

ICAR-DMAPR's classical journey in medicinal and aromatic plant research and advancement

Medicinal and aromatic plants (MAP) have occupied an important position in the socio-cultural, spiritual and medicinal arena of rural and tribal lives of India. They have contributed immensely by producing diverse range of plant based intermediary compounds and value-added downstream end products used in several applications; drug formulation, food flavouring, perfumery, culinary, toiletry, health products, food supplements, cosmetics, incense and other anthropogenic applications and animal care products. MAP are in use since time immemorial with the recognition that smelling, chewing, and/or eating of some plant materials could provide relief from nausea, pain, and/or other infirmities. With the advancement of knowledge led by scientific innovations, the MAP are gradually gaining importance.

An old and strong base of medicinal plants

It is estimated that about 70,000 plant species starting from lichens to flowering trees have been used at one time or another for medicinal purposes. In India, medicinal plants have made a good contribution in the development of ancient Indian *Materia Medica*. One of the earliest treatises on Indian medicine, the *Charak Samhita* (1000 B.C.), records the use of over 340 drugs of plant origin. There is now an urgent need to mainstream medicinal plants to provide primary health care on a sustainable basis to the poorest of the poor. Most of the medicinal and aromatic plants are either collected from the wild or are harvested from introduced non-descript land races. Attention now must be given for breeding of superior quality and high-yielding varieties. Specificities of genotype environment interactions for obtaining optimal quality content of commercially important constituents also need to be focused. Attention must be paid to know the best time and stage of harvesting. There is also a need to use modern tools of experimentation to select, multiply and conserve the genotypes. Research efforts must be strengthened for understanding biosynthetic pathways of secondary metabolites.

Need of the hour

In view of this changing scenario and in the light of urgency of meeting both domestic as well as export demands, there is a need to improve cultivars, ecotypes, chemo-types, cultivation practices and post-harvest technology so as to make research in medicinal and aromatic plants economically viable and socially acceptable. In this endeavour, the then National Research Centre for Medicinal and Aromatic Plants (NRCMAP) took several steps to conduct research in all the above-mentioned aspects. In this effort, its outreach programme

on All India Networking Research Project on Medicinal and Aromatic Plants and Betelvine also shared its infrastructure and manpower towards the same goal. NRCMAP was established in 1992 to carry out research on medicinal and aromatic plants.

Genesis

The Indian Council of Agricultural Research (ICAR), New Delhi established National Research Centre for Medicinal and Aromatic Plants (NRCMAP) in 1992 on a 20.2 ha irrigated land at Boriavi, Anand, Gujarat with a well-defined mandate to work on medicinal and aromatic crops. The NRCMAP has been rechristened as the Directorate of Medicinal and Aromatic Plants Research (ICAR-DMAPR) in 2009. The Directorate has another farm campus at Lambhvel, Anand with 19.18 ha of land, of which 4 ha is for residential complex. In about 2 ha land, an herbal garden with about 220 species of medicinal and aromatic plants and in about 6 ha, an Arboretum with about 110 species of medicinal trees/herbs are being maintained.



Bird eye view of ICAR-DMAPR premise



Herbal garden at ICAR-DMAPR

Vision

Provide 'Medicinal and aromatic plants for health and wellbeing of all' to ever-increasing world population through ensuring quality raw drug production and supply.

Mission

To contribute for sustainable production of quality medicinal and aromatic plants (MAPs) through development of new varieties, good agricultural practices, quality assessment methodologies and standard products using frontier cutting age technologies such as IT and Biotechnology.

Mandate and Mandate crops

- Basic, strategic and applied research on genetic resource management, crop improvement and enhancing productivity of medicinal and aromatic plants through good agricultural practices and organic farming technologies.
- Identification, purification and synthesis of active biomolecules of medicinal and aromatic plants.
- Transfer of technology, capacity building and impact assessment of technologies.
- Coordinate research and validation of technologies through AICRP on Medicinal and Aromatic Plants.

ICAR-AICRP on Medicinal and Aromatic Plants and Betelvine

- The ICAR-All India Coordinated Research Project on Medicinal and Aromatic Plants and Betelvine (AICRP-MAPB) made its beginning in the Fourth Five Year Plan (1967-72).
- The headquarters of the project is located at ICAR-DMAPR, Anand. The Director of DMAPR is the Project Coordinator of ICAR-AICRP-MAPB.
- AICRP on MAP and Betelvine has now 23 centres which are coordinated from the ICAR-DMAPR, Anand. Recently, three voluntary centres viz., Agricultural University (AU), Jodhpur; Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Kashmir; and Banda University of Agriculture and Technology (BUAT), Banda have joined.

Facilities

- Directorate has the privilege of having sophisticated

Mandate Crops



equipments viz. GLC, HPL, HPTLC, Poly Ploidy Analyzer, LC-MS, GC-MS, Supercritical Fluid Extractor, FTIR spectra photometer, Atomic Absorption Spectrophotometer, UPLC, Inverted Microscope etc.

- Directorate houses laboratories like horticulture, soil science, plant biotechnology, organic chemistry, plant physiology, plant pathology and entomology and post harvest technology with all required sophisticated equipments.
- ICAR-DMAPR has seminar hall and conference hall with seating capacity of 100 and 25, respectively.
- Guest House of DMAPR is located at Anand comprising 2 VIP suites, 8 air-conditioned double

Centres of AICRP on Medicinal & Aromatic Plants and Betelvine

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|--------------------------------|-----------------------|
| 1. AAU, Anand | 14. NDUAT, Ayodhya |
| 2. DYSRHU, Venkataramannagudem | 15. OUAT, Bhubaneswar |
| 3. AAU, Jorhat | 16. PDKV, Akola |
| 4. BCKY, Kalyani | 17. BAU, Islampur |
| 5. BAU, Ranchi | 18. DRPCA, Pusa |
| 6. CCSHAU, Hisar | 19. RVSKVV, Mandsaur |
| 7. UHF, Bharsar | 20. TNAU, Coimbatore |
| 8. IGKV, Raipur | 21. UBKV, Kalimpong |
| 9. IHR, Bengaluru | 22. YSPHF, Solan |
| 10. JNKVV, Jabalpur | 23. CAU, Pasighat |
| 11. KAU, Thrissur | 24. AU, Jodhpur |
| 12. MPUAT, Udaipur | 25. BUAT, Banda |
| 13. MPKV, Rahuri | 26. SKUAST, Kashmir |

- ICAR-DMAPR, Anand (Headquarters)

bedrooms, one air-conditioned dormitory with nine beds, a non-AC Driver's room, a well-equipped dining hall and a kitchen.

- Directorate has a well-established library with international and national journals, books and proceedings.

Services

- Consultancy on production of quality medicinal and aromatic plants, technologies/ processes for extraction of bioactive principles, innovative formulations of different bioactive natural products and other aspects related to MAPs.
- Contract services such as testing of chemicals/ products, soil test, plant analysis etc.
- Providing quality planting materials of medicinal and aromatic plants.

Model nursery

- ICAR-DMAPR has hi-tech nursery with automated temperature, ventilation, light and water facilities available for mass multiplication of medicinal and aromatic plants.
- Standardized the propagation technology such as tissue culture, grafting, cutting and through seed for Medicinal and Aromatic plants.



Hi-tech nursery

Lab-to-Land

- Conducting training /workshop programme for farmers, students and other stakeholders on need and demand basis on various aspects of MAPs.
- Promoting cultivation of medicinal and aromatic plants through field demonstration and awareness programme.

Professional society

- Medicinal and Aromatic Plants Association of India (MAPAI) has headquarters at ICAR-DMAPR, Anand. The Director, ICAR-DMAPR is the President of MAPAI. MAPAI conducts seminars/conferences in emerging areas of MAPs. It also publishes an Open Access Journal of Medicinal and Aromatic Plants (OAJMAP).

Varieties Developed by the ICAR-DMAPR

ICAR-DMAPR, Anand has recently developed

high-yielding varieties in important medicinal plants like ashwagandha, isabgol and kalmegh.

Ashwgandha (*Withania somnifera* L. Dunal)

Vallabh Ashwagandha-1: High dry root yield of 589.4 kg/ha with orange-coloured berries suitable for cultivation in Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh and Haryana.



Vallabh Ashwagandha-1

Isabgol (*Plantago ovata*)

Vallabh Isabgol-1: High yielding medium duration (120-125 days) variety. The mean seed yield of Vallabh Isabgol-1 is 10.3 q/ha as compared to 8.3 q/ha of GI-2. Suitable for cultivation in all Isabgol growing areas.



Vallabh Isabgol-2: An early maturing variety (100 days) with higher seed yield of 1104.47 kg/ha (higher yield by 9.94% than check) and moderately resistant to Downey mildew. Suitable for cultivation in all Isabgol growing areas.



Kalmegh (*Andrographis paniculata* (Burm.f.) Nees)

Vallabh Kalmegh-1: Gives herbage yield of 45-50 q/ha (10% more than check) with Andrographolide content of 92 kg/ha (24% more than check). Suitable for growing in Gujarat, Rajasthan, Maharashtra, Madhya Pradesh, Uttar Pradesh, Haryana, Kerala and West Bengal.



Mandukaparni (*Centela asiatica*)

Vallabh Medha: It is bigger in size in respect to all the morphological characters and leaf area is more than 4.5 times higher than the local cultivar. Fresh herbage and dry herbage yields harvested are 12331 and 2113 kg/ha, respectively as compared to 2050 and 392 kg/ha in local variety. Active ingredients (asiaticoside, madecassic acid and asiatic acid) are also present in higher quantity.



Other Achievements

- Developed 42 varieties of medicinal crops and 8 varieties of aromatic crops. Directorate has also introduced many exotic species of MAP for cultivation.
- Field gene bank of ICAR-DMAPR, Anand maintains 2313 accessions of 15 important MAP species and 5060 accessions of 54 medicinal and aromatic plants (including betelvine) at different AICRP-MAPB centers (26).
- The Directorate has registered 35 unique germplasm of 9 species with National Bureau of Plant Genetic Resources, New Delhi.



- The ICAR-DMAPR has established a Medicinal Plant Botanical Garden in 21 ha which maintains 110 tree species, 64 shrub species, 350 herb species and 50 climber species of different Medicinal and Aromatic plants collected from various parts of India.
- ICAR-DMAPR developed a website (<http://www.herbalgardenindia.org>) which serves as an advisory website for the end users to get the information on different Medicinal and Aromatic Plant species. A total of 750 records of herb species, 350 records of tree species, 275 records of shrub species and 125 records of climber species are uploaded in the database.
- DUS descriptors in Kalmegh (*Andrographis paniculata*) and Isabgol (*Plantago ovata*) have been developed and notified by PPVFRA, New Delhi.
- Directorate has filed 14 patents on different aspect of methods and products of Medicinal plants and one got approved.
- ICAR-DMAPR has developed Good Agricultural Practices (GAP) in 31 medicinal crops for higher productivity.
- A good agricultural and collection practices (GACP) training toolkit for medicinal plants have been developed in collaboration with Food and Agriculture Organization (FAO).
- Technology on production of biochar from distillation waste of aromatic plants has been developed.
- Technology for preparation of enriched compost from Isabgol straw and low-graded rock phosphate has been developed.
- A modified Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) GC-MS based method was standardized for the detection of 11 multi-class pesticides in Ashwagandha, Isabgol, Senna and Kalmegh.
- Process for preparation of withanolide enriched extracts from roots of Ashwagandha was standardized.
- Innovative technology for removing coloured impurities from water by utilizing aromatic plant waste has been developed.

- Process developed for microencapsulation of extracts of *Andrographis paniculata* (King of bitters) and *Cassia angustifolia*.
- Process developed for anthocyanin rich microencapsulated product from *Garcinia indica* fruit juice.
- Developed improved protocol to obtain callus in endangered plant guggal (*Commiphora wightii*).
- A low-cost organic growing media was prepared from waste biomass and low-grade mineral powder for kalmegh seedling production.
- Process for isolation of high value molecules namely-mangostin and xanthochymol was developed.
- Two phytoformulations F5 and F10 developed for control of acaricide resistant ticks were found effective in experimentally challenged and naturally highly infested animals.

Technologies developed

Protocols developed for seed standards and seed testing in medicinal plants: Protocol for minimum seed standards and seed testing of 25 medicinal plants has been developed and notified for undertaking detailed studies on germination ecology and studies on seed development and maturation.



Tulsi cultivation as a trap crop for male fruit fly management and livelihood security

- Tulsi (*Ocimum sanctum* L.) comprises methyl eugenol as major constituent that acts as a pheromone precursor which is attractive to male fruit flies and is used in insect traps to attract certain species of fruit flies.
- Being a rich source of methyl eugenol (82.81%), tulsi can be introduced in fruits (mango and guava) and vegetables (cucurbits) orchard as an intercrop to act as a trap crop for male fruit fly.
- Tulsi can be successfully integrated into existing farming systems (as an intercrop) as one of the viable options for enhancing income (₹ 41000/ha) of poor farmers and suitable trap crop for fruit fly management.

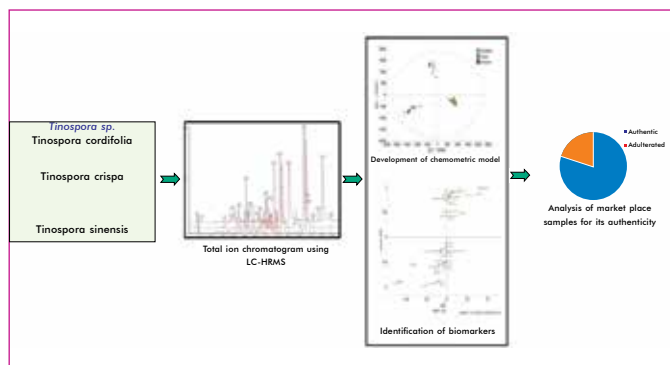
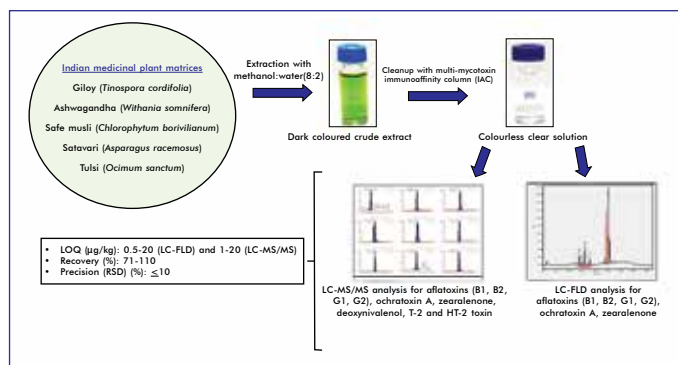
Shatavari: A suitable option for intercrop in perennial orchards to harness root yield and shatavarin IV content

- The plants were grown under different green shade net intensity (SNI) (0, 25, 50, 75 and 90%) and harvested at three different times (6, 12 and 18 months of transplanting). The maximum number of stems/plants, stem weight, root length, root diameter, fresh root weight and dry root weight were observed under 0% SNI followed by 25% SNI.
- Shatavarin IV content was maximum (8.53 µg/g) in plants under 25% SNI. This study indicates that shatavari could be cultivated as an intercrop (25% SNI) for fetching higher shatavarin IV content without causing significant root yield loss.



Method for multi-mycotoxin analysis in Indian medicinal herbs

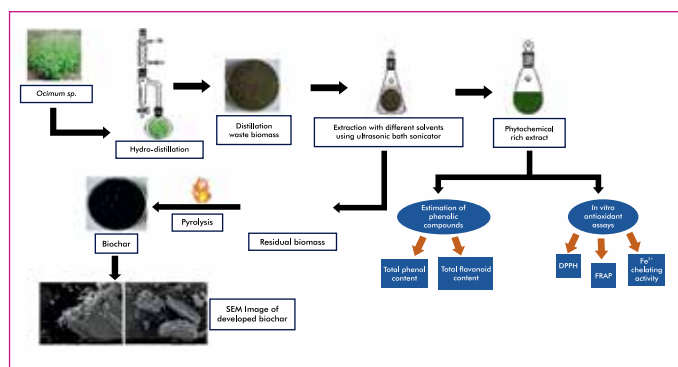
- This study reports a method to estimate nine regulated mycotoxins in Indian medicinal plants including giloy (*Tinospora cordifolia*), ashwagandha (*Withania somnifera*), safed musli (*Chlorophytum borivilianum*), satavari (*Asparagus racemosus*) and tulsi (*Ocimum sanctum*).
- The method was initially developed and validated using liquid chromatography tandem mass spectrometry (LC-MS/MS) for the simultaneous analysis of aflatoxins (B1, B2, G1, G2), ochratoxin A, zearalenone, deoxynivalenol, T-2 and HT-2 toxin. Later, it was validated using LC-fluorescence (LC-FLD) for aflatoxins, ochratoxin A and zearalenone.



- Compared to LC-FLD, it was possible to attain a lower limit of quantification (LOQ) with LC-MS/MS for all the tested analytes except aflatoxins. However, the recoveries of targeted analytes were ranging between 71-110% with precision (RSD) of ≤10% across the matrices tested.

Process for utilization of distillation waste biomass of *Ocimum* sp. as source for phenolics/antioxidants as well as feedstock for biochar

- Distillation by-products (distillation waste biomass and deodorized water) of two *Ocimum* sp. were explored for their versatile applications.
- After extraction of bioactive compounds, the exhausted biomasses were further utilized for development of biochar.
- The porous surface morphology of biochar indicated the high surface area of biochar that provide support to soil microbiota and reduce the nutrient loss from soil, acting as potential soil amendment.

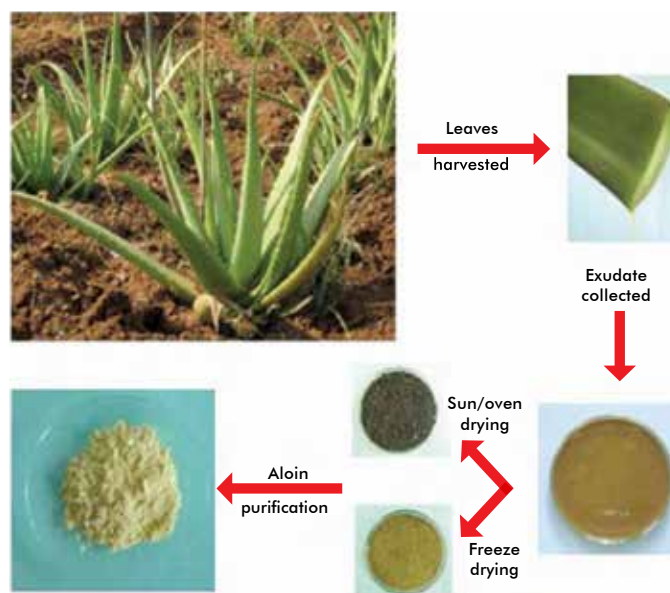


Process for authentication of *Tinospora cordifolia* based herbal supplements using high resolution mass spectrometry-based metabolomics approach

- This technology is based on a process about discriminating *Tinospora cordifolia* from two other closely related species (*T. crispa* and *T. sinensis*) employing high resolution mass spectrometry (HRMS)-based metabolomics and chemometrics approach.
- In total, 7 biomarkers were identified which discriminated *Tinospora cordifolia* from the two other species.
- The label claim of 25 commercial *Tinospora* samples collected from different parts of India was verified based on the relative abundance of the biomarker compounds, of which 20 were found authentic.

Patents granted

A novel method for aloin extraction from *Aloe borbadense* (Patent No. 277501): A novel process for preparation of pure aloin from aloe (*Aloe borbadensis*) through extraction and purification. The method is quicker, efficient (recovery up to 90%) and cost-effective with aloin purity of more than 90–95%.



Value added products developed

Powders (Churna) from Ashwagandha, Tulsi, Kalmegh, Arjun, Arduša: Powders (Churna) were prepared from organically grown medicinal crops,





Cookies (3% husk)



Cake (3% husk)



Brownie (2.5% husk; 15% Ragi; no added sugar)



Crackers (5% husk)



Biscuits (2.5% husk)

properly processed and packaged. All powders can be used as immune booster as directed by the physician.

Innovative food with Isabgol husk: Innovative food items were manufactured with Isabgol husk like cookies, cake, brownie, crackers, biscuits, muffins and bread. These products are gluten free made with natural sugar having high fibre and no food additive, eggless.

Establishment of Medi-Hub, Technology Business Incubator

Medi-Hub Technology Business Incubator (Medi-Hub, TBI) is an Agri-Business Incubator in the field of medicinal and aromatic plants established at ICAR-DMAPR, Anand funded by ICAR. The services provided by Medi-Hub, TBI includes technology consultation, business consultation, mentoring and networking, infra facilities, access to funding and knowledge sharing to foster business development. So far 30 incubatees having novel business idea in medicinal and aromatic plants have been supported under Medi-Hub. A total of 41 trainings were organized during last three years.

SUMMARY

The MAP sector is facing several challenges. Since, diversity of bioactive chemicals in MAP is vast and remains untapped for its potential use as human, animal and plant health products, there is a need to accelerate efforts for conservation of species and habitats, and development of technologies from production to finished products for sustainable supply of quality raw drugs. Current and upcoming improved research capabilities undertaken by ICAR-DMAPR provide unique opportunities for enhancing and fostering new uses of plants for human health. The seamless merging of exploratory and translational research with advances in genomics, bioinformatics, combinatorial chemistry, smart and targeted delivery systems, and innovative formulations will accelerate the pipeline for new plants resilient to climate change and drugs produced from it for human health and well-being. The Directorate is committed to move from galenical to genomics era with the advancement in agricultural and basic sciences. Traditional knowledge supplemented with innovation and product development under GAP, GLP, GMP and QA/QC will be the core principles of the Directorate in achieving the delivery of highest quality botanical products to the consumers. In this sector, involvement of private organizations is negligible and the stakeholders are mainly looking forward to the ICAR-SAU system for the technology generation to fulfill their aspiration. The ICAR-DMAPR will develop strategies in a participatory mode with the industries and other organizations by introducing a culture of responsibility, accountability and integrity to respond to the demand of every stakeholder and uplifting the status through MAP sector.

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Profitable Nursery through “Mini-Shade Net”

Shri M. Sankara Rao is a marginal farmer, belonging to a remote village of Naiduvalasa of Rambadrapuram Mandal of Vizianagaram district in Andhra Pradesh. He is an ex-trainee of KVK, Vizianagaram. Having gained knowledge and skill in nursery, he established nursery unit with “mini-shade net” under the technical guidance of KVK faculty. He raised seedlings of different vegetables and papaya under *mini-shade net* (60 sq m) and produced high quality virus-free papaya seedlings (2,500) and vegetables seedlings, viz. Tomato (5,000), Brinjal (5,000), Chilli (5,000) during May 2021 to October 2021, with which, he received a net income of ₹ 25,700. Farmers from the neighbouring villages got attracted with the benefits gained by protected shade-net nursery production; and accordingly, approached KVK, Vizianagaram for further guidance to adopt the technology.



A view of nursery unit of Shri M. Sankara Rao with mini-shade net

Source: ICAR Annual Report 2022-23