DIRECTORATE OF MEDICINAL AND AROMATIC PLANTS RESEARCH

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NEWSLETTER

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About the Newsletter

The Directorate of Medicinal and Aromatic Plants Research (DMAPR) is one of the institutes of the Indian Council of Agricultural Research (ICAR). DMAPR's mission is to conduct research on all aspects of improvement, production and utilization of medicinal and aromatic crops. It also supports and is engaged in activities of multilocational testing of technologies through its out reach organ, All India Co-ordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRPMAP&B).

AICRPMAP&B works in partnership with State Agricultural Universities and other organisations; undertakes research, multilocation testing of technologies and training; provides scientific information and technical advice to a host of clients such as farmers, industries, etc.

This newsletter is published half yearly to promote overall concern on medicinal and aromatic plants with emphasis on their conservation and production technology. It provides information, mainly generated in DMAPR and AICRPMAP&B.

Contents

IXth Research Advisory Committee (RAC) Meeting Held

Ninth Research Advisory Committee meeting was held on April 19, 2011 at DMAPR, Anand under the chairmanship of Dr. B. R. Tyagi, Retd. Deputy Director, CIMAP, Lucknow. Other members participated in the meeting were : Dr. R.C. Srivastava, Joint Director, Botanical Survey of India, Kolkata; Dr. G.S.R. Murti, Retd. Head, Division of Plant Physiology and Biochemistry, IIHR, Bangalore; Dr. Y.B. Tripathi, Head, Department of Medicinal Chemistry, Institute of Medical Sciences, BHU, Varanasi; Dr. Umesh Srivastava, ADG (Hort. II), ICAR, New Delhi; Dr. Satyabrata Maiti, Director, DMAPR and Dr. Vandana Joshi, Principal Scientist (Eco. Botany) as Member Secretary, RAC. The meeting started with a welcome note proposed by Dr. Vandana Joshi. The Chairman initiated proceedings with introductory remarks of RAC members. Dr. Y. B. Tripathi highlighted the importance of research in the field of herbal products and also the importance of computer applications in planning the medicinal plants research. Dr. Umesh Srivastava underlined the importance of *in situ* conservation of medicinal plants and also supply of the quality seed/ planting materials to the farmers. Dr. G.S.R. Murti, mentioned about the importance of prioritization of research in medicinal and aromatic plants (MAP) since priorities are changing over the time due to shifting of emphasis on health care needs of people. He also pointed out the need of organic farming and marketing problems faced by the MAP growers. The importance of taxonomy in authentication of medicinal plants was highlighted by Dr. R.C. Srivastava. Further,

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EDITORIAL

At the dawn of a new five year plan

We are once again at the dawn of a new five year plan i.e. 12th Five year plan. Last plan is phasing out and new plan is setting in. At this crack of dawn it is the time to look back and assess, what we could achieve and which unfinished task we have to carry forward along with new goals to target in the new plan. I get mixed feelings of sweet and sour at this juncture. Sweet feelings for whatever we could achieve and contribute collectively in spite of the odds that we had to face in the manpower sector at the directorate. Three well trained scientists have left the directorate either on promotion or for their home state placement. Our notable achievements are: released one variety of Manduka parni (Centella asiatica) named as "Vallabh Medha" from the directorate; one variety each of Aswagandha (RVA-100), Safed musli (RVSM -414), Senna (AS-1) and Betelvine (Swarna Kapoori) from the AICRP centers ; filed 2 patents; registered seven new elite germplasm; identified molecular markers linked to sex determination in guggal, developed DUS descriptor for isabgol for notification, developed Good Agricultural Practices for five species, enhanced germplasm of MAP; developed GACP training tool kit in collaboration with FAO; developed a web based network on herbal gardens in India and hosted at www.herbalgardenindia.org; initiated Guggal networking project with four centers, etc. We have played a key role in developing a strategic road map for developing the medicinal and aromatic plants sectors in Bhutan with the help of FAO, India.

Let's now talk about my sour feelings during the last plan. In spite of our best efforts and best efforts of the council we were forced to continue to deliver with more than 30% deficit of staff. We have to make our planners understand that robot and software can increase the efficiency but they can not be considered as replacement of scientific manpower. We are expanding in many areas without manpower, as a result we are trailing in delivery. We must give up now, counting our achievements by number of new projects initiated; rather it should be on the basis of how much we have delivered. Country as a whole needs an objective view about the functional efficiency of the research institutes. Moreover, I feel there are number of research organizations, such as: DST, DBT, ICAR, ICMR, CSIR, ICFR, General Universities, SAUs, NGOs, IITs, etc, are putting their efforts in R& D of MAP and many a time efforts are overlapping. This can be avoided, if each organization shares their data bases as well as their expertise while framing up new projects. It would be wonderful, if we all work in a complementary mode for sharing each value chain to the organizations having their core competence. We are all suffering from the syndrome "we can do every thing". We have not learnt to build with each others competence. I am sure that planning commission will take note of these concerns and try to fill up the gap in the 12th plan to make this sector internationally competitive in all respect.

Jai Hind!

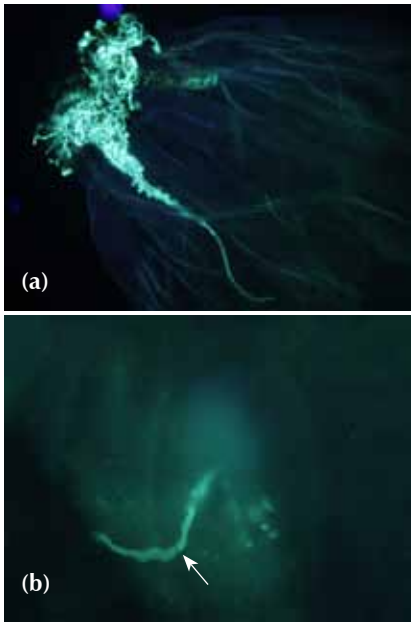
Satyabrata Maiti

...Continued from page 1

he emphasized the need for documentation of traditional knowledge available on MAP, use of tools like bar coding to ratify the problems with classical taxonomy and establishment of the authenticity of medicinal products in context of adulteration using DNA markers. Thereafter, the Chairman highlighted the importance of meticulous literature review before planning any research proposal. He also emphasized that the orientation of research should be based on stakeholders' needs. An interaction meeting of research scientists and various stakeholders for planning, prioritization and execution of research activities was suggested by him. After the appraisal of the action taken on recommendations made during the last RAC meeting by the Member Secretary. Dr. Satyabrata Maiti presented an overview of the directorate. Thereafter, research findings in germplasm collection, characterization, maintenance, breeding, biotechnology, crop production, crop protection, phytochemistry and computer application were presented before the RAC by Drs. P. Manivel , Principal Scientist (Plant Breeding) and Vipin Chaudhary, Senior Scientist (Entomology). Dr. Y.B. Tripathi delivered a lecture on the topic "Polyherbal formulation for diabetic complications: leads for collaborative research". An interaction among scientists, Chairman and the Members on refinement of ongoing research activities was also held leading to drawing the recommendation for the next year. The meeting ended with the vote of thanks proposed by Dr. P. Manivel.

Sexual plant type identified in Guggal

Guggal *(Commiphora wightii)* is an endangered medicinal plant species naturally distributed in the arid zones of Rajasthan and Gujarat. Oleo-gum resins secreted from this plant is used in a number of Ayurvedic preparations. E and Z-gugglusterone are the main bioactive ingredients of oleo-gum resins. Modern medicines have also recognised the efficacy of Guggal oleo-gum resins for curative purposes. This species is characterized by the occurrence of apomixis, polyembryony, autonomous endosperm and includes male, female and hermaphrodites plant types. However, no evidences of sexuality have been detected so far. An attempt was made to detect the sexual type of plant at DMAPR. The detailed surveys of natural populations and their characterization, led to identification of sexual plant types from one of the accessions. The sexuality of the putative sexual accession was also established. Controlled pollination experiments showed fruit settings in pollinated plant type. Histological studies of the developing seeds of the identified accession showed origin of embryo from the egg cell. Flow cytometry data also confirmed the development of endosperm by triple fusion. RAPD analysis of the seedlings from the accession showed variability among them and also differed from the mother plant. Identification of sexual plant type would help for the creation of variability and scopes for further improvement of Guggal.



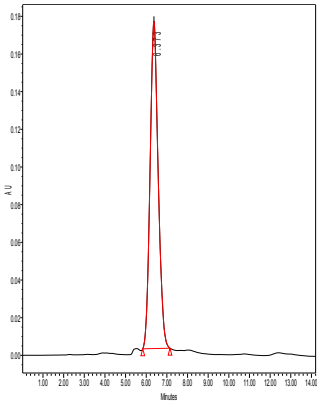
Pistils showing heavy pollen germination (a) and pollen tube entry in the sexual plant type in Guggal.

TLC profiling of five *Swertia* species

The plant materials of five *Swertia* species namely, *S. chirayita, S. cordata, S. alata, S. purpurascens and S. angustifolia* were sequentially extracted with petroleum ether, chloroform and methanol. Comparative TLC profiles of the three extracts of the five species were investigated at YSPUHF, Solan. TLC profile of petroleum ether and chloroform extracts of all the five species had a number of spots, however, two distinct spots of amarogentin and amaroswerin were present only in methanol extract of *swertia chirayita*. Red coloured spots of amarogentin and amaroswerin were observed after spraying the TLC plates with fast red B salt solution.

A rapid HPLC method for identification and quantification of swertiamarin

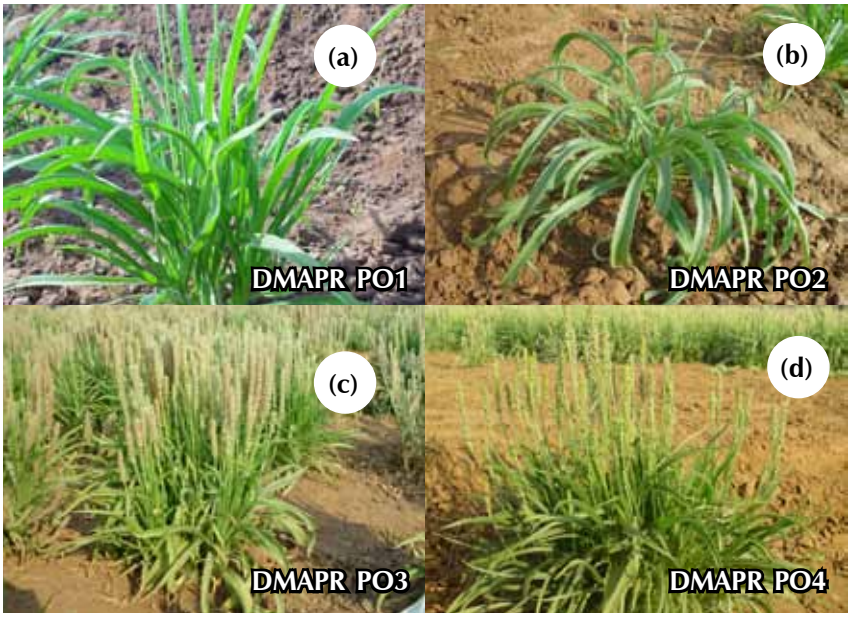
Swertiamarin, a major bioactive compound isolated and described from *Swertia* species was also identified to be present in *Enicostemma axillaris* at DMAPR. A rapid HPLC method with limit of detection (LOD) 4 μg/ml and limit of quantification (LOQ) 6 μg/ml has been developed and validated for identification and quantification of swertiamarin in different extracts.



HPLC chromatogram of swertiamarin

DUS plant descriptor of Isabgol developed

Characters were identified which would be used for DUS testing of varieties under the Protection of Plant Varieties and Farmers' Right Authority (PPVFRA) at DMAPR. DUS characters identified were plant growth habit, leaf breadth, leaf colour, leaf pubescence, spike arrangement in the plant, arrangement of flowers on spike, type of peduncle, peduncle axis and an other type. For all these characters lines developed at DMAPR would be used as reference varieties. Reference varieties for plant type: erect (DMAPR PO1) and spreading (DMAPR PO2); leaf breadth: narrow (DMAPR PO5), medium (DMAPR PO1, DMAPR PO2, DMAPRP O3) and broad (DMAPR PO9); under leaf colour types: whitish green (DMAPR PO 8), yellowish green (DMAPR PO5) and green (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO6, DMAPR PO7); leaf pubescence: sparse (DMAPR PO5), medium (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO6, DMAPR PO7 and dense (DMAPR



DUS characters of isabgol plant types: erect (a) prostrate (b); inflorescence arrangement: compact (c) spreading (d)

DUS characters of inflorescence type of isabgol

PO8); spike arrangement: compact (DMAPR PO3) and spreading (DMAPR PO4); inflorescence peduncle: branched (DMAPR PO6) and unbranched (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO5), axis of the inflorescence: completely filled (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPR PO5, DMAPR PO6) and partially filled (DMAPR PO7); flowers on the spike: completely compressed on the axis (DMAPR PO1,DMAPR PO2, DMAPR PO3, DMAPR PO4) or protruded (DMAPR PO5, DMAPR PO11), anthers: normally filled (DMAPR PO1, DMAPR PO2, DMAPR PO3, DMAPR PO4, DMAPRP O6, DMAPR PO7, DMAPR PO8, DMAPR PO9) and shrivelled (DMAPR PO10).

Vegetative propagation of Asoka by air layering

Asoka [*Saraca asoca* (Roxb.)] belongs to *Caesalpinaceae*, is a small evergreen tree. Barks of Asoka contain tannins, glycosides, alkaloids (leucopelargonidin and leucocyanidin) and is used in many ayurvedic preparations. Due to overexploitation of the species, it has been described as vulnerable by the IUCN. Propagation by true seed in rainy season is the conventional method; however, to maintain genetic purity, an efficient clonal propagation method is needed. Among the vegetative propagation methods air layering was found to be the best method. Vegetative propagation technique of air layering has been successfully standardized at KAU, Thrissur. Among the media for air layering, coir pith (90%) was found to be most efficient followed by moss (80%) and potting mixture (20%). The transplanted air layers performed better than its seedlings in terms of growth rate and vigour.

Air layering in Asoka

Air layered transplanted plant in Asoka

From the Directorate

Institute Research Committee (IRC) meeting held

The 20th Institute Research Committee Meeting was held as a follow up action of RAC under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR, Anand during April 20-21, 2011. Dr. B.R. Tyagi, Chairman, RAC, DMAPR was also present as a special invitee on the first day of the meeting to discuss the new research project proposals submitted by newly joined scientists. Dr. P. Manivel, Principal Scientist (Plant Breeding) and Secretary, IRC, welcomed the Chairman and members of IRC. Drs. Smitha, G.R. and N.A. Gajbhiye were congratulated for getting the Ph. D. degree during last year. Dr. Manivel also reminded the house about the points suggested by Hon'ble DG, ICAR during his visit to the directorate last year. Dr. Satyabrata Maiti, in his introductory remarks, welcomed Dr. B. R. Tyagi for the meeting and emphasized that the new projects should be prepared only after the thorough literature search for analyzing the existing gaps in our knowledge. Further, he also mentioned that importance of healthy criticism in research activities and need of being cautious in publicity. Dr. B. R. Tyagi, advised the scientists for multidisciplinary research and suggested writing a review article on the selected topic before proposing a new research proposal. Thereafter, the action taken report of the last IRC recommendations was presented by Member Secretary. New project proposals were presented by the newly joined scientists. After detailed discussions of the projects, some modifications were suggested in new research proposals. The progress of research covering the different aspects of medicinal and aromatic plants such as germplasm characterization, plant breeding, crop production, crop physiology, crop protection, quality management and information technology during 2010-11 was presented by the individual Scientists. The findings of research projects and targets to be accomplished during next year were also thoroughly discussed. At the end, the Member Secretary proposed vote of thanks to the Chairman and members.

IPR awareness and business planning training organised

Zonal Technology Management - Business Planning and Development for Western Zone, CIFE, Mumbai organised one day training programme for IPR awareness and business planning at DMAPR on January 06, 2011. In the training programme, scientific personnel and research fellows of the directorate participated. Details of IPR related aspects, their protection and planning for developing business were discussed with the participants.

DMAPR team participated in ICAR western zonal sports meet at Jhansi

In ICAR Zonal Sports meet (Western Zone) held at Jhansi during February 15-19, 2011, a nine member team of DMAPR led by Dr. Smitha, G. R. Scientist (Horticulture) as Chief-de-mission participated. She won eight medals including six gold and two silver medals. Further to her credit, she was also adjudged the Best Athlete (Women) of the tournament and "Best sports person of the tournament" for overall performance in the tournament. After return, the team members were felicitated at the directorate.

A delegation of royal government of Bhutan visited DMAPR

A six member high level team of Royal Government of Bhutan visited DMAPR on March 12, 2011.The delegation team comprised of Mr Ugyen Dorji, Commodity Coordinator, Horticulture Division, Department of Agriculture; Mr Tshitila, MAP Specialist, RNRRDC Yusipang; Mr Lakey, Sr. Horticulture Officer, Horticulture Division, Department of Agriculture; Mr Dechen Tshering, Sr. Post Production Officer, National Post Harvest Centre, Department of Agriculture; Ms Singye Dem, Extension Supervisor, Horticulture Division, Department of Agriculture; and Mr Karma Pelden, Research Officer, RNR RDC Yusipang . After the visit of

the Field Gene Bank at Lambhvel, main experimental fields at Boriavi campus and laboratories of DMAPR, a scientific interaction meeting with the scientists of DMAPR was organized. The role of ICAR in medicinal and aromatic plants (MAP) research was highlighted by Dr. Satyabrata Maiti, Director, DMAPR, in his presentation during the interaction meeting. The role of good agricultural practices (GAP), good manufacturing practices (GMP) and certification standard developed with the support of NMPB in context of global trade of MAP were specifically mentioned by him. Later on March 24, 2011, Dr. Satyabrata Maiti led the delegation to FAO office, New Delhi and to Som Extract Limited at Ghaziabad.

International Women's Day celebrated

International Women's Day was celebrated at the directorate on March 8, 2011.On this occasion, a lecture on "Art of Living" was organized and also a voluntary donation collected from staff of DMAPR was given to Hindu Anath Ashram, Nadiad for education of orphan children.

Institute Management Committee (IMC) meeting held

The 22nd IMC meeting was held on March 14, 2011, at DMAPR under the Chairmanship of Dr. Satyabrata Maiti, Director, DMAPR. Dr A. M. Sheikh, Dr. K. G. Patel, Dr. G. G Rao, Dr. R. S. Kurothe, Dr. Vipin Chaudhary, Sh. Rajnish Awasthi, Sh. Mangal Singh and Sh. R. T. Thakar were the other members present. Member Secretary, Sh. R.T. Thakar presented a brief report of progress made by the directorate and action taken report of the last meeting. Agenda items, research and development activities of the directorate was discussed by the committee members in the meeting.

Training toolkit on good agricultural and collection practices of medicinal plants released

A unique toolkit comprising of Good Agricultural and Collection Practices (GAPC) illustrated booklet, training manual, training video and illustrated cause and effect of training tool was jointly released by ICAR and FAO on May 30, 2011 at New Delhi by Dr. S. Ayyappan, Secretary, DARE & Director General , ICAR and Dr. Gavin Wall, FAO, in presence of dignitaries present in the functions from DBT, QCI, ICAR Hqs. and NMPB. A short film on the subject was also screened in the function. This toolkit was developed under a project implemented by FAO in India and Bhutan with the grant support from the International Fund for Agriculture Development (IFAD).

Compliance to quality standards is necessary to consolidate our position in the world herbal market and adoption of GACP by farmers and collectors is an important starting point. This also will improve the livelihood by adding premium price to the produce and also generating additional employment in rural sector for educated youth.

These were the highlights of the GACP toolkit expressed by various dignitaries.

Training cum workshop on growing importance of medicinal and aromatic plants organised

A two day training cum-workshop on Growing Importance of Medicinal & Aromatic Plants was organised at DMAPR during April 15-16, 2011 by Fragrance & Flavour Development Centre, Kannauj. Hon'ble Shri Bharat Sing Solanki, Minister of State for Railways, Govt. of India inaugurated the programme.

Meeting of National Network Project on Guggal

Review meeting of NMPB funded project Network Research Project on Guggal was held at DMAPR on June 7, 2011. Scientiest from CAZRI, Jodhpur AFRI, Jodhpur and DMAPR presented the progress report.

Contract research

The Directorate has carried out a contract research for developing good agricultural practices of Mamejo (*Enicostemma axillare*) for M/s Shree Dhootapapeshwar Limited, Mumbai. M/s Dhootpapeshwar Limited delivered a cheque for ₹ 2.00 lakhs on June 09, 2011 in a small ceremony. This opens the further contract research possibilities and capabilities of the Directorate.

Director, DMAPR receiving cheque from M/s Dhootpapeshwar Limited

Promotion

- Sh. S. B. Prajapati, T-2 (Field Assistant) promoted to T-3, w.e.f February 16, 2011
- Sh. S. R. Patel, T-2 (Field Assistant) promoted to T-3, w.e.f February 19, 2011
- Smt. S. H. Nair, T-2 (Laboratory Assistant) promoted to T-3 (Laboratory Assistant) w.e.f March 01, 2011
- Sh. R. B. Koli, T-3 (Driver) promoted to T-4 (Driver) w.e.f June 29, 2011
- Sh. H.A. Khatri, T-3 (Driver) promoted to T-4 (Driver) w.e.f June 29, 2011

Transfer

- Dr. Kunal Mandal, Senior Scientist (Plant Pathology) transferred to DMR Solan, as Principal Scientist on February 28, 2011
- Sh. Saravanan Raju, Scientist, Plant Physiology, transferred to CTCRI, Trivandrum, on April 01, 2011
- Dr. K. Abirami, Scientist (Horticulture), transferred to CARI, Port Blair on April 01, 2011
- Shri R. T. Thakar, Assistant Administrative Officer, transferred to DGR, Junagardh on April, 2011

List of distinguished visitors

- Prof. H. D. Kumar, Ex. Professor of Botany, BHU, Varanasi on January 24, 2011
- Dr. P. R. Kumar, Ex. Director, NRC on Rapeseed Mustard, Bharatpur on March 9, 2011
- A delegation from Royal Government of Bhutan on March 12, 2011
- Dr. D. M. Hegde, Director, DOR, Hyderabad on March 21, 2011
- Dr. N. K. Tyagi, Member, ASRB, New Delhi on April 8, 2011
- Sh. Bharat Sinh Solanki, Minister of State (Railways), Govt. of India on April 15, 2011
- Dr. B. R. Tyagi, Ex. Deputy Director, CIMAP, Lucknow on April 19, 2011
- Dr. Umesh Srivastava, ADG (Hort. II), ICAR, New Delhi on April 19, 2011
- Dr. R. C. Srivastava, Joint Director, Botanical Survey of India, Kolkata on April 19, 2011
- Dr. GSR Murti, Ex. Director (Acting), IIHR, Bangalore on April 19, 2011
- Prof. Y. B. Tripathi, Dept. of Medicinal Chemistry, IMS, BHU, Varanasi on April 19, 2011
- Dr. Nawab Ali, Retd. DDG (Engg.), ICAR on June 26, 2011

Seminars organised

Date	Topic	Speaker
24.01.2011	Human microbiomes	Prof. (Dr.) H.D. Kumar, Retd. Prof., Deptt. of Botany, BHU, Varanasi
19.04.2011	Polyherbal formulation for diabetic complications: leads for collaborative research	Dr. Y.B. Tripathi, Member, RAC, DMAPR Professor & Head, Deptt. of Medicinal Chemistry, IMS, BHU, Varanasi
21.05.2011	Recent advances in analytical techniques for natural product research	Dr. Satyanshu Kumar, Principal Scientist (Organic Chemistry) DMAPR
04.06.2011	Bio-molecules of commercial values	Dr. V.S. Rana, Sr. Scientist (Organic Chemistry) DMAPR

Human Resource Development

Date	Course/place	Name
16.04.2011	National consultation-cum-training in diagnosis in horticulture crops at CPCRI, Solan, Himachal Pradesh	Mr. Ram Prasnna Meena, Scientist (Plant Pathology), DMAPR
22.03.2011 to 26.03.2011	Innovative solutions to production of nutraceuticals and functional foods at Agriculatural Chemicals Division, IARI, New Delhi	Dr. Satyanshu Kumar, Principal Scientist (Organic Chemistry) DMAPR

International Year of Chemistry

Chemistry appropriately called the Central Science is a deep philosophical inquiry as well as an applied scientific endeavour. This branch of science is fundamental to our understanding of world and the cosmos. Molecular transformation, the basic approach of Chemistry, is involved everywhere, whether it is production of medicine, production of food stuff, fuel or material of any kind (metal, non metal or semiconductor).Solute and solvent concept is applicable everywhere from kitchen to a space laboratory. Our knowledge of the understanding of the material nature of the world is stranded in our developing knowledge of chemistry. All living processes, of course, are controlled by the chemical reactions. As our understanding of molecular properties grow, we develop more creative opportunities to discover new exciting principles and applications for betterment of human kind. Deep understanding of chemical sciences is essentially required for developing molecular medicine, sustainable supply of food and energy and creation of new materials of desired physical - chemical characters like super conductor.

The Year 2011 is being celebrated as International Year of Chemistry (IYC) as jointly declared by UNESCO and IUPAC with the theme "Chemistry –Our life, Our future". The year also marks the 100th anniversary of the Nobel Prize in Chemistry awarded to Marie Sklodowska Curie for recognition of her discovery of two radioactive elements namely radium and polonium. The main idea behind the IYC is raise awareness of chemistry among the general public and to attract youth into the scientific field.

This international initiative is being led by the International Union of Pure and Applied Chemistry (IUPAC). In 1919, IUPAC succeeded the International Association of Chemical Societies (IACS) and has global reach with 51 National Adhering Organizations and 21 Associate Adhering Organizations.

Species of Conservation Interest

Aconitum heterophyllum Wall. ex Royle

The species is commonly known as Atis and is a tall herb distributed in the sub-alpine and alpine zones of western Himalayas at a height of 2500 to 3900 m. Roots are tuberous, paired, 2-5 cm long, bearing root fibres. Leaves are heteromorphous, ovate with upper leaves amplexic and the lower long petioled. Flowers are bright blue in panicled racemes and fruits are follicles 16-18 mm long, linear with blackish brown seeds.

Twenty four different *Aconitum* species are distributed in the Himalayan region and nine out of these species (*A. ferox, A. heterophyllum, A. chasmanthum,* etc) are known as Atis or ativisha or aconite, commonly traded in the Indian markets and *A. heterophyllum* and *A. kashmiricum* grow together in nature and both the species get mixed in commercial samples. The roots are adulterated in the market with roots of *Asparagus*.

The roots are highly poisonous and processed to remove poisons before using for drug purposes. The drug is used commonly in Ayurveda, Unani and Homeopathic prescriptions. Alkaloids present in the root are responsible for the therapeutic uses. The roots are astringent and are used for the treatment of diabetics, debility, leprosy, rheumatism and typhoid. It is also used against hysteria and throat diseases.

Organized cultivation is lacking in the species and the entire supply of the drug is obtained from the wild sources particularly from the Himalayas. Hence maintenance of quality of the raw drug is very difficult. The crop can be cultivated in the higher altitudes in Kashmir, Himachal Pradesh, Uttaranchal and Sikkim. It prefers a cool climate with well drained loamy soil. Root stocks or seeds can be used for propagation. Research work for bringing the crop under domestication has been initiated by the ICAR through its All India Co-ordinated Research Project at its centre in YSPUAT, Solan.

> Knowing trees, I understand the meaning of patience. Knowing grass, I can appreciate persistence.
>
> – Hal Borland

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