



# Biodiversity and Applied Botany Division

Biodiversity and Applied Botany Division was established in year 2000 with an objective of exploring the rich plant bioresource. It undertakes studies on high altitude biology addressing botanical curiosities for sustainable utilization of critically endangered medicinal plants with focus on genetic diversity studies, genepool characterization and development of new elite varieties. Conservation of gene pool is one of the major activities of our division, which we carry out by several means like establishing seed banks and use of micropropagation techniques. We are also interested to understand the effect of climate change and other environmental stress on various medicinal plants.

## Missions & Goals

Quality control and standardization of herbal drugs/products is the key for their global acceptability. So one of the missions is to adopt the GSP (Good Sourcing Practices); GAP (Good Agricultural Practices); GMP (Good manufacturing Practices) and Bio-safety protocols.

To study climate change and adaptation of species complexes in ESAs (Ecological Sensitive Areas) of the country with focus on Adaptive /stress biology.

Functional genomic approaches to engineer pathways in high altitude medicinal plants. Identification of genes and regulatory mechanisms that affect adaptation and characterizing the mechanisms that underlie these effects (Relevant tools of genome/ proteome/ metabolome analysis will be employed wherever required).

Elite genotype designing in focused medicinal plants using conventional /molecular breeding approaches.

Bioprospecting plant and microbial biodiversity with state-of-the-art chemical/biotechnological tools for developing technologies of quality bioproducts and bioprocesses.

## Competencies

Expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.

Production technology unit involved in crop biology/variety development.

Developing crop management strategies for quality & quantitative analysis using environmental factors/energy indices.

Studying physiological and biochemical pathways like photosynthesis, anti-oxidative responses, C and N metabolism.

Tissue culture/plant biotechnology unit involved in micropropagation, bioproduction of value added secondary metabolism, simulating climate change conditions to assess adaptive physiological responses, development of bioreactor cultivation and development of genetically transformed hairy root culture.

## Facilities

**Tissue Culture Facility:** Well equipped tissue culture facility consists of inoculation room, media room, one incubation room and two small shakers. We also have a small manually operated 10 L glass bioreactor.

**Seed Bank Module:** Group has a seed bank module for conservation of seeds at low temperature. This is useful for conservation of germplasm against habitat destruction.

**Hardening Unit/ Green Houses/Glass Houses:** Group has a hardening unit and a green house for conservation of elite germ plasm and hardening of in vitro raised plants. Hardening unit is presently being manually operated and would soon be upgraded to a computerized system. We also have two net houses- one at IIIM, Jammu and other at Chatta Farm and three glass houses.

**Plant Growth Chamber:** A plant growth chamber system has been procured and would be installed soon. This would be used for controlled experiments and other research activities.

**Field Gene Banks:**  
Withania somnifera germ plasm collection  
: about 4,000 sq m

Ginger germ plasm collection  
: about 1,000 sq m

Germ plasm maintenance /experimental field  
: about 6,000 sq m (at two locations)

Germplasm propagation area  
: about 1,000 sq m

## Current Research

### Protocol for rapid in vitro propagation of swertia chirayita

A novel culture media composition for rapid in vitro propagation of Swertia chirata, a threatened Himalayan plant species has been invented. Culture media of the invention comprise a modified Murashige and Skoog's (MS) basal culture medium and various plant hormones. The particular composition leads to extraordinarily rapid in vitro propagation of specific parts of Swertia chirata. Mass propagation of the plant using compositions of the invention may be achieved by using axillary buds and shoot apices in the in vitro culture media.



No 6,855 547, Feb 2005; US Patent No 7,238,527 July, 2007; Methods Mol Biol; 547:139-53. 2009)

### Bioreactor cultivation of swertia chirayita shoot cultures

Chemical investigations of various in vitro developed morphotypes revealed that proliferating shoot cultures produce bioactive molecules (Amarogentin & Amaroswerin) equal to the parental plants. As the herb is directly being used by the industry without any downstream process of extraction of active principal, the shoot cultures seem to have potential for direct use in the industry. Studies are being carried out to explore possibility for an alternative supply route through biotechnological production of biomass/product using shoot cultures in a bioreactor. Present study is aimed at to develop procedure for a. development of shoot cultures of Swertia chirayita ; b. culturing shoot material in tissue culture under conditions that organogenically produce a proliferating of shoot biomass ; and c. standardization of the conditions for harvesting said shoots and/or leafy material while at green, actively-growing, non-senescent stage and produce desired amount of amarogentin and amaroswerin.



### Withanolide pathway modulation in withania somnifera through plant growth regulator mediated organogenesis

Withanolides expression was at higher level in structurally differentiated cultures, as compared to undifferentiated ones. Study indicated that explant source and differentiation state influenced the expression of withanolides synthesis in vitro. A correlation between morphological differentiation and withanolide spectrum has been detected. A shift in organogenetic

differentiation (adventitious shoot buds/multiple shoots) resulted in improved potential of the cultures to synthesize withanolides. The total extractive value improved considerably as the tissues differentiated shoot primordia. Expression of withanolide contents was more pronounced in shoots bud cultures, multiple shoot cultures, and regenerated plantlets indicating that the capability to synthesize withanolides is associated with differentiation, thereby suggesting that culture morphology is a dominant factor for withanolide synthesis in vitro (Biologia Plantarum; 51:161-164,2007)

#### Glycowithanolides accumulation in in vitro shoot cultures of indian ginseng withania somnifera

Phytochemical investigations of multiple shoot cultures of selected cultivars AGB002 and AGB025 of *Withania somnifera*. established in vitro utilizing shoot tip apices cultured on Murashige and Skoog's medium supplemented with BAP (1mg/l) have been carried out. This has lead to isolation of four glycowithanolides viz. Withanoside IV (WSG-3), Withanoside VI (WSG-3A), Physagulin D (WSG-P) and Withastraronolide (WSC-O).The structures of these have been confirmed on the basis of spectroscopic data. Multiple shoot cultures could be an alternative renewable resource for production of these biologically active molecules (Nat. Prod. Comm. 4 : 479-482,2009)

#### Towards understanding of morphogenesis in saffron

Recent investigation extended significant information regarding differential biochemical expression of isozymes and polypeptide banding pattern, which corroborates their role as markers of growth and differentiation process in economically important plant species, Saffron. Metabolic changes viz. total soluble protein and activity of various enzymes (peroxidase, EC:1.11.1.7; IAA-oxidase, EC: 1.11.1.8;  $\alpha$ -amylase, EC: 3.2.1.1;  $\beta$ -amylase, EC: 3.2.1.2; glucose-6-phosphatase, EC: 3.12.3.9) associated with morphogenetic stages of various tissue culture lines were studied in an economically important, sterile, autotriploid plant species *Crocus sativus* (L.).Data and principal component analysis for various biochemical attributes clearly distinguished the various

developmental stages. Callus line derived from bulblet explants tended to differentiate into somatic embryos. The calli initiated from corm and corm segment shoot buds exhibited higher protein content and enzymatic activity for peroxidase, IAA-oxidase and amylases ( $\alpha,\beta$ ). Expression of eleven polypeptides noticed during somatic embryogenesis, while the presence of nine additional polypeptides was detected during differentiation of shoot buds from callus. On the other hand, callus induced from leaf segments exhibited least protein polypeptide content and enzyme activity, which was associated with lower morphogenetic competence (Recent Advances in Plant Tissue Culture. Prof HC Arya Comm Volume (Ashwani Kumar & Shekhawat NS and Sopory SK (eds.), IK, International Pvt. Ltd, New Delhi, India, Chapter 37. pp 519-534.2009)

#### Varieties/elite strains developed

Six varieties/elite strains of four important medicinal/aromatic plants were finally characterized.

- Ashwagandha (2 varieties – AGB 002/AGB 025).
- *Cymbopogon flexuosus* (2 chemotypes).
  - . RRL(J)HP: Isointermediol type having promising anticancer activity
  - . RRL(J)HSR: 1-Bisabolone type having promising antibacterial activity
- *Mentha longifolia* (RRL(J)ML4-carvone rich strain. Promising alternative source of carvone)
- *Monarda citriodorea* (Novel/rich source of thymol 65-70%)

(US Patent No. 6,787,674; *Chemico-Biological Interactions*. 7: 332-347, 2008)



### Leads obtained from high altitudes

From the work being carried out with high altitude plants following leads have been obtained and are now being carried forward:

*Tanacetum gracile*: a major source of lavandulol (21.5%) with Anti-cancer activity (flavour fragr. J.2006;21:690-692), (planta med. 2008:74:515-520)

*Podophyllum hexandrum*: hyperaccumulation of podophyllotoxin (10% to 12%) in the propagules and can be used as renewable resource plant part.

*Artemisia dracunculus*: The high percentage of capillin upto 24.6% was recorded in its essential oil.

*Origanum vulgare*: carvacrol type (>75%) in their essential oil (0.8% to 1%) were identified.

