army printing press

Annual Report 2012-2013 CSIR-Central Institute of Medicinal and Aromatic Plants

वार्षिक प्रतिवेदन
Annual Report
2012-2013

CSIR-Central Institute of Medicinal and Aromatic Plants
(Council of Scientific and Industrial Research)
Lucknow | India

Acknowledgments
Research Council, Management Council
Project Leaders, Scientists, Technical Staff
Research Students and Scholars
MAPs Cultivators, Growers and Processors

Published by
Prof. AK Tripathi, Director CSIR-CIMAP, Lucknow

Editing, Designing and Production
Rakesh Tiwari
HP Singh

A Team CSIR-CIMAP Effort

Glimpses from the history

Central Indian Medicinal Plants Organisation (CIMPO) (which was later renamed as Central Institute of Medicinal and Aromatic Plants – CIMAP) was established with following objectives*:

'To co-ordinate and channelise along fruitful directions the present activities in the field of medicinal plants carried out by the various agencies, State Governments etc.; to develop the already existing medicinal plant resources of India; to bring under cultivation some of the important medicinal plants in great demand and also to introduce the cultivation into the country of exotic medicinal plants of high yielding active principle content.'

*Scope and Functions

- To pursue developmental, promotional and related work on cultivation, production, processing, utilisation and marketing of medicinal and aromatic plants with specific reference to their practical application and utility
- To cultivate medicinal and aromatic plants, either in its own farms or through other agencies, and to process wherever necessary, the plant materials for obtaining their end products
- To carry out, in collaboration with other agencies, introduction, acclimatization (including measures for prevention and control of pests and diseases) of exotic-species and also production of authentic high-yielding seeds, leaves and other propagating materials of medicinal and aromatic plants of economic importance
- To encourage cultivation of medicinal and aromatic plants in suitable regions of the country by giving grants-in-aid or loans and other incentives, wherever necessary
- To carry out surveys of resources of medicinal and aromatic plants and to maintain economic statistics of the raw materials as well as the finished products
- To set up and maintain a specialized herbarium and museum of medicinal and aromatic plants of economic importance as well as of products derived therefrom
- To undertake research and to encourage the same in established research institutions, e.g. university laboratories, technological institutions, national laboratories, etc. for schemes relating to improvement, processing and utilization of medicinal and aromatic plants
- To act as a 'clearing house' for collecting techno-economic data relating to medicinal and aromatic plants and products derived there from, by scientific ledgering and documentation and to disseminate information through publications of monographs, brochures, books and all other effective means

*cited from the 1977 brochure of the Central Indian Medicinal Plants Organisation (CIMPO)

वार्षिक प्रतिवेदन
2012-2013

With Best Compliments From

Director
CSIR-CIMAP

CSIR-Central Institute of Medicinal and Aromatic Plants

(Council of Scientific and Industrial Research)

Lucknow | Bengaluru | Hyderabad | Pantnagar | Purara

Contents

	Page No.
निदेशक की कलम से	ii
From the Director's Desk	iii
Genetic enhancement of MAPs using crop specific breeding methodologies	1
Phytochemical exploration and value addition in bioactive molecules from MAPs	5
Development of pre- and post-harvest technologies for commercially viable medicinal and aromatic crops and their popularization	9
Herbal products, formulations and process development using traditional/modern approaches	12
Development of DNA barcodes for selected trade in demand and CITES medicinal plants	13
Metabolic modulation in pyrethrin producing plants for enhanced production	14
Production of bio-chemicals and biofuels from spent aromatic biomass by bio-chemical processes	15
Structural diversification of natural naphthoquinones and phenolics through biotransformation/elicitation by transgenic hairy roots	16
Plant-Microbe and soil interactions (PMSI)	17
Studying adaptation biology and understanding / exploiting medicinally important plants for useful bioactives (SIMPLE)	18
Genomics and informatics solutions for integrating biology (GENESIS)	19
Chemical biology of Ocimum and other aromatic plants (ChemBio)	20
Rural Development Program (CSIR-800) and New Technologies	30
New Products and Varieties	31
Entrepreneurial Trainings	32
HRD, Honours, Awards and Recognitions	33
New Staff and Superannuations	34
Publications	35
Patents	41
Research Council	42
Management Council & Budget	43
Staff List	44

निदेशक की कलम से.....

सीएसआईआर-सीमैप की वर्ष 2012-13 के वार्षिक प्रतिवदेन को प्रस्तुत करने में मुझे अपार हर्ष हो रहा है। सीमैप अपनी तरह का एक विशिष्ठ संस्थान है जिसके शोध परिणाम किसानो उद्यमियों तथा जन साधरण के बड़े वर्ग को लाभान्वित करने के लिये उत्प्रेरक का कार्य कर रहा है। यह संस्थान सीएसआईआर की दो प्रमुख प्राथमिकताओं ''सर्व सुलभ स्वास्थ्य एवं ''कृषि आधारित खाद्य प्रौद्योगिकी'' के क्षेत्र में शोध संबंधी विषयों पर अपनी क्षमताओं को केन्द्रित करता है। संस्थान ने औषधि एवं सगंध गुणों से युक्त पादपों की पहचान कर उनके कृषि के लिये प्रौद्योगिकियों को विकसित करने, अधिक उपज प्राप्त करने हेतु उच्च किस्मों को विकसित करने, जैविक क्रियाशील यौगिकों को पौधो से निष्कर्षित करने संबंधी प्रौद्योगिकियों के विकास तथा इनको किसानों तथा उद्यमियों तक पहुँचाने के लिये उल्लेखनीय कार्य किया है जिससे उत्तर प्रदेश, बिहार, उत्तराखण्ड, छत्तीसगढ एवं उत्तरपूर्व के ग्रामीण अचलों के अल्प आय वर्गो के जीवन स्तर को सुधारने में उल्लेखनीय प्रभाव पड़ा है। संस्थान ने अनेक हर्बल उत्पादों की प्रौद्योगिकी भी विकसित की है जिन्हें अनेक उद्योगों को हस्तान्तरित किया गया है।

सशक्त सामाजिक पहुँच के साथ-साथ सीमैप उच्च गुणवत्तायुक्त, वैज्ञानिक शोध के क्षेत्र में भी अपना एक विशिष्ठ स्थान रखता है। संस्थान ने उच्च इम्पैक्ट फैक्टर वाले शोध ग्रन्थों में अपने शोध को प्रकाशित किया है तथा पेटेंट भी प्राप्त किये हैं। सीमैप ने परम्परिक चिकित्सा पद्धति प्रयुक्त औषधीय गुणों से युक्त पादप यौगिकों की पहचान तथा बायोसिम्थेटिक पाथवे संबंधी शोध के क्षेत्र में महत्वपूर्ण योगदान दिया हे। इसी क्रम में सीमैप का शोध प्रयास होगा कि आयुर्वेद सिद्धान्त 'कारण एवं प्रभाव' के बीच निहित वैज्ञानिक ज्ञानाभाव को दूर किया जा सके ताकि आयुर्वेदिक औषधियों की स्वीकार्यता बढ सके और इसके लिये इनके परीक्षण हेतु प्रौद्योगिकियों का विकास किया जाय ताकि हर्बल फामुलेशन की गुणवत्ता पर नियंत्रण हो सके। समाज तक शोध परिणामों को सशक्त रूप से पहुंचाने के लिये सस्य पादप प्रजनन, रसायन तथा प्रसार विशेषज्ञों को नियुक्त किया जायेगा। ग्रामीण अंचलों में समाज का निचला वर्ग जो राष्ट्रीय विकास की दौड में पीछे छूट गया है, के जीवन स्तर को सुधारने के लिये सीमैप अपनी शोध क्षमताओं का निरंतर प्रयोग करता रहेगा।

इस अवसर पर मैं संस्थान के सभी वैज्ञानकों तकनीकी कार्मिकों एवं सहायकों का आभार प्रकट करता हूँ जिनके वैज्ञानिक क्रिया कलापों के कारण संस्थान अपने मिशन को पूरा करने की दिशा में कार्यरत है तथा एक ब्रैंड नेम की तरह उभरा है। मैं अपने पूर्ववर्ती निदेशकों की सराहना करता हूँ जिनके समर्पित दिशानिर्देशन के कारण आज संस्थान सही दिशा में अग्रसर है।

प्रोफेसर अनिल कुमार त्रिपाठी

From the Director's Desk....

I am extremely delighted to present the Annual Report 2012-13 for CSIR-CIMAP, which is a unique institution of excellence that has been a catalyst of change for the destiny of a large number of farmers, entrepreneurs and society. This institute focuses its efforts in addressing two important priorities of CSIR i.e. "affordable healthcare" and "agri-food technologies". By identifying plants of medicinal and aromatic value, developing agricultural practices for their cultivation, producing high yielding varieties, developing technologies for extraction of the active compounds, and by reaching out to farmers and entrepreneurs, it has made a notable contribution in impacting the quality of life of lesser privileged class of our society in the rural areas of Uttar Pradesh, Bihar, Uttarakhand, Chattisgarh and North East region. It has also developed technologies for the herbal products, which have been transferred to different industries.

Besides its strong social outreach, CIMAP has also established its leading position in high quality science by way of its publications in high impact journals and patents. CSIR-CIMAP has made substantial contributions in identifying pharmaceutically important phytochemicals and their biosynthetic pathways to provide a better scientific foundation to our traditional systems of medicine. We will redeem our efforts to bridge the scientific gap between the cause-effect relationships of Ayurveda to enhance the acceptability of Ayurvedic drugs by developing technologies for testing and thereby controlling the quality of herbal formulations. Social outreach will be strengthened by recruiting specialists in agronomy, breeding, chemistry and extension work. Keeping in view our mission of impacting the quality of life of "the poorest of poor" in our country, CSIR-CIMAP will continue its efforts to empower rural folk of our society which has trailed behind in the process of our national development.

I take this opportunity to record our appreciation for the scientists, technical and support staffs, who have very actively and enthusiastically contributed in achieving the mission of the institute, and in making CIMAP a brand name. I also express my appreciation for the past Directors of CIMAP who have led this institution with full dedication and steered it in right directions.

Prof. Anil Kumar Tripathi

Genetic improvement and basic genetic studies in *Catharanthus roseus* : Epistatic interaction for alkaloids content

Twenty one double-mutant recombinants for morphological mutant traits were developed from ten mutants differing in alkaloid contents. Three of them showed epistatic interaction for contents of leaf alkaloids with 8 -13% higher contents of leaf alkaloids than the better parent. Four of them showed epistatic interaction for contents of root alkaloids with 10 -21% higher contents of root alkaloids (RA) than the better parent. However, their leaf and root yields were similar or lower than their parental mutants.

Parent mutant : NEU 6-15
RA 2.51%

Double–mutant recombinant
NEU 6-15 / EMS 18-2 (RA 3.14%)

Parent mutant NEU 18-2
RA 2.82 %

Parent mutant : NEU 6-15
RA 2.51%

Double–mutant recombinant
NEU 6-15 / EMS 24-5 (RA 3.05%)

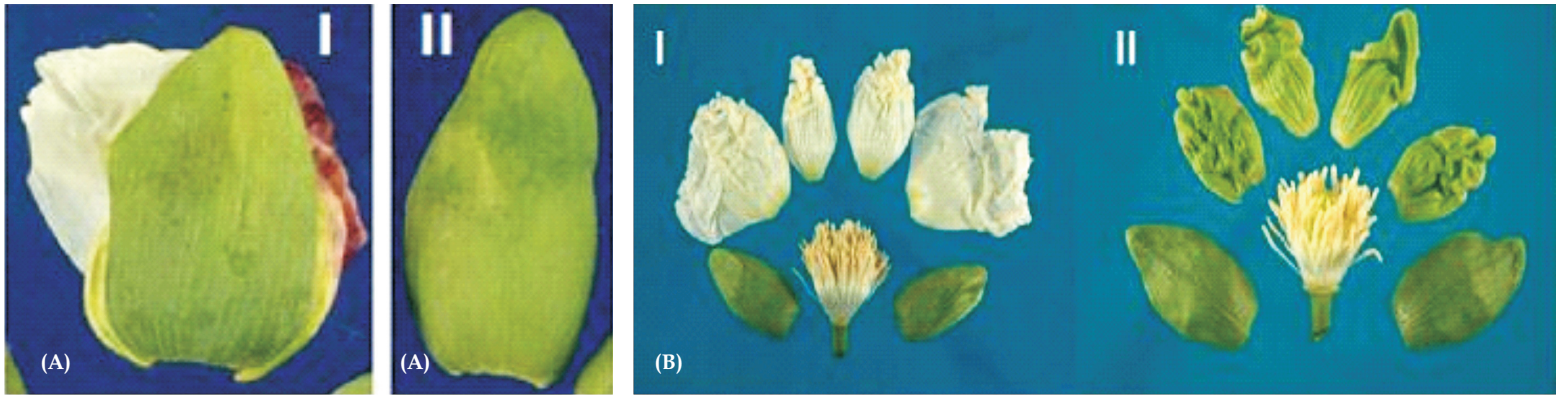
Parent mutant : EMS 24-5
RA 2.04 %

Input: Kulkarni RN

Mendelian inheritance and gene expression analysis in the novel homeotic mutants in *Papaver somniferum*

True breeding lines of two novel homeotic mutants - one with partially petaloid sepals (Pps-1) and another with sepaloid petals (OM) have been generated in *Papaver somniferum*. These mutations in reciprocal crosses with respective parents provided a good fit of the monogenic Mendelian inheritance ratio indicating control of the mutant trait by a single recessive nuclear gene.

Both the mutants were also analysed for expression of twelve genes of the ABC model in sepals and petals through semi-quantitative RT-PCR. Significant differences were detected for *PapsP1-1* gene. Its expression in sepals of Pps-1 genotype was significantly higher as compared to normal sepals of parental line I-14 whereas such differential expression was not detected in the petals of both the genotypes. A similar expression pattern was also detected for *PapsAP3-1*. For the remaining genes, there was no significant difference in expression in the sepals of the genotypes I-14 and Pps-1. This confirms the involvement of *PspsPI-1* and *PapsAP3-1* genes in petal development of *P. somniferum. T*wo paralogues (*PapsPI-1* and *PapsPI-3)* of pistillata-1 gene of opium poppy have been cloned and expression of these is being studied in floral organs of both the homeotic mutants Pps-1 and OM.



Floral morphology of homeotic mutants with their parental genotypes
A.Partially petaloid sepal of Pps-1 mutant (I) with normal sepal of the parental line I-14 (II)
B.Sepaloid petals of OM mutant (II) with normal sepals of the parental line I-268(1)

Input: Dhawan OP

Identification of acetylinic compound rich mutant with big and high flower yield in Chamomile (*Chamomila recutita*)

Big flower mutant

Seeds of variety CIMAP *Sammohak* were irradiated with gamma rays ^{60}C source 20-100 kR

↓

Induced genetic variability for flower morphology, plant type, flower yield, oil content and oil composition

↓

Variant at 20 KR had dry flower yield 10 ql/ha; check 7.0ql/ha; oil content 0.90%; oil yield kg/ha = 9.00kg in mutant v/s check 7.00 kg/ha. An enzyme derivative, (2Z,8Z)-matricaria acid methyl ester (80.7%) was identified as major constituents in essential oil by means of spectroscopic analysis.

Input: Lal RK

Comparison of flowers size with control ***(A)*** *Big flower mutant* ***(B)*** *Control CIMAP Sammohak*

Development of a dwarf and high silymarin containing variety "CIMAP SIL-9" of *Silybum marianum*

Accession No. "CIMAP1891"

Four seed lots consisting of 50 seeds each were subjected to 40Kr irradiation.

Progeny evaluations; seed lot 4 was further grown and single plants were selfed

Within and between family selections

CIM-1112-S9 identified and evaluated against check CIM-Liv

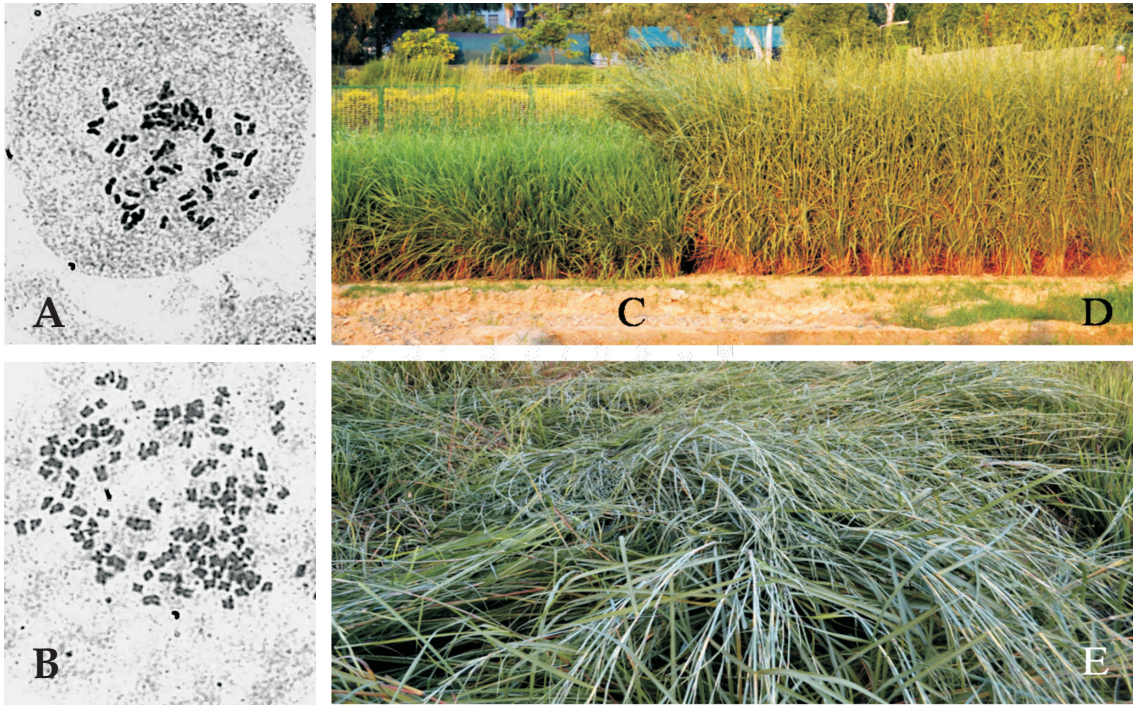
Released as CIMAP SIL-9

The variety CIMAP-SIL-9 grows upto a height of 80-90 cm, has a yield potential of 80-85 kg of silymarin from an average seed yield of 1000 kg per hectare.

Input: Gupta AK

Development of lodging resistant autotetraploid *Cymbopogon khasianus*

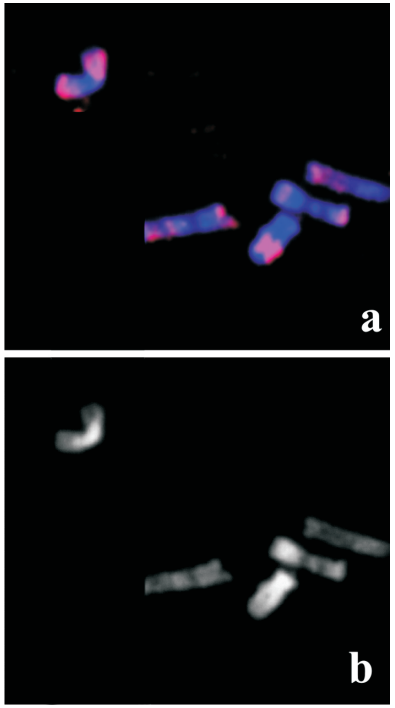
Taking cues that polyploidy may bring about organ thickness, efforts were made to realize sturdy plants in an improved clone 'CIM-Suwarna' of *C. khasianus* (2n=60), leading to the lodging resistance in the autotetraploid clone. This clone owes 15% higher concentration in its essential oil over source diploid, as well as, check clone '*Krishna*'.



A. *Somatic chromosomes of diploid source (2n = 60);* ***B.*** *Autotetraploid (4n = 4x - 120);* ***C.*** *Check clone Krishna;* ***D.*** *Lodging resistant autotetraploid;* ***E.*** *Lodging diploid progenitor*

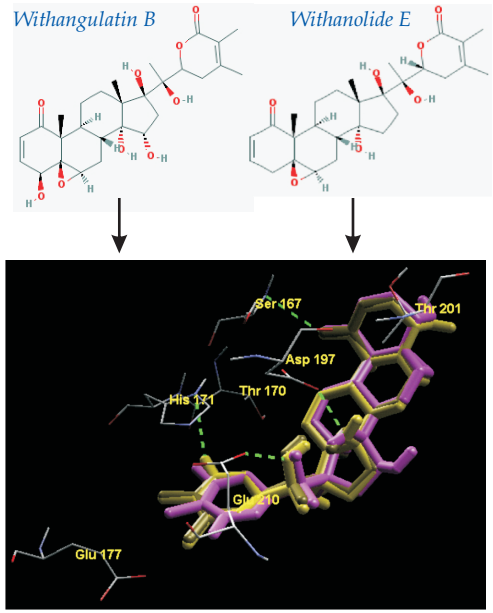
Inputs: Lavania UC

Development of protocol for immunolocalization of euchromatic histones on somatic chromosomes *in situ*



(a) *Immunolocalized euchromatic reagions – stained magenta,* ***(b)*** *same chromosomes showing fluorescence on AT rich hetrochromatic sites*

Artificial neural network (ANN)-QSAR model development for virtual screening of androstenedione C-skeleton containing small molecules for anticancer activity against aromatase

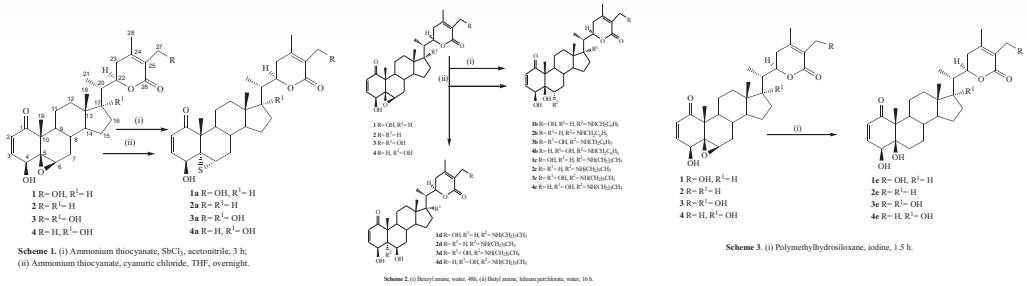


Docking of '4beta-hydroxy withanolide E' (-8.7 kcal/mol), and withangulatin B (-8.9 kcal/mol) on anticancer target aromatase.

Comb Chem High Throughput Screen, 16(1): 57-72, 2013 (IF:1.79)

Input: Khan Feroz

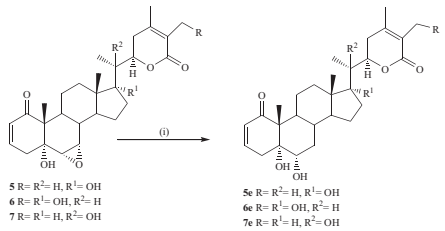
Epoxide group relationship with cytotoxicity in withanolide derivatives from *Withania somnifera*



Scheme 1. (i) Ammonium thiocyanate, $SbCl_3$, acetonitrile, 3 h; (ii) Ammonium thiocyanate, cyanuric chloride, THF, overnight.

Scheme 2. (i) Benzylamine, water, 48h; (ii) Butylamine, lithium perchlorate, water, 16 h.

Scheme 3. (i) Polymethylhydrosiloxane, iodine, 1.5 h.



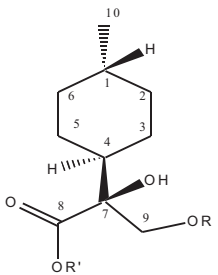
Scheme 4. (i) Polymethylhydrosiloxane, iodine, 1.5 h.

Cytotoxicity of all 23 derivatives was tested *in vitro* against 4 cancer cell lines. The anticancer activity of withasteroid derivatives showed significant reduction in biological activity. Interestingly, a moderate activity was observed for the withanone nucleus which is, otherwise, generally not active.

Input: Misra LN

Steroids, 79: 19-27 (IF 2.80)

Zantholic acid, a new monoterpenoid from *Zanthoxylum zanthoxyloides*



1, R= R'= H
1a, R= Ac, R'= H
1b, R= H, R'= Me

Chemistry Central J., 2013, 7, 125 (IF 3.281
Nat. Prod. Res., 20134, 27, 1994 (IF 1.03)

Cluster Major compounds

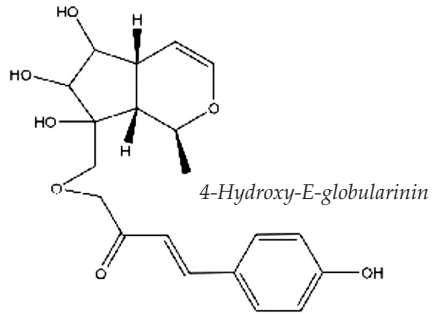
I	(E)-Caryophyllene (47.9%), caryophyllene oxide (8.6%), germacrene D (7.5%)
II	-Pinene (8.5-39.5%), (E)-caryophyllene (1.4-26.9%), germacrene D (5.0-23.3%), -pinene (3.1-18.1%) and -humulene (1.1-11.8%)
III	Germacrene D (16.1-22.1%), (E)-caryophyllene (10.4-13.5%), -copaene (6.5-10.1%)

Industrial Crops and Products 42; 195-201, 2013 (IF: 2.47)

Input: Misra LN

Longevity promoting effects of 4- hydroxy-E-globularinin in *Caenorhabditis elegans*

Mean life span of worms was enhanced by over 18.8% in *C. elegans* test model under oxidative stress. The activity was associated with reduced reactive oxygen species (ROS).

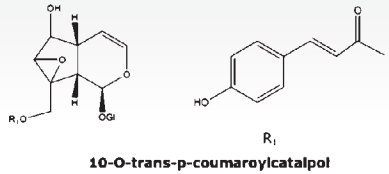


4-Hydroxy-E-globularinin

Free Radical Biol. & Medicine 53: 1848, 2012 (IF 5.271)

Iridoid compound 10-O-trans-p-coumaroylcatalpol extends longevity and reduces alpha synuclein aggregation in *Caenorhabditis elegans*

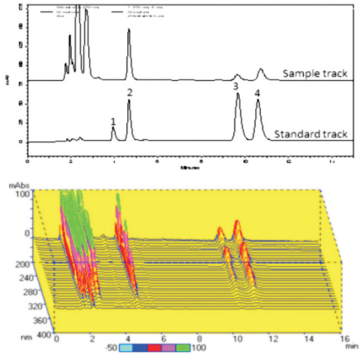
The iridoid compound has the ability to ameliorate a-syn aggregation, reduces oxidative stress and promotes longevity (>18%) in *C. elegans* via activation of longevity promoting transcription factor DAF-16.



10-O-trans-p-coumaroylcatalpol

CNS & Neurological Disorders-Drug Targets 11: 984, 2012 (IF 3.769)

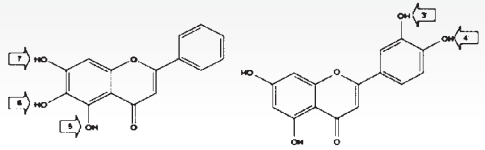
Simultaneous determination of flavonoids in *Oroxylum indicum* by RP-HPLC



Medicinal Chemistry Research 22: 2222, 2013 (IF 1.612)

Screening of flavonoids for anti-tubercular activity and their structure-activity relationships

Luteolin, baicalein, quercetin, myricetin and hispidulin showed anti-tubercular activity at MIC 25–100 µg ml^{-1} against *Mycobacterium tuberculosis* H37Rv strain radiometrically by BACTEC 460.



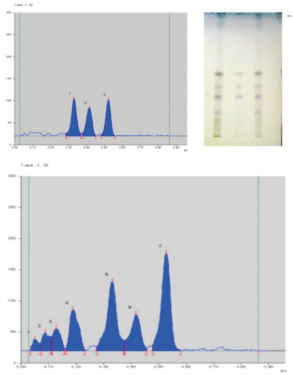
Specific structural requirements for anti-tubercular activity in tested flavonoids.

Medicinal Chemistry Research 22:2706, 2013 (IF 1.612)

Isolation and HPTLC analysis of iridoids in *Premna integrifolia*, an important ingredient of Ayurvedic drug *Dashmool*

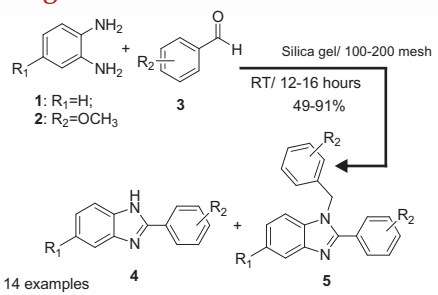
10-O-*trans*-p-coumaroylcatalpol (A), 4?-hydroxy-E-globularinin (B), and premnosidic acid were isolated and a new HPTLC protocol has been developed.

Journal of Planar Chromatography 26: 260, 2013 (IF 0.955)



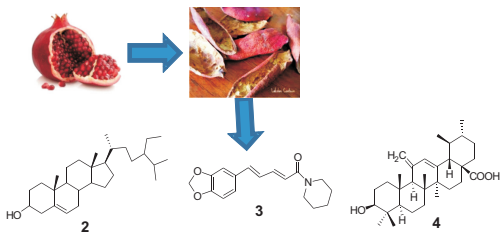
Inputs: Gupta MM

A simple, straightforward synthesis of substituted 2-arylbenzimidazoles over silica gel



RSC Advances 3: 4500-4504, 2013

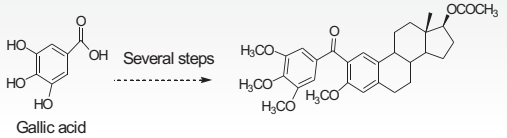
Cathepsin D protease inhibition activity of *Punica granatum* fruit peel extracts, isolates and semisynthetic analogues



Med. Chem. Research 22:3953-3958, 2013

Gallic acid based steroidal phenstatin analogues for selective targeting of breast cancer cells through inhibiting tubulin polymerization

Anti-breast cancer activity, IC_{50}=5µM (MDAMB-231), anti-estrogenic in rats,



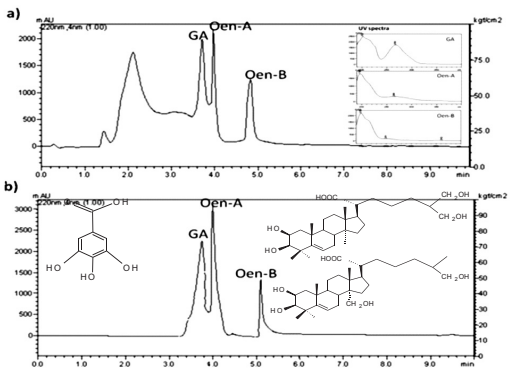
tubulin polymerisation inhibitor IC50=0.99µM, Non-toxic up to 300mg/kg dose

Steroids 77: 878-886, 2012 (IF 2.80)

Inputs: Negi AS

HILIC* quantification of oenotheralanosterol A and B from *Oenothera biennis* and their suppression of IL-6 and TNF-α expression in mouse macrophages

A HILIC method for simultaneous quantitation of oenotheralanosterol A and B (Oen-A & Oen-B) along with gallic acid (GA) in *O. biennis* was developed for



HILIC= Hydrophillic Interaction Liquid Chromatography

quality assurance. Compounds suppressed IL-6, TNF-α and NO synthesis in mouse macrophages.

Journal of Ethnopharmacology 141(1), 357-362, 2012

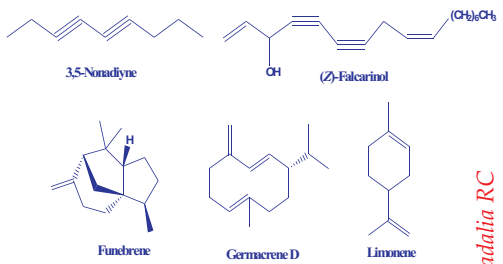
Studies in *Pluchea lanceolata*: Chemical and biological potential of *Rasayana* herb used in traditional system of medicine was studied *in vivo*, *in vitro* and *ex vivo*

Fitoterapia 2012, 83(8), 1371-1385

Inputs: Shanker Karuna

Study on bioactive acetylenic metabolites of *Ligusticopsis wallichiana*

Major classes of constituents were acetylenic (31.51%-92.86%), sesquiterpenoids (0.27%-41.00%). (Z)-Falcarinol (1.94%-21.00%), α-funebrene (0.10%-10.12%), limonene (0.17%-19.86%) along with other twenty minor constituents were identified from *L. wallichiana.*



Natural Product Communications 7(8), 1070-1078, 2012, (IF : 0.956)

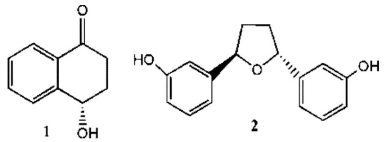
Input: Padalia RC

Anti-hyperglycemic agents from *Ammannia multiflora*

The chloroform and n-butanol fractions of *A. multiflora* resulted in the isolation and characterization of 4-hydroxy-α-tetralone (1) and a new compound, ammaniol (2).

The ammaniol (2) increased glucose uptake (64.8%) while 4-O-(3,4,5-trimethoxybenzoyl) derivative of α-tetralone (1) showed potent anti-hyperglycemic activity and increased glucose uptake by 94.6%, even more than rosiglitazone (88.8%).

Since the derivative possesses better anti-hyperglycemic activity than rosigli-tazone (standard) this may be optimized for a new safer anti-diabetic drug of herbal origin.

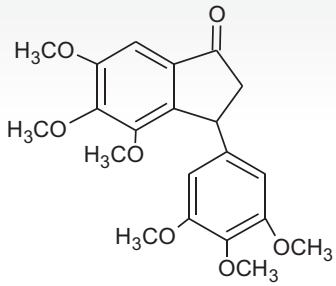


Nat. Prod. Comm. 7: 899, 2012

Input: Srivastava SK

Pharmacokinetic study of anti-cancer lead molecule AM3

Pharmacokinetic study of anti-cancer lead molecule AM3 was conducted and the results were as following:

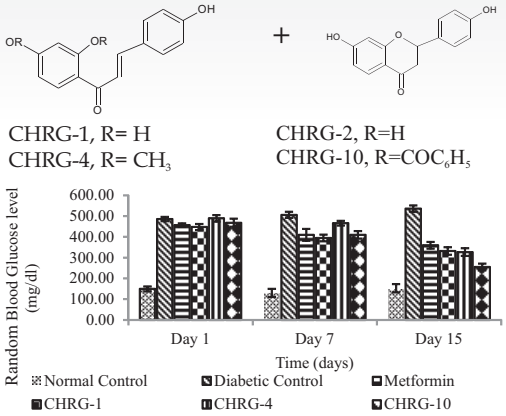


Cmax (µg/ml)	32.45
$T_{1/2}$ (h)	1.94
Elim Rate Const	0.36
AUC 0-t (h.µg/ml)	22.62
AUC 0-α(h.µg/ml)	29.87
CL (l/h/Kg)	0.54

Eur. J. Pharm. Sci. 18;47(5): 988-95, 2012 (IF: 2.987)

Input: Chand D

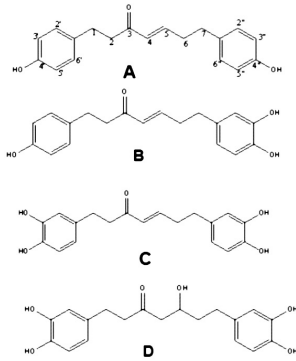
Anti-diabetic activity of isoliquiritigenin, liquiritigenin derivatives against Swiss albino mice



Input: Bhakuni RS

Anti-filarial diarylheptanoids from *Alnus nepalensis* leaves growing in high altitude areas of Uttarakhand, India

First report of hirustenone (C) showing promising anti-filarial activity both *in-vitro* and *in-vivo* studies.



Input: Verma RS

Phytomedicine 20;124, 2013 (IF: 2.972)

Identification and performance of stress tolerant phosphate solubilizing bacterial isolates on *Tagetes minuta* grown in sodic soil

Tagetes minuta is a potential crop grown in salt affected soil. Its tolerance to adverse condition and association with halophilic microbes can play a role for crop production and soil health improvement. After screening the potential phosphate solubilizing bacteria (PSB) (RS-1, RS-2and RS-3) from sodic soil, those were identified and tested in pot experiment in naturally occurring sodic soil having pH 9.3 and ESP about 45. At optimum condition, these bacteria showed phosphorus solubilization potential in liquid medium containing tricalcium phosphate (TCP) under laboratory condition. Inoculation of PSB significantly increased the plant growth with respect to height, number of branches, dry matter accumulation and nutrient uptake of plants. Significant changes have also been found in content and quality of essential oil. It has been observed that PSB also improved the physical, chemical and biological properties of soil. The data indicated that the bacterial strains tested in this study have a potential to be used as a biofertilizer in sustaining the growth of *Tagetes minuta* in salt stress soil and mitigating soil stress problems.

Soil Use and Management, 29, 494–500; 2013

Influence of vermicompost on dry matter yield and uptake of Ni and Cd by Chamomile (*Matricaria chamomila*) in Ni- and Cd-polluted soils

The influence of vermicompost on growth, yield and heavy metal accumulation by chamomile (*Matricaria chamomila*) was studied. Nickel and cadmium applied at 20 mg kg^{-1} soil significantly enhanced the dry matter yield as compared to the control (no heavy metal). The results revealed that addition of vermicompost (at 2.5 g kg^{-1} soil) enhanced the heavy metal accumulation by chamomile in metal treated soils. Although a sizeable amount of metals were being translocated to flowers, the oil content in flowers and chemical constituent of the oil were not affected by heavy metal application.

Water Air Soil Pollut. 22: 2257-2262, 2012

Production, purification, and characterization of anti-fungal metabolite from *Pseudomonas aeruginosa* SD12, a new strain obtained from tannery waste polluted soil

A new strain, SD12, was isolated from tannery waste polluted soil and identified as *Pseudomonas aeruginosa* on the basis of phenotypic traits and by comparison of 16S rRNA sequences. This bacterium exhibited broad-spectrum antagonistic activity against phytopathogenic fungi. The strain produced phosphatases, cellulases, proteases, pectinases, and HCN and also retained its ability to produce hydroxamate-type siderophore. A bioactive metabolite was isolated from *P. aeruginosa* SD12 and characterized as 1-hydroxyphenazine (1-OH-PHZ) by nuclear magnetic resonance (NMR) spectral analysis. The strain was used as a biocontrol agent against root rot and wilt disease of pyrethrum caused by *Rhizoctonia solani*. The purified compound, 1-hydroxyphenazine, also showed broad-spectrum antagonistic activity towards a range of phytopathogenic fungi, which is the first report of its kind. It was concluded that *P. aeruginosa* SD12 can be used as an effective bioinoculant for soil fertility, plant protection and promoting plant growth with reduced disease incidence.

Journal Microbiology and Biotechnology, 22(5), 674-983, 2012.

Inputs: Patra DD

Assessment of carbon sequestration potential of lemongrass, palmarosa and vetiver under normal practice of cultivation

Carbon sequestration potential of lemongrass, palmarosa and vetiver were investigated. During the eight month period of first year cultivation, two harvests were taken and on the basis of biomass and carbon percentage of the

shoots and roots of individual plant it has been found that total carbon sequestrated by shoot biomass palmarosa was 57% higher and that by vetiver was 44% higher than lemongrass. In case of roots, however, vetiver sequestrated 79% more carbon than lemongrass which was followed by palmarosa that sequestrated 40.3% more carbon than lemongrass.

Input: Chattopadhyay A

Carbon sequestration potential and soil fertility enhancement from biochar prepared from waste of MAPs

Biochar samples were prepared from distillation waste of *Cymbopogon flexuosus* (lemongrass), *Vetiveria zizanioides* (khus), root of *Rosa damascena* (rose) and bark of *Eucalyptus citriodora*. Bio-char were taken for assessment of soil carbon sequestration and as enhancer of soil properties (soil organic matter, available potassium and phosphorus, urease activity, and microbial population). Principal component analysis (PCA) and hierarchical clustering analysis (HCA) were applied on the data set. Study suggests that carbon sequestration is highest with high rank char. However, low rank char can improve the quality of soil. Hence, bio-char used for soil amendment and carbon sequestration may have rational proportion of condensed ring and oxygenated functional groups.

Input: Khare P

Intercropping in vetiver for higher productivity and return

Vetiver being a wider spaced crop and long initial lag phase, intercropping is an option to sustain its productivity. In field experiments thirteen cropping systems viz., sole crop of each of vetiver, sweet basil – radish - *Tagetes*, black gram - clarysage, kalmegh - garlic, okra - geranium, pigeon pea - menthol mint, maize – radish - onion and intercropping of above cropping sequences with vetiver were evaluated in randomized block design with three replications. Intercropping of sweet basil-radish – *Tagetes* with vetiver during kharif and rabi seasons was highly productive in terms of land equivalent ratio (1.34), area time equivalent ratio (1.05), money equivalent ratio (1.36) and land use efficiency (120 %) and a net return of Rs. 288000 ha^{-1} followed by intercropping of vetiver + kalmegh – garlic with vetiver. The system also gave about 35 % more profit over the sole cropping of vetiver. The major constituent of vetiver oil, khusimol was not affected by different intercropping systems.

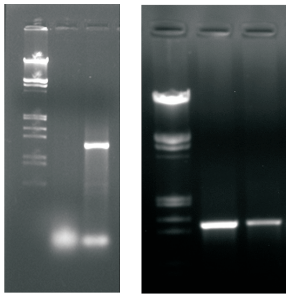
Vetiver + Ocimum (Rainy)

Vetiver + Radish (Autumn)

Vetiver +Tagetes (Winter)

Input: Chauhan HS

Detection of phytoplasma as mixed infection with Begomovirus - a case study on mint (*Mentha piperita)*



A very high incidence of yellow and little leaf type disease symptom of mint (up to 20-35%) was recorded in farmer's fields and experimental farms of CIMAP, Lucknow.

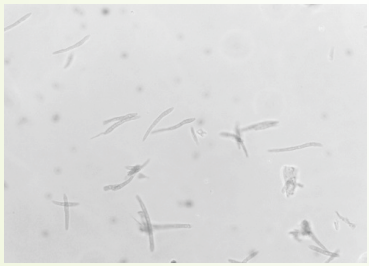
Symptoms : Strong chlorosis , little leaf, shortened internodes, foliar malformations with reduced size and aborted flowers. TEM revealed the presence of phytoplasma bodies ranging from 400 to 1200 nm in the phloem of diseased samples

Whitefly (*Bemisia tabaci*) instigated transmission of the begomovirus infection in the field

Nucleic acid based screening of samples from different locations of farmers' fields revealed mixed phytoplasma-begomovirus infection in mint for the first time.

Diagnosis of Black leaf spot mould (*Pseudoce rcospora fuligena*) on *Withania somnifera*

Symptoms: Black color spots on the leaves of *W. somnifera*.



Pathogenicity Test: Initial symptoms start appearing on 7th day while typical disease symptoms appeared on all the inoculated plants after 12 to 17 days. Re-isolation of the pathogen on PDA fulfilled Koch's postulate.

Microscopic studies: Early and mature stages of infection showed conidiophores and conidia. On the basis of cultural and morphological studies, pathogen was identified as *Pseudocercospora fuligena*.

The pathogen was further confirmed at molecular level using universal primers ITS 1 and ITS 4 and sequence was deposited in NCBI Genbank (Acc. no KF881898).

Inputs: Samad A

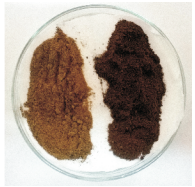
Herbal mouthwash for oral care

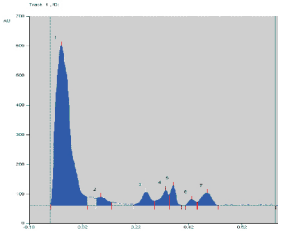
Modern times 'mouth wash' finds reference in *Auyrveda* as *Gandush* which is described as an Ayurvedic oil/decoction which is to be retained in mouth. It prevents tooth decay and oral diseases, strengthens teeth and is rejuvenating. The traditional wisdom of *Ayurveda* was scientifically evaluated and validated to develop a herbal mouth wash based on glycyrrhiza and clove (Devkusum).

Yashthimadhu & Devkusum (Glycyrrhiza glabra & Syzygium aromaticum)

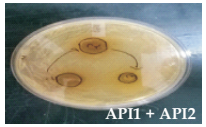
Coarse powder of the above

Synergistic effect of *Yashthimadhu* and *Devkusum* Extract (API 1 & API 2)





Standard of the active ingredient peak formulation for batch to batch variation



Anti-microbial activity against S.mutans

Pre-clinical safety evaluation of extract and formulation (*in-vitro* & *in-vivo*)

Anti-microbial activity against *Staphylococcus mutans*

Evaluation of mouthwash formulation by using multiple parameters

↓

Safety evaluation studies of mouthwash formulation (*in-vitro* & *in-vivo*)

↓

Feedback study of mouthwash on 70 volunteers

↓

Mouthwash ready for industrial licensing

Development of DNA barcodes for commercially important medicinal plants

Primers selected for DNA Barcoding:

matK	390F	CGATCTATTCATTCAATATTTC
	1326R	TCTAGCACACGAAAGTCGAAGT
rbcL	1f	ATGTCACCACAAACAGAAAC
	724r	TCGCATGTACCTGCAGTAGC
trnH-PsbA	fwd PA	GTTATGCATGAACGTAATGCTC
	rev TH	CGCGCATGGTGGATTCACAATCC
ITS	5a fwd	CCTTATCATTTAGAGGAAGGAG
	4 rev	TCCTCCGCTTATTGATATGC
ITS2	S2F	ATGCGATACTTGGTGTGAAT
	S3R	GACGCTTCTCCAGACTACAAT

32 accessions of *Adhatoda vasica* Nees were collected from three different states. The different loci matK, rbcL, trnH-PsbA, ITS and ITS2 were selected for DNA barcoding studies. Amplification was successfully done with matK, rbcL, trnH-psbA, and ITS2 with their suitable PCR conditions. Amplification was not achieved to ITS with their PCR conditions. Work is in progress to optimize suitable PCR conditions for ITS amplification. Amplified products were successfully purified and sequenced. Sequence of rbcL and trnH-psbA was obtained with forward primers. Sequence of rbcL submitted to NCBI Genbank {BankIt 1608718: (1)}.

Variations in Adhatoda vasica

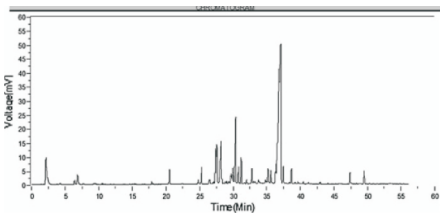
Impact of geographic range on genetic and chemical diversity of Indian Valerian (*Valeriana jatamansi*) from Northwestern Himalaya

An effort was made to determine the impact of geographic range on genetic richness and chemical constituents of *Valeriana jatamansi* Jones, an herb indigenous to the northwestern Himalaya. The genetic structure of 16 accessions from two major divisions of Uttarakhand state (Kumaon and Garhwal) was analyzed by ISSR markers. Overall genetic diversity among the populations was 45 %, with a cumulative range of 35–92 % similarity for most of the high-altitude plants and a comparatively narrow range, 50–88 %, for the population below the altitude of 1,800 m.

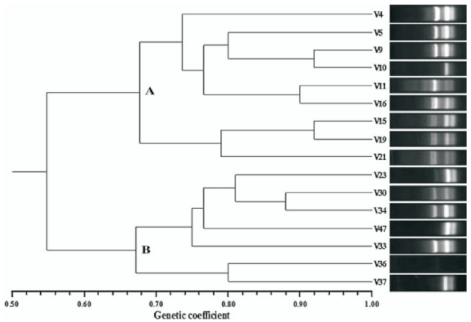
Likewise, a remarkable predictability was evident from the chemical constituents on an individual basis. In principal component analysis, most of the accessions fall into two major groups and are classified as chemotypes based on the percentage of similar chemical constituents; these are mostly correlated to altitude. Geographic distance seems to influence the genetic and chemical variability, indicating the genetic inbreeding within the population.

Collection sites

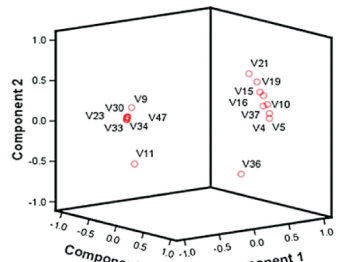
Plant habit



GC of root essential oil



Dendogram with similarity matrix



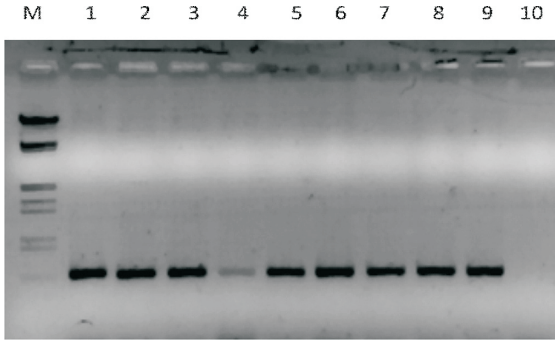
Chemotype grouping

Inputs: Sundaresan V

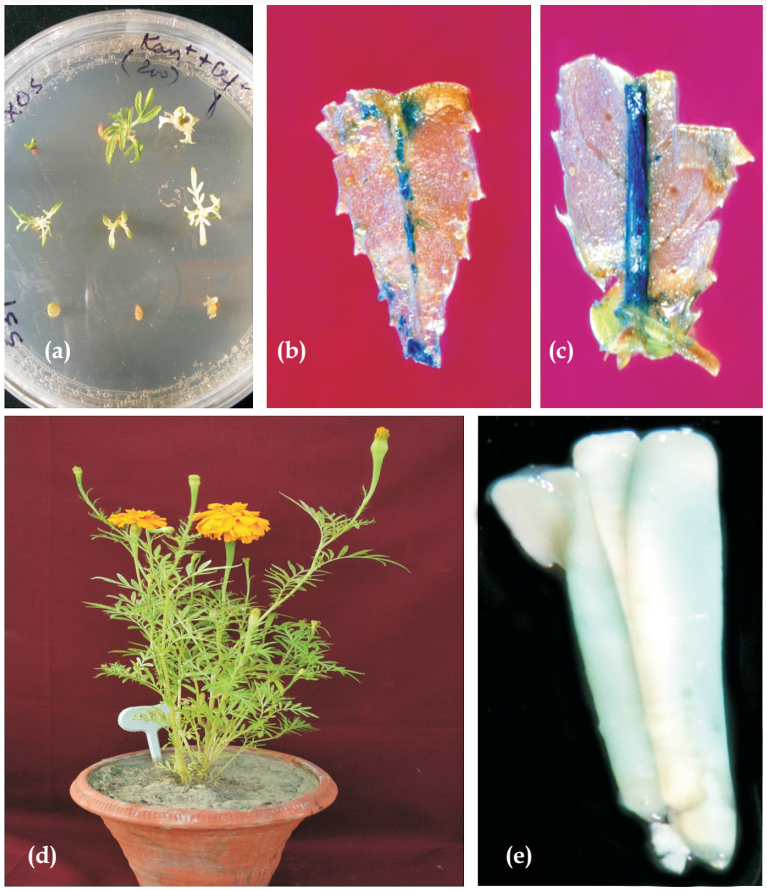
Biochemical Genetics 50: 797-808, 2012 (IF=0.938)

Development of efficient genetic transformation protocol in *Tagetes erecta*

Agrobacterium tumefaciens mediated genetic transformation of *Tagetes erecta* – an Asteraceous plant of industrial and medicinal importance was established. The transformation protocol was established using *A. tumefaciens* strain LBA4404, containing the binary vector pBI121, along with the *gus A* reporter gene with intron under the transcriptional control of the Cauliflower Mosaic Virus (CaMV) 35S promoter and the *neomycin phosphotransferase II (nptII)* gene as a kanamycin-resistant plant-selectable marker. Hypocotyls, cotyledonary leaves and leaf sections were used as explants. Shoots developed on *Agrobacterium* treated explants were selected on MS medium supplemented with BAP and GA_3 and kanamycin. Elongated transgenic shoots were subsequently rooted on MS medium and transferred to green house successfully. Integration of T-DNA into nuclear genome of transformed plants was confirmed by PCR amplification of *npt II* fragment.



PCR amplification of nptII gene from transformed Tagetes plants. M- marker, 1-8 putative transformants, 9-positive control, 10- negative control



(a) Selection of kanamycin resistatnt putative transformants; (b-c) Histochemical gus expression in leaf; (d) Complete plant of Tagetes erecta; (e) Gus expression in embryo

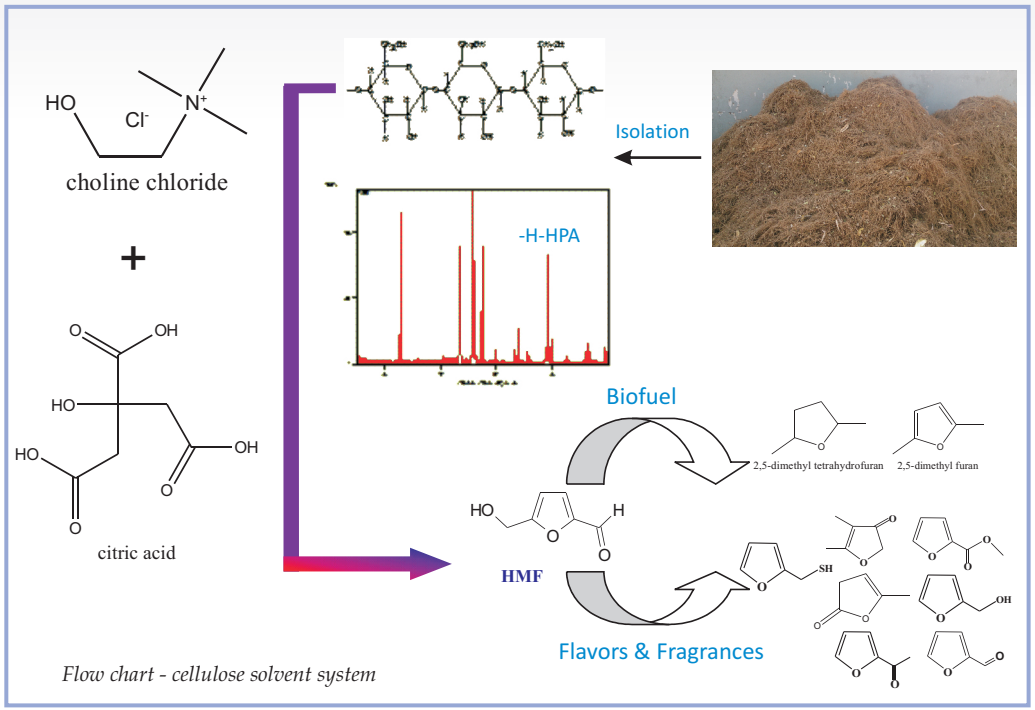
Input: Laiq-ur-Rahman

Novel solvent system for dissolution of cellulose: A new solvent system (deep eutectic) for dissolution of cellulose was developed. Further, a new catalyst (Zeolite-Heteropoly acids) for effective conversion of cellulose to hydroxymethyl furfural (HMF) was prepared. HMF is a valuable chemical, which can be further used for synthesis of various flavor and fragrance derivatives and high calorific value bio-fuel.

Chemical studies on *Simarouba* seed lipids: Extraction and characterization of *Simarouba glauca* seed lipids were carried out. The chemical analysis and *in-vitro* studies suggested that the lipids can be used for edible purposes.

Studies on *Tagetes patula* & Jasmine: The work on chemical composition of *Tagetes patula* essential oil, liquid CO_2 extraction of *Jasminum grandiflorum* and HS-SPME analysis of few floral fragrances have been carried out.

Inputs: Rout PK



Flow chart - cellulose solvent system

Patents

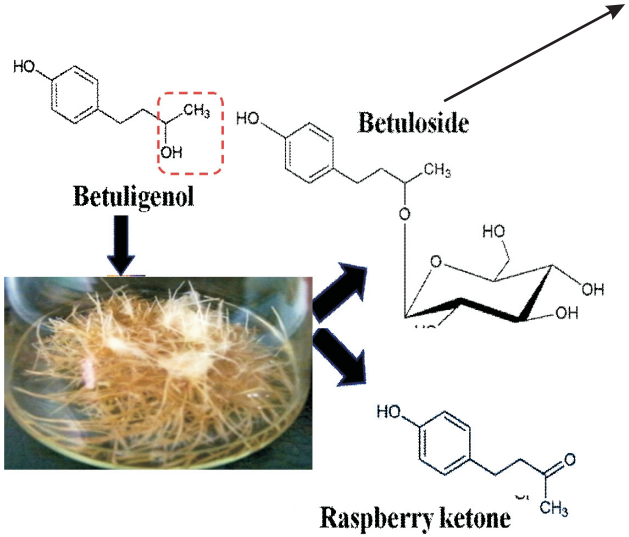
1. PK Rout, AD Nannaware, R Rajasekharan. Green process and catalyst for conversion of cellulose from aromatic biomass waste to hydroxymethylfurfural, 2013, WO 2013102911.
2. PK Rout, AD Nannaware, R Rajasekharan, A process for chemical conversion of isolated cellulose from aromatic spent biomass to hydroxymethyl furfural, 2012, IN 2012DE00012; AU2012364198.

Asian Journal Chemistry, 24: 945-956, 2012 (IF: 0.8)
Industrial Crops Products 37: 195-199, 2012 (IF: 2.46)
Natural products communication, 7: 89-92, 2012 (IF: 1.24)
J. Food Science Technology, doi: 10.1007/s13197-012-0636-9, 2013 (IF: 1.12)

Regio-specific oxidation and glucosylation of betuligenol into raspberry ketone and betuloside by *Atropa belladonna* hairy root clone

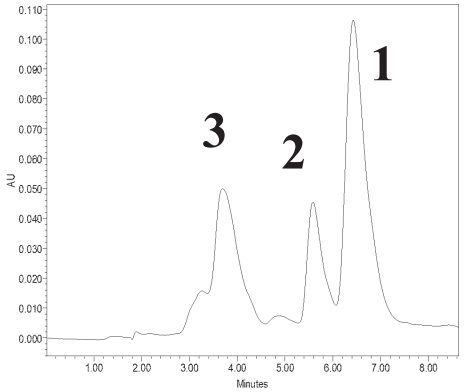
A. belladonna hairy root was studied for the bioconversion of betuligenol or 4-(*p*-hydroxyphenyl) butan-2-ol (1). Two biotransformed products were obtained – (i) raspberry ketone (2) or [4-(*p*-hydroxyphenyl)-2-butanone] as oxidized product and (ii) betuloside (3) or [4-(*p*-hydroxyphenyl) but-2-yl--d-gluco- pyranoside] as glucosylated product respectively.

Derivatives of Betuligenol (1) have attained substantial therapeutic and "cosmaceutical" considerations.

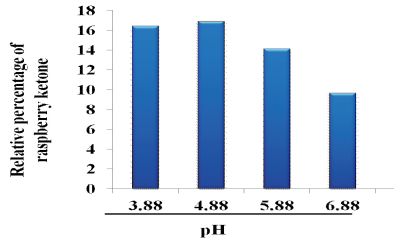


Rasberry ketone (2) is a 'natural' ingredient in cosmaceutical industry used in skin-lightening cosmetics, and as anti-obesity dietary supplement.

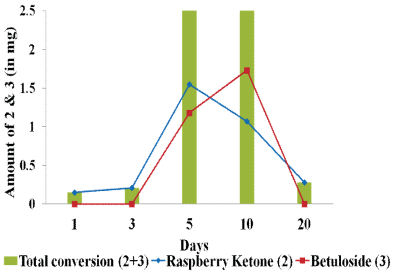
Betuloside (3): Anti-inflammatory, analgesic and liver-protective molecule that acts as natural pain-killer for the treatment of inflammatory diseases.



Time course study revealed the maximum bioconversion of betuligenol (1) to raspberry ketone (2) on the 5th day and to betuloside (3) on the 10th day of feeding, respectively



pH influenced the bioconversion rate : optimum result at pH 4.88.

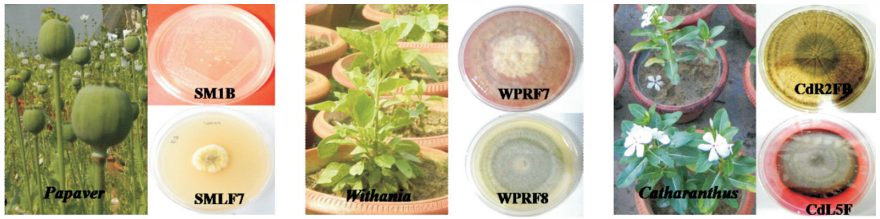


Maximum bioconversion of betuligenol (1) to raspberry ketone (2) on 5th day and to betuloside (3) on 10th day

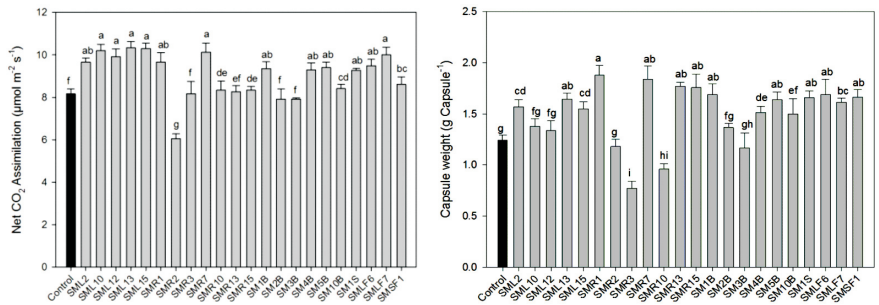
Input: Banerjee Suchitra

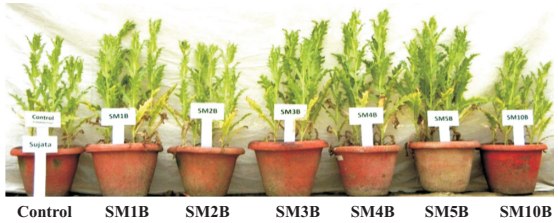
Industrial Crops and Products 44: 171–175, 2013; (IF- 2.46)

Plant-endophyte interactions responsible for enhancing yields of selected therapeutically useful secondary metabolites

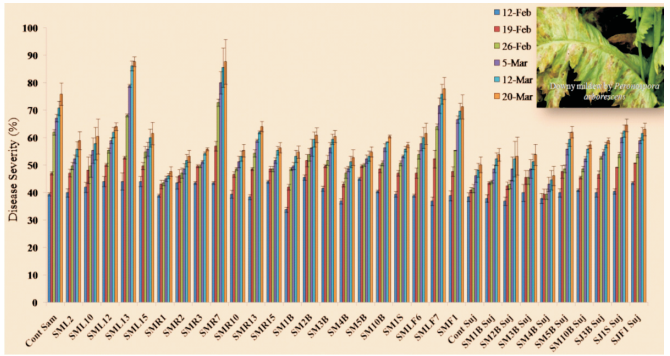


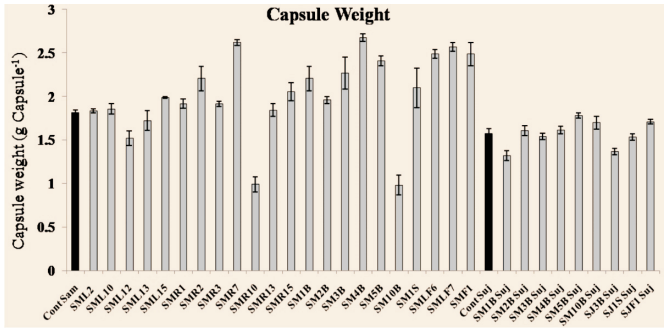
Endophytes isolated from *Papaver somniferum* (32), *Catharanthus roseus* (46) and *Withania somnifera* (44).





Endophytes improved photosynthesis, growth and yield of Papaver plants. SM1B, SM4B and SM5B enhanced plant yield by 22-36%.





Endophytes protected Papaver plants from downy mildew disease and enhanced plant yield. Maximum protection was afforded by SM4B resulting in 48% increase in yield.

Input: Kalra Alok

Analysis of expression of *CYPs* (Cytochrome P450) isolated from *Artemisia annua* trichomes

Multiple Sequence alignment of *CYP*s Degenerate Primers

↓

Artemisia annua Trichome RNA

↓

20 partial sequences amplified

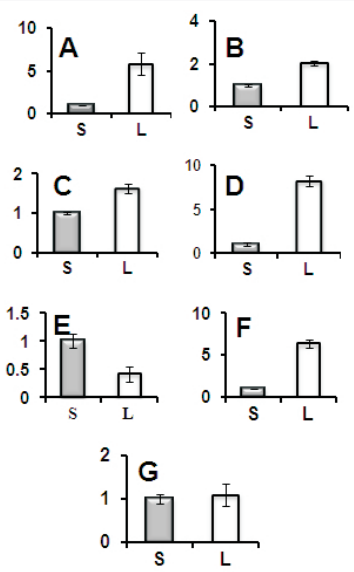
↓

Seven *CYP*s converted to full length and assigned to different families based on sequence homology

↓

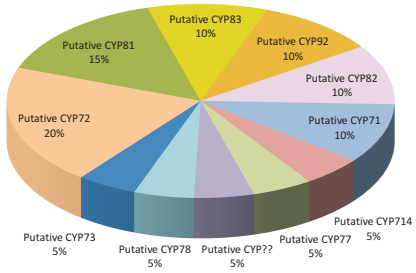
A: *CIM_CYP71AV1*, **B:** CIM_ CYP02(c73), **C:** CIM_CYP03(c72a), **D:** CIM_CYP04(c83), **E:** CIM_ CYP05(c81), **F:** CIM_CYP06 (c72b) and **G:** CIM_CYP07(c92)

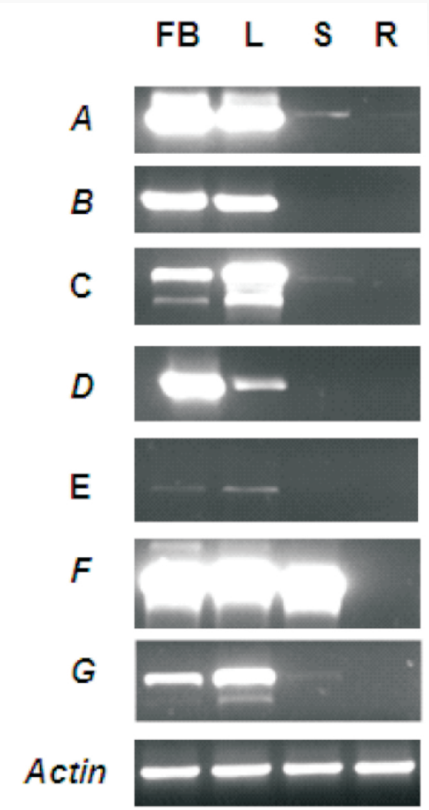
Input: Shasany AK



Expression analysis 1.
S: 20 days old seedling and L: mature leaf from 150 days old plant

Partial CYPs





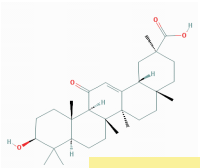
Expression analysis 2.
FB: Flower bud, L: Leaf, S: Stem, R: Root

Computer aided translational medicine: Genome to medicine
Optimization of active phytomolecules derivatives as lead against cancer and drug resistant bacterial pathogens

Objective was to develop new virtual screening methods and identification of anticancer and antibacterial compounds.

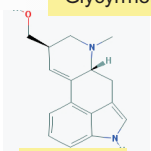
Active Phyto-Molecules → In silico design, ADMET Screening, Docking studies → QSAR model development (in silico assay) → Isolation, chemical synthesis, transformation → *in-vitro* experimental validation (Antimicrobial, Anticancer activity) → **New Leads**

In silico & *in vitro* anticancer studies of 18ß-glycyrrhetinic acid from *Glycyrrhiza glabra*



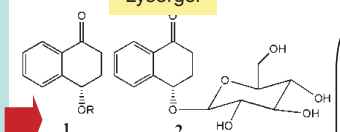
Glycyrrhetinic acid

Structure activity relation of gallic acid & lysergol derivatives for antibacterial activity



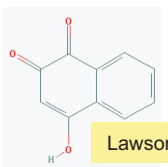
Lysergol

In silico & *in vitro* studies for anti-oxidant and anti-inflammatory activity of 4-hydroxy-a-tetralone derivatives from *Ammannia baccifera* Linn.



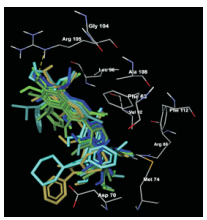
4-Hydroxy-a-tetralone

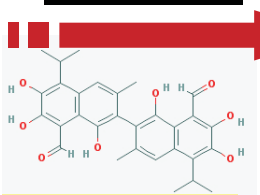
In silico & *in vitro* studies on Lawsone & its derivatives for anticancer & anticandidal activities



Lawsone

Development of method for 3-point data estimation & SVR-QSAR model, to screen anticancer leads against human colorectal cancer protein BCL2 (induces Apoptosis)





Gossypol acetic acid (from Cotton seed & root)

***In vitro* anticancer activity evaluated by MTT Assay**

Human Cancer Cell Lines	Percent Cytotoxicity Range
Lung	0-6.9
Liver	0-3.7
Colon*	38.1-48.3
Breast	0-2.9
Neuron	0-14.6

* Significant cytotoxicity range

***In vitro* activity**

Active derivatives of glycyrrhetinic acid, lysergol, 4- hydroxy-a tetralone and lawsone

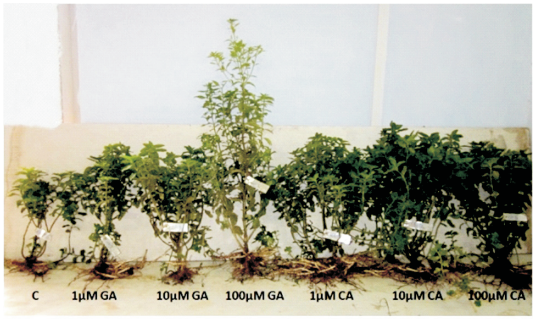
Input: Khan Feroz

Outcome: Developed a method for virtual screening of Gossypol analogs targeting BCL2 anticancer target; identified 18β-glycyrrhetinic acid from *Glycyrrhiza glabra* as potent anticancer compound.

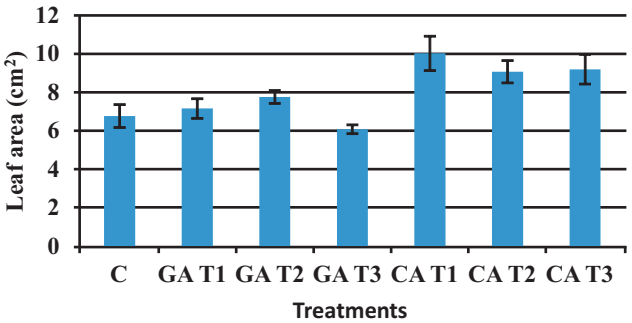
Comb Chem High Throughput Screen. 16 (6): 425-34, 2013. (IF: 2.0)
Med Chem. 9 (8): 1073-84, 2013. (IF:1.496)

Studies on evaluation of calliterpenone and GA_3 on growth parameters, trichomes, essential oil and gene expression in *Mentha arvensis*

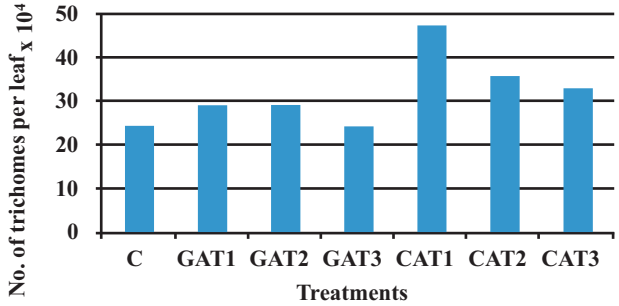
Experiments were conducted on *M. arvensis* variety *Kosi* for understanding the effect of gibberllic acid (GA) and calliterpenone (CA) treatments on growth attributes, trichomes and essential oil biosynthesis. CA, a stereo-isomer of abbekutone, the precursor of gibberellic acid has shown considerable improvement in the growth parameters studied. The exogenous application of CA (0 µM, 10 µM, 100 µM) was found to be better in improving biomass and sucker yield, leaf area, branching, leaf stem ratio than GA_3 at same concentrations. CA treated plants showed higher glandular trichome number, density and diameter correlated with enhanced oil biogenetic capacity. The results suggest CA as a novel plant derived diterpenoid with growth promoting action and opens up new possibilities for improving the crop yields and quality and quantity of essential oil from commercially important medicinal and aromatic plants.



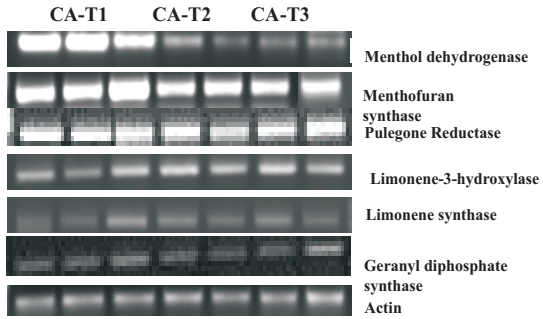
Growth of plants under various treatments of GA and CA



Variation in leaf area : C-control; GAT1- 1µM, GAT2-10 µM, GAT3-100 µM: CAT1-1µM, CAT2-10µM, CAT3-100 µM



Variation in total trichome number

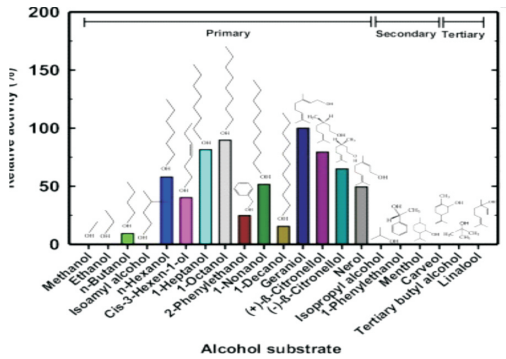


Expression profile of key pathway genes

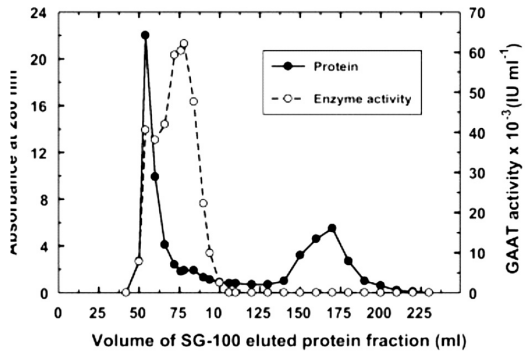
Input: Sangwan NS

Studies on Alcohol Acyl Transferase (AATs): Biochemical characteristics of a novel vegetative tissue geraniol acetyltransferase from a monoterpene oil grass (Palmarosa, *Cymbopogon martinii* var. *motia*) leaf

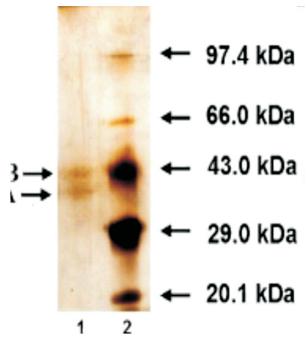
The enzyme plays key role in volatile aroma ester formation in the plant. The native AAT enzyme from palmarosa leaf tissues was purified for the first time and kinetically and biochemically characterized.



Substrate specificity of Palmarosa leaf geraniol: (GAAT) activity with primary, secondary and tertiary alcohols.



Size-exclusion chromatography of Palamarosa leaf GAAT on a Sephadex G-100 column.

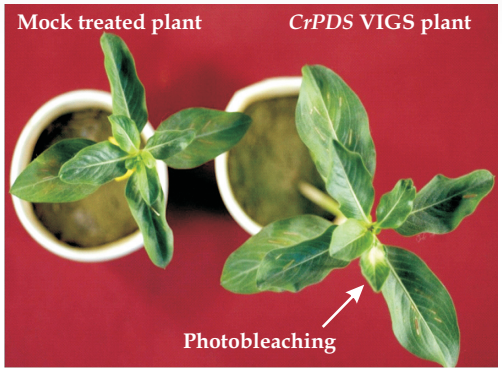


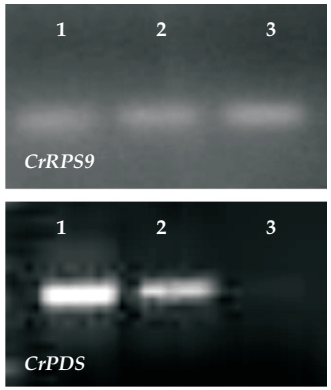
- GAAT (Geraniol Alcohol Acyl Transferase) from palmarosa possess novel attributes in terms of specificity and kinetic constants
- amino acid sequence deviations in or at proximity to the motifs (HXXD and DFGWG) believed to be essentially conserved in BAHDs.
- some additional motifs of significant conservation and potential functional or catalytic significance observed
- remarkably broad but stereo-selectivity of the GAAT for acyl-acceptor hydroxyl group ordains it to be catalytically named as a broad specificity primary aliphatic alcohol AAT.

Input: Sangwan NS

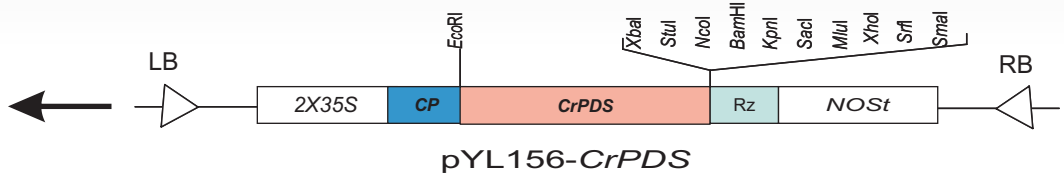
Plant Science Volume (203–204): 63–73, 2013

Development of an efficient Virus Induced Gene Silencing (VIGS) protocol for *Catharanthus roseus* using phytoene desaturase in genotype Dhawal





Semi-quantitative RT-PCR for expression profiling of CrPDS gene, whereby CrRPS9 gene was used as an endogenous control
Lane 1 - Untreated
Lane 2 - Mock treated
Lane 3 – VIGS Experimental photobleached



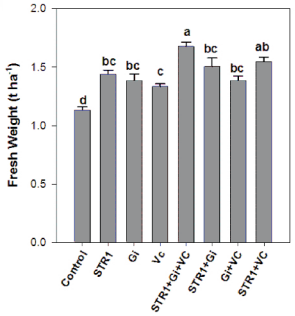
Map of pYL156-CrPDS construct. CP-Coat Protein; Rz-self-cleaving ribozyme; NOSt-nopaline synthase terminator

- Virus Induced Gene Silencing (VIGS) is an attractive method for assaying gene function, specially in plant species that are recalcitrant to conventional genetic transformation.
- Although VIGS methods have become available for many medicinal plant species including *C. roseus*, there is always a need to improve upon their efficiency and make them applicable to our indigenous genotypes.
- A highly efficient Tobacco Rattle Virus (TRV)-based VIGS protocol has been developed using phytoene desaturase (*CrPDS*) marker gene in elite genotype Dhawal.
- Partial sequence of *CrPDS,* available in NCBI GeneBank (Accession GU179342) was used to amplify a 527bp fragment. It was cloned in the EcoR site of pYL156 (pTRV2) and the pYL156-*CrPDS* (pTRV2-*CrPDS*) construct was transformed into *Agrobacterium* GV3101 strain. Besides, empty pTRV2 vector (pTRV2-E) and pTRV1 were also transformed into *Agrobacterium* separately.
- Dhawal plants were vacuum infiltrated at 2-8 leaves stage with 1:1 mixture of *Agrobacterium* carrying pTRV1 and pTRV2-*CrPDS*. As a mock treatment, Dhawal plants of the same stage were infiltrated with 1:1 mixture of *Agrobacterium* carrying pTRV1 and pTRV2-E.
- Leaf photobleaching was observed in the *CrPDS* VIGS plants but not in the mock treated plants and *CrPDS* transcript abundance decreased in photobleached plant leaves as compared to control (mock treated or untreated) leaves.
- Subsequently, the full length mRNA sequence of the *CrPDS* (Accession JX390616) has also been obtained through RACE (Rapid Amplification of cDNA Ends).

Input: Shukla Ashutosh

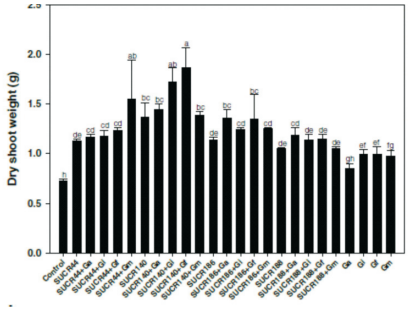
Microbial interventions to improve yields and reduce stress induced damage

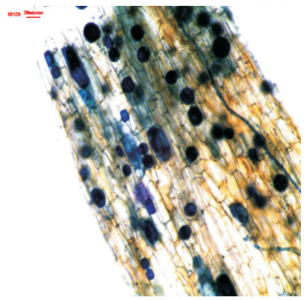
Improving salt tolerance in *Ocimum*



Salt tolerant PGPR *Dietzia natronolimnaea (STR1)* in combination with AM fungi *Glomus intraradices* and vermicompost improved *Ocimum basilicum* growth in salt stressed fields.

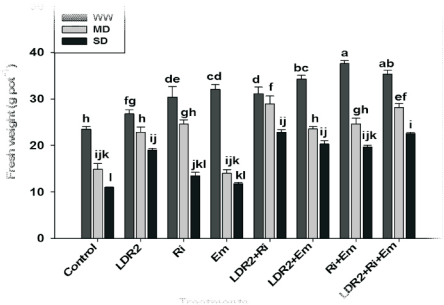
Reducing chromium induced damage

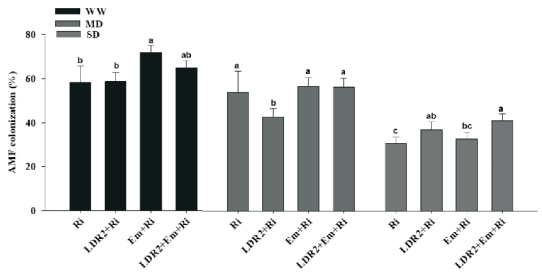


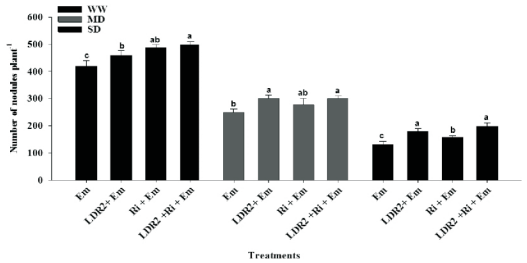


Cr(VI)-reducing bacteria SUCR140 (*Microbacterium* sp.) reduces the chromium toxicity, improves the colonization of mycorrhizal fungi *Glomus fasciculatum* resulting in enhanced growth and yield of *Zea mays*.

Managing drought stress







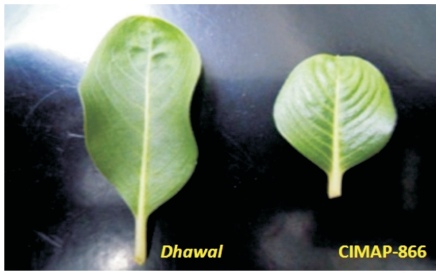
Application of a ACC deaminase producing *Bacillus subtilis* (LDR2) improved nodulation *(Ensifer meliloti)* and mycorrhization (*Glomus intraradices)* resulting in enhanced *Trigonella* growth under varying drought levels.

Input: Kalra Alok

Journal of Plant Growth Regulation 32: 809-822, 2013 (IF=1.99)
Environmental Science Pollution Research 20(3): 161-174, 2013 (IF=2.618)

Molecular analysis of tissues / genotypes of *Catharanthus roseus* having contrasting terpenoid indole alkaloid (TIA) profiles

Comparative analysis of *Catharanthus roseus* genotypes differing in their morphological and chemotypic (alkaloid) characters



Selection

Vegetative multiplication

Validation of vindoline content; further variety development

Catharanthus plants in the National Gene Bank for Medicinal and Aromatic Plants

- For semi-synthetic production of anticancer bisindole alkaloids from monomers, catharanthine is easily available but sourcing vindoline is the main bottleneck.
- *Catharanthus roseus* being the only known source of vindoline, there is need to identify its genotypes that accumulate higher-than-usual levels of vindoline.
- A *C. roseus* genotype (CIMAP-866) in the National Gene Bank for Medicinal and Aromatic Plants at CIMAP, Lucknow has been found to accumulate significantly higher amount of vindoline as compared to the elite variety *Dhawal*.
- The total alkaloid content of CIMAP-866 was also higher than that in *Dhawal*.
- As compared to *Dhawal*, CIMAP-866 possesses distinct morphology like dwarf character, spreading/bushy growth, wider canopy, non-wavy leaf margin, shorter petiole and higher chlorophyll content.
- Real Time PCR indicated that the transcript abundance of the gene involved in the last step of vindoline biosynthesis [Acetyl-CoA: 4-*O*-deacetylvindoline 4-*O*-acetyl-transferase (*DAT*)] was higher in CIMAP-866 as compared to *Dhawal*.
- Attempts are on to answer the key question - "How do *C. roseus* genotypes and/or stages having higher-than-usual levels of key alkaloids differ from the normal ones?"

Input: Shukla Ashutosh

Cloning and sequence characterization of coumarate CoA ligase (4CL) gene from *Ocimum sanctum*

Abies beshanzuensis, Abies holophylla, Agastache rugosa, Allium cepa, Arabidopsis thaliana, Camellia sinensis, Cedrus atlantica, Glycine max, Lithospermum, erythrorhizon, Nicotinana tabacum, Populus balsamifera, Populus tremuloides, Pseudolarix amabilis, Rubus idaeus, Tsuga canadensis, Tsuga mertensiana

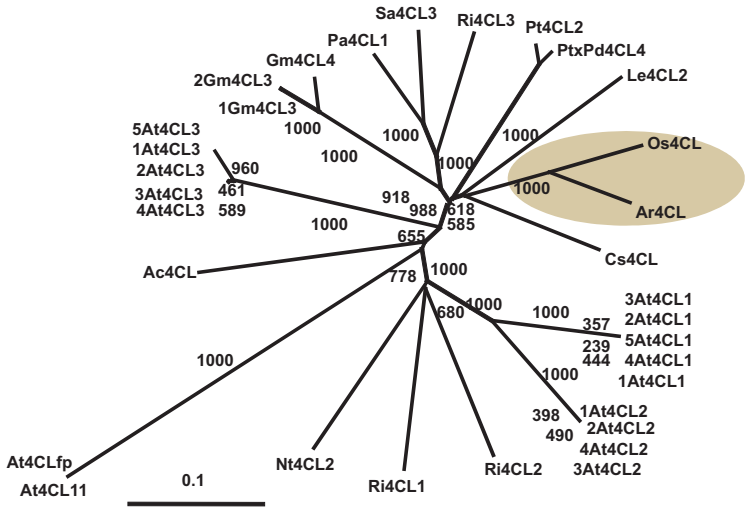
4CL genes in 8 Groups

Multiple sequence alignment

8 primer pairs amplification of trichome RNA

531 bases was obtained from the group1 primer pair

RACE (Rapid Amplification of cDNA Ends) & Full Length



Phylogenetic tree

Input: Shasany AK

Unrooted phylogenetic tree of plant 4CLs comparing the nucleotide sequence of *Ocimum* 4CL with 4CLs reported from other species. GenBank accession numbers for the corresponding DNA sequences are:*Ocimum sanctum* **Os4CL** (HM990148); *Arabidopsis thaliana* **1At4CL1** (NM_104046); *Glycine max* **1Gm4CL3** (AF002257); *Glycine max* **2Gm4CL3** (AF002258); *Populus tremuloides* **Pt4CL2** (AF041050); *Arabidopsis thaliana* **1At4CL3** (AF106087); *Arabidopsis thaliana* **2At4CL3** (AF106088); *Rubus idaeus* **Ri4CL3** (AF239685); *Rubus idaeus* **Ri4CL2** (AF239686); *Rubus idaeus* **Ri4CL1** (AF239687); *Populus balsamifera* **PtxPd4CL4** (AF283553); *Arabidopsis thaliana* **1At4CL2** (AY099695); *Arabidopsis thaliana* **2At4CL1** (AY099747); *Arabidopsis thaliana* **2At4CL2** (AY376728); *Arabidopsis thaliana* **3At4CL1** (AY376729); *Arabidopsis thaliana* **3At4CL3** (AY376730); *Arabidopsis thaliana* **At4CL11** (AY376735); *Allium cepa* **Ac4CL** (AY541033); *Agastache rugosa* **Ar4CL** (AY587891); *Arabidopsis thaliana* **3At4CL2** (BT000296); *Lithospermum erythrorhizon* **Le4CL2** (D49367); *Camellia sinensis* **Cs4CL** (DQ194356); *Arabidopsis thaliana* **4At4CL3** (NM_105180); *Arabidopsis thaliana* **4At4CL2** (NM_113019); *Arabidopsis thaliana* **At4CLfp** (NM_123172); *Arabidopsis thaliana* **4At4CL1** (NM_179462); *Arabidopsis thaliana* **5At4CL3** (NM_179513); *Arabidopsis thaliana* **5At4CL1** (U18675); *Arabidopsis thaliana* **Nt4CL2** (U50846); *Glycine max* **Gm4CL4** (X69955); *Prunus avium* **Pa4CL1**(GU990523); *Sorbus aucuparia* **Sa4CL3**(GU949553).

Full length cDNA sequence of 4CL gene was found to be 1704bp, encoding a polypeptide of 568 amino acid residues. The weight of the deduced protein was predicted to be 60.88 kDa. The nucleotide sequence has been submitted in the NCBI database with the accession number HM990148.

Extraction and isolation of aromatic and bioactive components of *Nepeta hindostana*

Chemical composition of the essential oil was analyzed by GC/GC-MS and its anti-inflammatory activity was studied. The n-hexane extract after chromatographic separations has given several fractions. The test showed that the methanol extract is most active with carragenon induced paw edema having 39% inhibition in 3hrs *in-vivo* test. While aqueous methanol extract showed moderate activity, the ethyl acetate did not show any significant activity.

Inputs: Mishra LN

Exploration of Unexplored Aroma Plants for Characterization and Creation of Aroma Library

Aroma profiling of Himalayan cypress (*Cupressus torulosa* D. Don):

The essential oils from male and female branchlets and from female cones of *Cupressus torulosa* were analyzed and compared. Monoterpene hydrocarbons (51.09%–58.06%) and oxygenated monoterpenes (28.61%-39.48%) were found to be the major group of the constituents. Predominant constituents were umbellulone (16.26%-26.66%), terpinen-4-ol (0.10%-19.64%), α-pinene (9.62%-17.76%), limonene (13.27%-14.56%), sabinene (5.87%-14.33%), γ-terpinene (1.97-6.89%) and α-terpinene (1.95%-5.31%). This is the first report on comparative essential oil composition of male, female branchlets and female cones of *Cupressus torulosa* from India.

Journal of Essential oil Research 25(4):251-256, 2013 (IF: 0.55)

Characterization of volatile constituents of Pindrow Fir (*Abies pindrow* (Royle ex D. Don) Royle):

Essential oils extracted from needle and stem of *A. pindrow* were analyzed GC and GC-MS; 56 constituents were identified comprising 96.33%, 83.68% of needle and stem oil compositions. Results showed that the essential oil of pindrow fir contained 73.44%, 66.29% monoterpene hydrocarbons, 6.55%, 2.62% oxygenated monoterpenes, 4.76%, 4.68% sesquiterpene hydrocarbons, 11.58%, 2.56% oxygenated sesquiterpenes in needle and stem oil respectively. Major constituents were limonene (20.98%-34.38%), camphene (0.53%-19.86%), α-pinene (13.81%-16.80%), myrcene (6.74%-8.34%) and β-pinene (6.51%-8.57%).

Inputs: Padalia RC

Seasonal variation study on volatile constituents of *Artemisia nilagirica* var. *septentrionalis* Pamp.:

Variation in essential oil content and composition of the aerial parts of *A. nilagirica* var. *septentrionalis* Pamp. in different seasons (spring, summer, rainy, autumn and winter) were analysed and compared. The results have been tabulated

Compounds	Content of Major constituents (%)				
	Spring	Summer	Rainy	Autumn	Winter
Artemisia ketone	**60.71**	**55.21**	**45.03**	**38.26**	**61.20**
Artemisia alcohol	3.62	2.98	2.34	1.37	3.20
Perillene	2.12	1.17	0.80	1.10	0.52
2,6-Dimethyl phenol	1.88	0.18	0.35	0.23	1.54
Chrysanthenone	1.52	6.53	7.71	6.67	3.78
Carvone	1.23	1.60	1.17	1.21	1.37
Bornyl acetate	1.24	1.51	2.30	2.28	1.01
β-Caryophyllene	3.26	2.31	4.33	6.76	1.91
Germacrene D	3.11	4.22	6.81	6.81	3.14
δ-Cadinene	1.12	1.34	2.12	2.39	0.93
Total identified	94.16	94.31	93.14	92.07	94.56

Inputs: Verma RS

Chemical profiling of the essential oil of *Perilla frutescens*

Perilla frutescens

Essential oil isolated from Indian Perilla [*Perilla frutescens* (L.) Britton] was analysed by GC/FID and GC/MS. Essential oil yield varied from 0.26% to 0.35% during different phenophases. Major constituents of the oil were perilla ketone (39.5-59.3%), isoegomaketone (9.4-45.7%), (*E*)-caryophyllene (0.1-13.4%), and caryophyllene oxide (0.4-3.8%). Perilla ketone was found to be higher at seed maturity stage (59.3%), while isoegomaketone recorded higher during vegetative stages (39.8-43.6%). Further, perilla ketone and (E)-caryophyllene were found to be higher in inflorescence, while isoegomaketone was higher in leaves.

Journal of Essential Oil Research **25(2); 92-96, 2013 (IF: 0.55)**

Characterization of *Paeonia emodi* Royle essential oil

Roots of the Himalayan Peony (*Paeonia emodi* Royle) have been used as a traditional medicine of epilepsy since long. Hydrodistilled volatile oil of the fresh roots of *P. emodi* was investigated by GC/FID, GC/MS, and NMR (^{1}H, & ^{13}C). Twenty four constituents comprising 97.4% of the total oil composition were identified. Major components of the essential oil were salicylaldehyde (85.5%), *cis*-myrtanal (4.9%), myrtenal (1.8%), *trans*-myrtanol (1.6%) and nopinone (1.4%).

Paeonia emodi

Inputs: Verma RS

Anti-bacterial activity of the essential oils of under-explored aromatic plants

The anti-bacterial activity of the essential oils of tabulated plants was studied. The major chemical compounds and results of the anti-bacterial activity test are given below:

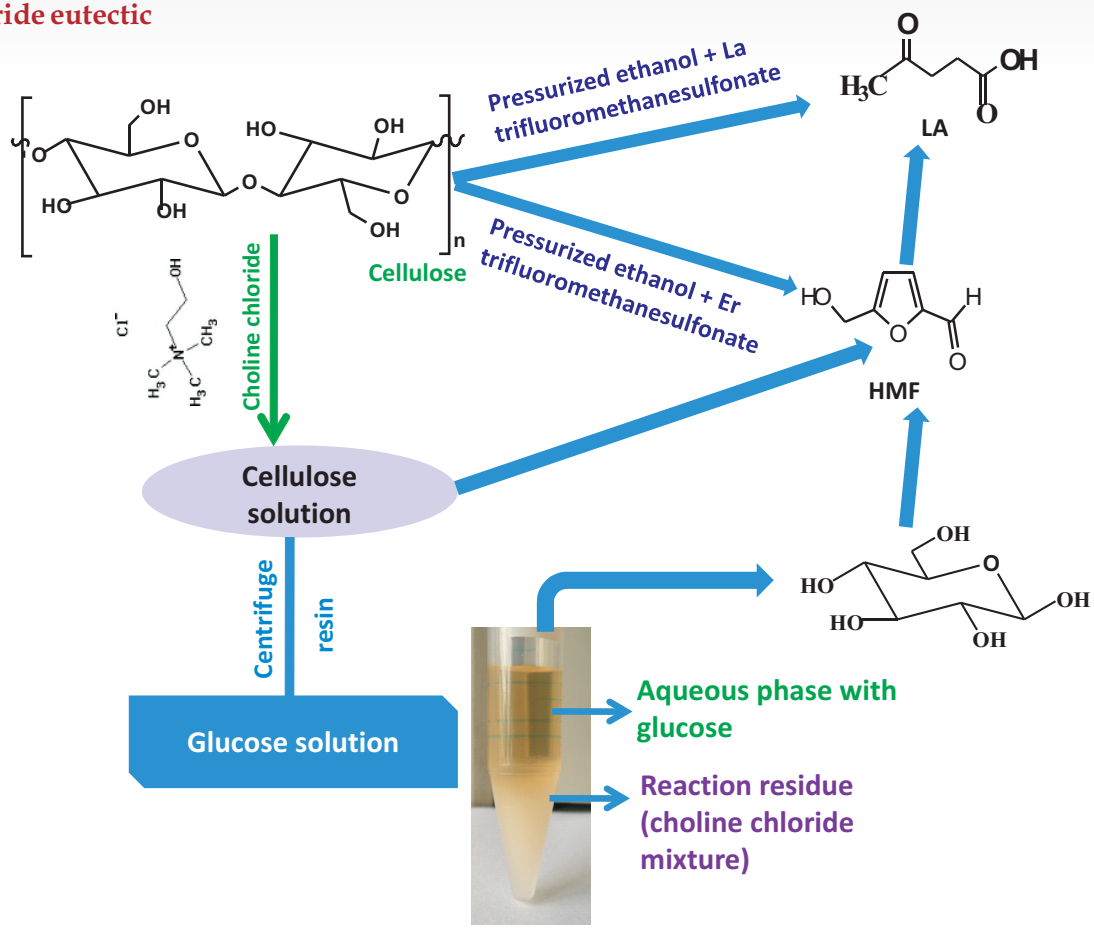
Aromatic plant	Major compounds
Conyza canadensis	Limonene (18.2%), β-Copaen-4-α-ol (14.2%), Carvone (5.0%), ar-Curcumene (4.6%)
Cyclospermum leptophyllum	Thymohydroquinone dimethyl ether (46.8%), Thymol, methyl ether (14.6%) p-Cymene (13.9%), γ-Terpinene (8.9%), Carvacrol methyl ether (7.5%)
Perilla frutescens	Perilla ketone (48.0%), Isoegomaketone (38.0%)
Laggera crispata	2,5 Dimethoxy-p-cymene (47.8%), 10-epi- -Eudesmol (17.7%), -Humulene (5.1%), Juniper camphor (4.8%), 7-epi-α-Eudesmol (3.2%)
Cannabis sativa	(*E*)-Caryophyllene (19.6%), Limonene (15.8%), α-Pinene (7.7%), Myrcene (6.0%), Terpinolene (6.0%), α-Humulene (5.7%), (*E*)-β-Farnesene (4.8%)
Bidens pilosa	Octadecadienol (32.8%), Bornyl acetate (19.4%), n-Hexadecanol (7.7%)
Limnophila rugosa	Methyl chavicol (76.6%), (*E*)-Anethole (19.1%)
Eucalyptus citriodora (fruit)	α-Pinene (40.7%), γ-Terpinene (11.8%), Citronellal (7.1%), p-Cymene (6.5%)
Pimenta dioca	Eugenol (76.6%), Myrcene (11.0%), Chavicol (3.3%), Limonene (3.1%)

Essential oil	Zone of Inhibition (mm)								
	SA-96	EC-789	SM	EC-DH5α	PA	STm	KP	BS	SA-2940
Conyza canadensis	6	-	3	-	-	-	-	-	7
Cyclospermum leptophyllum	7	-	8	-	-	-	-	-	8
Perilla frutescens	4	-	12	-	-	-	-	12	-
Laggera crispata	-	-	10	-	-	-	6	-	8
Cannabis sativa	11	-	9	-	-	7	-	4	10
Bidens pilosa	5	-	3	-	-	-	-	-	7
Limnophila rugosa	8	5	6	5	-	10	7	9	7
Eucalyptus citriodora (fruit)	13	10	10	8	8	11	6	10	14
Pimenta dioca	12	8	10	15	10	16	12	20	16

SA: *Staphylococcus aureus*; **EC**: *Escherichia coli*; **SM**: *Streptococcus mutans*; **PA**: *Pseudomonas aerugenosa*; **STm**: *Salmonella typhimurium*; **KP**: *Klebsiella pneumoniae*; **BS**: *Bacillus subtilis*.

Input: Verma RS

Synthesis of glucose, hydroxymethyl furfural (HMF) and levuliniC acid (CA) from cellulose in supercritical ethanol and choline chloride eutectic



Isolation process of glucose

Flow chart of synthesis of glucose, HMF and LA

Input: Rout PK

Technology Enabled Village (TechVill)

Survey for the selection of medicinal and aromatic plant entrepreneurship based technology enabled village (TechVill) in Uttar Pradesh was conducted. The Tech Vill aims at developing MAPs based entrepreneurial skills in local inhabitatnts for enhancement of income by cultivation, post harvest processing, product development and waste management for health, energy and prosperity. Based on the selection criteria of percentage of SC/ST, unemployed youth and women population in the area, a pilot village Daun (District Unnao) was selected as TechVill. Area measuring 0.492 ha was acquired from the local *Gram Sabha*.

The land was leveled for making it usable for cultivation of MAPs. Layouts for setting up of the demonstration, production and experimental plots were developed. Commercially viable aromatic crops were planted in the plots for demonstration and production of the elite planting material for distribution among the nearby farmers.

Tractor Trolley Mounted Mobile Distillation Unit

A tractor trolley mounted directly-fired-type mobile distillation unit was conceptualized, designed and developed by the institute. The unit was fabricated as part of rural development project and released on May 11 2012, the National Technology Day. The mobile distillation unit is easy to operate, efficient, safe and robust. It is mounted on a tractor trolley and can be easily transported and made operational in a short period of time. The unit will be beneficial for the small and marginal farmers cultivating aromatic crops like mints, lemongrass, palmarosa, citronella, basil, patchouli, vetiver etc., who cannot afford to have their own distillation unit.

Improvement in Khus-Digger

The Khus-digger developed by the institute was further improved with additional attachment – a detachable iron disc for making pre-cut furrows to minimize the harvesting load on the tractor. The attachment improves efficiency and provides a balanced, well supported in-line field operation of the Khus-digger.

New Improved Varieties

Three new improved varieties of following commercially important medicinal and aromatic crops were released.

(A) Vetiver: CIMAP-Khus 22 of vetiver (*Chrysopogon zizanioides*) is an improved variety with higher essential oil yield (28kg/ha) and average oil content (1.8%).

(B) Geranium: CIMAP Bio-G-171 of geranium (*Pelargonium graveolens*) is an improved variety with significantly higher oil content (0.24%) and oil yield (45kg/ha) against the checks Bourbon and CIM-Pawan.

(C) Silybum: CIMAP Sil-9 of Silybum (*Silybum marianum*) is an improved variety having shorter plant height (80-90cm), higher (>8%) silymarin content and higher seed yield (10 quintal eeds/ha).

New Products Released

Lip Balm: Strawberry flavored lip balm formulation was developed jointly with CSIR-National Botanical Research Institute, Lucknow and released. The product uses herbal colour and natural ingredients to protect the lips.

Training on Essential Oil Processing Technologies (EOPT-2012)

Six day hands-on entrepreneurial training cum workshop on Essential Oil Processing Technologies (EOPT-2012) for processing and value addition of essential oils was organized from 23-28 April 2012. Twelve participants from the states of Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Haryana, and Uttar Pradesh participated in the six day training workshop. The training programme covered different aspects of processing and value addition technologies for aromatic plants with particular emphasis on the quality control procedures for the essential oils.

Training on processing and quality aspects of *Mentha arvensis* essential oil

Three day hands-on training programme on processing and quality aspects of *Mentha arvensis* essential oil was organized from 28 - 30 August 2012. Ten participants mainly from the states of Bihar, Uttar Pradesh and Delhi participated. The programme covered different aspects of post harvest management and agro-technology of *Mentha* and practical exposure on distillation, menthol production, value addition, purification and quality control of the oil.

Training on *Aloe vera* processing technologies (AVPT-2013)

Four day training-cum-workshop for the budding entrepreneurs interested in setting up processing units for aloe juice, sap and gel was organized from 20 - 23 November 2012. Twenty two participants from the states of Tamil Nadu, Maharashtra, Rajasthan, Chattisgarh, West Bengal, Madhya Pradesh, Haryana, Uttarakhand, Delhi and Uttar Pradesh participated. The training module was designed to impart step by step knowledge on the processing technologies for production of *Aloe vera* juice, sap and gel and familiarize the participants with the technical and practical aspects of the technologies by hands-on experience at pilot scale level. Emphasis was laid on the quality analysis procedures of the aloe based products for maintaining quality.

Training programme organised for farmers and entrepreneurs:

S. No.	Dates	Sponsoring Agency	Number of participants
1.	6-9 June, 2012	SIDBI	50
2.	6-8 August, 2012	SIDBI	40
3.	8-9 October, 2012	ATMA, West Champaran, Bihar	25
4.	7-9 November, 2012	SIBDI	32
5.	3-5 December, 2012	SIBDI	45
6.	21-22 June, 2012	DFO, Renukoot	40
7.	6 November, 2012	In-house	25
8.	8-10 January, 2013	ATMA, Buxer, Bihar	30
9.	5-7 March, 2013	SIBDI and DHO Vaishali, Bihar	50

CSIR Technology Award 2012

Institute received the CSIR Technology Award for Life Sciences 2012 for development and commercialization of anti-malarial drug plant *Artemisia annua* technology package facilitating industrial growth, societal health and rural prosperity. The award was given by Minister for Science & Technology and Earth Sciences and Vice President, CSIR Shri Vayalar Ravi in the 70th CSIR Foundation Day function held at Vigyan Bhawan, New Delhi on 26th September, 2012. The Award included a citation and a cash prize of Rs Two Lakhs. The team comprises Drs. AK Gupta, AK Shasany, MM Gupta, Sudeep Tandon, RS Bhakuni, Alok Kalra, AK Singh, RP Bansal, SPS Khanuja and Prof. Ram Rajasekharan.

Prof. Ram Rajasekharan (centre) receiving the award from Hon'ble Minister for S&T and ES and VP, CSIR Shri Vayalar Ravi

The high yielding superior variety 'CIM-Arogya' has remarkably enhanced biosynthesis of anti-malarial drug molecule 'artemisinin'. A unique Pharma-Farm value chain linkage in Public-Private Partnership (PPP) mode through CSIR-CIMAP Biovillage approach was established resulting in self reliance in drug production for the deadly malaria and enhancement of the farmers' income.

Students enrolled for PhD

Academy of Scientific Innovative Research (AcSIR)

Biological Science: 13

Chemical Sciences: 3

CIMAP-JNU (New Delhi) PhD program

Biological and Chemical Sciences: 20

PhDs Awarded under CIMAP-JNU Program: 4

Dr U.C. Lavania
Elected as Fellow of National Academy of Sciences, India
President, Plant Sciences Section, Indian Science Congress Association 2012-13

Dr Karuna Shanker, Dr Suaib Luqman
Dr P D Sethi Award-2012

Dr Ashutosh Shukla
Indo-US Research Fellowship of the Indo-US Science and Technology Forum (IUSSTF) and DST for advanced research at Donald Danforth Plant Science Center, St. Louis, Missouri, USA.

Dr Dinesh Nagegowda
Editorial Board Member – Biomed Research International (IF -2.88) (Hindawi Publishers)
Editorial Board Member – Molecular Biology and Genetic Engineering (Herbert Publications)

Dr Sunita Singh Dhawan
Member, Academic Council of Fragrance and Flavour Development Centre (FFDC), Kannauj

Staff superannuated

Mr. U.S. Rawat, Controller of Finance & Accounts, superannuated on 30 March 2012

Dr H.N. Singh, Senior Principal Scientist, superannuated on 31 July 2012

Mr. Mehdi Mirza, Senior Technical Officer, superannuated on 31 August 2012

Mr. Sushil Kumar, Principal Technical Officer, superannuated on 31 August 2012

Dr. A.K. Singh, Chief Scientist, superannuated on 31 October 2012

Mr. Syed Tahir Husain, Principal Technical Officer, superannuated on 31 October 2012

Dr Mansoor Alam, Chief Scientist, superannuated on 31 December 2012

Dr Dwijendra Singh, Chief Scientist, superannuated on 31 December 2012

Mr. V.P. Rakhwal, Technician, superannuated on 31 December 2012

Mr. S. Manjunatha, Assistant, superannuated on 31 December 2012

CIMAP welcomes new staff

Dr (Ms) Preeti Srivastava
Scientist w.e.f. 18 April 2012

Dr Dinesh A. Nagegowda
Principal Scientist w.e.f. 26 April 2012

Dr D.K. Venkata Rao
Sr. Scientist w.e.f. 26 April 2012

Mr Bhaskar Shukla
Scienist w.e.f. 17 May 2012

Dr. C.S. Vivek Babu
Sr. Scientist w.e.f. 23 May 2012

Dr. (Mrs) Poornima Priyadarshini, CG
Scientist w.e.f. 13 Sept. 2012

Sri Sanjay Kumar Ram
Section Officer (G) w.e.f. 28 Dec. 2012

Dr. Sumit Ghosh
Sr. Scientist w.e.f. 30 Jan. 2013

Dr (Mrs) Prema G. Vasudev
Sr. Scientist w.e.f. 01 Feb. 2013

Dr Rakesh K. Upadhayay
Scientist w.e.f. 12 Feb. 2013

Kripa Ram
Group D (NT) w.e.f. 04 March 2013

Research Paper

1. Adinarayana G, Rahul G, Ravi KS, Syamasundar KV, Rao BRR. 2012. Journal of Pharmacognosy 3:142-146.
2. Agrawal J, Shanker K, Chanda D, Pal A. 2013. Parasitology Research 112 :2601-2609.
3. Ahmad I, Thakur JP, Chanda D, Saikia D, Khan F, Dixit S, Kumar A, Konwar R, Negi AS, Gupta A. 2013. Bioorg Med Chem Lett. 23(5):1322-5.
4. Alam M, Dharni S, Khaliq A., Srivastava SK, Samad A., Gupta MK. 2012. Ind. J. Exprt. Biol. 50, 559-568.
5. Anshul N, Bhakuni RS, Gaur R, Singh D. 2013. Florida Entomologist 96:897-903.
6. Barnawal D, Bharti N, Maji D, Chanotiya CS, Kalra A. 2012. Plant Physiology and Biochemistry, 58: 227-235.
7. Barnawal D, Maji D, Bharti N, Chanotiya CS, Kalra A. 2013. Journal of Plant Growth Regulation, 32: 809-822.
8. Baskaran K, Srinivas KVNS, Kulkarni RN. 2013. Industrial Crops and Products 43:701-703
9. Bhargava M, Sharma A. 2012. Molecular Phylogenetics and Evolution 67:631-641
10. Bharti N, Agrawal P, Misra B, Tripathi A, Singh R, Maji D, Singh HP, Kalra A, 2012, Biocontrol Science and Technology, 23(2): 239-244.
11. Bharti N, Baghel S, Barnawal D, Yadav A, Kalra A, 2013, Journal of the Science of Food and Agriculture, 93: 2154-2161.
12. Bharti N, Barnawal D, Awasthi A, Yadav A, Kalra A, 2014, Acta Physiologiae Plantarum, 36: 45-60.
13. Bharti N, Yadav D, Barnawal D, Maji D, Kalra A, 2013, World Journal of Microbiology and Biotechnology, 29: 379-387.
14. Chanda D, Bhushan S, Guru SK, Shanker K, Wani Z A, Rah B A, Lquman S, Mondhe D M, Pal A, Negi A S. 2012. European Journal of Pharmaceutical Sciences 47:988-995
15. Chanda D, Bhushan S, Guru SK, Shanker K, Wani ZA, Rah BA, Luqman S, Mondhe DM, Pal A, Negi AS. 2012. Journal of Pharmaceutical Sciences 47: 988-995.
16. Chanda D, Pal A and Shanker K 2013. Medicinal Chemistry Research 22(1): 219-224.
17. Chanda D, Pal A, Shanker K. 2013. Medicinal Chemistry Research 22:219-224
18. Chanotiya CS. 2012. Medicinal and Aromatic Plants (Editorial) 1:1-2.
19. Chatterjee A, Chattopadhyay SK, Tandon S, Kaur R, Gupta A K, Malik R, Kant R. 2013. Industrial Crops and Products, 45:395-400.
20. Chatterjee A, Kumar S, Chattopadhyay S K. 2013. Biomedical Chromatography 27:1720-1725
21. Chattopadhyay A, Prasad A, Chand S, Rajkumari, Chauhan R, Pandey A. 2012. Journal of the Indian Society of Soil Science 60:330-334
22. Chaturvedi N, Singh M, Shukla AK, Shasany A, Shanker K, Lal RK, Khanuja SPS.2013. Protoplasma. 13:1-11
23. Chaturvedi N, Singh SK, Shukla A., Lal RK, Gupta MM, Dwivedi UN, Sashny AK. 2013. Physiologia Plantarum 12:1-10
24. Chauhan R, Gupta S, Soni G, Sudhamalla B, Sharma A. 2012. Journal of Biomolecular Structure and Dynamics, USA 31:874-887
25. Dharni S, Alam M, Kalani K, Abdul-Khaliq, Samad A, Srivastava SK, Patra DD. 2012. J. Microbiol. Biotechnol. 22, 674–683.

26. Dharni S, Alam M, Samad A, Khan F, Khaliq A, Luqman S, Patra DD. 2012. Indian Journal of Biotechnology 11: 438-444.
27. Dubey V, Masood N, Negi AS, Luqman Suaib. 2012. Current Bioactive Compounds 8:345-352
28. Dwivedi GR, Upadhyay HC, Singh A, Pal A, Srivastava SK, Srivastava PK, Darokar MP. 2012. European Journal of Clinical Microbiology and Infectious Diseases 31:3375-3383
29. Gaur R, Patel S, Verma RK, Mathur A, Bhakuni RS. 2013. Medicinal Chemistry Research DOI 10.1007/s00044-013-0726.
30. Goswami S, Bhakuni RS, Chinniah A, Pal A, Kar SK, Das PK. 2012. Antimicrobial Agents and Chemotherapy 56:4594-4607
31. Gupta N, Manika N, Singh S, Singh SC, Pragadheesh VS, Yadav Anju, Chanotiya C S. 2012. Natural Product Research 26:1945-1947
32. Gupta P, Gupta VK, Tiwari N, Pal A, Shanker K, Agrawal S, Verma RK, Darokar MP. 2012. African Journal of Pharmacy and Pharmacology 6:3221-3229
33. Gupta S, Sharma A. 2012. Science and Technology Journal 1:00-30
34. Kahlon A K, Darokar MP, Sharma A. 2012. Indian Journal of Biochemistry and Biophysics 49:442-450
35. Kashyap MP, Singh AK, Kumar V, Yadav DK, Khan F, Jahan S, Khanna VK, Yadav S, Pant AB. Stem Cells Dev. 2013. Jan; 22(2):224-38.
36. Kaur R, Chattopadhyay SK, Tandon S, Sharma S. 2012. Industrial Crops and Products 37:420-426
37. Kaur R, Vasudev G, Chattopadhyay S K. 2012. Acta Crystallographica section E 68:01861-01862
38. Khare P, Goyal DK. 2013. Ecological Engineering 52 :161-166
39. Khare SS, Mishra AK, Tiwari S, Pandey R. 2012. Journal of Cytology and Histology 3 :141-149
40. Khare SS, Tiwari S, Pandey R. 2012. International Environmental Sciences and Engineering Research 3:26-34
41. Klempien A, Kaminaga Y, Qualley A, Nagegowda DA, Widhalm JR, Orlova I, Shasany AK, Taguchi G, Kish CM, Cooper BR, D'Auria JC, Rhodes D, Pichersky E and Dudareva N. 2012. Plant Cell, 24: 2015-2030.
42. Kulkarni RN, Baskaran K. 2013. Journal of Heredity 104:140-148.
43. Kulkarni SS, Ravindra NS, Srinivas KVNS, Kulkarni RN. 2012. Natural Product Communications 7:1223-1224.
44. Kumar B, Gupta E, Mali H, Singh HP, Akash M. 2013. Journal of Crop Improvement 27:636-642
45. Kumar S, Sharma S, Chattopadhyay SK. 2013. Fitoterapia 89:86-125
46. Kumar S, Sharma S, Chattopadhyay SK. 2013. International Food Research Journal 20:397-402
47. Lal RK, Chandra R, Chauhan HS, Misra HO, Sangwan RS, Gupta MM, Verma RK, Singh AK, Yadav AN, Dhawan OP, Kalra A, Bahal JR, Singh HP, Gupta AK, Rai SK, Kumar B, Dubey B, Jhang T, Singh S, Singh VR, Pandey R, Bagchi GD, Sarkar S, Singh S. 2012. J of Medcinal Aromat. Plant. Sciencies 34:178-182
48. Lal RK, Gupta MM, Verma RK, Gupta P, Sarkar S, Singh S. 2013. J of Herb Spices and Medicinal Plants. 20:92-101
49. Lal RK, Gupta P, Gupta V, Sarkar S, Singh S. 2013. Industrial Crops and Products 49:273-277
50. Lal RK, Gupta V, Gupta P, Sarkar S, Singh S. 2013. J Herb Spices and Medicinal Plants. 20:70-82

51. Lal RK. 2013. Industrial Crop and Products. 40:296-301
52. Lal RK. 2013. Industrial Crops and Products 50:176-181
53. Lavania U C, Srivastava S, Lavania S, Basu S, Misra N, Mukai Y. 2012. Plant Journal 71:539-549
54. Luqman S, Kumar R. 2012. Annals of Phytomedicine 1:54-61
55. Luqman S, Kumar R. 2012. International Journal of Food Properties 15:942-948
56. Luqman S, Meena A, Singh P, Kondratyuk TP, Marler LE, Pezzuto JM, Negi AS. 2012. Chemical Biology & Drug Design 80 (4): 616-624.
57. Luqman S. 2012. Asian Pacific Journal of Cancer Prevention 13:2425-2427
58. Maji D, Barnawal D, Gupta A, King S, Singh AK, Kalra A. 2013, World Journal of Microbiology and Biotechnology, 29: 833-839.
59. Maurya A, Khan F, Bawankule DU, Yadav DK, Srivastava SK. Eur J Pharm Sci. 2012 Aug; 47(1):152-61.
60. Meher JG, Tarai M, Yadav NP, Patnaik A, Mishra A, Yadav KS. 2013. Carbohydrate Polymer 96:172-180
61. Meher JG, Yadav NP, Sahu J J, Sinha P. 2013. Drug Development and Industrial Pharmacy 39 :1540-1546
62. Meher JG, Yadav NP, Yadav KS, Rai VK. 2012. The Pharma Review 7:144-149
63. Mehrotra S, Prakash O, Khan F, Kukreja AK. Plant Cell Rep. 2013 Feb; 32(2):309-17.
64. Mishra AK, Tiwari S, Pandey R. 2012. Journal of Mycology and Plant Pathology 42:423-428.
65. Mishra N, Yadav NP, Meher JG, Sinha P, 2012. Asian Pacific Journal of Tropical Biomedicine, S1728-S1734.
66. Misra A, Chanotiya CS, Gupta MM, Dwivedi UN, Shasany A K (2012) Gene, 510:193-201.
67. Misra HO, Lal RK, Gupta AK, Kumar B, Misra AN, Sarkar S, Gupta V, Singh S, Singh S, Gupta P, Zaim M, Singh VR. 2013. Industrial Crop and Products. 49:593-597
68. Naidu RC, Kumar AN, Komuraiah B, Srinivas KVNS, Kumar JK, Ramakrishna KVS, Nayak VL, Ramakrishna S 2012. Journal of Chemical and Pharmaceutical Research 4:4558-4561
69. Osman MA, Dhawan SS, Bahl JR, Darokar MP. 2013. International Journal of Integrative sciences, Innovation and Technology Vol.2:50-54
70. Padalia RC, Verma RS, Chauhan A, Chanotiya CS, Yadav A 2012. Natural Product Communications 7:1070-1078
71. Padalia RC, Verma RS, Chauhan A, Chanotiya CS. 2012. Natural Product Research 26:2040-2044
72. Padalia RC, Verma RS, Chauhan A, Sundaresan V, Chanotiya CS. 2013. Maejo International Journal of Science and Technology 7:1070-93
73. Padalia RC, Verma RS, Chauhan A, Sundaresan V, Chanotiya CS. 2013. Maejo International Journal of Science and Technology 7:83-93
74. Padalia RC, Verma RS, Sah AN, Karki N, Chauhan A, Saikia D, Krishna B 2012. Journal of Essential Oil Bearing Plants 15:800-808
75. Padalia RC, Verma RS, Sundaresan V, Chauhan A, Chanotiya CS, Yadav A. 2013. Journal of Essential Oil Research 25:17-22
76. Padalia RC. 2012. Journal of Medicinal and Aromatic Plants 1:1-2
77. Pandey R, Gupta S, Shukla V, Tandon S, Shukla V. 2013. Indian Journal of experimental Biology 51:515-521
78. Pandey R, Saikia SK, Tiwari S, Shukla V, Kalra A 2012. International Journal of Environmental Sciences and Engineering Research 3:12-21

79. Parihar S, Gupta A, Chaturvedi AK, Agarwal J, Luqman S, Changkija B, Manohar M, Chanda D, Chanotiya CS, Shanker K, Dwivedi A, Konwar R, Negi AS. 2012. Steroids 77: 878-886.

80. Patel V, Maji D, Singh AK, Suseela MR, Sundaram S, Kalra A. 2014. Journal of Applied Phycology, 26: 279-286.

81. Pooja S, Karuna S. 2012. Fitoterapia 83(8): 1371-1385.

82. Pragadheesh VS, Yadav A, Singh M, Chanotiya CS 2013. Natural product Communications 8:221-224

83. Prakash O, Khan F, Sangwan RS, Misra LN 2013. Combinatorial Chemistry & High Throughput Screening 16:57-72

84. Prakash O, Rout PK, Chanotiya CS, Misra LN 2012. Industrial Crops Products 37:195-199

85. Prakash O, Sahoo D, Rout PK 2012. Natural products communication 7:89-92

86. Prakash, Rout PK, Chanotiya CS, Misra LN. 2012. Industrial Crops Products, 37, 195-199.

87. Prakash, Sahoo D, Rout PK, Natural Products Communication, 2012, 7, 89-92.

88. Prakasham AP, Saxena AK, Luqman S, Chanda D, Kaur T, Gupta A, Yadav DK, Chanotiya CS, Shanker K, Khan F, Negi AS. 2012. Bioorganic & Medicinal Chemistry 20 (9): 3049-3057.

89. Prasad A, Mathur A, Kalra A, Gupta MM, Lal RK and Mathur AK (2013) shoot cultures. Plant Growth Regulation 69: 265-273.

90. Prasad A, Mathur A, Singh M, Gupta MM, Uniyal GC, Lal RK, Mathur AK. 2012. J. Nat. Med. 66: 383- 387.

91. Prasad A, Pragdeesh VS, Mathur A, Srivastava NK, Singh M, Mathur, AK. 2012. Industrial Crops and Products. 35(1): 309-312.

92. Prasad A, Mathur A, Kalra A, Gupta MM, Lal RK., Mathur AK. 2012. Plant Growth Regul 10:1-9

93. Priya A, Tripathi H, Yadav DK, Khan F, Gupta V, Shukla RK, Darokar MP 2012. Plant Omics Journal 5:223-230

94. Qidwai T, Khan F. 2012. Chemical Biology & Drug Design 80:155-172

95. Qidwai T, Yadav D K, Khan F, Dhawan S, Bhakuni R S. 2012. Current Pharmaceutical Design 18:6133-6154

96. Rai A, Smita SS, Singh AK, Shanker K, Nagegowda DA 2013. Molecular Plant 6 : 1531-1549

97. Rao BRR 2012. Indian Perfumer 56:29-33

98. Rao BRR 2012. Journal of Pharmacognosy 3:138-141

99. Rao BRR, Rajput DK, Nagaraju G, Adinarayana G 2012. Journal of Pharmacognosy 3:88-91

100. Rao BRR, Rajput DK, Nagaraju G, Adinarayana G 2012. Journal of Pharmacognosy 3:112-114

101. Rao BRR, Syamasundar KV, Rajput DK, Nagaraju G, Adinarayana G 2012. Journal of Pharmacognosy 3:59-62

102. Rao BRR, Syamasundar KV, Rajput DK, Nagaraju G, Adinarayana G 2012. Journal of Pharmacognosy 3:96-100

103. Rizvi MZ, Mishra P, Roy S, Kukreja AK, Sharma A. 2012. Open Access Scientific Reports 1:1-6

104. Rout PK, Rao YR, Naik SN. 2012. Asian Journal Chemistry 24:945-956

105. Rout PK, Rao YR, Sahoo D, Ali S, 2013. J. Food Science Technology, doi: 10.1007/s13197-012-0636-9.

106. Sahoo D. 2013. International Journal of Pharmacy 4:10-28

107. Sahoo D. 2013. Journal of Essential Bearing Plants,TEOP,16(5) 16:636-640

108. Saikia D, Parveen S, Gupta VK, Luqman S. 2012. Complimentary Therapies in Medicine 20: 434-436.

109. Saikia D, Shama P, Gupta VK, Luqman S. 2012. Complementary Therapies in Medicine 20:434-436

110. Saroj A, Kumar A, Qamar N, Alam M, Singh HN and Khaliq A. 2012. Plant Dis. 96:293.

111. Saroj, A Kumar, ST Saeed, Samad A, Alam M. 2013. Plant Dis. 97, 1251.

112. Sastry KP, Kumar RD, Karnati K, Kumar AN., Kumar RR. 2013. Journal of Scientific Research and Reports 2:121-132

113. Sastry KP, Kumar RD, Kumar AN. 2013. Albanian Journal of agricultural sciences 12:471-478

114. Sastry KP, Kumar RD, Kumar AN. 2013. Scientific Journal of Crop Science 2:154-159

115. Sastry KP, Kumar RD, Kumar N, Sneha G, Elizabeth M. 2012. Journal of Plant Development 19:53-64

116. Saxena A, Singh P, Yadav DK, Sharma P, Alam S, Khan F, Thul ST, Shukla RK, Gupta V, Sangwan NS. 2013. Plant Omics Journal 6:1-12

117. Sharma S, Chattopadhyay S K, Yadav D K, Khan F, Mohanty S, Maurya A, Bawankule D. 2012. European journal of Pharmaceutical Sciences 47:952-964

118. Sharmah M, Baruah BP, Khare P. 2013. Fuel Processing and Technology 106,:490-497

119. Sharmah M, Khare P, Baruah BP. 2012. Water air and soil pollution 223:4795-4800

120. Shukla AK, Mall M, Rai SK, Singh S, Nair P, Parashar G, Shasany AK, Singh SC, Joshi VK, Khanuja SPS, 2013. Molecular Biology Reports 40, 3255-3262.

121. Shukla AK, Shasany AK, Khanuja SPS 2012. OMICS: A Journal of Integrative Biology 16:397-401

122. Shukla AK, Shasany AK, Khanuja SPS, 2012. OMICS: A Journal of Integrative Biology 16, 397-401.

123. Shukla V, Phulara SC, Yadav D, Tiwari S, Kaur S, Gupta MM, Nazir A, Pandey R. 2012. CNS & Neurological Disorders - Drug Targets 11:984-992

124. Shukla V, Yadav D, Phulara SC, Gupta MM, Saikia SK, Pandey R. 2012. Free Radical Biology and Medicine 52:1848-1856

125. Singh R, Awasthi A, Kalra A. 2012, Australasian Plant Pathology, 41: 397-403.

126. Singh R, Singh R, Soni SK, Singh SP, Chauhan UK, Kalra A. 2013. Applied Soil Ecology, 70: 48-56.

127. Singh R, Soni SK, Kalra A. 2013. Mycorrhiza, 23: 35-44.

128. Singh R, Soni SK, Patel RP, Kalra A. 2013. Industrial Crops and Products, 45: 335-342.

129. Singh R, Trivedi P, Bawankule DU, Ahmad A, Shanker K. 2012. Journal of Ethnopharmacology 141: 357-362.

130. Soni SK, Singh R, Awasthi A, Singh M, Kalra A. 2013. Environmental Science and Pollution Research, 20: 1661-1674.

131. Srivastav NK, Lal R.K. 2012. International Journal of Medicinal Plant Research 1:045-049

132. Srivastava V, Kaur R, Chattopadhyay S K, Banerjee S. 2012. Industrial Crops and Products 44:171-175

133. Thul ST, Darokar MP, Shasany AK, Khanuja SPS. 2012. Mol Biotechnol 51:137–147.

134. Tiwari R, Awasthi A, Mall M, Shukla AK, Srinivas KVNS, Syamasundar KV, Kalra A. 2013. Industrial Crop and Products, 43: 306-310.

135. Verma P, Mathur AK, Singh A, Srivastava A, Masood N, Luqman S, Upadhyaya M, Mathur A. 2012. Journal of Medicinal Plants Research. 6(36): 4978-4988.

136. Verma P, Mathur AK, Jain SP, Mathur A 2012. The Scientific World Journal, Article ID 929650, 10 pages; doi:10.1100/2012/929650.

137. Verma P, Mathur AK, Srivastava A and Mathur A 2012. Protoplasma 249: 255-268.

138. Verma RS, Padalia RC, Chauhan A. 2012. Natural Product Research 26:1358-1362.

139. Verma RS, Padalia RC, Chauhan A, Chanotiya CS, Yadav A. 2012. Journal of Essential Oil Research 24:501-505.

140. Verma RS, Padalia RC, Chauhan A, Thul ST. 2013. Industrial Crops and Products 45:7-19.

141. Verma RS, Padalia RC, Chauhan A, Thul ST. 2013. Industrial Crops and Products 42:195-201.

142. Verma RS, Padalia RC, Chauhan A. 2012. Journal of Essential Oil Bearing Plants 15:651-656

143. Verma RS, Padalia RC, Chauhan A. 2012. Journal of Essential Oil Bearing Plants 15:174-179.

144. Verma RS, Padalia RC, Chauhan A. 2012. Journal of Essential Oil Research 24:487-491

145. Verma RS, Padalia RC, Chauhan A. 2013. Journal of Essential Oil Research 25:92-96.

146. Verma RS, Padalia RC, Saikia D, Chanotiya CS, Chauhan A, Krishna B. 2012. Natural Product Research 26:1257-1260.

147. Verma RS, Rahman L, Mishra S, Verma RK, Singh A, Chauhan A, Yadav AK. 2012. Journal of the Chilean Chemical Society 57:1066-1068.

148. Vijayaraj P, Jashal CB, Vijayakumar A, Rani SH, Venkata Rao DK, Rajasekharan R. 2012. Plant Physiology 160:667-683.

149. Yadav AK, Manika N, Bagchi GD, Gupta MM. 2013. Medicinal Chemistry Research 22:2222-2227.

150. Yadav AK, Thakur JP, Prakash O, Khan F, Saikia D, Gupta MM. 2012. Medicinal Chemistry Research 21:3327-3928.

151. Yadav AK, Thakur JP, Prakash O, Khan F, Saikia D, Gupta MM. 2013. Medicinal Chemistry Research 22:2706-2716.

152. Yadav D, Gupta MM. 2013. Journal of Planar Chromatography 26:260-266.

153. Yadav D, Singh SC, Verma RK, Saxena K, Verma R, Murthy PK, Gupta MM. 2013. Phytomedicine 20:124-132.

154. Yadav DK, Khan F. 2013. Journal of Chemometrics 27:21-33.

155. Yadav KS, Yadav NP, Kumar N, Luqman S. 2012. Annals of Phytomedicine, 1 (2): 62-66. 1:62-66.

156. Yadav KS, Yadav NP, Kumar N, Luqman S. 2012. Anti-inflammatory effect of Leucas cephalotes in 12-O-tetradecanoylphorbol-13-acetate-induced inflammation in mice, Annals of Phytomedicine, 1 (2): 62-66.

157. Yadav NP, Luqman S, Meher JG, Sahu AK. 2012. Planta Medica 78:1123-1123.

158. Yadav V, Baruah BP, Khare Puja. 2013. Bio resource technology 137 :376-385.

Book Chapter

1. Gutensohn Michael, Nagegowda Dinesh A, Dudareva Natalia. Involvement of compartmentalization in monoterpene and sesquiterpene biosynthesis in plants. In: TJ Bach and M. Rohmer (Eds.). In Rohmer Michel. Isoprenoid synthesis in plants and microorganisms; New concepts and experimental approaches.(2, 155-169).New York, USA

2. Rao BRR, Syamasundar KV. Millettia pinnata (L.) Panigrahi: Overview and biological properties of fixed oil. In Bhattacharya S. Recent Progress in Medicinal Plants, Volume 33: Fixed Oils and Fats.(2, 123-144).Houston, USA

3. Verma RS, Padalia RC, Chauhan A. 2013. Essential Oils of Indian Origanum Species. In: Natural Essential Oils - Fragrances and Flavours'. Baruah A & Nath SC (Eds.). Aavishkar Publishers, Distributors, Jaipur (India), pp-78-95.

Book Monograph

1. Khare Puja, Goyal Deepak, Yadav Vinit. 5. Bio-Char from Aromatic Plants Waste and its Applications In: 978-3-8465-3251-5 LAP Lambert Academic Publishing AG& Co. KG (www.lap-publishing.com), Germany.
2. Kumari A, Lal R.K., Khajuria R.K. Recent Advance in Medicinal Plants and Their Cultivation. In Khajuria R.K., 978-93-81142-68-4 Manglam Publications, L 2171, Street No. 5, Shivaji Marg, J.P. Nagar, Kartar Nagar, West g Honda, Delhi – 110063, Delhi, India.
3. Shanker Karuna, Srivastava Nidhi, Mishra Shruti, Srivastava Pooja. Nature's gift to health wellness: Anti-oxidant status of herbs. In: 978-3-659-29909-4 Lambert Academic Publishing GmbH & Co & KG, Germany, Germany.

Patents Granted

1. Immunomodulatory pharmaceutical composition comprising a combination of three coumarinolignoids and a process for preparation thereof. SPS Khanuja, Anirban Pal, SK Chattopadhyay, MP Darokar, RP Patel, AK Gupta, AS Negi, Tanpreet Kaur, Sudeep Tandon, AP Kahol. Ankur Garg Great Britain, France, Germany and Europe: 1968575; granted on 25.04.2012China: ZL200680051962.3; granted on 18.07.2012
2. Novel loganin analogues and a process for the preparation thereof. SPS Khanuja, SK Srivastava, Ankur Garg, Merajuddin Khan, MP Darokar, Anirban Pal Australia: 2005338556 granted on 23.08.2012 Europe: 1963349; granted on 24.10.2012.

   The invention relates to novel loganin analogues and a process for the preparation thereof, particularly use of iridoid glycoside loganin isolated from the fruit pulp of *Strychnos nux-vomica* and its bioactive semi-synthetic analogues against various human cancer cell lines grown *in-vitro*.
3. Antibacterial composition comprising oenostacin from *Oenothera biennis*. YN Shukla, TRS Kumar, Anil Srivastava, SPS Khanuja, VK Gupta, Sushil Kumar India: 253983; granted on 11.09.2012

   The composition may be used for the treatment of endocarditis in humans which is an inflammatory disease of the endocardium, the internal lining of the human heart. Endocarditis is caused by *Staphylococci* and *Gonococci* bacteria.

Research Council

Chairperson

Prof. Asis Datta
Professor of Eminence
National Institute of Plant Genetic Resources (NIPGR), New Delhi

External Members

Dr. Vivek Bhandari
Director
Institute of Rural Management, Anand

Dr. C.C. Lakshmanan
Chief Scientist & R&D Head
Research & Technology Innovation
ITC R&D Centre, Bengaluru

Prof. Sudip Chattopadhyay
Department of Biotechnology
National Institute of Technology
Durgapur

Mr. K. Rahul Raju
Joint Managing Director
Nagarjuna Fertilizers & Chemicals Ltd.
Hyderabad

Prof. A. Srikrishna
Professor
Organic Chemistry Division
Indian Institute of Science, Bengaluru

Agency Representative

Dr. (Mrs.) Vinita Sharma
Adviser & Head
Science for Equity, Empowerment & Development (SEED) Division
Department of Science & Technology
New Dehli

DG's Nominee

Dr. Ramesh V. Sonti
Scientist
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Sister Laboratory

Dr. Ram A Vishwakarma
Director
CSIR-Indian Institute of Integrative Medicine
Jammu

Cluster Director

Dr. PS Ahuja
Director
CSIR-Institute of Himalayan Bioresource Technology
Palampur

Director

Prof. Ram Rajasekharan
Director
CSIR-CIMAP
Lucknow

Permanent Invitee

Head
Planning &
Performance Division
CSIR, New Delhi

Member - Secretary

Rakesh Tiwari
Scientist
CSIR-CIMAP
Lucknow

Management Council

Chairperson

Dr CS Nautiyal
Director
CSIR-CIMAP, Lucknow

Members

Dr Tushar K Chakraborty
Director
CSIR-Central Drug Rearch Institute, Lucknow

Dr KP Sastry, Scientist
CSIR-CIMAP Research Centre, Hyderabad

Dr OP Dhawan, Scientist
CSIR-CIMAP, Lucknow

Dr AS Negi, Scientist
CSIR-CIMAP, Lucknow

Dr RP Bansal, Scientist
CSIR-CIMAP, Lucknow

Dr V Sundaresan, Scientist
CSIR-CIMAP, Lucknow

Dr SK Srivastava, Library Officer
CSIR-CIMAP, Lucknow

Finance & Accounts Officer
CSIR-CIMAP, Lucknow

Mr. Dhirendra Kumar
Controller of Administration
(Member Secretary)
CSIR-CIMAP, Lucknow

Budget at a Glance

	Rupees in Lakhs
Pay & Allowances	2159.185
Contingencies (P-04)	232.242
H.R.D. (P-05)	2.470
Lab Maintenance (P-06)	165.965
Staff QRS, Maintenance (P-701)	17.923
Chemicals/Consumables & Other Research Expenditures (P-07)	366.435
Works & Services (P-50)	223.970
Apparatus & Equipments - Scientific (P-50)	399.850
Office Equipments (P-50)	4.102
Furniture & Fittings (P-50)	10.134
Library Books (P-50)	5.00
Library Journals (P-50)	75.260
Staff Qtrs. (Construction) (P-702)	20.321
CSIR Network Projects	442.448
Total	**4270.325**
Pension (P804)	899.774
EMR (P81)	170.858
External Budgetary Resource	
Lab Reserve Fund (LRF)	108.608
External Cash Flow (ECF)	543.375

Staff Members
(As on 31.3.2013)

Director
Dr CS Nautiyal

Chief Scientist
Dr UC Lavania
Dr BRR Rao
Dr RN Kulkarni
Dr DD Patra
Dr LN Mishra
Dr AK Singh
Dr SK Chattopadhyay
Dr MM Gupta
Dr Ashok Sharma
Dr KP Sastry
Shri Anil Kumar
Dr AK Kukreja
Dr AK Mathur
Dr RS Sangwan
Dr SK Srivastava
Dr OP Dhawan
Dr Alok Kalra
Dr RK Lal

Sr. Principal Scientist
Dr KV Shyamsunder
Dr GD Bagchi
Dr NK Srivastava
Dr HO Mishra
Dr AK Tripathi
Dr Muni Ram
Dr Amitabh Chattopadhyay
Dr Mohd Yaseen
Dr (Mrs) Suchitra Banerjee
Dr Harmesh Singh Chauhan
Dr Munnu Singh
Dr Abdul Samad
Mr. Rakesh Tiwari
Mr. PV Ajay Kumar
Dr VKS Tomar
Dr Kambod Singh
Dr JR Bahl
Mr. JP Tiwari
Dr (Mrs) Archana Mathur
Dr PK Chaudhary
Dr (Mrs) Neelam Singh Sangwan
Dr AK Shasany
Dr Saudan Singh
Dr Alok Kumar Krishna

Principal Scientist
Dr Ved Ram Singh
Dr RS Bhakuni
Mr. Sudeep Tandon
Mr. MP Darokar
Dr AS Negi
Dr Birendra Kumar
Dr AK Gupta
Dr Dharmendra Saikia
Dr Laiq-ur-Rahman
Dr Dinesh A Nagegowda

Senior Scientist
Dr Vikrant Gupta
Dr Rakesh Pandey
Dr RP Bansal
Dr Anirban Pal
Dr J Kotesh Kumar
Dr (Mrs) Sunita Singh Dhawan
Dr Dayanandan Mani
Dr Venkata Rao DK
Dr CS Vivek Babu
Dr Sumit Ghosh
Dr (Ms) Prema G Vasudev

Scientist
Dr Rajesh Kumar Verma
Dr Karuna Shanker
Dr Sanjay Kumar
Mr. Manoj Semwal
Dr DU Bawankule
Mr Feroz Khan
Dr Narayan Prasad Yadav
Dr Suaib Luqman
Mrs Deeptanjali Sahoo
Dr V Sundaresan
Dr Ram Swaroop Verma
Dr Ashutosh Kumar Shukla
Mr. KVN Satya Srinivas
Dr RC Padalia
Dr PK Rout
Dr CS Chanotiya
Dr Debabrata Chanda
Dr (Ms) Puja Khare
Dr Rakesh K. Shukla
Dr (Ms.) Tripta Jhang
Dr Preeti Srivastava
Mr. Bhasker Shukla
Dr (Mrs) Poornima Priyadarshini C.G.
Dr Rakesh Kr Upadhyay
Ms. Abha Meena

Junior Scientist
Dr Atul Gupta
Dr Ram Suresh
Mr. Ashsin D Nannaware

Group-III
Principal Technical Officer
Dr SK Srivastava
Dr VK Agarwal
Dr HP Singh

Sr. Technical Officer (3)
Dr Man Singh
Dr Mohd Zaim
Mr. Kundan Singh
Dr SC Singh

Dr Dinesh Kumar
Mr. Jamil Ahmad
Mr. Vikram Singh
Dr AK Srivastava
Dr RK Verma
Mr. Krishna Gopal
Mr. AM Khan

Sr. Technical Officer (2)
Mr. Prem Singh
Dr DK Rajput
Dr Sukhmal Chand
Dr Dasha Ram
Mr. Anand Singh
Mr. K Bhaskaran

Sr. Technical Officer (1)
Dr Ateeque Ahmad
Mr. Govind Ram

Technical Officer
Ms. Anju Kumari Yadav
Mr. Shiv Prakash

Technical Assistant
Mr. Anil Kumar Singh

Technical Assistant
Ms. Manju Prajapati
Mr. Ram Pravesh
Mr. Rajendra Patel
Mr. Rakshpal Singh
Dr Amit Chauhan
Mr. Anil Kumar Maurya
Mr. Amit Mohan
Ms. Namita Gupta
Mr. Sanjay Singh
Mr. A Niranjan Kumar
Ms. Anju Kesarwani
Mr. Balakishan Bhukya

Sr. Technician (2)
Mr. OP Pandey
Mr. S Selveraj
Mr. SK Sharma
Mr. Phool Chand
Mr. MR Khan
Mr. AK Srivastava
Mr. RD Ram
Mr. Raja Ram
Mr. JP Singh
Mr. Israr Ali
Mr. Pawan Prasad
Mr. Shyam Behari
Mr. AR Kidwai
Mr. SAI Zaidi
Ms. IV Rautela
Mr. FA Siddiqui
Mr. SS Subramani
Mr. Ram Chandra
Mr. Durga Prasad
Mr. Y Shiv Rao
Mr. Salim Baig
Dr Abdul Khaliq
Mr. SK Pandey
Mr. Raghubind Kumar
Mr. Gopal Ram
Ms. S Sharda
Mr. PN Gautam
Mr. Joseph M Massey
Mr. Ram Lakhan
Mr. PK Tiwari
Mr. E Bhaskar

Sr. Technician (1)
Mr. Vinod Kumar
Mr. Siva Kumar DC
Ms. Raj Kumari

Technician (2)
Mr. DPS Meena
Mr. VK Shukla
Mr. Pankaj Kumar Shukla

Technician (1)
Mr. Kundan Narayan Wasnik
Mr. Yalla VVS Swamy
Mr. Basant Kumar Dubey
Mr. Vijay Kumar Verma
Mr. Harendra Nath Pathak
Mr. Hemraj Sharma
Mr. Jittendra Kumar Verma
Mr. Pramod Kumar
Mr. Ved Prakash Saini

Lab Assistant (Gr. I (4))
Mr. RC Verma
Mr. Om Prakash
Mr. Mahesh Prasad
Mr. VK Singh
Mr. Dhani Ram
Mr. Om Prakash
Mr. Abdul Mabood
Mr. Mohd Amin Khan
Mr. Ram Ujagir
Mr. Subhash Kumar
Mr. Bharat Singh Bisht
Mr. Man Mohan
Mr. Qasim Ali
Mr. Sabhajit
Mr. Mohd Navi
Mr. Munawar Ali
Mr. Hari Pal
Mr. Rajanna

Lab Attendant (2)
Ms. Pushpa Semwal
Mr. Surendra Nath
Ms. Samundra Devi
Mr. Nurul Huda
Mr. Lal Chand Prasad

Lab Attandant (1)
Mr. G Appa Rao
Mr. Manish Arya

Administrative Staff (Group-A)
Mr. Dhirendra Kumar
Mr. Baby Yohannan

Group-B
Mr. SM Kushwaha

Mr. Sanjay Kumar
Mr. Hare Ram
Mr. Ankeshwar Mishra
Mr. Neelambuj Shankar Prasad
Mr. Vikash Chand Mishra
Mr. AK Sharma
Mr. AK Chauhan
Mr. Sanjay Kumar Ram

Group-B (Non Gazetted)
Mr. Anil Kumar
Mr. US Mishra
Mr. Shivakant
Mr. Sufia Kirmani
Mr. Muneshwar Prasad
Mr. Sant Lal
Mr. Parvez Nasir
Mr. P. Srinivas
Mr. Rajesh Kumar
Mr. Kaushal Kishore
Mr. Siddhartha Shukla
Mr. Ravi Prakash
Mr. KP Dubey

Asstt (F & A) Grade I
Mr. CS Kandpal
Mr. OP Singh
Ms. Nisha Sharma
Mr. Harish Chandra
Mr. Shiv Kumar
Mr. Suneel Kumar
Mr. AL Sahoo

Asstt (S & P) Grade I
Mr. Pankaj Kumar
Mr. Shamiullah Khan
Mr. K. Viswanatha Rao
Mr. SK Srivastava

Senior Stenographer
Mr. Bhikhu Lal
Ms. Kanchan Lata Thomas
Ms. Gaitry Sharda
Ms. P Sabitha
Mr. SJ Sinha

Asstt Gen Grade-II
Mr. KG Thomas
Mr. PK Chaturvedi
Mr. SB Shah
Mr. Manoj Swaroop Shukla
Ms. Sheela Yadav
Mr. Vijay Kumar Bhartey

Asstt F & A Grade-II
Mr. Kanhaiya Lal
Mr. KS Ali
Ms. KC Nagarathnamma

Asstt S & P Grade-II
Mr. SA Warsi
Mr. Ajeet Verma

Asstt Gen. Grade-III
Ms. Preeti Gangwar

Asst F & A Grade-III
Mr. Pradeep Kumar
Ms. Farzana Hafeez

Group C (Non-Tech)
Mr. AK Srivastava
Mr. CS Pant

Isolated Posts
Mr. Yograj Singh
Mr. Rohit Khanna
Ms. Sangeeta Tanwar

Drivers PB-1
Mr. Ajay Kumar Verma
Mr. Sanjay Kr. Singh
Mr. Sarwesh Yadav
Mr. Chandrapal Verma
Mr. Rajesh Kumar

Canteen Staff
Mr. Yohamman Thankappan
Mr. Mohd Shamim
Mr. Victor Mukerjee

Group-D (NT)
Mr. Mata Prasad
Mr. Sadanand
Mr. Kailash Chandra
Mr. R Algarswamy
Mr. Tula Singh
Mr. Ashok Kr. Pathak
Mr. Mohd Aslam Khan
Mr. Kishan Lal
Mr. P Bhiskapathi
Mr. Ajay Kumar
Mr. RK Gupta
Ms. Nirmala Verma
Ms. Tara Devi
Ms. Nargis Sufia Ansari
Ms. Sunita Devi
Mr. Santosh Kumar
Mr. Sant Ram
Mr. Harihar
Mr. TP Suresh
Mr. Raja Ram
Mr. Praveen Kumar
Mr. Ram Baksh Singh
Mr. Kishan Ram
Ms. Zarina Bano
Mr. Ram Karan
Mr. Dharam Pal Balmiki
Mr. Abdul Nadir Khan
Mr. Arvind Kumar
Ms. Raj Mati
Mr. Harpal Valmiki
Mr. Kripa ram
Mr. Sudhir K. Bhattacharya