

- Ongoing initiatives and collaborative projects to promote medicinal plant research and development.

Conclusion:

The session emphasized the urgent need for enhanced collaboration, policy support, and financial investments in medicinal and aromatic plant research within the IORA region. The discussions laid the groundwork for a holistic approach to addressing challenges and harnessing opportunities for sustainable development in this sector.



Authentication of Herbal Raw Drugs: Problems, Perspectives, and Way Forward

Dr. V. Sundaresan

The lecture by Dr. Sundaresan emphasizes the global reliance on herbal medicinal products, used by approximately 80% of the world's population, and cleared that many modern drugs are plant-derived. The lecture outlines the growing demand for herbal and plant-based drugs, driven by increasing consumer preference for natural remedies, expanded research and clinical trials, and supportive regulatory frameworks. The key focus was on the importance of authenticating raw materials through macroscopic, microscopic, chemical, and DNA barcoding techniques to ensure quality and efficacy. The lecture also highlights the adulterations and covered important subtopics like accidental and economically motivated adulteration.



UAV Remote Sensing for Precision Agriculture

Dr. Manoj Semwal

The lecture on Precision Agriculture (PA), also known as Smart Farming, highlighted the integration of IoT tools and Unmanned Aerial Vehicles (UAVs) for data-driven crop management. Different types of UAVs—fixed-wing, multi-rotary wing (VTOL), and hybrid—were discussed, each suited for specific agricultural applications. UAVs equipped with RGB, multispectral, and hyperspectral sensors serve as efficient remote sensing platforms, enabling better imaging and real-time monitoring. Key applications covered included crop monitoring, weed and irrigation management, nutrient optimization, pest and disease control, and crop phenotype assessment. It was emphasized that UAV-based remote sensing improves precision in detecting crop stresses and enhances decision-making, leading to more efficient, sustainable, and productive farming practices. The session concluded by underlining how the integration of UAV technologies with IoT significantly transforms traditional agriculture into a modern, technology-driven system.



Herbarium Documentation Inventorization and Digitization: Traditional vs. Modern Techniques

Dr. Narendra Kumar

A session was conducted covering various aspects of herbaria, including their definition, types, and significance. Detailed information was provided on the processes involved in creating and maintaining herbaria, with a focus on storage and shelving methods, organization techniques, and procedures for inspecting specimens for damage. The session also highlighted the availability of online access to plant specimen images and associated data. Additionally, the process of developing a virtual herbarium using modern tools was explained, along with a discussion on the advantages and disadvantages of digital herbaria.

The delegates visited the Herbarium of CSIR-CIMAP and learned basic techniques, including specimen collection, taxonomic identification, systematic arrangement, proper storage, and long-term maintenance practices



Standardization of Medicinal Plants and their Derived Product used in Traditional Medicines: With respect to AYUSH medicines

Dr. Karuna Shanker

Dr. Karuna Shanker provided an in-depth overview of CSIR-CIMAP's research expertise in the field of Medicinal and Aromatic Plants (MAPs), highlighting the advanced instrumentation and analytical facilities available at the institute. He discussed the development and health benefits of Dashmularishta, a traditional Ayurvedic nutraceutical formulation designed for women's health management, elaborating on its key ingredients and therapeutic applications.

Considering the critical need for the standardization of medicinal plants, Dr. Karuna Shanker underlined the importance of ensuring batch-to-batch consistency and maintaining key quality parameters. He outlined the structure and essential parameters required for the preparation of herbal monographs. Furthermore, he detailed the current framework for quality evaluation and standardization of ASU (Ayurveda, Siddha, and Unani) crude drugs and described the methodologies developed by CSIR-CIMAP for quality control (QC) and quality assurance (QA) of plant-derived products.

Dr. Karuna Shanker also discussed the evolution and current status of chromatographic fingerprinting techniques, particularly High-Performance Liquid Chromatography (HPLC)-based standardization, and highlighted technical requirements through selected case studies, including the fingerprinting analysis of *Putranjiva roxburghii* Wall.



Essential Oil Chemistry of highly traded Aromatic plants

Dr. Chandan S. Chanotiya

Dr. Chanotiya delivered a comprehensive lecture on essential oils, discussing their current status and industrial relevance. He presented an overview of the mandate aromatic plant species under CSIR-CIMAP's research programs, with a particular focus on the journey of Vetiver and the observed variability in the composition of *Chrysopogon zizanioides* essential oils across different varieties developed by the institute.

He also shared detailed results on the compositional variability of *Pogostemon cablin* (Blanco) Benth and the chemical diversity observed among interspecific *Ocimum* hybrids and different *Ocimum* varieties. Techniques for assessing the authenticity of essential oils were also discussed, highlighting advanced methods currently in use. A key highlight of the session was the discussion on the importance of biobased radiocarbon dating (^{14}C testing) for differentiating natural products from fossil-derived or synthetic chemicals, an emerging necessity in quality control and certification processes.

During the practical session, participants were engaged in hands-on training that included the isolation of essential oils from aromatic herbs, followed by physicochemical analysis. Data collection and analysis were performed using Gas Chromatography (GC) techniques, providing participants with practical insights into the characterization and evaluation of essential oils.



Sustainable use of underutilized lands through cultivation of Medicinal and Aromatic plants

Dr Rajesh K. Verma

A comprehensive field visit was organized for the IORA Trainees. The visit was conducted under the leadership of Dr. Rajesh K. Verma. The delegates were first taken to the Experimental Farm Services, where they visited various demonstration plots showcasing the cultivation of a wide range of medicinal and aromatic plants (MAPs) under actual field conditions. One of the key highlights of the visit was the demonstration of the complete value addition process of distillation waste. Delegates were introduced to innovative strategies for recycling aromatic crop residues, focusing on a zero-waste approach. This included the conversion of waste materials into bio-manure, vermicompost, cutlery making and other valuable by-products.

The visit also featured successful demonstrations of mushroom cultivation and vermicomposting. A live demonstration of biodegradable cutlery production was conducted. These eco-friendly utensils, made from agricultural and aromatic crop residues, highlighted innovative applications of waste material in creating commercially viable, sustainable products. Throughout the visit, Dr. Rajesh K. Verma provided expert insights and technical explanations, field experiences and knowledge exchange.



Strategic Role of Gene Banking in Plant Biodiversity Conservation: Emphasizing MAP Germplasm Preservation and CIMAP's National Gene Bank Contributions

Dr. A. K Gupta and Dr. Gunjan Tiwari

Dr. Gunjan's lecture provided an insightful overview of plant biodiversity and current challenges in Plant Biodiversity Conservation. Emphasizing the importance of preserving genetic resources, she detailed the role of gene banks—particularly seed gene banks—in ensuring the long-term conservation and sustainable use of plant genetic material. She outlined the key steps in Plant Genetic Resource (PGR) management, including germplasm acquisition, processing, viability testing, registration, storage, and regeneration. A significant highlight of the lecture was the discussion on the Gene Bank for Medicinal and Aromatic Plant Species (GEBMAPS) established at CSIR-CIMAP, Lucknow, which serves as a national repository dedicated to conserving India's rich heritage of medicinal and aromatic plants. Through advanced facilities and scientific management, GEBMAPS plays a crucial role in supporting research, promoting sustainable utilization, and contributing to the needs of the AYUSH and pharmaceutical sectors.



Transformative molecular tools for the conservation: harnessing medicinal plant biodiversity for pharmaceutical advancements

Dr. (Mrs.) Sunita Singh Dhawan

Dr. Sunita emphasized the significance of Medicinal and Aromatic Plants (MAPs) as important sources of plant secondary metabolites crucial for human healthcare, highlighting the vast potential of the aroma in therapeutics and nutraceuticals industry. She shared the current global market status of aroma industry and clarified that the global fragrance and flavour industry is valued at \$24.10 billion, with India contributing approximately \$500 million; despite a 10–11% growth rate in recent years.

She discussed in her presentation that the Indian market is expected to expand rapidly due to rising demand for personal care products, increasing disposable income, and brand awareness. The success story of Mint was shared during the session. She discussed ongoing research on differential gene expression in *M. arvensis* to develop abiotic stress-tolerant varieties. Additionally, Dr. Sunita described *Ocimum*, known as the “Queen of Herbs,” for its extensive use in traditional medicine, cosmetics, fragrances, pharmacy, and nutraceuticals, and emphasized advancements in functional genomics and agrotechnology of the CIM-SHISHIR variety of *Ocimum*.





Path of Pre-Clinical Development Process in Medicinal and Aromatic Plants based leads

Dr. D. U Bawankule

Dr. Bawankule provided a comprehensive overview of herbal products, focusing on their regulation, development stages, and relevance in drug discovery. He explained the Drugs and Cosmetics Act, 1940, and supervised by the Ministry of AYUSH and CDSCO, with emphasis on safety, efficacy, and quality. He further elaborated on the importance of cell-based assays in pre-clinical research, detailing assay detection methods for plate-based readouts, such as luminescence and fluorescence, as well as cell culture techniques.

In addition, a visit to the animal laboratory was conducted where participants observed experimental procedures using mice models. The demonstrations included dosing techniques and behavioural analysis to monitor physiological and psychological changes post-treatment. Furthermore, toxicity evaluation experiments were carried out to offer participants a clear overview of safety assessment protocols and their importance in biomedical research.



Plant Tissue culture of Medicinal and Aromatic Plants

Dr. Laiq Ur Rahman

Dr. Laiq delivered an insightful lecture on various aspects of plant tissue culture and genetic transformation, aimed at enhancing participants' theoretical knowledge and technical skills. The session commenced with a detailed protocol for the preparation of MS medium. He elaborated on the instrumentation required in a standard Plant Tissue Culture Laboratory, including laminar airflow cabinets, autoclaves, pH meters, and growth chambers. Dr. Laiq further explained the protocols for in vitro inoculation. A comprehensive overview of Agrobacterium-mediated genetic transformation was also presented, detailing the stepwise process involving bacterial culture preparation, plant tissue co-cultivation, selection of transformants, and regeneration of genetically modified plants.

The lecture was supplemented by simultaneous hands-on laboratory experiments.



Distillation, extraction and value addition technologies for medicinal and aromatic plants

Dr. Sudeep Tandon

Dr. Sudeep Tandon delivered a detailed and engaging lecture focused on the distillation, extraction, and value addition technologies used in processing medicinal and aromatic plants. The session began with an overview of various distillation techniques used for the extraction of essential oils from aromatic plant. The methods discussed included Water and Steam Distillation, Direct Steam Distillation using boiler-operated units, Distillation with Cohobation, Solar Distillation, and advanced Supercritical Fluid Extraction (SCFE) technology.

As part of the hands-on training component, participants engaged in practical demonstrations of rose water extraction, with traditional hydrodistillation methods. The program also included visits to various distillation units at CSIR-CIMAP, where participants observed real-time functioning of different distillation systems. A comparative analysis session was conducted to evaluate and identify the sensory profiles of essential oils extracted from diverse aromatic plant varieties developed by CSIR-CIMAP





Herbal Formulation/Technology

Dr. N. P. Yadav

Dr. N. P. Yadav, delivered an engaging session on herbal product development, focusing on various dosage forms including solid (tablets, capsules), liquid (syrups, decoctions), semi-solid (ointments, gels), and sterile formulations (eye drops, injectables). He explained the significance of each type in terms of administration, stability, and therapeutic application. As part of the hands-on learning experience, participants were guided through the process of preparing Aloe Vera gel directly from the plant—beginning with leaf selection and cleaning, followed by gel extraction, homogenization, addition of stabilizers, and basic packaging.



Visit to CSIR-National Botanical Research Institute, India

As part of the program, a one-day visit was organized to the CSIR–National Botanical Research Institute (NBRI) to provide delegates with exposure to its diverse scientific and conservation facilities. The visit began at the Plant Diversity, Systematics and Herbarium (PDSH) Division, which focuses on the documentation, classification, and preservation of plant and lichen species. The group then visited the NBRI Botanic Garden, where they observed extensive germplasm collections and conservation efforts for rare, endangered, threatened, and ornamental plant species. The visit concluded at the Fragrance Repository, where delegates experienced a diverse range of essential oils stored in the institute's aroma library, providing valuable insights into the preservation of aromatic compounds. In addition, participants had the opportunity to interact with Director of the institute- Dr. Ajit K. Shasany.



Visit to Regional Fruit, Vegetable & Flower Exhibition at the Governor House, Lucknow

A one-day visit was organized to the Regional Fruit, Vegetable & Flower Exhibition held at the Governor House, Lucknow, offering delegates an informative experience. The exhibition showcased a variety of fruits, vegetables, and ornamental flowers, with a special importance on the rich diversity of regional produce. Participants had the opportunity to observe unique and locally cultivated varieties, including indigenous species.

Dr. Ramesh Srivastava demonstrated the various technologies displayed in the stalls set up by the various entrepreneurs.

In addition, participants had the opportunity to interact with Anandiben Patel, the Hon'ble Governor of Uttar Pradesh, which added great value to the visit.





Delegates with Anandiben Patel, the Hon'ble Governor of Uttar Pradesh (INDIA)

Valedictory Session and Certificate Distribution Ceremony

The closing ceremony of the training program was graced by the presence of Dr. A.S. Negi, Chief Scientist at CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP). In his address, Dr. Negi expressed his sincere appreciation to all the participants for their enthusiastic and active involvement throughout the course. He commended their dedication, keenness, and commitment, which contributed significantly to the success of the training program.

Dr. Jitendra, ICCMP, India extended his heartfelt congratulations to the participants on the successful completion of the course and acknowledged the efforts they made to absorb and engage with the diverse range of topics covered.

The Vote of Thanks was delivered by Dr. Deepa Bisht, ICCMP, India. Dr. Bisht encouraged the participants to remain connected with CSIR-CIMAP and continue collaborative efforts in the field of medicinal and aromatic plants, thereby strengthening international cooperation and capacity building.

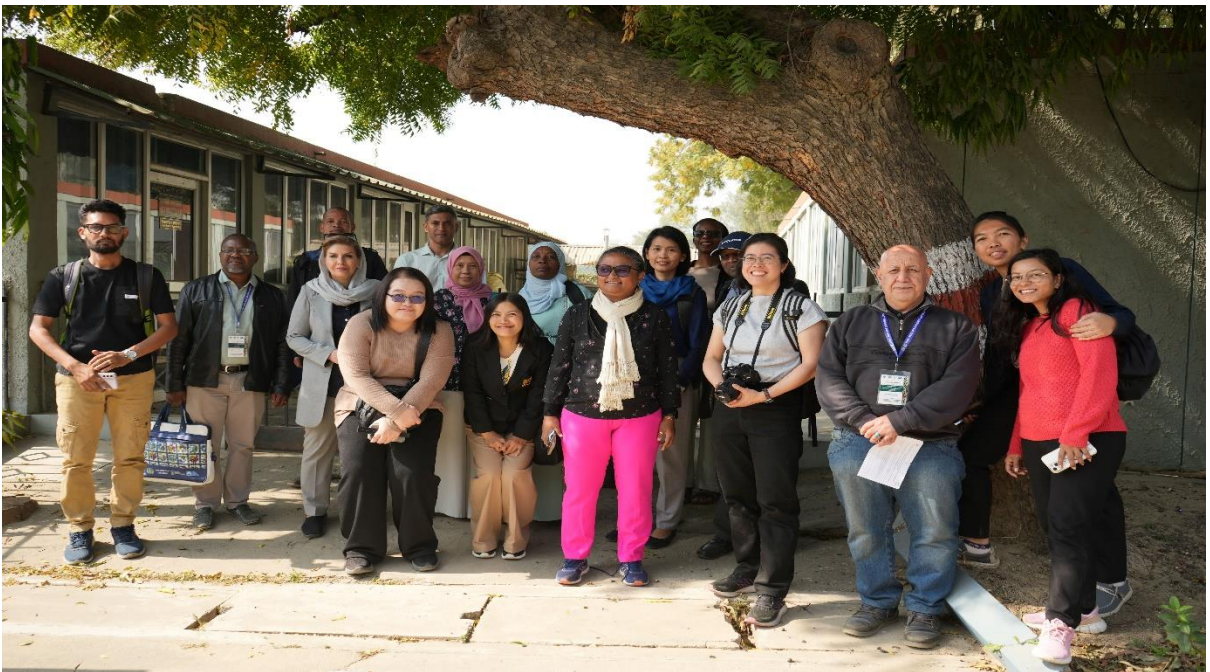




Glimpses of the Training in Action













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