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Annual Report

2013-2014

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

I am extremely delighted to present the Annual Report 2013-14 for CSIR-CIMAP. Since I joined CSIR-CIMAP as Director on 17th February, 2014 I did not have the opportunity to personally witness the research and developmental activities carried out earlier during the year. However, R & D accomplishments presented by the scientists in this report deserve appreciation. These achievements demonstrate the strides of our scientists towards basic as well as applied research on the one hand, and their commitment towards social responsibilities and outreach to the stakeholders on the other.

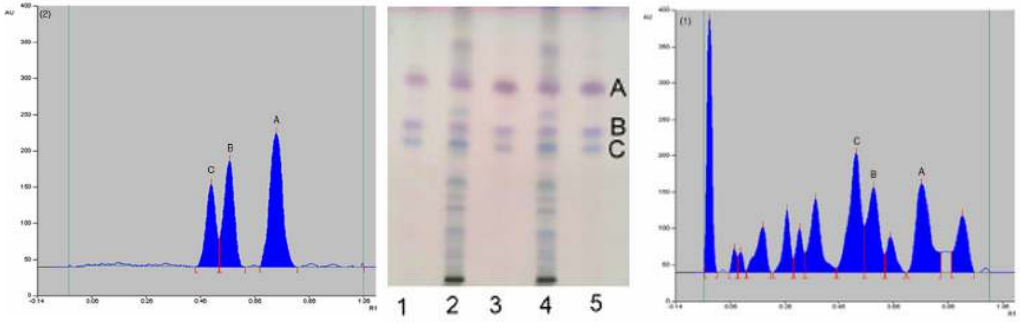
Today, the technologies of CSIR-CIMAP are reaching and benefiting the poor people of the rural society. Similarly, the entrepreneurs and manufacturers have shown their interest towards the herbal products developed by CSIR-CIMAP. The training programmes organised by the institute on different topics are empowering farmers and entrepreneurs. Improved technologies and plants varieties are being developed for higher profits. I am confident that these achievements will have visible impact on the quality of life in near future.

I take this opportunity to congratulate all the scientific, technical, and supporting staff, research students and project assistants who have contributed to the progress of CSIR-CIMAP. I also express my gratitude to all my predecessors for their contributions and guidance, which shall enable us to chart our future course of research activities to address upcoming challenges in the area of medicinal and aromatic plants.

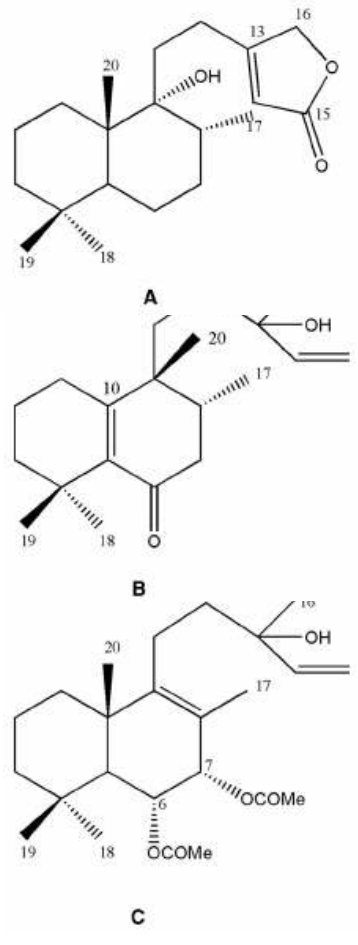
Prof. Anil Kumar Tripathi

Validated HPTLC method for simultaneous quantification of diterpenoids in *Vitex trifolia* L.

Diterpenoids, 6a, 7a-diacetoxy-13-hydroxy-8(9),14-labdadien (A), 13-hydroxy-5(10), 14-halimadien-6-one (B), and 9-hydroxy-13(14)-labden-16, 15-olide (C) were separated on silica gel 60F254 high-performance TLC plates using chloroform / acetone (98:2, v / v) as mobile phase. The quantitation of diterpenoids was carried out using densitometric reflection / absorption mode at 610 nm after post-chromatographic derivatization using a vanillin / sulfuric acid reagent. The method was validated for peak purity, precision, accuracy, robustness, LOD and LOQ as per the ICH guidelines.



The representative HPTLC chromatograms of mixtures of standards (A) and extract (B)

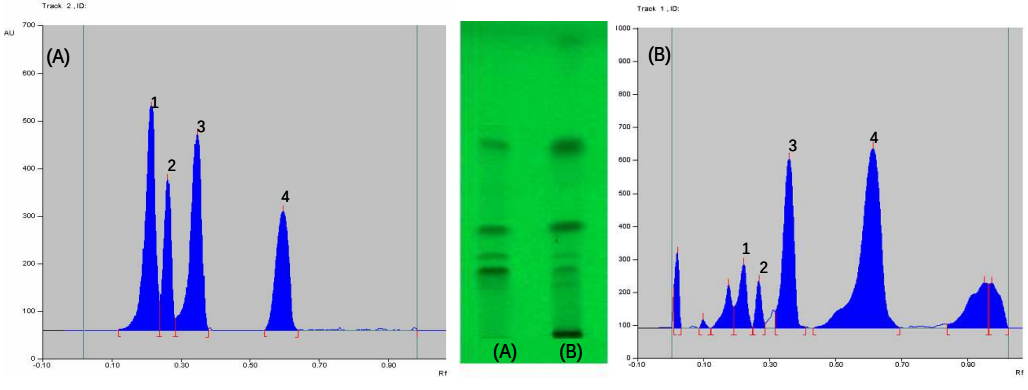


Input: Gupta MM

Journal of Separation Science 36: 2373–2378

Quantitation of anti-tubercular compounds in *Oroxylum indicum*: Thai vegetable used in Indian system of medicine

A high-performance thin-layer chromatographic method for simultaneous detection and quantification of four important flavonoids (baicalein, hispidulin, chrysin and oroxylin A) of *O. indicum* well resolved separation of marker compounds was achieved on silica gel 60F254 plates using the mobile phase consisting of chloroform–methanol–water–formic acid (97:3:0.25:0.25, v / v) with acceptable limit of validation parameters such as linearity, sensitivity, recovery, etc.



HPTLC image (at 254 nm) and digital scanning profiles (at 270 nm) of (A) standard markers [BA (1), hispidulin (2), chrysin (3) and oroxylin A (4)] and (B) methanol extract of O. indicum.

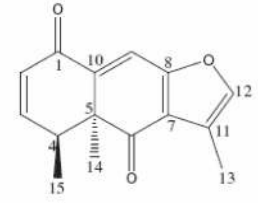
The precise, rapid, and sensitive analytical method involving a simple non-destructive extraction procedure may be suitable for the quality control of *O. indicum* and its products.

Input: Gupta MM

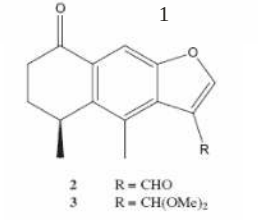
J. Planar Chronatography 26: 306-311

Isolation and structure determination of novel furanoeremophilanes from *Vitex negundo*

Two new sesquiterpenes [1,6-dioxo-2(3),9(10)-dehydrofuranoeremophilane (1), 4,6-dimethyl-11-dimethoxymethyl-1-oxo-4H,2,3-dihydronaphthofuran (3)] along with a known sesquiterpene [4,6-dimethyl-11-formyl-1-oxo-4H,2,3-dihydronaphthofuran (2)] were isolated from *Vitex negundo* L. stem. Structures of compounds were elucidated by NMR spectroscopy and their stereochemistries were established by X-ray diffraction.



1



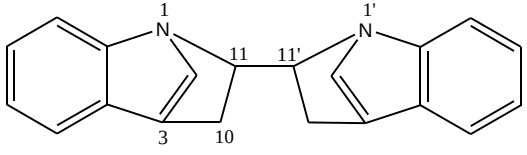
2 R = CHO
3 R = $CH(OMe)_2$

Tetrahedron Letters 54: 2428–2430

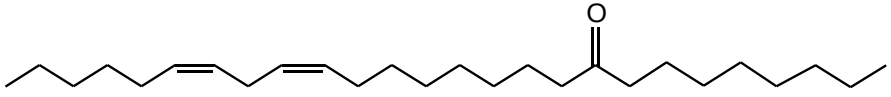
Input: Gupta MM, Vasudev PG

Novel anti-inflammatory phytoconstituents from *Desmodium gangeticum*

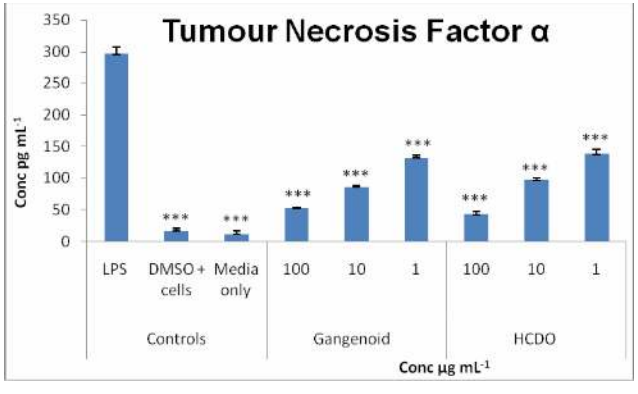
A new aliphatic enone, (17Z, 20Z)-hexacosa-17, 20-dien-9-one and one new bisindole alkaloid, gangenoid together with seven known compounds were isolated from *Desmodium gangeticum*. Both the compounds were investigated for their effects on lipopolysaccharide-stimulated macrophages for the production of pro-inflammatory cytokines such as tumour necrosis factor-a and interleukin-6.



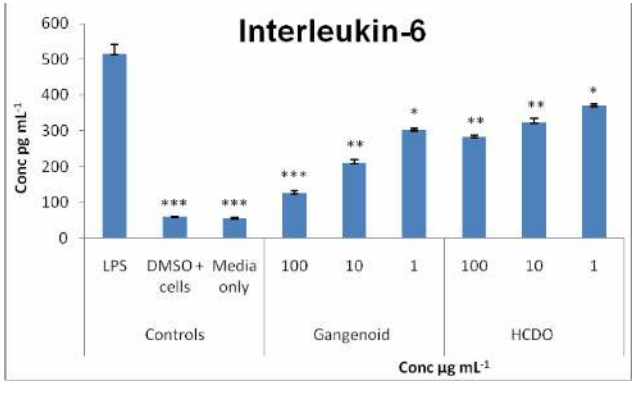
Gangenoid



(17Z, 20Z)-Hexacosa-17, 20-dien-9-one



Effect of test samples on TNF-a and IL-6 production from serum isolated from LPS-induced lethal toxicity model.



* p<0.05, ** p<0.01, *** p<0.001 LPS vs treatment

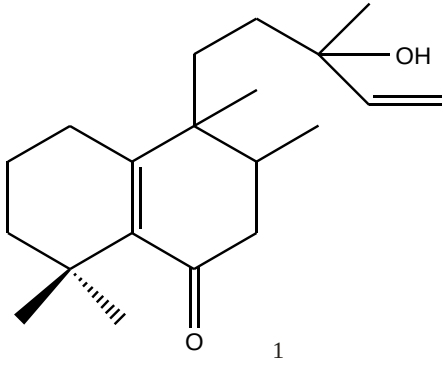
* p<0.05, ** p<0.01, *** p<0.001 LPS vs treatment

Input: Gupta MM, Pal A

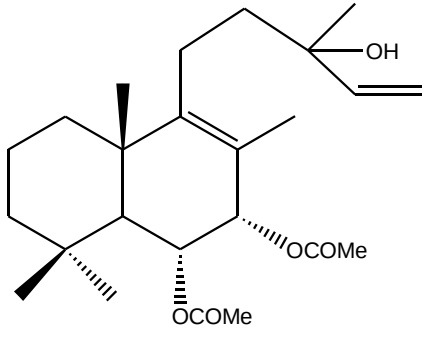
Natural Product Research 27: 1639-1645

Anti-tubercular diterpenoids from *Vitex trifolia*

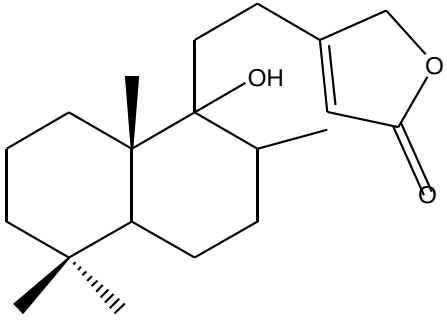
A new halimane diterpenoid, 13-hydroxy-5(10), 14-halimadien-6-one (1) and two new labdane diterpenoids, 6a, 7a-diacetoxy-13-hydroxy-8(9), 14-labdadien (2) and 9-hydroxy-13(14)-labden-15,16-olide (3) were isolated for the first time, along with fifteen known compounds, from *Vitex trifolia* leaves. The structures of these new diterpenoids were elucidated by spectral analysis.



1



2



3

Compounds 2, 3 and another known diterpenoid, isoambreinolide were evaluated for anti-tubercular activity. 9-Hydroxy-13(14)-labden-15, 16-olide and isoambreinolide exhibited anti-tubercular activity (MIC = 100 and 25 g / ml) against *Mycobacterium tuberculosis* H37Rv in BACTEC-460 assay.

Input: Gupta MM, Saikia D

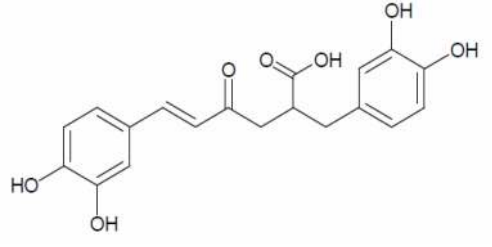
Phytomedicine 20: 605- 610

Comparative extraction and downstream processing for quantitative analysis of rosmarinic acid in *Rosmarinus officinalis*

Evaluation of different extraction and downstream processing techniques for the optimized extraction and quantification of rosmarinic acid (RA) in rosemary leaves was carried out.

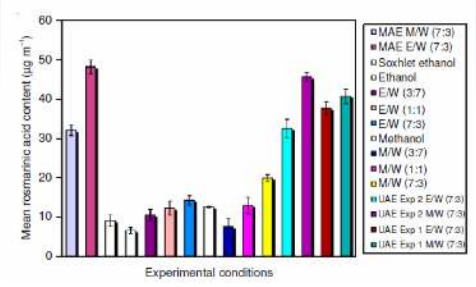
Extractive process development showed alcohol / water in an optimum combining ratio during solvent optimization parameters in terms of extraction efficiency at ambient conditions.

Ultrasonic-assisted extraction showed a two fold enhancement in the content of rosmarinic acid for 70% aqueous methanol whereas a three fold enhancement was



Chemical structure of rosmarinic acid

Input: Tandon S , Ahnad A



observed for microwave-assisted extraction in aqueous ethanol combination.

Application of solid-matrix partitioning technique substantially enhanced the content of rosmarinic acid during sequential solvent partitioning.

Asian Journal of Chemistry 26: 4313-4318

Variation in composition & yield of essential oil of *Matricaria* flowers using steam and hydro distillation techniques

Studies on the comparative yield and composition of the flowers of *Matricaria recutita* (Chamomile) obtained by steam and hydro-distillation essential oil was evaluated. It was observed that the essential oil yield obtained using steam distillation technique was 0.40% whereas in hydro-distillation technique it was 0.50%, respectively. 32 and 34 compounds comprising of 99.95 and 100% of the total peak area were identified in the different oils respectively.

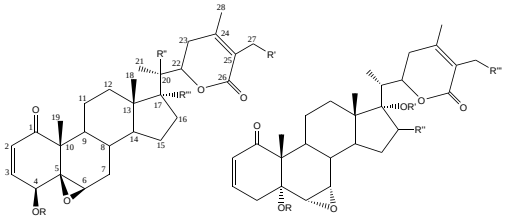
Asian Journal of Chemistry 25: 6048-6050

Chemical composition of the essential oil from flowers of *Bauhinia variegata* (Kachnar)

The essential oil obtained by hydro distillation of flowers of *Bauhinia variegata* were analyzed by GC and GC-MS analysis. Fifty-one compounds have been identified in the flowers oil, representing 87.3% of total oil. The major components were identified as a-pinene (5.1%), b-pinene (2.2%), b-elemene (2.6%), g-elemene (19.0%), d-cadinene (3.6%), occidentalol (2.3%), *cis*-murrol-5-en-4-a-ol (24.4%) and a-cadinol (4.4%). This is the first report on chemical composition of *B. variegata* flower essential oil of north Indian origin.

J. of Essential Oil Bearing Plants 16: 636–640

5,6-De-epoxy-5-en-7-one-17-hydroxy withaferin-a, a new cytotoxic steroid from *Withania somnifera* leaves



3,16-ene, R= R'=R"=R"'= H
4, R= R'= R"= R"'= H
5, R=R"= R"'= H, R'=OH (withaferin A)
6, 5-en-7-one, R= R"= H, R'= R"'= OH
6a, 5-en-7-one, R= R"= H, R'= R"'= OAc
7, R= R'= R"'= H, R"=OH (withanolide D)

Figure 1A. Structure of withaferin A type of steroidss

1, 17-dehydroxy-17(20)-ene, R= R"'= H, R"=OAc
2, R= R"= R"'= H, R'= OH (withanone)
8, R= R'= R"= H, R"'=OH (27-hydroxy withanone)

Figure 1B. Structure of withanone type of steroids

Nat. Prod. Res. 28: 392-98

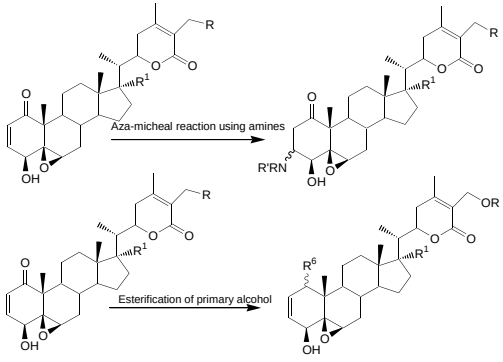
Input: Misra LN, Sangwan NS, Darokar MP

Essential oil of *Nepeta hindostana*

The essential oil of the plant was found to be rich mainly in sesquiterpenoids: β-sesquiphellandrene (32.35%), γ-bisabolene (17.32%), *trans*-caryophyllene (12.56), α-humulene(11.34), sesquisabinene hydrate (4.54%), caryophyllene alcohol (4.15.%), and *trans*-α-bergamotene (4.09%).

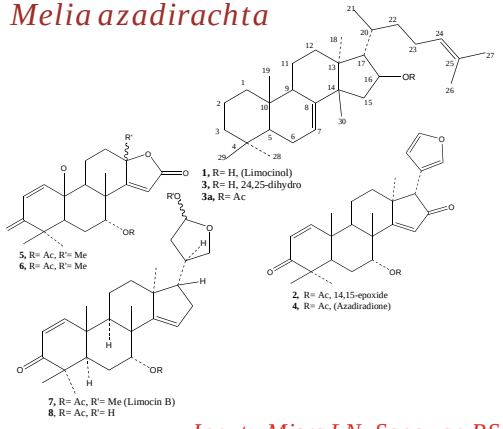
Input: Misra LN

A- ring modifications for value addition in withanolides from *Withania somnifera*



Input: Misra LN, Darokar MP

24,25-dihydrolimocinol, a new triterpenoid from fresh fruits of *Melia azadirachta*



1, R= H, (Limocinol)
3, R= H, 24,25-dihydro
3a, R= Ac

5, R= Ac, R"= Me
6, R= Ac, R"= Me

2, R= Ac, 14,15-epoxide
4, R= Ac, (Azadiradione)

7, R= Ac, R'= Me (Limocin B)
8. R= Ac, R'= H

Input: Misra LN, Sangwan RS

Anti-bacterial activity of essential oils of edible spices *Ocimum canum* and *Xylopia aethiopica*

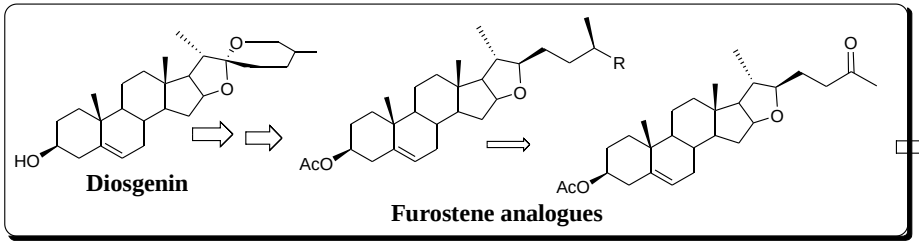
Compounds	KI	*O. canum*	*X. aethiopica*
α-Pinene	939	0.56	3.42
β-Pinene	984	0.94	9.00
p-Cymene	1026	0.27	2.32
Limonene	1030	2.38	6.00
1,8-Cineole	1033	10.19	2.00
Fenchone	1083	2.25	-
Linalool	1100	44.13	1.83
Sabinol trans	1140	0.21	7.00
Isopulegol	1147	-	2.55
Terpinen-4-ol	1178	4.83	0.34
α-Terpineol	1189	1.65	0.21
Myrtenol	1193	-	12.00
Methylchavicol	1200	-	4.45
D-Verbenone	1201	-	4.43
Cuminic aldehyde	1212	-	2.85
Phellandral	1240	-	2.96
Eugenol	1357	17.68	0.25
α-Trans Bergamotene	1435	2.94	-
Class composition			
Monoterpene hydrocarbons		7.96	23.21
Oxygenated monoterpenes		64.18	34.78
Phenyl derivatives		17.68	16.53
Sesquiterpene hydrocarbons		6.81	2.24
Oxygenated sesquiterpenes		1.05	3.33
Linear compounds		0.50	0.0
Total		98.18	80.09

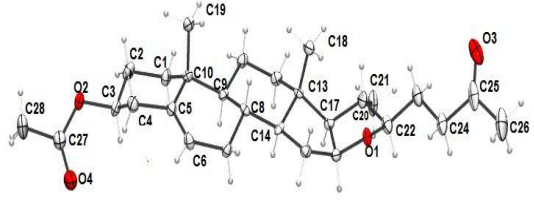
J. Food Sci. 79: 972-77

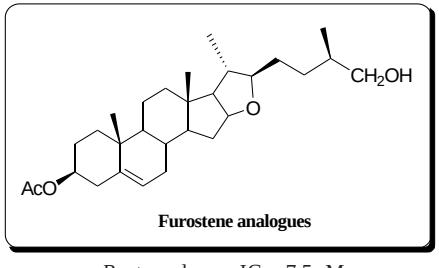
Input: Misra LN

Diosgenin derivative with potent anti-cancer activity against cervical carcinoma

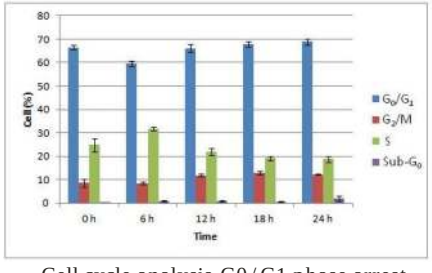
Furostane derivative of diosgenin possesses potent anti-cancer activity against cervical carcinoma. It induces apoptosis by activating caspase-3 and 9.



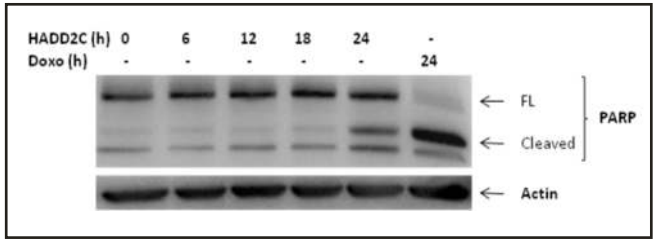




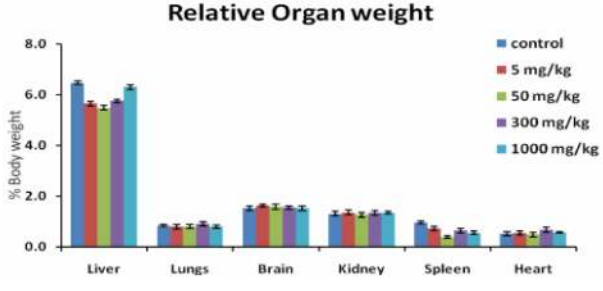
Best analogue IC_{50}=7.5µM

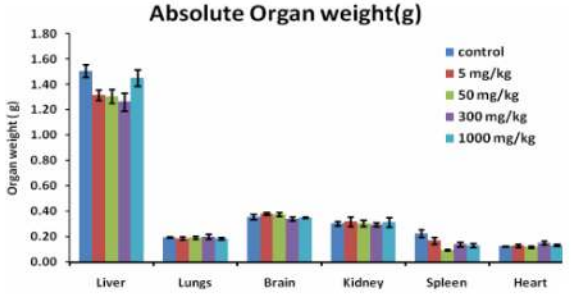


Cell cycle analysis-G0/G1 phase arrest.



Apoptosis induction by activation of Caspase-3 & 9





Acute oral activity non-toxic up to 1000mg/kg dose.

Input: Negi AS, Chanda D, Khan F

Steroids 87:108-118

Essential oil of *Melaleuca leucodendra* L. as a source of nerolidol

Aroma constituents	Content (%)		
	Leaf	Stem	Flower
Linalool	0.52	0.47	0.22
α-Terpineol	0.10	0.10	0.10
β-Caryophyllene	1.52	3.00	4.49
α-Humulene	0.22	0.56	1.03
(*Z*)-Nerolidol	0.10	0.10	-
(*E*)-Nerolidol	90.85	86.13	76.58

Chemical characterization of essential oil of *Melaleuca leucodendra* L. from India as a source of (E)-nerolidol: Chemical characterisation of *Meleleuca leucodendra* grown in Uttarakhand, India was done using GC, MS, and 1H- and 13C-NMR, DEPT analysis. Essential oil yield was found to be 1.20% in leaves, 0.70% in stem, and 1.50% in flowers (v / w, fresh weight basis). Altogether, 37 constituents identified forming 94.28%-98.84% of essential oil compositions, mainly represented by oxygenated sesquiterpenes (81.23%-93.50%). Predominant constituent of leaf, stem and flower essential oils were (*E*)-nerolidol (76.58%-90.85%), b-caryophyllene (1.52%-4.49%), viridiflorol (0.19%-2.79%). (*E*)-Nerolidol has a floral and fruity scent with a woody background. Its global consumption is estimated to be approximately 10-100 ton / year for food-flavor, perfumery, cosmetics and pharmaceutical industries. Therefore, *M. leucodendra* essential oil could be exploited as a potential source of (*E*)-nerolidol for natural derived flavour and pharmaceutical preparations.

Input: Padalia RC

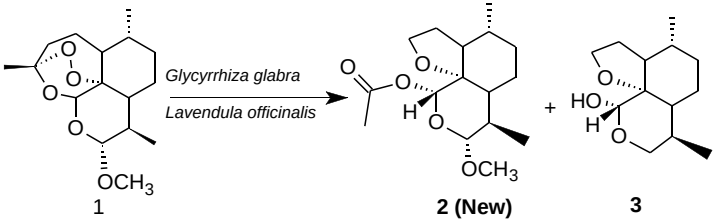
Essential oil constituents of *Inula cuspidata*

Inula cuspidata (Wall. ex DC.) C.B. Clarke is commonly known as 'Jhuri' or 'Pushkar'. Traditionally it is used for the treatment of dyspepsia and colic. The leaf essential oil composition of *I. cuspidata* was investigated using capillary gas chromatography (GC-FID) and GC-mass spectrometry (GC-MS). A total of 52 constituents, representing 83.4% of the total oil composition were identified. The oil was mainly dominated by sesquiterpenoids (78.1%). The major constituents of the essential oil were presilphiperfolan-8-ol (17.4%), ar-curcumene (17.0%), (*E*)-b-farnesene (8.2%), isoledene (6.7%), presilphiperfol-7-ene (5.5%), (*E*)-caryophyllene (4.1%), silphiperfol-6-ene (3.8%), silphinene (3.0%), cameroonal-7-a-ol (2.6%), a-pinene (1.8%), and silphiperfol-5-ene (1.5%). Characteristic of the *I. cuspidata* leaf oil was the presence of rare tricyclic sesquiterpenoids in higher amount.

Inputs: Verma RS, Padalia RC, Chauhan A

Journal of Essential Oil Research 26: 233-237 (IF 0.815)

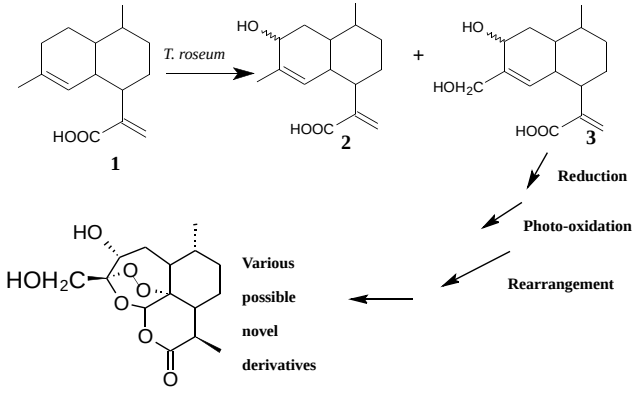
Biotransformation of a-artemether



Medicinal Chemistry Research 23: 1202–1206 (IF 1.612)

Input: Bhakuni RS, Mathur A

Biotransformation of artemisinic acid (1) by endophytic fungus *Trichothecium roseum* CIMAPN1



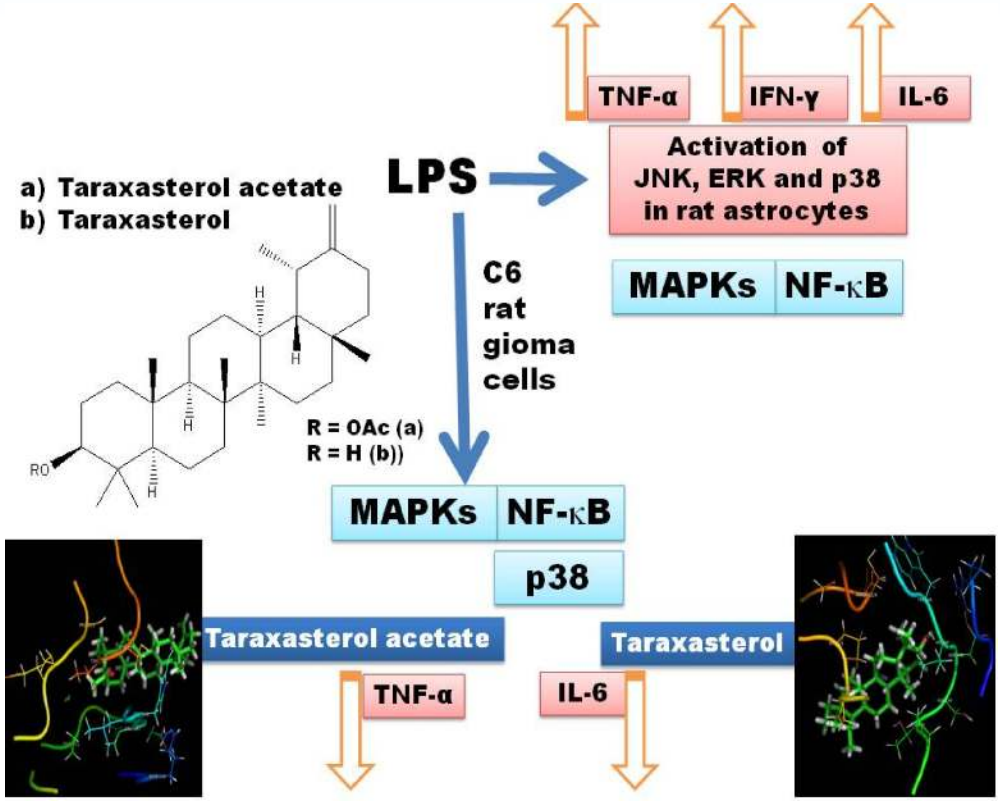
Journal of Molecular Catalysis B: Enzymatic 106: 46-55 (IF 2.823)

Input: Bhakuni RS, Pandey R

Taraxasterol and its acetyl derivative selectively inhibit LPS-induced inflammatory mediators in C6 rat glioma cells

Highlights

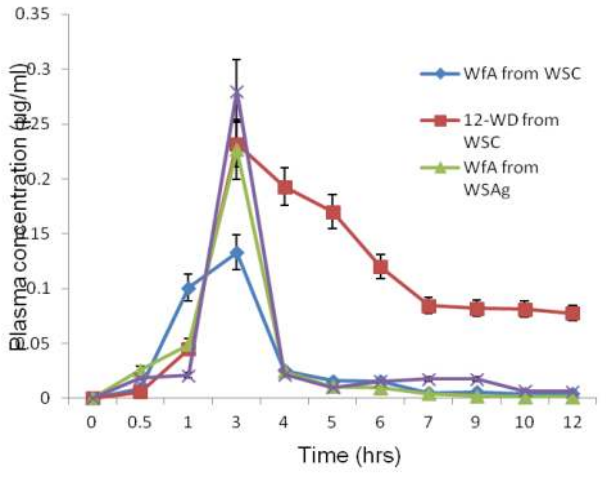
- The inhibition effects of inflammatory responses by *Pluchea* isolates in C6 rat glioma cell was studied.
- Tx and TxAc suppressed LPS-induced production of pro-inflammatory cytokines.
- Selective inhibition of pro-inflammatory mediators has been demonstrated.
- Neuroprotective effects involve in p38-MAPK / NF-kB signaling pathway.
- Tx and TxAc exert neuroprotection by its anti-inflammatory effect.

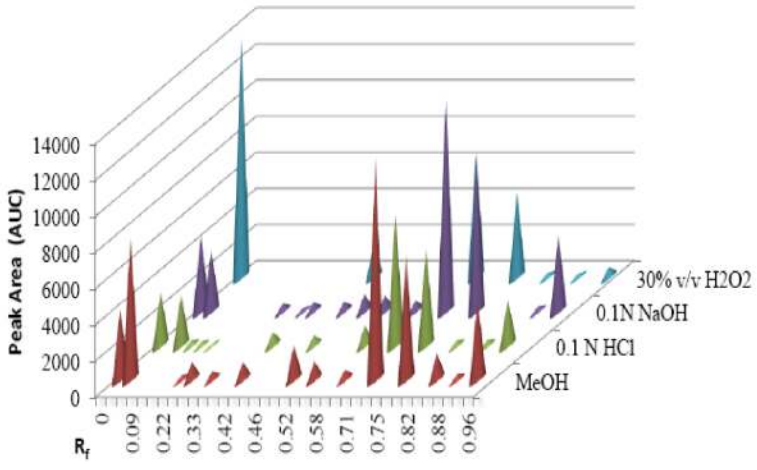


Input: Shanker K, Bawankule DU, Khan F

Naunyn-Schmiedebergs Archives of Pharmacology 387: 119-127 (IF 2.147)

Enrichment of aglycon fractions with immunomodulatory potential: Stability and pharmacokinetic of withania bioactives





Research highlights

- Enrichment of crude *W. somnifera* respect to its three key withanolides was achieved.
- Process resulted into glycone and aglycone fractions with immune-stimulant potential
- Modulation of two cytokines, TNF-a and IL-10 was estimated.
- Proposed scheme is more effective for the enrichment of 12-deoxy-withastramonolide
- Slow bioavailability and elimination of withaferin A from WSC as compared to WSAg was observed.

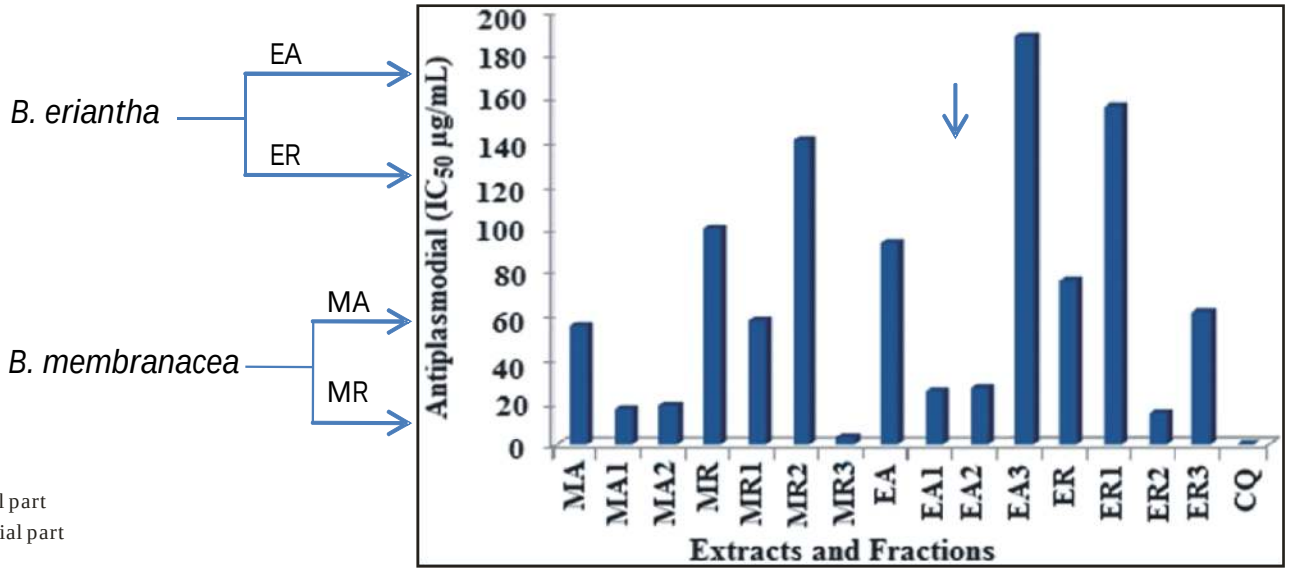
Parameter	WSC		WSAg	
	WfA	12-DW	WfA	12-DW
Tmax (hr)	1.32	4.58	1.24	1.73
Cmax (µg / mL)	0.03	0.12	0.06	0.05
T1 / 2 (hr)	2.10	6.61	2.97	3.54
AUC(0–t) (hrµg / L)	0.49	1.35	0.68	0.63
AUC(0–?) (hrµg / L	11.50	2.55	11.73	11.68
MRT(0–t) (hr)	2.51	5.89	3.62	3.51
AUMC(0–t) (hr2µg / mL)	1.22	7.96	2.46	2.19

Input: Shanker K, Bawankule DU, Pal A

Food Research International 54: 867–872 (IF 3.005)

Anti-plasmodial potential of extracts from two species of genus *Blumea*

A number of *Blumea* (Asteraceae) species are being used in traditional Chinese and Indian folklore medicines to cure various diseases including cancer, fungal and bacterial infections



EA: Ethanolic extract of root
ER: Ethanolic extract of aerial part
MA: : Ethanolic extract of aerial part
MR: Ethanolic extract of root
MA1: Hexane extract of aerial part MA2: EtoAc extract of aerial part MR1: hexane extract of root MR2: EtOAc extract of root
MR3: Butanol extract of root EA1: Hexane extract of aerial part EA2: EtOAc extract of aerial part EA3: Butanol extract of aerial part
ER1: Hexane extract of root ER2: EtOAc extract of root ER2: Butanol extract of root

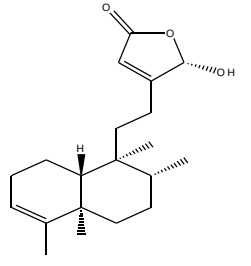
- *B. membranacea* and *B. eriantha* both possess significant anti-plasmodial activity, but among all the fractions tested, MA1, MA2 and MR3 *of B. membranacea* showed highest anti-plasmodial activity and selectivity indices.
- Hence, *B. membranacea* may be useful as a phytopharmaceuticals for the treatment of malaria.

Input: Srivastava SK

Pharma Biol. 10: 1326-30

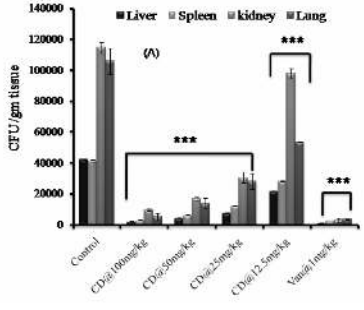
In vivo efficacy and synergistic interaction of 16a-hydroxycleroda-3, 13 (14) Z-dien-15, 16-olide, a clerodane diterpene from *Polyalthia longifolia* against methicillin resistant *Staphylococcus aureus*

The *Staphylococcus aureus* bacterium, a nosocomial pathogen often causing untreatable and lethal infection in patients, mutated to become resistant to all the first-line drugs. Natural clerodane diterpene 16a-Hydroxycleroda-3, 13 (14) Z-dien-15, 16-olide (CD) isolated from the leaves of *Polyalthia longifolia* var. *pendula* exhibits potent anti-MRSA activity which has been demonstrated for the first time. The efficacy of CD with probable mode of action is through disruption of bacterial membrane and its synergistic interaction with other antibiotics makes it a potential molecule for treating MRSA infections. Pharmacokinetic studies in future would enable the establishment of half life of the molecule.

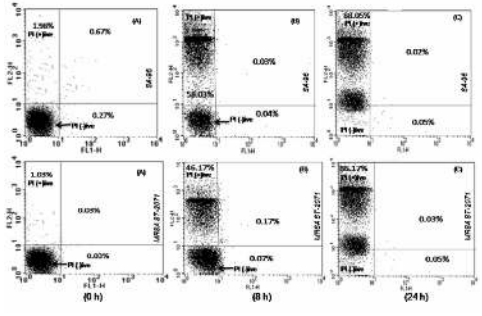


16a-hydroxycleroda-3,13-dien-15,16-olide

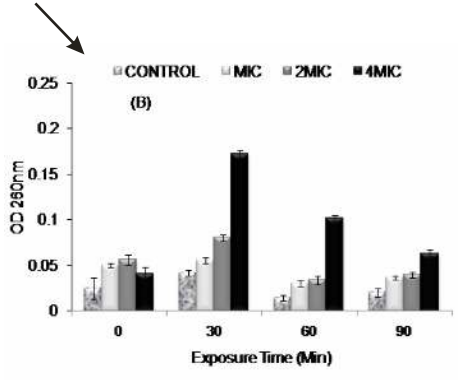
In vitro inhibitory activity (MIC) of CD alone as well as in combination with b*-lactam and other antibiotics against clinical isolated of S.aureus (MRSA)*



In vivo efficacy of CD at various doses in terms of reduction of bacterial load (S. aureus MTCC-96) in multiple organs.



Flowcytometry dot plot of S. aureus (SA-96) and MRSA ST-2071 grown in the presence of CD at 4MIC and stained with propidium iodide (PI).(A) Untreated control (B) after 8 h treatment and (C) after 24 h treatment



Appearance of 260 nm absorbing material released after treatment with CD in MRSA-ST 2071 at 37°C for 0, 30, 60 and 90 min

Input: Darokar MP, Pal A, Srivastava SK

Appl. Microbiol. Biotechnol. 97: 9121-9131 (IF 3.689)

Anti-cancer phytochemicals from *Jatropha heynei*

Phytochemical investigation of underground tubers and leaf parts of an indigenous rare herb *Jatopha heynei*, resulted in the isolation of three compounds, 6,8-dihydroxy-7-methoxy-2H-chromen-2-one, daucosterol and a flavonoid glycoside vitexin. Tuber's hexane extract showed potential anti-cancer activity, in *in vitro* mode, against both the cell lines MCF-7 and DU-145 (IC_{50} values 11.024 and 8.016 µg/ml) and significant anti-fungal activity against *C. albicans* and *A. niger*.

Anti-cancer homoisoflavone from the underground bulbs of *Ledebouria hyderabadensis*

Phytochemical investigation of underground bulbs of indigenous, rare herb *Ledebouria hyderabadensis* yielded a bioactive homoisoflavanone, scillascillin 1. *In vitro* anti-cancer activity, performed using MTT assay, showed compound 1 as significantly active against human cancer cell lines MCF-7 (breast cancer) and DU-145 (prostate cancer) with IC_{50} values 9.59 and 11.32 µg/ml respectively when compared to herb methanol extract (IC_{50} values 36.21 and 44.86 µg/ml respectively).

Phytochemicals from anti-cancer active extracts of *Syzygium alternifolium* leaf

The phytochemical investigation of the leaf of the plant yielded a flavonoid eucalyptin 1 and a triterpinoid epibetulinic acid 2 in pure state. The anti-cancer studies showed leaf hexane extract (IC_{50} values 8.177 and 2.687 µg/ml) was significantly active against human cancer cell lines MCF-7 and DU-145. Also, hexane extract potentially inhibited the growth of DU-145 cell lines when compared with the reference compound doxorubicin. Amongst the isolated compounds, 1 was better cytotoxic than 2.

Synthesis and cytotoxicity of novel andrographolide (1, 2, 3)-triazole derivatives

A series of new andrographolide (1,2,3)-triazole derivatives 3(a-k) were synthesized by a simple multi-step protocol starting from a natural bioactive terpenoid, andrographolide. The synthesized derivatives were screened against human cancer cell lines MCF7, MDA-MB-231, COLO205, HepG2, K562, Hela, HEK293 to evaluate their cytotoxic effect. Of all the compounds tested, two compounds showed moderate cytotoxicity against human reproductive organ cell lines, while others exhibited lower cytotoxicity against different human cancer cell lines.

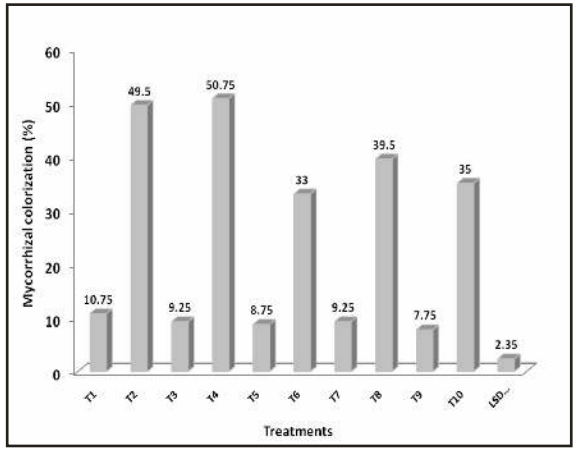
Synthesis of cyclic 1,9-acetal derivatives of forskolin and their bioactivity evaluation

A new series of 1,9-acetals of forskolin were synthesized by treating with aromatic and aliphatic aldehydes using ceric ammonium nitrate as catalyst and evaluated for anti-cancer and a-glucosidase inhibition activities. Three compounds showed potential cytotoxic activity towards human cancer cell lines including with IC_{50} values ranging between 0.95 and 47.96 µg/ml.

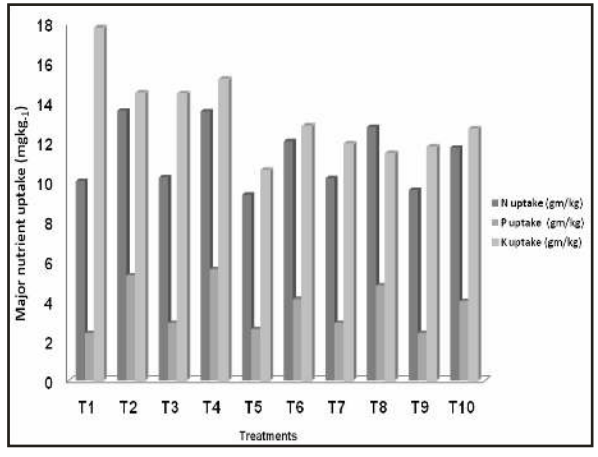
Input: Kumar K, Satya Srinivas KVN and Kumar AN

Effects of arbuscular mycorrhizal fungi on growth and oil yield of *Mentha arvensis* in soils treated with cadmium and chromium

The effect of arbuscular mycorrhizal fungi (AMF) (*Glomus fasciculatum*) on different growth parameters, nutrition characters, oil yield and root colonization of Mentha (*Mentha arvensis*) in soil contaminated with heavy metals was investigated. The effect of AMF inoculation was more pronounced at lower concentrations of heavy metals compared to higher concentrations. There were non-significant decreases in herb yield and significant decreases in root colonization at higher concentrations of heavy metals compared to control and the AMF inoculated treatments. Oil yield increased with AMF inoculation, which was indicted by higher leaf : stem ratio in AMF plants compared to non-AMF ones. The quality of the oil in AMF plants was superior to that of non-AMF plants. This study concludes that inoculation of Mentha plants with AMF increases plant growth and oil content in heavy metal treated soils.



Effect of AMF on root colonization in Mentha (Mentha arvensis) grown in Cr and Cd contaminated soils.

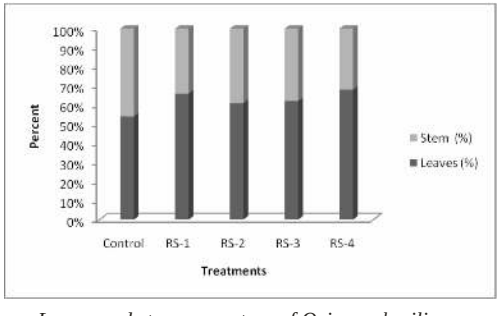


Influence of AMF on Nitrogen, Phosphorus and Potassium uptake by Mentha (Mentha arvensis) grown in Cr and Cd soils

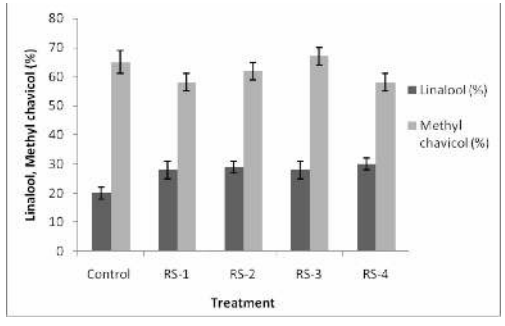
Input: Patra DD

Identification and performance of stress tolerant phosphate solubilizing bacterial isolates on *Ocimum basilicum* in sodic soil and their role in mitigating the sodicity problem

Ocimum basilicum is tolerant to higher salt, pH and exchangeable sodium percentage (ESP) in soil. It is observed as a potential crop to be grown in salt affected soil. Its tolerance to adverse condition and association with halophilic beneficial microbes together can play a greater role for utilization and improvement of sodic waste land. After screening the potential phosphate solubilizing bacteria (PSB) (RS-1, RS-2, RS-3 and RS-4) from sodic soil, they 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 P content of plants. Quantity and quality of essential oil were also significantly enhanced by PSB inoculation as compared to control. It has been observed that PSB also improved the physical, chemical and biological properties of the post harvest soil.



Leaves and stem percentage of Ocimum basilicum



Variation in linalool and methyl chavicol content of Ocimum basilicum

Effect of PSB on different growth parameters

Treatments	Height of Plants (Cms)	Branches (Nos)	Biomass (gms)	Dry matter content (gms)	Root weight (gms)	Oil yield (mL pot^{-1})
Control	38.0	18.2	61.25	43.50	10.75	0.41
RS-1	44.2	22.7	72.00	51.25	13.00	0.51
RS-2	45.7	24.7	72.75	52.75	13.25	0.50
RS-3	41.7	21.5	68.50	53.50	12.50	0.47
RS-4	47.5	26.0	75.50	55.00	16.25	0.53
LSD (P=0.05)	1.56	1.5	2.0	1.45	1.27	0.05

Input: Patra DD

Heavy metals affect yield, essential oil compound and rhizosphere microflora of vetiver grass

The effects of heavy metals chromium (Cr) cadmium (Cd), lead (Pb) and nickel (Ni) on the yield, khusimol content in the essential oil, accumulation of metals and rhizosphere microflora of vetiver (*Vetiveria zizanoides*) were studied in a pot experiment. The shoot yield and khusimol content in oil of vetiver were enhanced by the application of moderate amount of metals to soils. The application of Cr, Pb, and Ni had deleterious effects on the root and essential oil yield. The application of high levels of metals to soil had harmful effects on the bacterial and fungal counts in the rhizosphere. The concentrations of metals such as Cr, Cd, Pb, and Ni in shoot and root tissues were significantly enhanced by the application of those metals to soils. It can be concluded that the vetiver could be used as a promising crop for revegetation, soil remediation, and production of better quality essential oil in metal-contaminated soils.

It has been found that the shoot yield of vetiver was enhanced by the application of moderate amounts of Cr, Cd, Pb, and Ni to soils. However, the essential oil yield of vetiver was significantly restricted by the application of large doses of Cr and Ni to soils. The significant changes in khusimol content in vetiver oil by the application of metals indicate that the metals had significant impact on the quality of oil produced. The bacterial and fungal population in the rhizosphere of vetiver were significantly altered by the application of metals to soils. This study suggests that the vetiver could be a good choice for the revegetation and phytextraction of Cr, Cd, Pb, and Ni contaminated soils.

Input: Arun P, Chand S, Kumar S, Chattopadhyay A, Patra DD

Varietal improvement in Clarysage

Existing variety of Clarysage (*Salvia sclarea*) CIM-Chandni is high yielding but due to late maturing (last week of April) it could not be fitted in prevailing cropping systems. Hence, efforts were made to develop early maturing genotpe that may fit in existing cropping system. A preliminary yield trial was conducted during October, 2013 on 11 lines, marked as SS-1 to SS-11 (selected from open pollinated crop) and variety CIM-Chandni. Three lines were found to be synchronised in flowering and early maturing (about 9- 21 days earlier) than CIM-Chandni. The line SS-1 is erect in growth habit, has longer spikes and higher oil content (0.14% w / v) producing higher

Genotype SS-1

Input: Yaseen M

CIM- Chandni

spikes and essential oil. Being early maturing, farmers could grow summer pulses, transplanted mint/basil easily after harvesting of clarysage and could earn more profit. The characteristic features of three early maturing half sib seed progenies and variety CIM-Chandni are given in the table.

Characteristic features of 3 half sib seed progenies and variety CIM-Chandani

	CIM-Chandni	SS-1	SS-2	SS-3
Days to mature	175	154	166	166
Height (cm)	165	180	158	115
Branch/plant	4	5	4	6
Spike length (cm)	67	77	78	51
Spike number/plant	332	364	296	174
Spike yd (g/plant)	324	359	406	347
Oil Cont. (% v/w)	0.13	0.14	0.11	0.09
Spike yd (q/ha)	172	202	220	217
Oil yd (kg/ha)	20.1	25.4	21.8	17.6

Planting method and integrated nutrient management studies in rose scented geranium

Continuous use of chemical fertilizers in intensive cropping have resulted in significant decreases in crop productivity and adversely affected soil health. To cope-up with this problem and for increasing and sustainable productivity, a field trial with three planting methods (ridge, raised and flat bed planting) five integrated fertilizer levels (full recommended of NPK, full FYM, 25% NPK +75% FYM, 50% NPK +50% FYM and 75% NPK +25% FYM) was conducted in split plot design during November 2013-April 2014 at CSIR-CIMAP, Lucknow. The results revealed that geranium produced significantly higher herb and oil under raised bed planting followed by flat and ridge planting methods. Substitution of 50% inorganic fertilizer (NPK) by organic source (FYM) significantly increased herb and oil yield over all the remaining treatments.

Input: Yaseen M, Ram D

Utilization of distillation waste–based vermicompost and other fertilizers in improving production potential in geranium and soil health

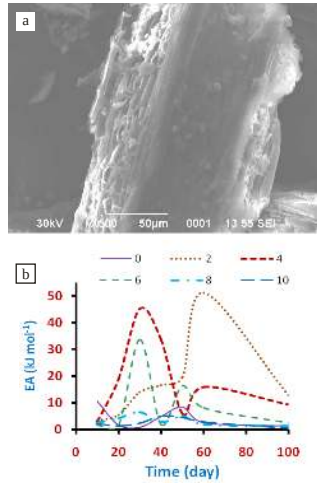
Vermicompost (VC) produced from distillation waste of geranium (*Pelargonium graveolens*), farmyard manure (FYM) produced from animal excreta mixed with pine needle (*Pinus* sp.), and biofertilzer (Azotobacter) were utilized for this experiment. The plant growth attributes, biomass, and oil yield of geranium were significantly increased with integrated nutrient supply, and maximum increase was found in treatment comprising N: P: K, 100:60:60+5t VC. Data obtained on total nitrogen (Nt) and available N, phosphorus (P), and potassium (K) clearly showed that the integrated nutrient supply considerably improved the soil health and sustainability. The soil respiration and microbial biomass C (C_{mic}) and N (N_{mic}) were increased by the manures as par application rate. The C_{mic} accounted for 1.8 to 2.7% of the soil C_{org} content and microbial N accounted for 3.9 to 5.8 % of Nt under different treatment combinations.

Input: Verma RK, Patra DD

Effect of biochar amendments on temperature sensitivity and priming of soil organic matter decomposition

In recent years, biochar has been considered as an important tool for carbon sequestration as well as soil fertility enhancer. The present study was carried out to understand the relationship between rates of soil respiration, temperature sensitivity and soil fertility indicators with the biochar amendment. Biochar prepared from lemongrass (*Cymbopogon flexuosus*) after oil extraction had 53% carbon content, 1% nitrogen and negligible amount (below detection limit) of sulphur. It contains K, Ca, Fe, Mg and Zn. The elements Cd, Co, Cr and Pb were absent in the biochar. Surface area and porosity of biochar was 3.449 m^2/g and 70% respectively. FTIR spectra of biochar indicated the presence of a large number of carboxylic acids and hydroxyl groups. Generally, these groups are responsible for the chelating processes. SEM of the biochar is shown in the figure 1a.

The biochar showed priming effect of soil organic carbon decomposition. The temperature sensitivity (activation energy Ea) varied with incubation time and biochar dose. This may be due to the availability of organic carbon with different labile group. Chemometric analysis showed that the soil respiration, priming and temperature sensitivity depends not only on the microbial growth, but interaction between biotic and abiotic factor, mineral released and redox kinetic also plays an important role. The change in the magnitude of these processes on biochar addition on soil is responsible for the alteration in soil organic matter dynamics.



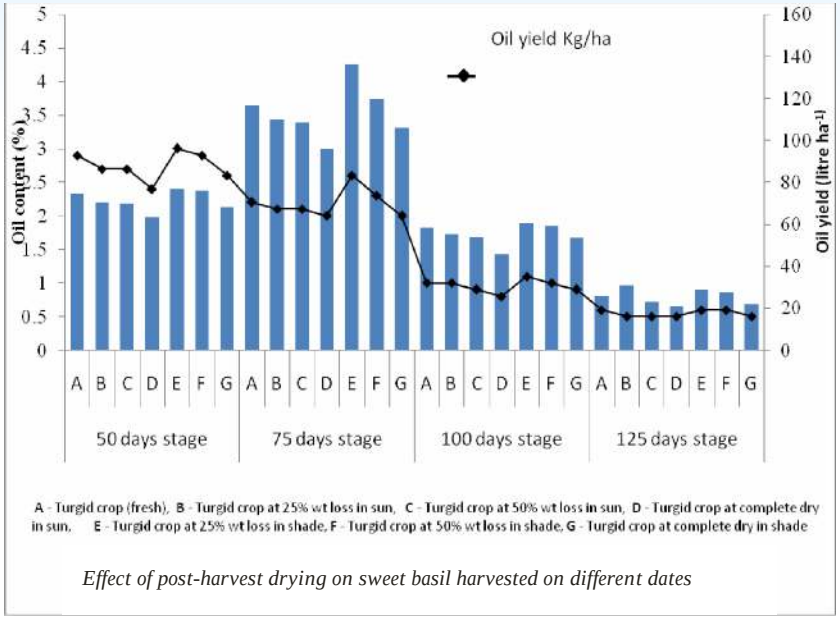
a. SEM analysis of biochar. b Temperature sensitivity of biochar (legends are showing the amendments rates)

Input: Khare P

Post-harvest interventions in some commercially viable medicinal and aromatic crops: Enhancing oil content and oil yield in sweet basil through post harvest drying

Dried Indian basil herb is beneficial over fully turgid crop. However practice of shade drying up to 50% weight loss in early October and early November and up to 25% weight loss in late October resulted in maximum oil content and yield. In December harvest, highest yield was recorded in sun drying.

Input: Singh S



Effect of post-harvest drying on sweet basil harvested on different dates

Effect of yield and quality of essential oil of vetiver roots using different modes of distillation

Studies have been carried out on variation of essential oil content and quality by using different modes and techniques of distillation. Initial studies were conducted at bench scale clevenger apparatus level. Pilot scale studies using plant material obtained from farmers' field were carried out at scale of 10 kg to 50 kg per batch capacity. Different modes of distillation viz. (i) Water and steam distillation (Field Distillation) (ii) Direct steam distillation and (iii) Distillation with cohobation / recycling have been studied. Initial results have indicated a better oil recovery using water and steam distilling method with recycling of the condensate. Further trials and repetitions at different scales and methodologies are proposed to be carried out during the next harvesting of the crop.

Experiments on post harvest treatment of the vetiver roots like effect of drying, presoaking of herb in plain and water added with sodium chloride have also been conducted at bench scale level. Further trials to confirm the results and new experiments shall be taken up in next season.

Effect of yield and quality of essential oil of *Salvia* using different modes of distillation

Studies were carried out on variation of essential oil content and quality of Clarysage (*Salvia sclarea*) by using different modes and techniques of distillation. Initial studies were conducted at bench scale Clevenger apparatus level. Pilot scale studies were carried out at scale of 10 kg to 40 kg per batch capacity. Different modes of distillation viz. hydro distillation and steam distillation have been studied. Initial results have indicated a better recovery of the oil using steam distillation technique with an average oil yield of 0.122% as compared to oil content of 0.125% as obtained at Clevenger level.

Yield and quality of the concrete and absolute in *Salvia*

Experiments on processing of salvia flowers for concrete and absolute was carried out at pilot scale 5 kg/batch capacity level to evaluate the percentage content and quality of the products. The concrete was obtained using a hydrocarbon solvent with an yield of ~1.4% This concrete was further converted to absolute by removing the waxes and other unwanted chemical entities to finally get an absolute of ~1.3%. Physico-chemical analysis of the concrete and absolutes are under progress. Further work is proposed to be carried out on extraction of *Salvia* flowers and seeds for isolation of scalreol an important phyto molecule.

GC-MS analysis of the steam and hydro-distilled essential oil of *Matricaria recutita* flowers

Studies on the comparative composition of the flowers of *Matricaria recutita* (Chamomile) obtained by steam and hydro-distillation essential oil were examined by gas chromatographic-mass spectroscopic analysis. The flowers were obtained from the North Eastern region of India. The essential oil yield (mL/100 g dry weight) obtained were 0.40% and 0.50%, respectively. 32 and 34 compounds comprising of 99.95 and 100% of the total peak area were identified in the different oils, respectively. The common major components of essential oils have been identified as b-farnesene (10.23, 11.96%), *trans*-limonene oxide (3.48, 3.31%), bisabolol oxide B (16.91, 17.43%), a-bisabolol (23.14, 23.30 %), azulene 7-ethyl-1,4-dimethyl (camazulene) (5.42, 4.82 %), bisabolol oxide A (16.17, 14.91%), 1,6-dioxaspironon-3-ene (11.20, 10.52%). The identity of components of essential oil was confirmed on the basis of retention time, mass and supplemented library of NIST, USA.

Inputs: Tandon S, Ahmad A, Ahmad J

Molecular and innovative diagnostic for plant pathogens infecting MAPs and their management

The associated fungal pathogens, *Alternaria alternate*, *Rhizoctonia solani*, *Colletotrichum* spp., responsible for the diseases of MAPs, were isolated and characterized on the basis of conventional and molecular techniques.

New leaf curl disease of kalmegh

Kalmegh (*Andrographis paniculata*) is an important medicinal herb known for its various pharmaceutical properties. A new disease of kalmegh with upward leaf curling, retardation in leaves and overall stunted growth was recorded. The associated pathogen was identified as an isolate of begomovirus on the basis of characteristic symptoms, mode of transmission, PCR profile, cloning and sequence data analysis. Begomovirus coat protein specific primers were used for the amplification of 771 bp gene. The full length genome was amplified using primer pairs F1 (F/R) and F2 (F/R) which was further confirmed via cloning and sequencing.

Leaf curl disease of kalmegh

Witches' broom disease of kalmegh

New witches' broom disease of kalmegh

A new phytoplasma disease of kalmegh has been noticed with typical little leaf and apical proliferation. Typical symptoms, DNA profile in PCR/Nested PCR, sequencing data and *in silico* analysis revealed the causal pathogen as *Candidatus* phytoplasma of 16Sr II-D group. It is the first record of phytoplasma infection on kalmegh.

Input: Samad A

In vitro conservation of MAPs

About 25 pharmaceutically important plants, are being successfully maintained and conserved at various morphogenic levels under *in vitro* tissue bank. New plant species such as *Ginkgo biloba* , *Morinda* sp., *Costus pictus* and *Gymnema sylvestris* have been added to the tissue bank collections during the year 2013-14. Micropropagation protocol for anti-diabetic plant *Costus pictus* has been optimized for generating nucleus stock of this highly endangered medicinal herb (Fig. 1). The *in vitro* developed plantlets have been transferred in pots and kept in the glasshouse for acclimatization. A procedure for DNA isolation for RAPD analysis of *Gymnema sylvestre* microcloned progeny has also been standardized to test clonal fidelity of *in vitro* conserved accessions.

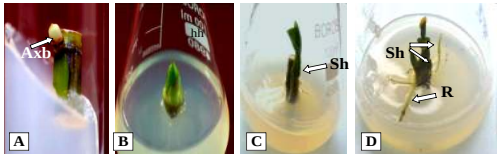


Fig. 1: In vitro plantlet development in Costus pictus (A-D). A. Axillary bud (Axb) explant; B,C. Shoot(Sh) development from axillary bud; D. Complete plantlet with shoot (Sh) and root

Input: Mathur A

Hairy root induction in pyrethrum and enrichment of pyrethrins

Pyrethrins, a naturally occurring insecticide which has characteristics such as swift action, broad spectrum of activity against insects, low cost and more importantly their fast degradation in environment and less side effects to mammals puts it to the elite panel in the field of potent insecticidal. Experiments were conducted with *Agrobacterium rhizogenes* strain A-4 for hairy root induction in so far recalcitrant *Chrysanthemum cinerariaefolium* plants. Total of six clones were established successfully. Hairy root clone D3 showed highest pyrethrin content followed by D2 while clone D1, D5 and B2 showed only traces of pyrethrins. PCR analysis of transformed hairy root clones showed the presence of *rol* B with amplicon size of 530 bp in all six established hairy root clones. The extract of the maximum pyrethrin yielding lines will be assessed for their biological activities.

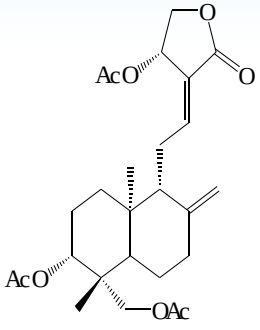
Studies on the comparative extraction and enrichment techniques for pyrethrins from flowers of *Chrysanthemum cinerariaefolium* have been carried out. Different extraction techniques such as

Hairy root induction and culture from leaf explants of Chrysanthemum cinerariaefolium folium

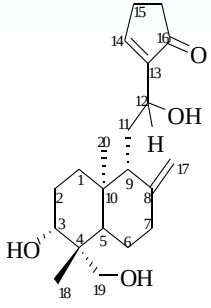
maceration, agitation with heat, sonication and soxhlet using five different solvents viz hexane, ethyl acetate, acetone, acetonitrile and methanol have been evaluated for evaluation of extraction efficiency and total pyrethrin content. Experiments on the successive enrichment of the total pyrethrins have also been carried out by the application of solid-matrix partitioning technique by which enrichment of total pyrethrins upto 60% content has been achieved.

Input: Rahman L

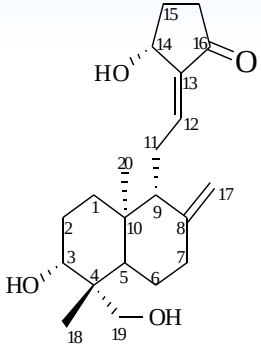
Chemical biology of andrographolides and 12-oleanenes



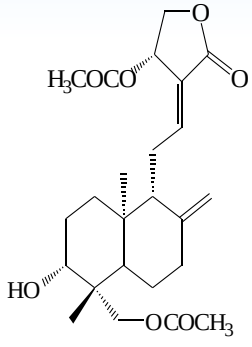
3, 14, 19-Triacetyl andrographolide



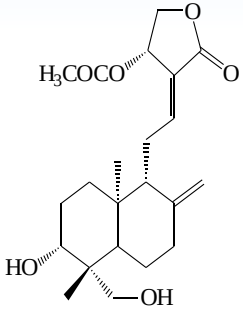
12-Hydroxy-13,14-dehydro andrographolide



Andrographolide

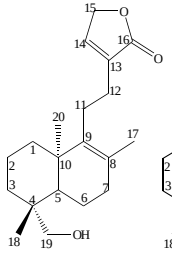


14, 19-Diacetylandrographolide

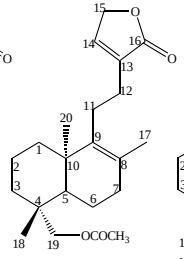


14-Acetylandrographolide

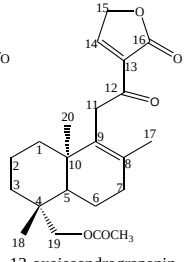
Acetylation of andrographolide was optimised to exploit the reactivity of three hydroxyl groups to get acetylation product in a single step and their activities were studied against the cancer cell lines *in vitro*. The several products such as 3,19-diacetyl-14-deoxy-11,12-didehydroandrographolide, 3,19-diacetyl-14,15-didehydroandrographolide, 14-acetylandrographolide, 14,19-diacetylandrographolide and 3,14,19-triacetylandrographolide were prepared. The triacetyled andrographolide is difficult to prepare under normal acylation condition.



Isoandrograpanin

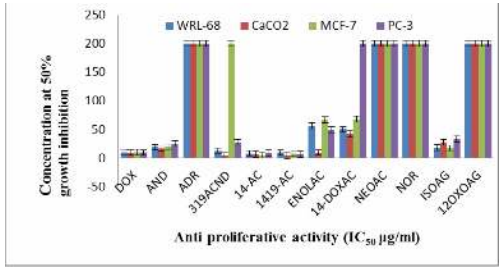


Isoandrograpanin acetate



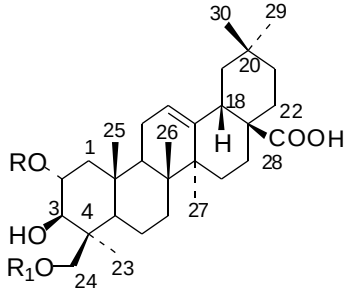
12-oxoisoandrograpanin acetate

Reduction of $D^{12,13}$ double bond in andrographolide (ADR) and $D^{13,14}$ double bond in neoandrographolide (NOR) resulted in the loss of antiproliferative activity. Isoandrograpanin having antiproliferative activity similar to that of andrographolide became inactive with oxidation at C-12.



No	Compounds	Coded as	Anticancer activity (IC_{50} expressed in µg/ml) against			
			WRL-68	$CaCO_2$	MCF-7	PC-3
1.	Doxorubicin	DOX	9.5	9.1	9.7	9.2
2.	Andrographolide	AND	18.5	16.5	19.6	25.0
3.	12,13-Dihydroandrographolide	ADR	>100	>100	>100	>100
4.	3,19-Isopropylandrographolide	319-ACAN	12.6	4.5	>100	27.5
5.	14-Acetylandrographolide	14-AC	8	6.6	4.5	8.5
6.	14,19-Diacetylandrographolide	319-AC	9.2	4	7.5	6
7.	Andrographolide enol lactone diacetate	ENOLAC	56	9	67	49
8.	14-Deoxy-3,19-diacetylandrographolide	14-DOXAC	50	42	68	>100
9.	Neoandrographolide	NEO	>100	>100	>100	>100
10.	13,14-Dihydroneoandrographolide	NOR	>100	>100	>100	>100
11.	Neoandrographolide	NEOAC	>100	>100	>100	>100
12.	Isoandrograpanin	ISOAG	18.2	27.5	17.5	33.2
13.	12-Oxoisoandrograpanin acetate	12-OXOAG	>100	>100	>100	>100

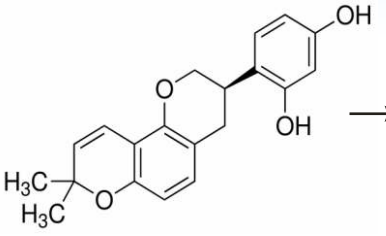
A new triterpenoid, 2a,24-diacetoxy-3b-hydroxyolean-12-en-28-oic acid (1), which exhibited antitumor activity against MCF-7 and PC-3 cell lines, was identified by spectral methods from the tubers of *N. nucifera* beside active betulinic acid (0.9%, active against MCF-7 cell line). The bioactive alkaloids jatrorrhizine, palmatine, S-corydine and magnoflorine were identified along with corydine-N-oxide from *Tinospora cordifolia*. A diterpenoid furanolactone was purified by RP-C18 and further spectral analyses are in progress.



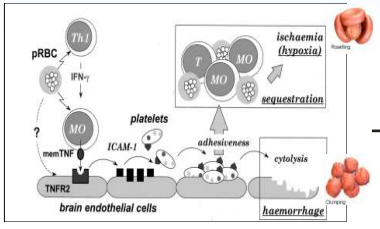
1 R=R_1=OAc

Input: Chaudhuri PK

Validation of plant derived leads against malaria pathogens *in silico*, *in vitro* and *in vivo* studies

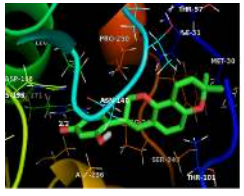


Glabridin
(isolated from *Glycyrrhiza glabra)*



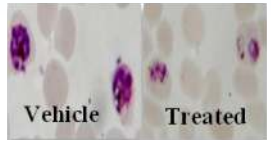
Inflammatory pathogenesis in cerebral malaria

In silico



Glabridin inhibits *Pf* LDH

plasmodium
NF-54 strain



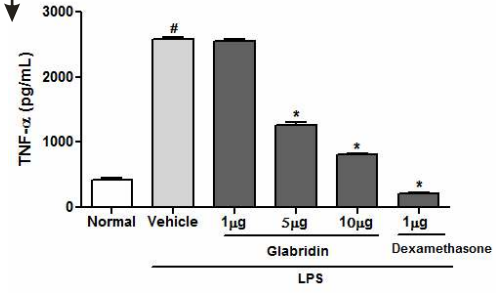
IC50 (µg/ml)	
Glabradin	8.000
Artimisinin	0.006
Chloroquine	0.015

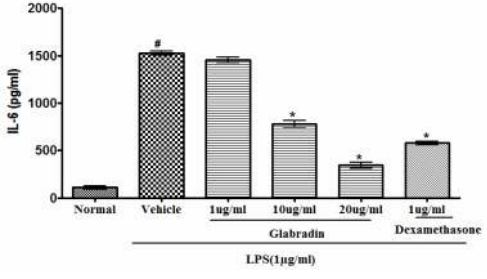
in-vivo

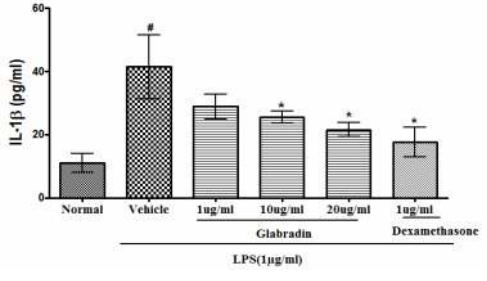
In vitro
Inflammation

Plasmodium berghei
infected mice

Treatment	Dose (mg/kg)	Parasitaemia (%)	Suppression (%)	Mean survival time (Days)
Normal	-	NA	NA	NA
Vehicle	-	28.19±5.09	0	8.2±0.33
Glabridin	10	21.96±4.34	22.10	13.6±1.03
Chloroquine	2.5	0.00	100	?28







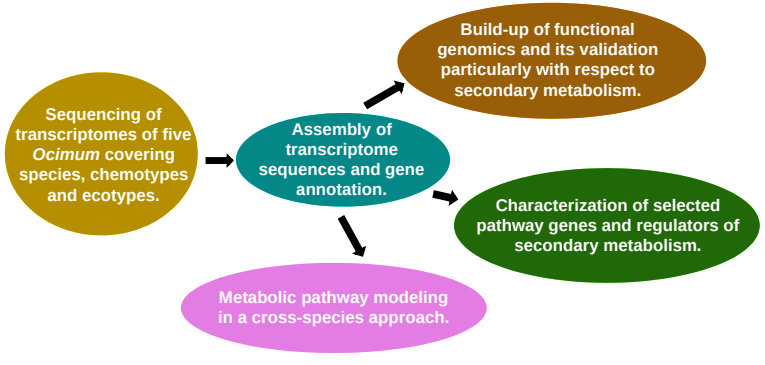
The results of the study confirm the suitability of glabridin from *Glycyrrhiza glabra* as a candidate for further studies to obtain a prototype for anti-malarial medicine

Input: Bawankule DU, Darokar MP, Pal A, Khan F

Parasitology International. 63: 349-358 (IF 2.302)

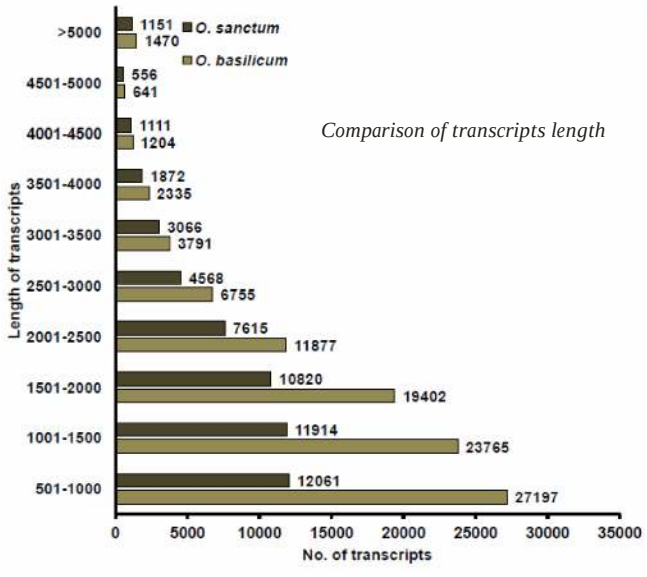
Structural and functional genomics of *Ocimum* species

More than 100 *Ocimum* species exist in nature which produce diverse kind of secondary metabolites. Five most prominent species which are grown in India include *O. Sanctum, O. basilicum, O. gratissimum, O. kilimandscharicum* and *O. americanum*. Because of the biosynthesis of several important volatiles and non-volatiles which have commercial significance in *Ocimum*, the plant is immensely important. Therefore, to understand the metabolic diversity deduced at the transcriptome level, the transcriptome sequencing of selected *Ocimum* species are proposed.

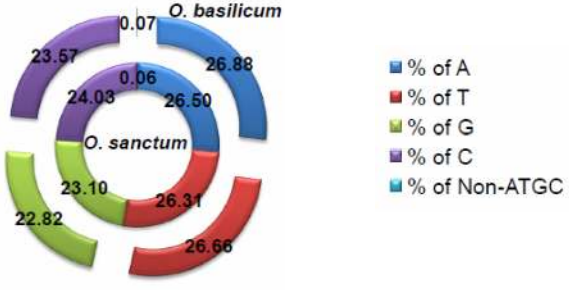


Work layout and strategies

Assembly and comparison of *O. sanctum* (CIM-Ayu) and *O. basilicum* (CIM-Saumya) sequences



Comparison of transcripts length

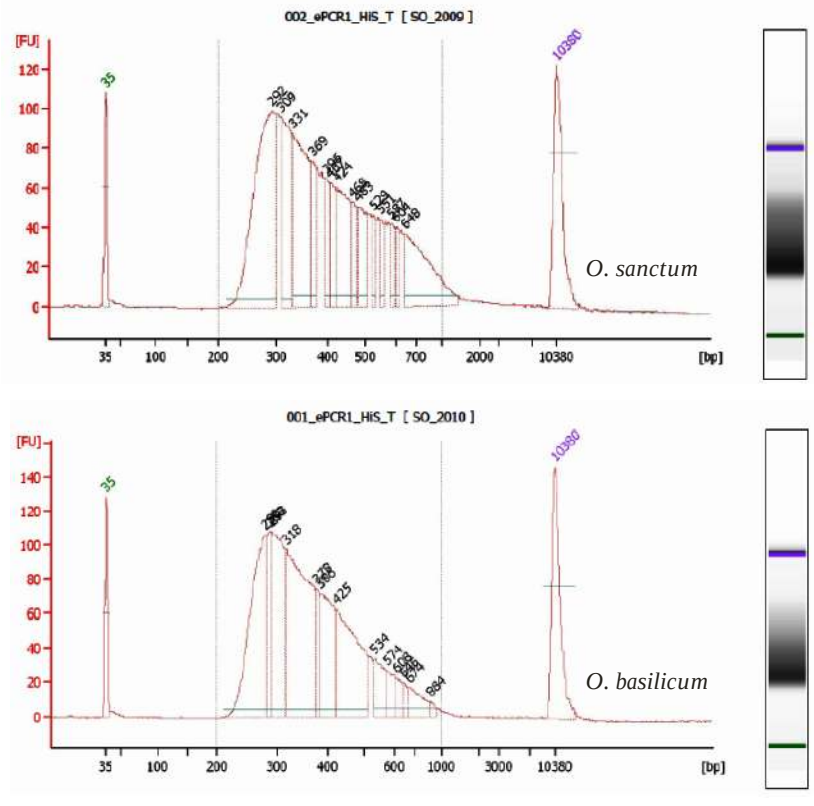


Comparison (%) of nucleotides and GC content

Transcriptome sequencing of *O. sanctum* and *O. basilicum*

O. sanctum (CIM-Ayu) and *O. basilicum* (CIM-Saumya) were primarily selected for high-throughput transcriptome sequencing. Both these species were grown and maintained in green house under controlled conditions and fields of CSIR-CIMAP. The leaves of mature plants were collected, washed properly with sterile MQ-water and subjected to transcriptome sequencing. Deep-sequencing of *O. sanctum* (CIM-Ayu) and *O. basilicum* (CIM-Saumya) transcriptomes by illumina technology (paired end) was completed. The mean read length of each of the sequence produced was found to be 99 from paired ends. Around 45.97 million reads covering 4.5 Gb data of *O. sanctum* and 50.84 million reads covering around 5.0 Gb data of *O. basilicum* was generated. After trimming of low quality reads, around 98.11% and 97.02% reads of *O. sanctum* were found to be of high quality from paired ends while 98.46% and 97.14% reads of *O. basilicum* from pair ends were found to be of high quality. High quality reads from paired ends were assembled to generate contigs by Oases program individually for both the *Ocimum* species. More than 45 million reads from *O. sanctum* were assembled into 69117 contigs with an average length of 1646 bp covering around 113.766 Mb of the transcriptome. In case of *O. basilicum*, around 50 million reads got assembled into 130043 contigs with an average length of 1363 bp which covered around 177 Mb of the transcriptome.

Preparation of libraries for sequencing and its QC

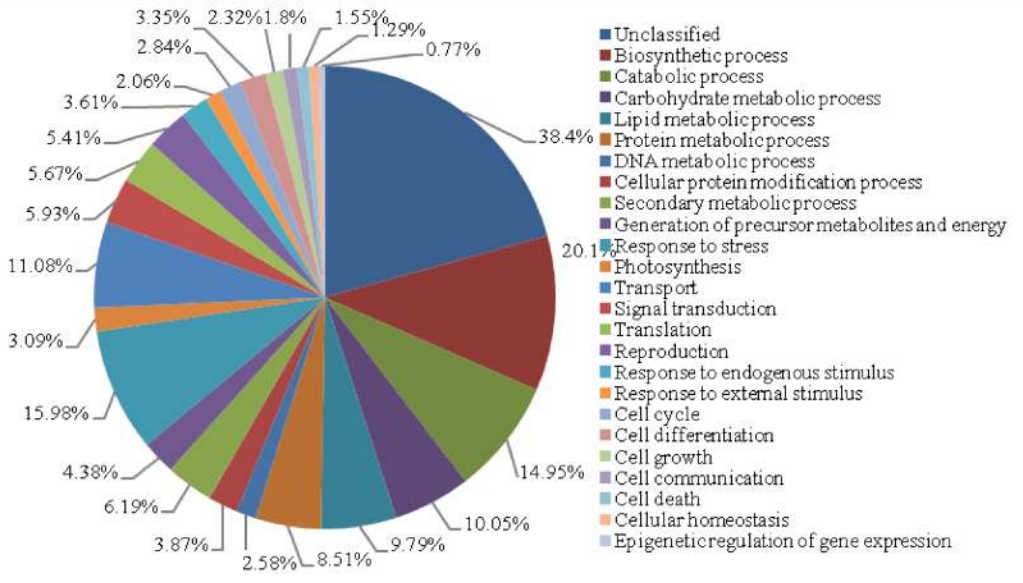


Bioanalyzer profiles of amplified product of O. sanctum (CIM-Ayu) and O. basilicum (CIM-Saumya): Insert size: 160-480 bp; Adaptor size: 120 bp

Methyl jasmonate-elicited transcriptional responses and pentacyclic triterpene biosynthesis in sweet basil

In order to identify the transcripts that are responsive to elicitors, subtractive EST approach was used to identify methyl jasmonate-responsive transcripts and to study the pentacyclic triterpene biosynthesis in sweet basil (*O. basilicum*). A total of 550 cDNA clones were sequenced, annotated and categorized into different categories. Triterpene biosynthesis genes such as amyrin synthases could be identified in the subtracted EST pools.

Description	Number
Total clones sequenced	550
High quality ESTs obtained	509
Average length of ESTs (bp)	481.59
GC content (%) of ESTs	43.92
Unique sequences	388
Average length of unique sequence (bp)	478.82
Total contigs	74
Total singletons	314
Annotated unique sequences	323
Non-annotated unique sequences	65
Novel sweet basil unique ESTs	275



The transcriptome sequencing of *O. sanctum* and *O. basilicum* has been completed. Several important genes encoding pathway enzymes related to aromatic components such as volatile terpenoids, phenylpropanoids and non-volatile medicinal compounds such as pentacyclic triterpenes and rosmarinic acid have been identified in the generated transcriptome data.

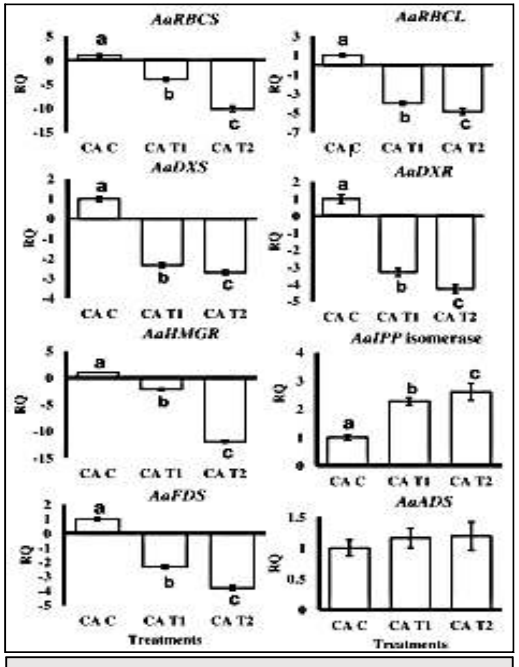
Input: Gupta V, Nagegowda DA, Shasany AK, Sangwan NS, Ghosh S, Shukla RK

Plant Physiology, 164: 1028-1044, DOI:10.1104/pp.113.232884

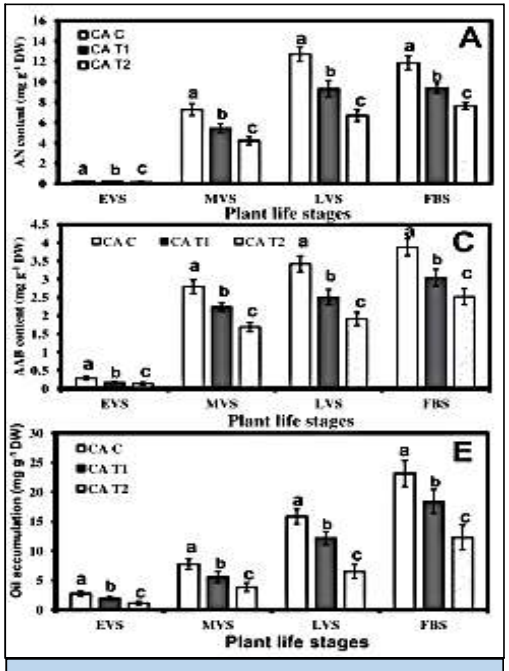
Effect of prolonged water stress on specialized secondary metabolites, peltate glandular trichomes and pathway gene expression in *Artemisia annua* L.

Pathway gene expression, biochemical parameters and metabolome analysed revealed that the secondary metabolites in *A. annua* are positively regulated by plant development whereas negatively regulated under prolonged water stress conditions.

Plants growing under water stress



Real time PCR of selected artemisinin biosynthetic pathway genes.



The level of secondary metabolites in control and treated plant stages.

Input: Sangwan NS

Plant Physiol Biochem 74:70-83

Early Mint Technology- A novel agro-system for minimizing cost of production of Menthol mint oil

India is a leading country in world in the production of menthol mint. In recent times, the productivity levels of menthol mint have reached a plateau or decreasing. The main reasons are: (i) lack of safe cropping period for the menthol mint cultivation and food crops being grown in menthol mint based crop rotations, (ii) Practical and environmental problems associated with the second harvest and it's poor productivity, (iii) high water requirement and physiological features of the crop (iv)Weed problem and high cost of weed management (v) losses due to excess availability of water at maturity due to early onset of monsoon or during second harvest. Thus it is essential to increase per unit productivity is for sustaining it's production. Hence a novel cost effective package of agricultural practices for menthol mint was developed.

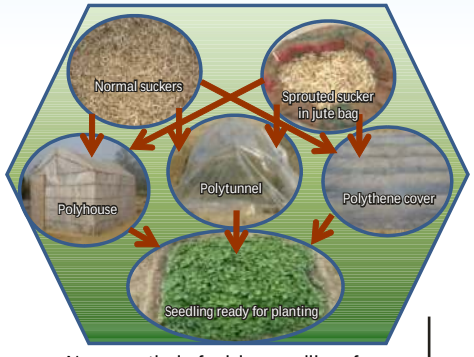
Conventional (flat) planting) *Ridge planting*

Early Mint Technology at Farmer's fields

Early mint technology involving Improved method of the production of planting material (suckers / roots (ridge planting), menthol of raising seedlings from suckers in winter season (poly house / polytunnel / polycover); modified menthol of transplanting / planting (ridge method), preparation before harvesting and precautions to be taken at harvest (withdrawing irrigation about 10-15 days before harvest) and improved method of processing (distillation) has been adopted by the farmers. Early mint technology is responsible to brig earliness about 20-30 days and can minimize expenditure on land, labour, water and fuel about 20-25% with 15-20% increase in the productivity. Water requirement is reduced about 20%

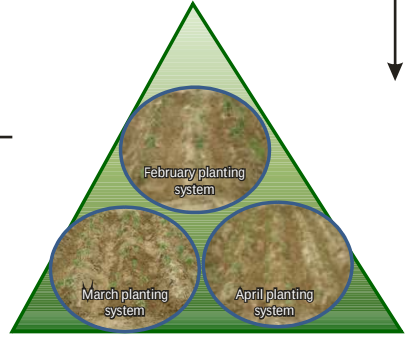
Early Mint Technology-A pictorial presentation

New method of sucker production



New menthol of raising seedlings from suckers in winter season

Preparation before harvesting and distillation



New menthol of transplanting/planting

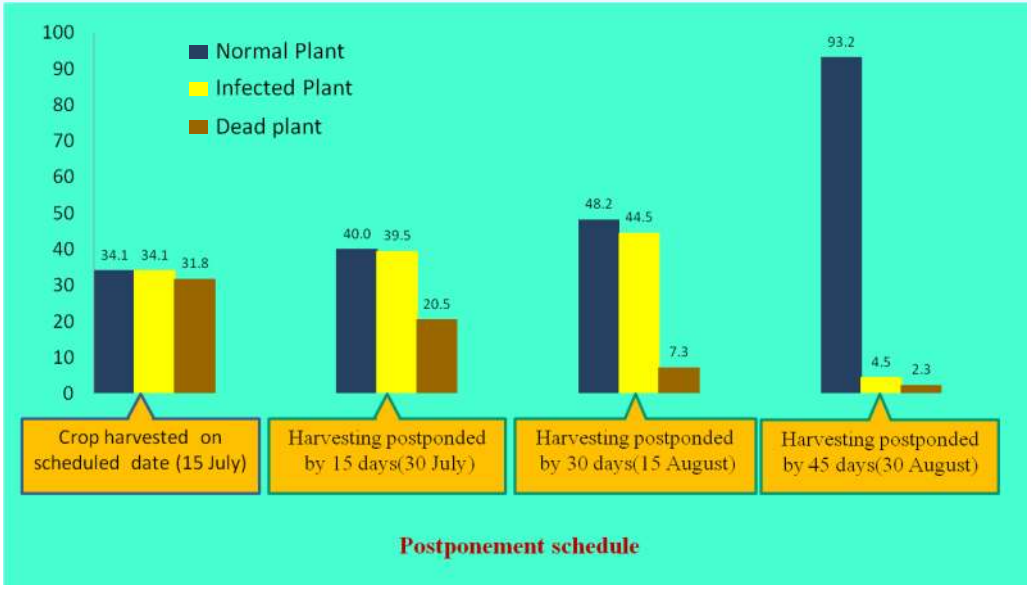
and crop can be saved from the availability of excess water due to early rains. Productivity of second harvest is enhanced about 30%. Early mint technology' can minimize expenditure on land, labour, and water with significant enhancement in yield; hence it can play important role in sustaining menthol mint cultivation by reducing cost of productions.

Input: Singh S

Management of lethal yellowing in Citronella through harvest management

Cymbopogon winterianus reports losses in yield due to incidence of lethal yellowing in hot and humid climate of north India. Therefore, these regions are not considered ideal for the commercial cultivation of citronella despite increasing demand for cultivation. Efforts have been made to manage diseases causes by nutritional and plant pathological reasons, but complete cure is not yet available. Therefore, experiments were planned to manage it by manipulation of the date of harvesting during rainy season.

The study was conducted on Citronella cv. Medini and Citronella cv. Bio-13. Results show that postponement of the harvesting of Citronella cv Bio-13 during rainy season is beneficial for the saving of crop from lethal yellowing and successful cultivation of this crop as perennial under indo-genetic plains of north India. However there is no need of postponement of harvesting date due to onset of monsoons in cv Medini.



Normal plants (%), Plants affected by lethal yellowing (%) and mortality (%) in citronella cv. Bio-13 under different postponement schedule of harvesting.

Input: Singh S

Agro-technology for the cultivation of *Mucuna* without stacking for semi-arid tropics

Mucuna is an important plant and expenditure on the staking for its commercial cultivation is very high. If cultivation of this crop is done without staking, it can be accepted by the farmers due to reduced cost of production. Efforts were made to develop cultivation technology of *Mucuna* without staking at , Hyderabad Centre. Seeds of two white seed variants and two black seed variants of *Mucuna cochinchinensis* Syn. *M. pruriens* were sown along with the variety CIM-Ajar. It was experimentally demonstrated that the crop can be raised without staking to serve as a demonstration for the rainfed farmers.

Field view of the crop at CRC Hyderabad without staking

Fruiting and pod development in mucuna at ground level

Input: Sastry KP

Little-leaf disease in cv Ranisahiba of scented rose

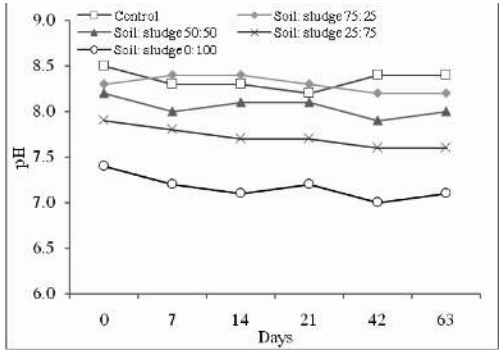
A little-leaf disease has been identified in the cv. Ranisahiba of scented rose. The symptoms of disease include shortening of leaves, axillary proliferation, dense clusters of branches, shortened internodes resulting in witches broom and stunted growth observed during the months of February and March. PCR amplification of targeted DNA fragment was done using a set of universal primers P1 / P6. For nested PCR specific primer pairs R16f2n / R16R2 were used. 1.5 and 1.2 Kb of amplicon were generated with PCR and Nested PCR respectively. PCR product was cloned with TOPO TA cloning kit.

Little-leaf disease of scented rose

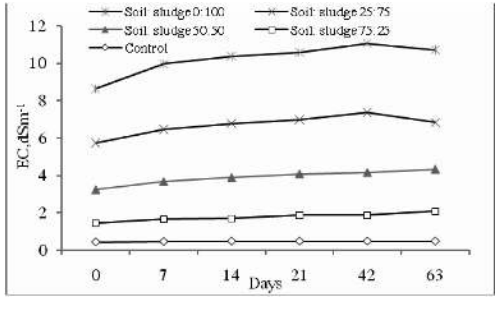
Input: Samad A

Influence of tannery sludge on soil microbial and biochemical properties and growth of sweet basil

Separate laboratory incubation and pot culture experiments were conducted to study the influence of tannery sludge (TS) on soil microbial and biochemical properties and growth of sweet basil (*Ocimum basilicum*) an important essential oil bearing crop. In the incubation experiment, while pH of the soil remained unchanged the electrical conductivity marginally increased with the increase in TS level. Soil microbial biomass C increased, but basal respiration and metabolic quotient decreased with the incubation period. Among the enzymes, dehydrogenase, urease, b-glucosidase decreased with the days of incubation; phosphatase and protease increased with incubation and was stimulated by TS addition. In the potted experiment, growth parameters of basil, dry weight and metal accumulation were stimulated by TS application.



pH of soil untreated and treated with different levels of TS, at different stages of incubation.



Electrical conductivity (EC,dSm^{-1}) of soils untreated and treated with different levels of TS treated soils at different stages of incubation.

Input: Patra DD

Influence of heavy metal rich tannery sludge on soil enzymes vis-à-vis growth of *Tagetes minuta*, an essential oil bearing crop

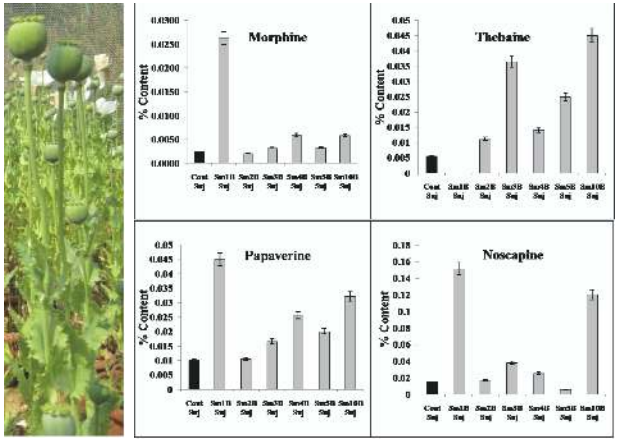
Tannery sludge is available in plenty and is hazardous to environment as well as plant and animal life. It is very important to manage the tannery sludge in an environmentally sound manner. The aim of this study was to assess the physico-chemical, microbial and biochemical properties of soil treated with different levels of sludge. In this study, *Tagetes minuta* an essential oil bearing crop was grown in two different textured soils treated with different levels of tannery sludge. Application of tannery sludge (TS) increased the growth and oil yield of plant and also the activity of urease and soil microbial biomass nitrogen (SMBN) when applied in 50:50 combinations of soil:sludge. The crop performed well in coarse soil with a soil:sludge ratio of 50:50. High concentration of tannery sludge exhibited inhibitory effect on SMBN and urease activity. Acid/alkaline phosphatase, dehydrogenase and soil microbial biomass carbon (SMBC) increased as the sludge concentration increased in soil. This may be due to high organic matter present in tannery sludge. Roots accumulated more metal than the shoot. No detectable amount of metal was found in oil of *T. minuta*. To test the relation between 20 characters principal component analysis (PCA) was performed. PCA analysis indicates that cation exchange capacity (CEC), SMBC, dehydrogenase, acid and alkaline phosphatases were grouped in group 1. SMBN, urease and cis-ocimene content in oil were in group 2 whereas biomasss, chlorophyll a, limonene, Z and E-tagetone were in group 3. PC-I contributes 54% of total variance and PC-II contributes 38% of the total variance. The results concluded that *T. minuta* can mitigate metal toxicity by root absorption. Microbial activity and biomass of plant was higher in coarse soil with TS than fine soil with TS.

The texture of soil was of higher importance for soil microbial properties when mixed with tannery sludge. Microbial activity was higher in the coarse soil than in the fine soil treated with tannery sludge. Coarse soil (SET A) combination facilitated more uptake of metals in roots and leaves than fine soil (SET B) combination. Cation exchange capacity enhanced the growth of microbial biomass carbon, dehydrogenase and acid and alkaline phosphatase activity which was further proved by PCA analysis. On the whole account, the plant performed best in terms of biomass and oil yield at 50:50 combinations. Heavy metal present in tannery sludge were mostly deposited in the roots of *T. minuta*. So this plant cannot be a good candidate for phytoremediation. However, this can mitigate metal toxicity by root absorption. *T. minuta* can be preferred over food and other edible crops for utilization of TS. Unlike food crops the *Tagetes* oil does not contain toxic metal, as the oil is extracted through hydro-distillation.

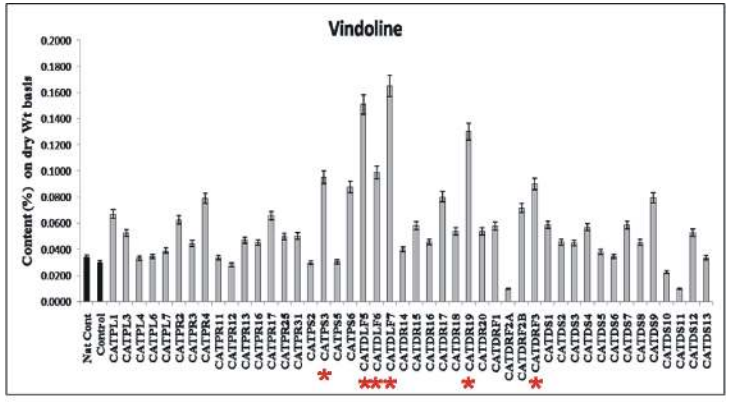
Input: Patra DD

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

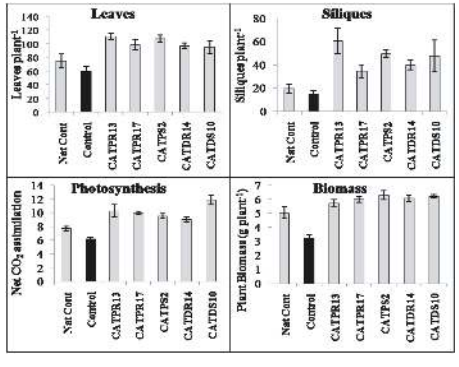
The project aims at identifying endophytic microbes responsible for enhancing the content of therapeutically important secondary metabolites of three important medicinal plants viz.: *Papaver somniferum*, *Withania somnifera* and *Catharanthus roseus*



Endophytes isolated from capsule of morphine rich variety Sampada enhanced BIAs production in alkaloid less Papaver var. Sujata. Strain SM1B substantially enhanced morphine, papaverine and noscapine content.



Endophytes from cv. Dhawal CATDLF5, CATDLF6, CATDLF7, CATDR19, CATDRF3 enhanced vindoline production in Catharanthus cv. Prabal; an increase of 200-450%.

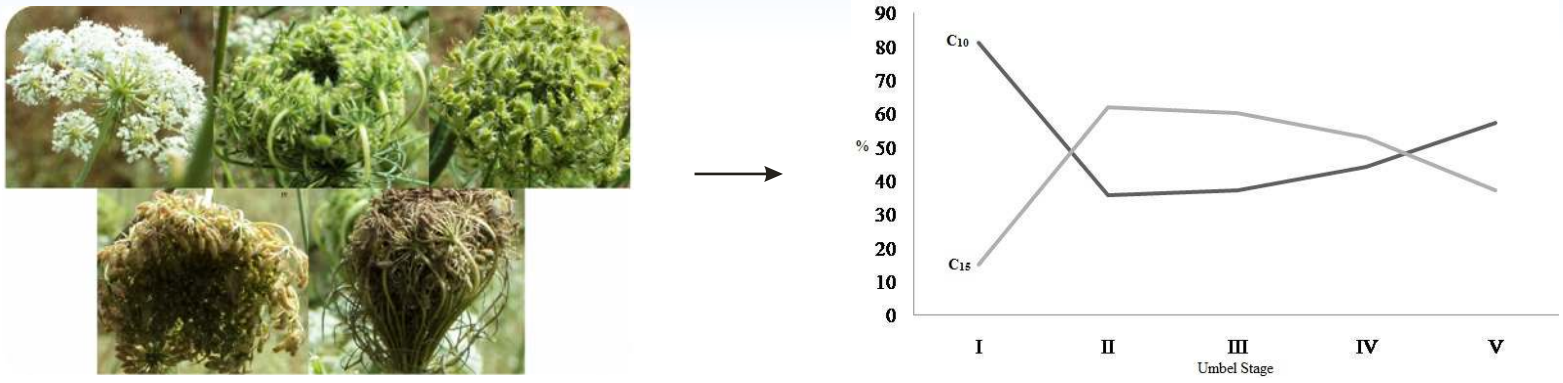


Endophytes promoting growth of Catharanthus roseus plant by increasing no. of leaves (60-86%), no. of siliques (131-304%), photosynthesis (46-92%) and biomass (78-95%) were identified.

This study clearly demonstrated that endophytes play a crucial role in enhancing the primary productivity as well as secondary metabolites production.

Input: Kalra A

Ontogenic changes of monoterpenoids and sesquiterpenoids in the umbels of *Daucus carota*



Ontogenic changes of C_{10} (monoterpenoids) and C_{15} (sesquiterpenoids) components in the umbels of Daucus carota subsp. sativus (I: full bloom stage; II: seed setting initiation stage; III: green seed stage; IV: light brown seed stage; V: fully brown seed stage)

Daucus carota L. (Apiaceae) is an important vegetable crop cultivated worldwide for its nutritive roots. The aim of this study was to examine changes occurring in the essential oil yield and chemical composition of *Daucus carota* L. subsp. *sativus* (Hoffm.) Arcang. umbels during flowering and fruiting process. The essential oil yield varied from 0.7 to 1.8% (v/w) during umbel ontogeny. The resulted essential oils were analysed using gas chromatography-flame ionization detector (GC-FID) and GC-mass spectrometry (GC-MS). Altogether, 34 constituents, forming 94.5-97.9% of the total compositions were identified. The essential oil composition was characterized by high proportions of monoterpenoids (35.9-81.3%) and sesquiterpenoids (15.1-62.0%). Major constituents of the essential oils were carotol (10.2-58.5%), a-pinene (21.2-41.2%), myrcene (6.4-14.1%), limonene (4.4-12.7%), and sabinene (0.2-5.3%).

The results obtained are of significance for determining the most favorable time for harvesting carrot umbels for better yield of quality essential oil. Flowering umbels had chemically different oil than fruiting umbels. Umbels at seed setting initiation stage produced highest amount of essential oil and carotane sesquiterpene, carotol.

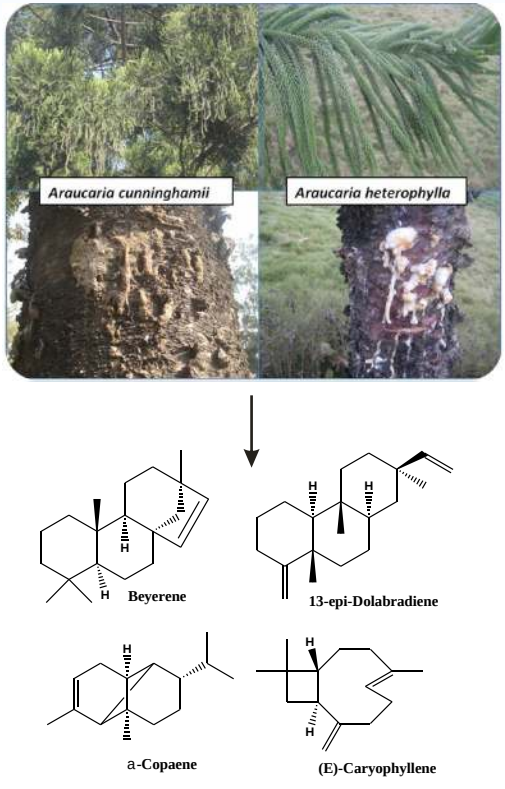
Input: Verma RS, Padalia RC, Chauhan A

Industrial Crops and products 52: 809-814 (IF 3.208)

Exploration of *Araucaria* species for aroma molecules and their anti-bacterial property

The essential oils of foliage and resin of *Araucaria cunninghamii* Aiton ex D.Don and *Araucaria heterophylla* (Salisb.) Franco were isolated by hydrodistillation and subsequently analyzed using gas chromatography (GC/FID) and GC-mass spectrometry (GC/MS). Altogether 113 constituents, representing 84.0 to 97.6% of the total oil compositions were identified. Major constituents of the foliage oil of *A. cunninghamii* were beyerene (34.6-44.4%), caryophyllene oxide (0.5-17.9%), a-pinene (3.3-16.2%), germacrene D (0.1-9.8%), kaurene (1.7-5.1%), and 13-*epi*-dolabradiene (4.2-4.8%). However, the resin oil of *A. cunninghamii* was characterized by higher amounts of (*E*)-caryophyllene (60.8%), caryophyllene oxide (13.4%), and (*E*)-b-farnesene (4.9%). The foliage oil of *A. heterophylla* was dominated by 13-*epi*-dolabradiene (42.7%), beyerene (22.2%), rimuene (13.7%), and dolabradiene (3.9%), whereas the resin oil of *A. heterophylla* contained a-copaene (29.9%), germacrene D (21.4%), g-gurjunene (9.7%), d-cadinene (7.1%), and sandaracopimara-8(14),15-diene (6.5%) as main constituents. The foliage and resin essential oils of both species showed minimum inhibitory concentration (MIC) in the range of 250 to 500 µg/mL and minimum bactericidal concentration (MBC) in the range of 1000 to > 1000 µg/mL against tested bacterial strains {*Staphylococcus aureus* (MTCC 96), *Staphylococcus aureus* (MTCC 2940), *Bacillus subtilis* (MTCC 121), *Staphylococcus epidermidis* (MTCC 435), *Streptococcus mutans* (MTCC 890), *Klebsiella pneumoniae* (MTCC 109), *Escherichia coli* (MTCC 723), *Escherichia coli* (DH5a), and *Salmonella typhimurium* (MTCC 98)}.

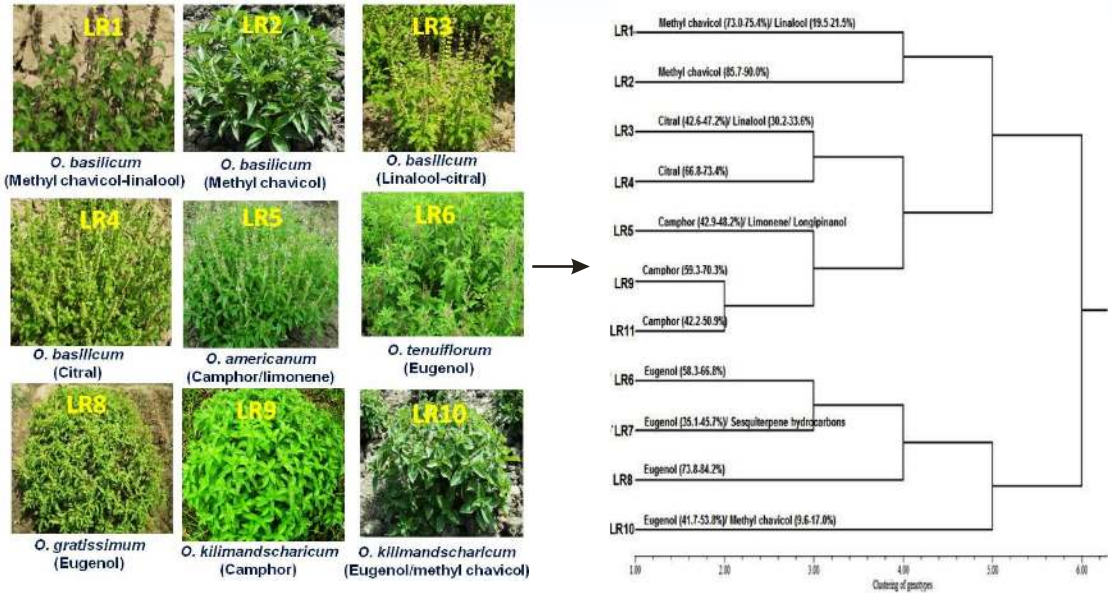
The interest in the isolation of diterpenes is growing due to their biological activities, ecological function, and use as templates for synthesis, and chemotaxonomic implications. Therefore, these oils could be interesting sources of diterpenes and sesquiterpenes for industrial use and further research.



Input: Verma RS, Padalia RC, Chauhan A, Darokar MP

Industrial Crops and Products 61: 410–416 (IF 3.208)

Changes in aroma profiles of eleven Indian *Ocimum* taxa during plant ontogeny



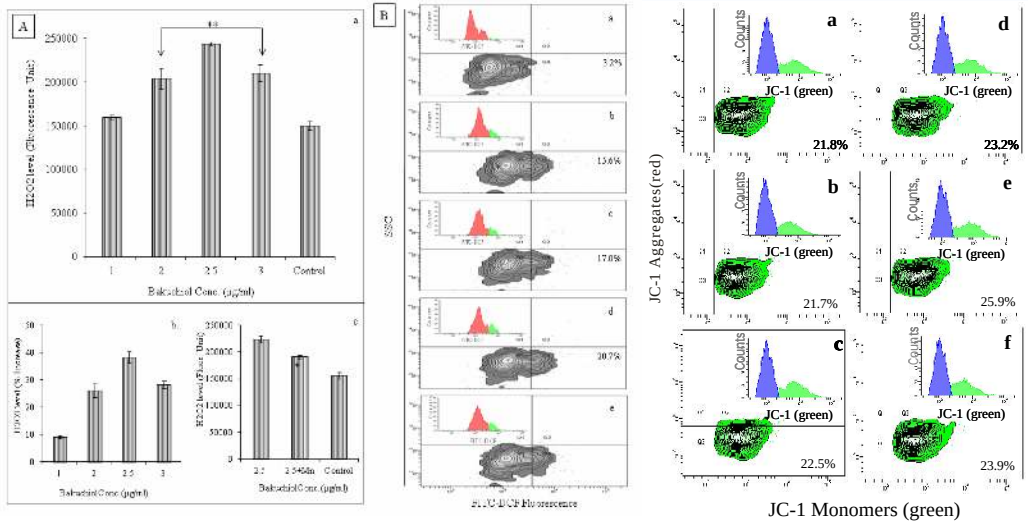
An experiment was conducted to evaluate the ontogenic variations in aroma profiles of eleven Indian *Ocimum* taxa belonging to five *Ocimum* species, viz. *O. basilicum* L., *O. americanum* L., *O. gratissimum* L., *O. tenuiflorum* L., and O. *kilimandscharicum* Guerke during rain-autumn cropping season. Essential oil yield was found to be higher at full bloom stage in most of the studied *Ocimum* taxa. A total of 95 constituents forming 93.8%-99.7% of essential oil compositions were identified. Methyl chavicol (≥85.0%); methyl chavicol (74.0%)/linalool (21.0%); linalool (≥ 30.0%)-citral (≥ 40.0%); and citral (≥ 65.0%) chemotypes in *O. basilicum*; camphor (70.0%) and eugenol (41.7%-53.8%)-methyl chavicol (9.6%-17.0%) chemotypes in *O. kilimandscharicum*, eugenol chemotypes in *O. tenuiflorum* (65.0%) and *O. grattisimum* (73.8%-84.2%); and camphor (42.9%-48.2%)-limonene (6.8%-8.5%) chemotype of *O. americanum* were identified. Substantial variations in essential oil yield and contents of aroma constituents were noticed due to different growth stages. The optimum harvesting stages were standardized for higher quality essential oils.

Input: Padalia RC, Verma RS, Chauhan A

Acta Physiologiae Plantarum 35: 2567

In vitro anti-malarial activity evaluation mechanism of action studies of bakuchiol

About 215 million cases and 655,000 deaths occurs due to malaria, making it most lethal parasitic disease worldwide. The emergence of *P. falciparum* resistance to artemisinin or its derivatives threatens the world's malaria control and elimination effort. Bakuchiol, a meroterpene, isolated from *Psoralea corylifolia* seeds exhibited potent anti-malarial activity *in vitro* (IC_{50}-3.1µg / ml) against *Plasmodium falciparum* (NF-54) and *in vivo* against *P. berghei*. Late trophozoite and early schizont parasite stages were found to be most sensitive to bakuchiol. Bakuchiol interacts specifically with *Pf*LDH in the NADH binding pocket similar to chloroquine. Bakuchiol induced oxidative stress and caused mitochondrial membrane depolarization leading to parasite cell death. Bakuchiol is being further derivatized to obtain more potent analogue that may lead to the development of a novel therapeutic agent for combating malaria.

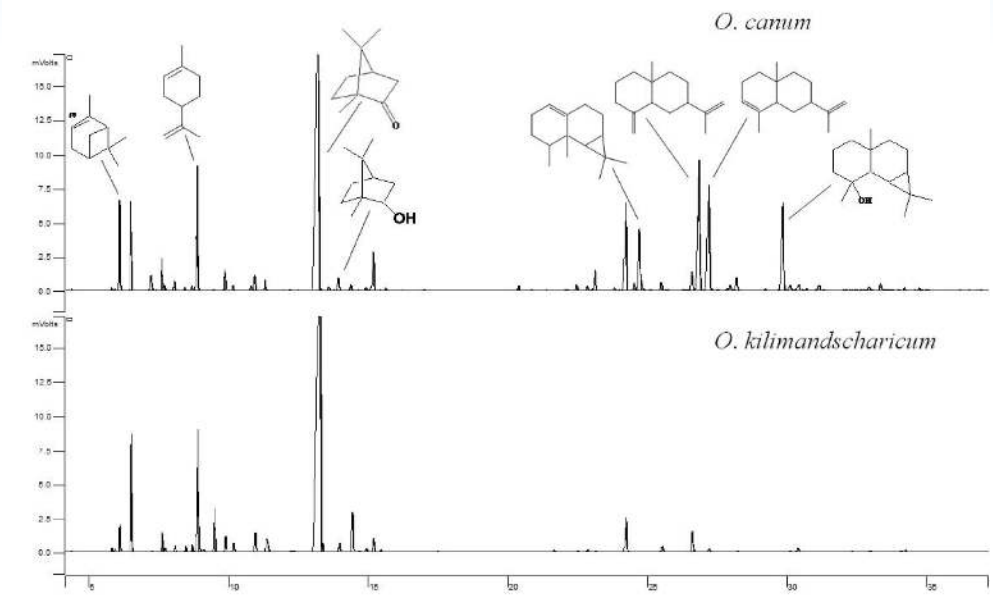


Bakuchiol induced ROS (H_2O_2) generation, A. ROS level measured using spectrofluorometer, a. level of intracellular ROS, b. percent increase in ROS level, c. ROS level in presence of mannitol. B. Cytofluorimetric analysis, contour plot and histograms showing the shifting of population towards DCF positive cells (represent in %) after treatment at various concentrations of bakuchiol. C. Cytofluorimetric Contour plot and histograms (inset) showing the shifting of population (represent in %) towards JC-1 green channel after the treatment of bakuchiol at various concentrations.

The experiments were performed thrice (n=3) and data expressed as mean values ±SEM. *P<0.05, **P<0.01 *vs.* control.

Input: Darokar MP, Pal A, Bhakuni RS

Compositions, enantiomer characterization and anti-fungal activity of two *Ocimum* essential oils



Essential oils extracted from aerial parts of two Ocimum species (*O. canum* Sims. and *O. kilimandscharicum* Baker ex Güerke) were investigated using gas chromatography and gas chromatography / mass spectrometry techniques on DB-5 (5% diphenyl-95% dimethylpolysiloxane) and b-cyclodextrin (6-tertiarybutyldimethylsiliyl-2,3-diethyl-b-cyclodextrin) capillary columns. Essential oil of *O. canum* contained camphor, limonene, camphene and myrtenol as most abundant constituents among monoterpenoids, whereas b-selinene, a-selinene, maaliol and b-caryophyllene were identified as sesquiterpenoids. On the contrary, two folds higher camphor was recorded in *O. kilimandscharicum* than *O. canum*. Maaliol (6.4%) was characterized in *O. canum* essential oil for the first time with the help of extensive 1D and 2D-NMR experiments. Therefore, maaliol can be considered as a marker constituent to differentiate both the camphor rich oils. Further, when the oils were subjected to chiral analysis on b-cyclodextrin column; a high enantiomeric excess for (1*R*)-(+)-camphor was recorded.

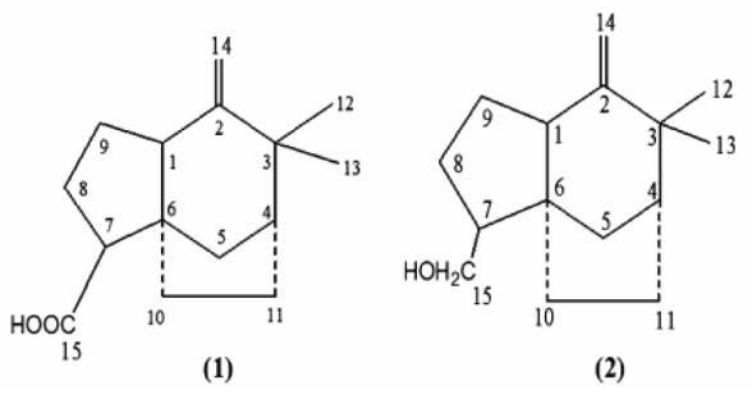
This revealed a close relationship between these two species in terms of biosynthesis of single enantiomer. Apart from analysis, oils were assessed for antifungal activity against *Rhizoctonia solani* and *Choanephora cucurbitarum*. *O. kilimandscharicum* exhibited a complete inhibition against *R. solani* and *C. cucurbitarum* while *O. canum* was only effective against *R. solani*.

Input: Chanotiya CS

Industrial Crops and Products 50: 333-337

Anti-mycobacterial agents from Vetiver

As a part of anti-mycobacterial drug discovery programme, roots of *Vetiveria zizanioides* were chemically and biologically investigated in detail. Activity-guided fractionation and isolation resulted in the characterization of two antimycobacterial agents, khusenic acid (1) and khusimol (2).



Chemical structures of khusenic acid (1) and khusimol (2)

Anti-mycobacterial activity of khusenic acid (1) and khusimol (2) against *Mycobacterium tuberculosis* H37Rv strain by BACTEC assay

	GI values at different days						
Compounds	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Khusenic acid (**1**) 12.5 μg/mL	8	4	0	0	0	0	0
Khusimol (**2**) 25 μg/mL	10	3	0	0	0	0	0
NA 25 μg/mL	4	1	1	0	0	1	0
CF 0.75 μg/mL	6	3	1	2	0	0	0
1/100 Dilution	1	1	1	2	7	21	45

GI, growth index; CF, ciprofloxacin; NA, nalidixic acid.

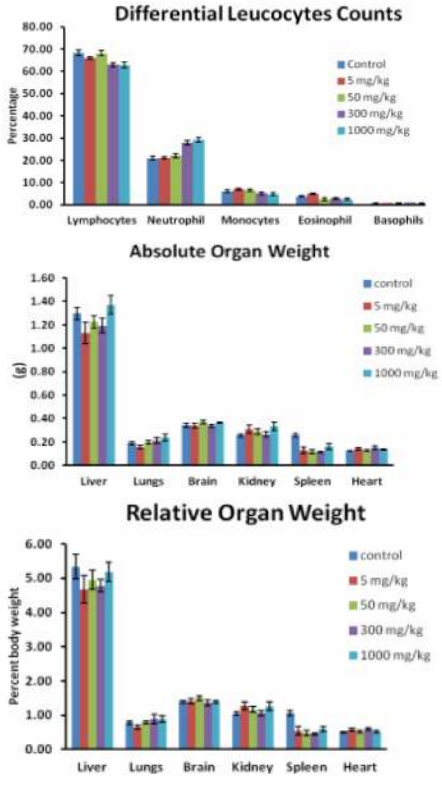
Both compound (1 and 2) exhibited significant antimycobacterial activity against drug-resistant mutants of *Mycobacterium smegmatis* and virulent strain H37Rv of *M. tuberculosis*. These observations may be of great help in the QSAR-based anti-mycobacterial drug designing from a very common, inexpensive and non-toxic natural product for the management of MDR and XDR tuberculosis.

Input: Srivastava SK

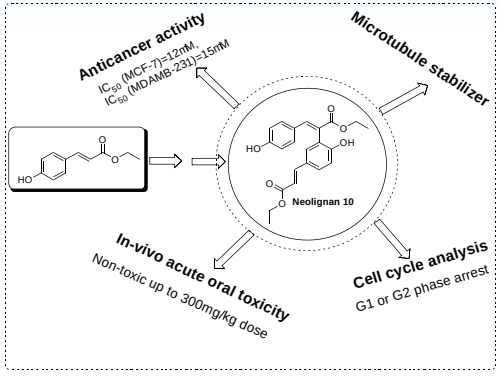
Chemical Biology & Drug Design 82: 587–594 (IF 2.469)

Modification of phenylpropanoids to potent anti-cancer neolignans

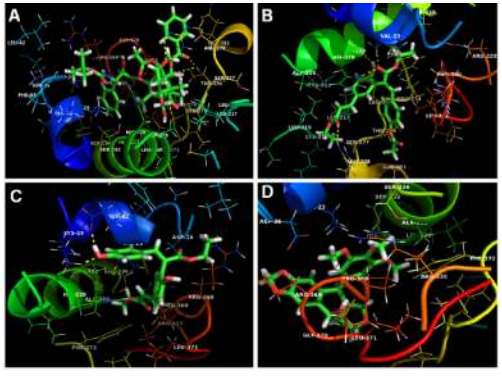
Neolignan 10 exhibits potent anti-breast cancer activity through microtubule stabilization.



Acute oral toxicity

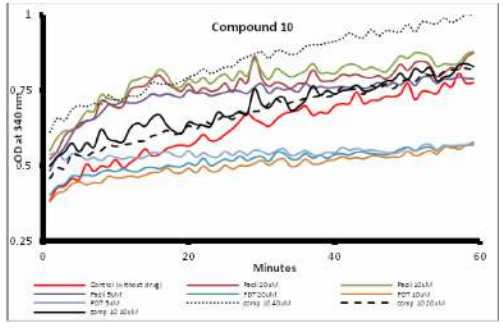


Neolignan 10 occupies taxol binding pocket of tubulin

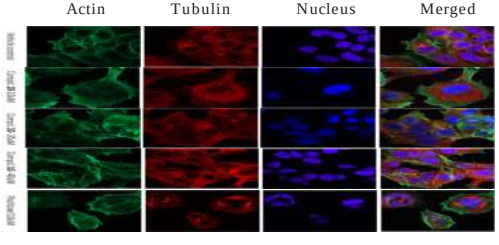


A. Taxol, B & C. neolignans, D. Podophyllotoxin

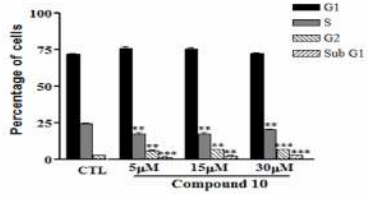
Microtubule stabilization



Confocal microscopy



Cell cycle analysis



Modified neolignans showed potent anti-cancer activity

Input: Negi AS, Luqman S, Chanda D, Pal A, Khan F

Bioorganic Medicinal Chemistry 22: 1342-1354

QSAR guided semi-synthesis and *in vitro* validation of anti-cancer activity in ursolic acid derivatives

As a part of our anti-cancer drug discovery programme, QSAR models were developed for the prediction of anticancer activities of ursolic acid derivatives against the human hepatocellular carcinoma HepG2, breast carcinoma MDA-MB-231 and the human ductal breast epithelial T47D cancer cell lines followed by wet lab semi-synthesis of virtually active derivatives, their *in vitro* biological evaluation and apoptosis.

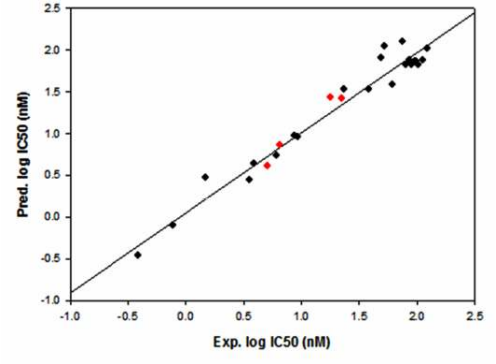


Fig. (1). Graphical plot of multiple linear regression analysis which indicates linear relationship between experimental and predicted log IC_{50} with r2= 0.95 for HepG2 cancer cell line.

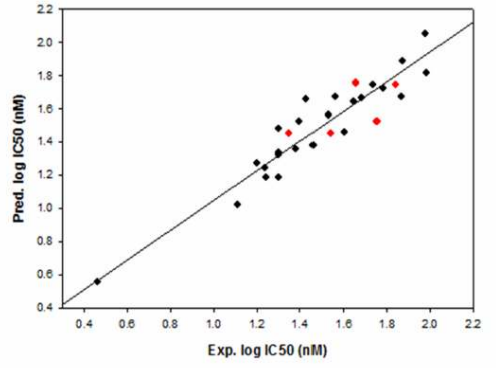


Fig. (2). Graphical plot of multiple linear regression analysis which indicates linear relationship between experimental and predicted log IC_{50} with r2= 0.92 for MDA-MB-231cancer cell line.

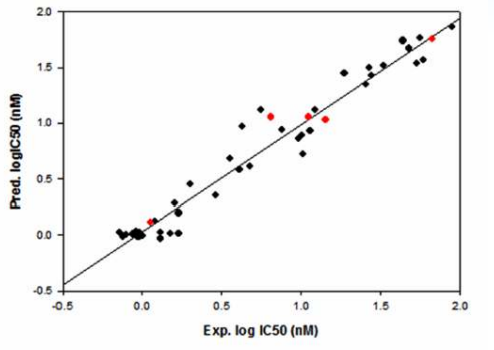


Fig. (3). Graphical plot of multiple linear regression analysis which indicates linear relationship between experimental and predicted log IC_{50} with r2= 0.89 for T47D cancer cell line.

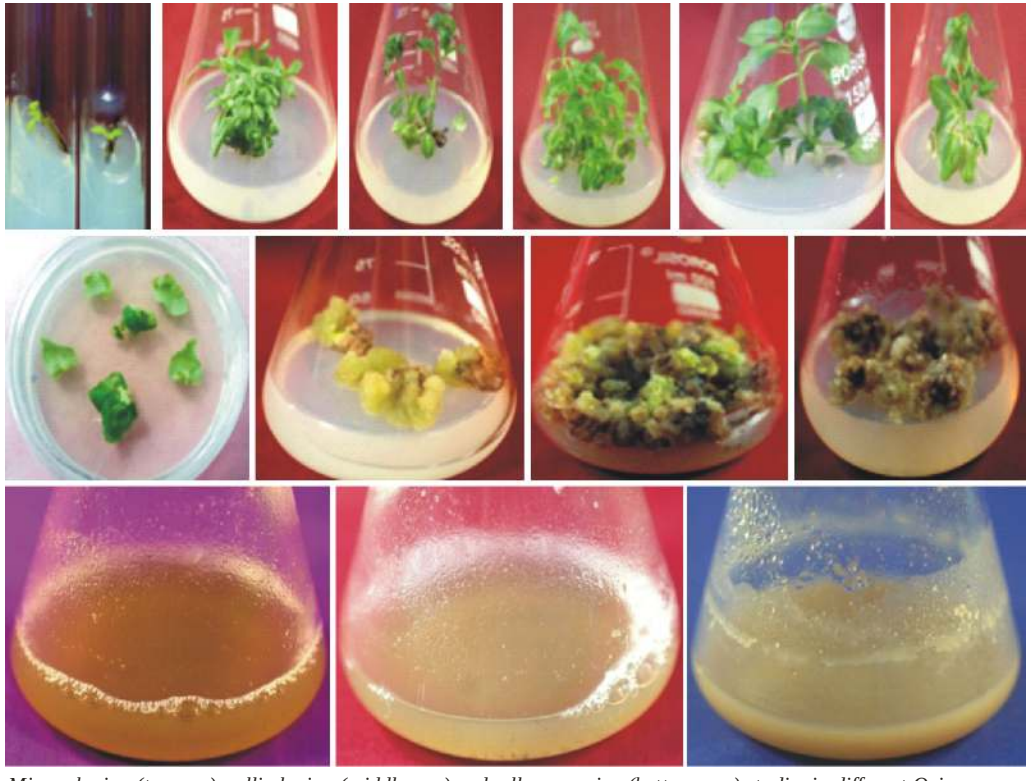
The most active virtual derivatives of UA were semi- synthesized and their *in vitro* and *ex vivo* evaluation showed similar results with the predicted one, validating our QSAR models. Out of several active derivatives, the three UA2, UA7 and UA10 were potentially active against the above human cancer cell lines. These findings may be of immense importance in the anti-cancer drug development of an inexpensive and widely available natural product, ursolic acid.

Input: Khan F, Srivastava SK

Current Topics in Medicinal Chemistry 14: 1005-13

Tissue culture studies for metabolite production, micro-cloning, somaclonal breeding and pollen banking in *Ocimum* species

Medium recipes for micro-cloning of true to type plants of *O. basilicum* (cv. CIM-Saumya), *O. sanctum* (cv. CIM- Angana), *O. gratisissimum*, *O. kilimandscharicum* and a cold tolerant genotype of *O. sanctum x O. kilimandscharicum* have been optimized using axillary and apical bud explants. Hormonal requirements for bud break and shoot elongation were found to vary in genotype-specific manner. BAP (0.2-1.0 mg / l) either alone or in combination with Kn or IAA (0.01-0.5 mg / l) was found most effective cytokinin for shoot regeneration. For root induction and plantlet formation half strength MS medium with 0.10 mg / l IAA was sufficient in case of *O. sanctum*, *O. gratissimum* and *O. kilimandscharicum*. In case of *O. basilicum* rooting occurred simultaneously with shoot growth on BAP fortified medium. Direct shoot bud organogenesis from leaf explants of *O. gratisissimum* has also been achieved to apply transgenic approaches for terpene pathway engineering .



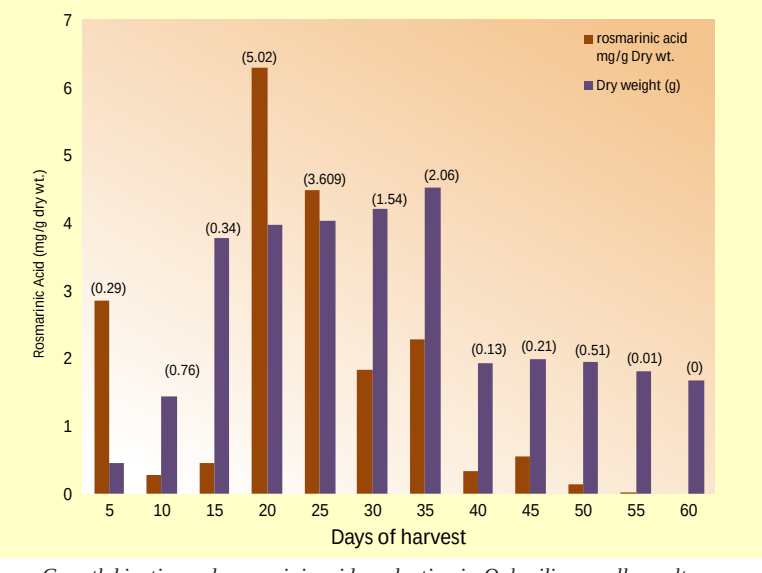
Micro-cloning (top row), calli-cloning (middle row) and cell suspension (bottom row) studies in different Ocimum spp.

For induction of variability callus was successfully raised using leaf and internode- explants in all five *Ocimum* species. A vitamin-enriched MS medium supplemented with 1.0 mg / l 2, 4-D and 0.1 mg / l Kn supported the best callus proliferation. For *in vitro* mutagenesis, cell suspensions have also been induced using the callus of *O. sanctum* and O. *basilicum*.

The induced cell suspensions of both the species turned embryogenic after 4-6 sieving cycles. Plant regeneration studies from induced calli to raise somaclones are underway.

Growth and metabolite production in callus cultures of *O. basilicum* was monitored over a period of 60 days *in vitro*. Rosmarinic acid was found to be the major constituent in 20-35 days old calli. The corresponding cell suspension cultures of this callus line, on the other hand, accumulated more of caffic and ferulic acids.

Efforts towards pollen banking in *Ocimum* species were also initiated. For this, method to check pollen viability in terms of their germinability as a function of flower bud age and size, time of pollen collection and plating methods have been optimised using *in vitro* germination test in sitting drop cultures. Pollen of *O. basilicum* (cv. CIM-Saumya) were used as test system for protocol standardization. Out of a large number of germination medium tested so far, liquid medium comprising of Brewbaker and Kwack salts, boric acid, polyethylene glycol and sucrose was found to support maximum pollen germination *in vitro*.

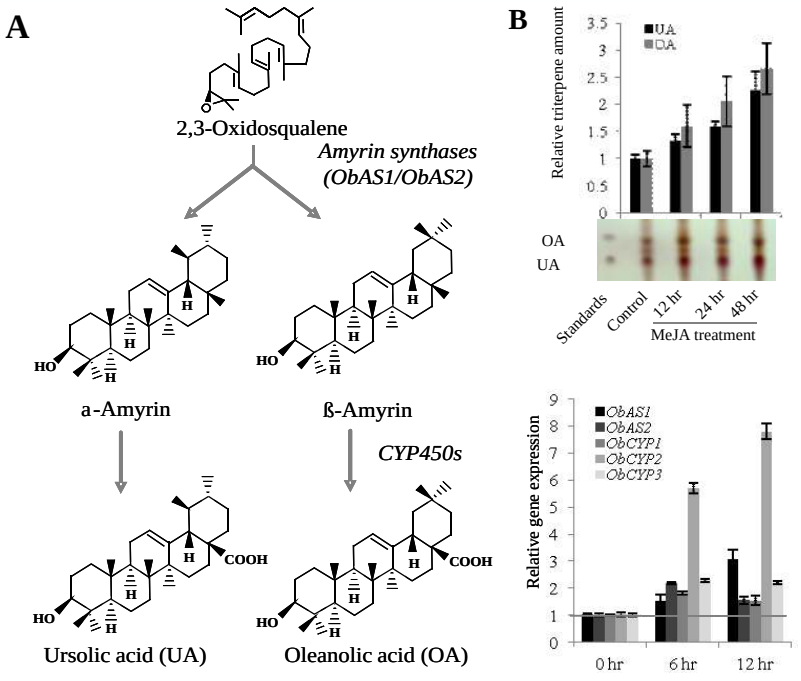


Growth kinetics and rosmarinic acid production in O. basilicum callus cultures

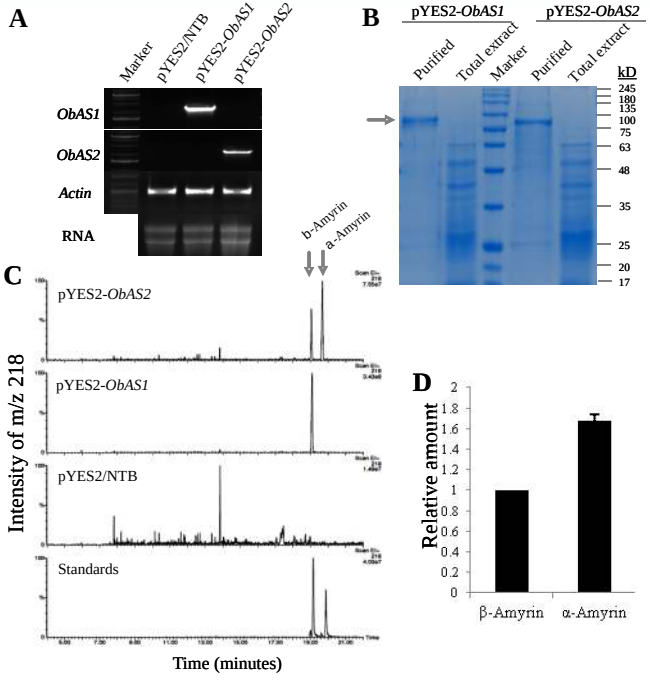
In vitro viability testing in sitting drop culture using modified B&K medium with PEG in O. basilicum.

Inputs: Mathur AK, Mathur A

Identification and characterization of the genes involved in pentacyclic triterpene biosynthesis in sweet basil (*Ocimum basilicum*)



MeJA-responsiveness of the pentacyclic triterpene biosynthetic pathway. (A) Ursolic acid (UA) and oleanolic acid (OA) biosynthetic pathway of sweet basil (B) TLC analysis to determine the relative levels of UA and OA in sweet basil leaves after MeJA treatment for the indicated time periods. (C) Quantitative RT-PCR expression analysis of amyrin synthases (*ObAS1*, *ObAS2*) and cytochrome P450s (*ObCYP1*, *ObCYP2*, *ObCYP3*) revealed MeJA-inducible expression.



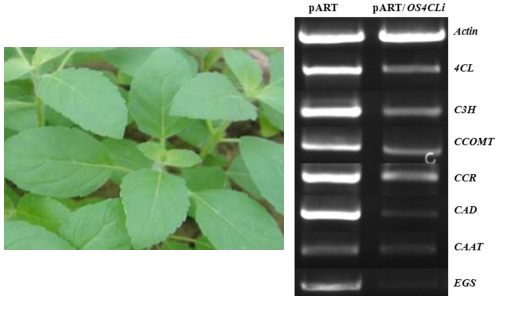
Functional expression of *ObAS1* and *ObAS2* in yeast. (A, B) RT-PCR analysis (A) and purification of 6xHis-tagged recombinant proteins (B) to confirm the expression of *ObAS1* and *ObAS2* in *S. cerevisiae*. (C) GC-MS analysis of hexane extracts of yeast cells-expressing *ObAS1* and *ObAS2*. pYES2 / NTB denotes empty vector control. (D) The relative comparison of a-amyrin and b-amyrin accumulated in *ObAS2*-expressing yeast strain.

Input: Chanotiya CS, Shanker K, Ghosh S

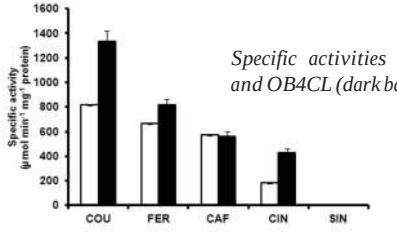
Plant Physiology 164: 1028-1044

4-Coumarate: CoA ligase partitions metabolites for eugenol biosynthesis

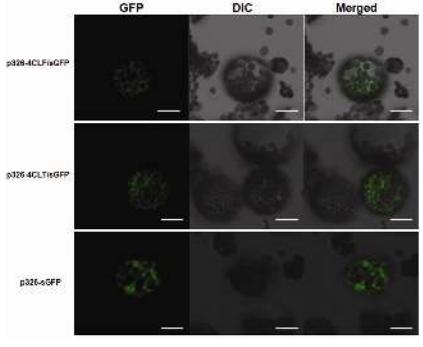
Biosynthesis of eugenol shares its initial steps with that of lignin, involving conversion of hydroxycinnamic acids to their corresponding coenzyme A (CoA) esters by 4-coumarate:CoA ligases (4CLs). Earlier we have isolated and identified a *4CL* (*OS4CL*) from glandular trichome-rich tissue of *Ocimum sanctum* with high sequence similarity to an isoform (*OB4CL_ctg4*) from *O. basilicum*. The levels of *OS4CL* and *OB4CL_ctg4*-like transcripts were highest in *O. sanctum* trichome, followed by leaf, stem and root. The eugenol content in leaf essential oil was positively correlated with the expression of *OS4CL* in the leaf at different developmental stages. Recombinant *OS4CL* showed the highest activity with *p*-coumaric acid, followed by ferulic, caffeic and *trans*-cinnamic acids. Transient RNA interference (RNAi) suppression of *OS4CL* in *O. sanctum* leaves caused a reduction in leaf eugenol content and trichome transcript level, with a considerable increase in endogenous *p*-coumaric, ferulic, *trans*-cinnamic and caffeic acids. Sinapic acid and lignin content were unaffected in RNAi suppressed leaf samples. Expression of *OS4CL* was localized to the cytosol.



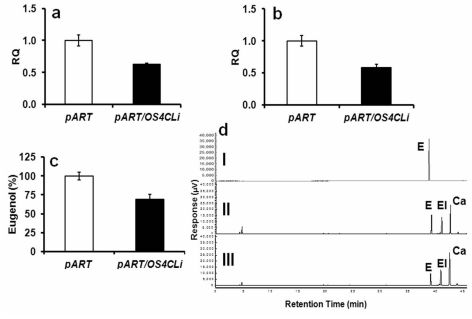
Effect of OS4CL suppression on the expression of downstream genes



Specific activities of OS4CL and OB4CL (dark bars).



OS4CL protein was localized to cytosol of Arabidopsis protoplast



Effect of pART/OS4CLi (RNAi construct) on OS4CL transcript and eugenol level

These results indicate metabolite channeling of intermediates towards eugenol by a specific *4CL* and is the first report demonstrating the involvement of *4CL* in creation of virtual compartments through substrate utilization and committing metabolites for eugenol biosynthesis at an early stage of the pathway.

Input: Chanotiya CS, Shanker K, Gupta MM, Nagegowda DA, Shasany AK

Plant Cell Physiol. 54: 1238–1252

Cannabis sativa essential oil and anti-bacterial nature of molecules

Cannabis sativa L. (Cannabaceae), commonly known as 'Bhang' or 'Marijuana', an annual herb that grows freely throughout the world. In India the plant is distributed throughout the Himalayan foothills and the adjoining plains, from Kashmir in the west to Assam in the east. Present study aims to investigate the essential oil composition and anti-microbial activity of *C. sativa*. The hydrodistilled essential oil of *C. sativa* was investigated using GC-FID and GC-MS and evaluated against nine pathogenic bacterial strains using disc diffusion assay.

A total of fifty-seven constituents, representing 90.5 to 93.1% of the total oil compositions were identified. Major constituents of the essential oil were (*E*)-caryophyllene (19.6-26.1%), limonene (4.1-15.8%), caryophyllene oxide (2.0-10.7%), (*E*)-b-farnesene (4.8-8.5%), a-humulene (5.4-7.8%), a-pinene (0.7-7.7%), myrcene (0.8-6.0%), terpinolene (0.2-6.0%), and b-selinene (1.8-5.4%).

The oil showed moderate to good activity against most of the tested Gram-positive bacteria [*Staphylococcus aureus* (MTCC 2940), *Staphylococcus aureus* (MTCC 96), and *Streptococcus mutans*].

Current Science 107: 645-650 (IF 0.833)

Input: Verma RS, Padalia RC, Chauhan A, Darokar MP

Lipids from spent biomass

The solvents comprised of equal amounts of hexane-ethyl acetate-methanol. The lipids were analyzed by GC-FID and ^{1}NMR. The neutral lipids were enriched with unsaturated fatty acids. It might be used for non-food industrial applications such as bio-lubricant, bio-diesel, green diesel, additive in paint, emulsifier, etc.

For comparison of non-polar lipids of biomass with traditional oil-seed crops, we have worked on isolation and systematic characterization of mature *Psophocarpus tetragonolobus* seeds. The neutral lipids fulfilled all the food value parameters contrary to the earlier report that the lipids contained anti-nutritional compound viz. parinaric acid. The neutral lipids contained improved percentages of monounsaturated fatty acids (MUFA, 38.6%), polyunsaturated fatty acids (PUFA, 36.9%) along with saturated fatty acids (SFA, 21.9%). Thus *P. tetragonolobus* neutral lipids were enriched with unsaturated fatty acids (USFA, 75.5%) and seed-cake closely compared with the well-known high value food soyabean.

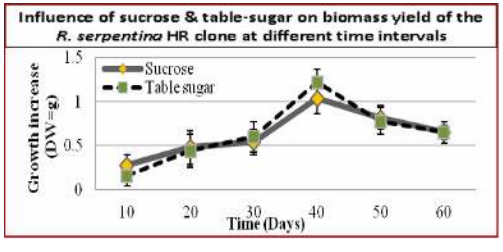
Input: Rout PK, Nannaware AD

A low-cost strategy of commercial merit endorsing enhanced biomass and terpene indole alkaloid production using hairy-root culture of *Rauvolfia serpentina* Benth

Rauvolfia alkaloids have immense therapeutic applications to treat diverse ailments such as breast cancer and cardio-vascular diseases, which highlight their increasing commercial demand.

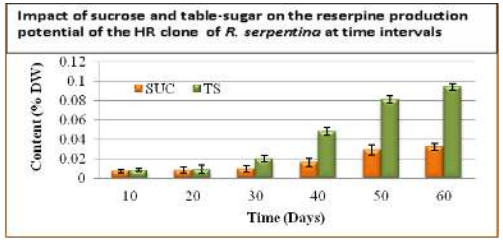
The endangered status of the plant and requirement of long cultivation periods for optimum yield of its alkaloids have prompted exploring the possibility of utilizing hairy-root (HR) cultures as production alternative.

The effect of table-sugar (TS) on the biomass and TIA productivities were studied in a *R. serpentina* HR clone, as an innovative attempt to explore industrial realism.

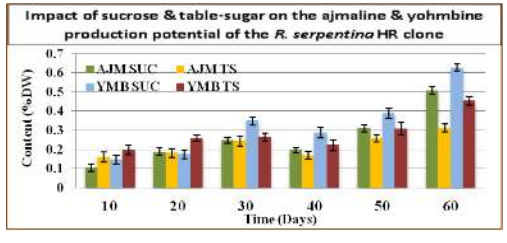


Input: Banerjee S

Table sugar demonstrated 1.17 & 2.9 times more biomass & reserpine yields respectively than that with sucrose at the optimum growth and production phases.



Sucrose showed 1.4 & 1.6 times higher yields of yohimbine & ajmaline respectively than that with TS.



The media cost could be reduced >18 fold by replacing sucrose with table-sugar – an unexplored avenue for HR cultivation professing commercial potential.

HR with Sucrose

HR with Table sugar

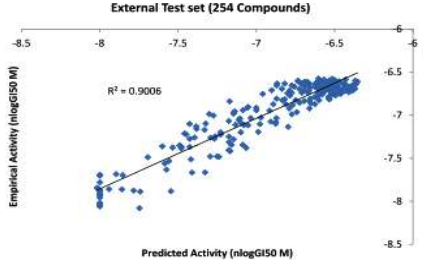
Biotechnology Letters 36:1523–1528

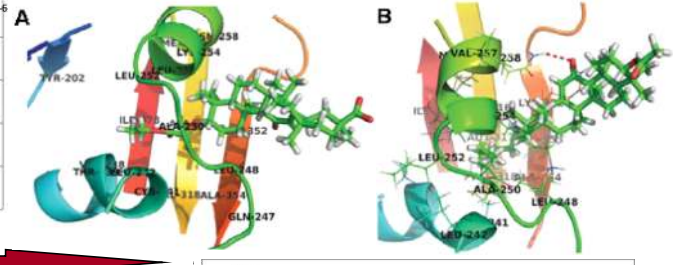
Optimization of active phytomolecules derivatives as lead against cancer and drug resistant bacterial pathogens. Development of *in silico / in vitro* screening methods & identification of anti-cancer & anti-bacterial leads

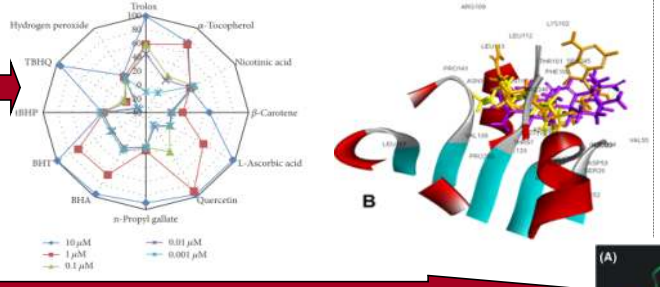
Phyto-Molecules → *In silico* design, ADMET Screening, Docking studies → QSAR model development (*in silico* assay) → Isolation, chemical synthesis, transformation → *In vitro* exp. (Anti-microbial, Anti-cancer activity) → New Active Leads

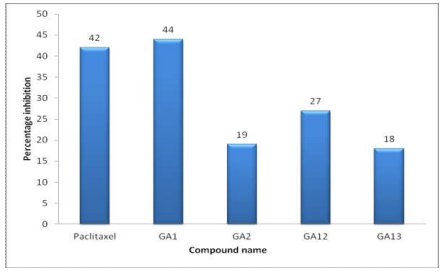
Outcome:

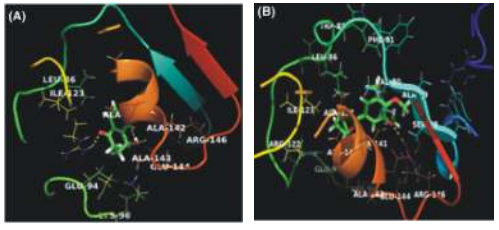
- Developed *in silico* assay for screening of anti-cancer compound active against human breast (MCF7) cancer cell line by using cluster based SVR-QSAR.
- Identified *in vitro* anti-cancer activity of 18 β -glycyrrhetinic acid (GA)/derivatives (*Glycyrrhiza glabra*) against lung (A549) & breast (MCF7) cancer cell lines & also anti-malarial activity of GA.
- Developed *in vitro* method for peroxyl radical trapping capacity assay.
- Identified *in vitro* 4-Hydroxy- α -tetralone/derivatives (*Ammannia baccifera*) as drug resistance reversal agents in multi drug resistant *E. coli*











Anti-cancer and anti-bacterial lead identification, SAR and assay was developed

Input: Khan F, Srivastava SK, Darokar MP, Bawankule DU, Luqman S

Genetic improvement in ginger through mutation breeding

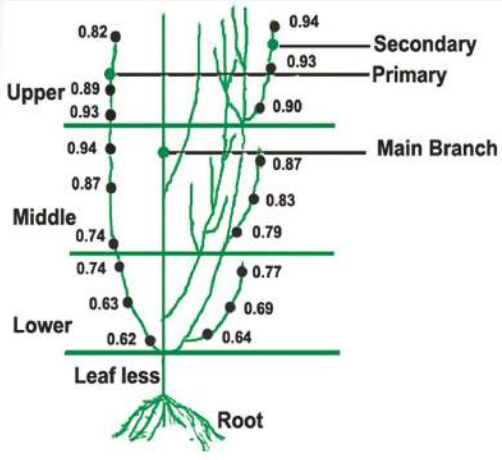

Mutant of ginger

Ginger clones have been irradiated with gamma rays (different doses), in VGM2 generation and growth and yield observations were recorded. The highest ranking rhizome yield was recorded in 03 kR fresh rhizome weight 1.210gm / plant .

Input: Singh VR

Genetic improvement, ontogeny and plant age-related variation in artemisinin content

In order to sustain the livelihood of the peoples engaged in medicinal and aromatic plants business (both cultivation as well as industry) constant and consistent efforts are required for genetic improvement activities and generating the improved varieties of MAP's. Breeders at CSIR-CIMAP are trying at least 20 % improvement in the artemisinin content over the best available check variety. Our genetic improvement program for artemisinin content in *Artemisia* is based on the principle of accumulation of desirable genes for artemisinin content from two different backgrounds i.e. Jeevan Raksha and CIM Arogya using poly cross breeding and exercising half-sib selection . We are in the process of enriching these populations.



Besides, experiment was carried out to study the ontogenic variation of artemisinin content in mature (6-month-old) field grown *A. annua*. The aerial portion of the plant was demarcated into upper (top about 30 cm), middle (about 30 cm), lower (between middle and leafless region, about 30 cm) and leafless (up to 45 cm height from the ground) regions. Leaf samples were collected from different ontogeny levels of primary and secondary branches as indicated in Fig. Artemisinin content was always found to be optimum in the young leaves at upper levels of secondary branches. The content of artemisinin in the stem, seed and seed husk was found to be 1/10th, 1/35th and 1/3rd respectively as compared to the leaves, whereas it was undetected in the roots of the plant.

Conservation of germplasm accessions of MAP's and gene bank status

Our National Gene Bank is serving the scientific community and society as well by conserving and providing the germplasm of MAP's. The germplasm lines which seem to be useless in the present scenario may turn out to be the most important ones in the future under

changed climatic or geographical conditions. Under such circumstances the germplasm accessions already preserved in the "Gene Banks" may play a pivotal role. Availability of germplasm resources are the backbone for starting and running any genetic improvement program.

Following number of germplasm accessions are conserved and maintained in seed and field gene bank

Status of CSIR-CIMAP Gene Bank at Lucknow

About 105 germplasm collections of Ashwagandha (*Withania somnifera*), 200 lines of miscellaneous spices germplasm, 40 lines of Fennel, 35 lines of *Allium*, 300 lines of *Papaver* and more than 110 released varieties (from CIMAP) of different MAP crops are also maintained.

SN		Seed Bank (Mid & Short term storage)	Field Gene Bank*
1	No. of Accessions	2476	868
2	Families	132	80
3	Genera	386	176
4	Species	515	227

Input: Gupta AK

Surveillance for heterotic Withanolide QTLs in Ashwagandha hybrids

Strategic introgression of metabolite QTLs in a well adapted, good root quality, Withaferrin A rich recipient Nagore accession from high Withanolide A content, high biomass and biotic stress tolerant donar accession; ~300 hybrids were generated. Surveillance for heterotic withanolide QTLs have been carried out on 163 hybrids for Withaferrin A, Withanolide A, 12-deoxywithastra-monolide, Withanoside V, Withanoside IV, Withanone, total leaf alkaloids, total root alkaloids and seventeen agronomic traits using 131 novel Withania genomic and Unigene derived microsatellite markers developed in house; 74 tomato microsatellite markers, 63 inter simple sequence repeat markers and 12 universal rice primers and HPLC.

Table: Surveillance of heterosis in 271 (CWS11xCWS7) hybrids

Trait	Best Parent Heterosis		Mid Parent Heterosis		Maternal Parent CWS11Y Heterosis	
	%	Hybrids	%	Hybrids	%	Hybrids
Plant Height	20.905-137.069	97	21.081-45.881	6	20.905---137.069	96
Berry Size	20.899-30.624	16	21.704-36.917	40	20.899---30.624	16
Calyx Length	20.040-71.486	107	20.523-84.050	145	20.040---71.486	107
Inflation	21.027-27.397	9	21.671-40.660	65	20.345---57.005	39
Berry No.	37.143	1	28.885-71.847	19	29.412--30.065	25
Primary Branch	(-33.858) – (-90.551)	240	(-11.701) – (-87.387)	40	35.758	2
Secondary Branch	29.730-397.30	140	20.754-594.340	180	25--1050	212
Length / Breadth	31.166-359.825	3	20.488-288.748	10	20.019--322.728	40
Root Length	20.472-48.819	4	20.163-80.245	12	25.129--128.497	43
Root Diameter	23.288-310.960	48	25.362-112.151	124	30.293 - 87.199	218
Root Fresh Weight	20-492	30	23.75-732.50	63	23.158 - 1302	142
Days to Maturity	20.54019-34.61103	59	20.53431-21.38017	6	20.54019 - 34.61103	59

*Desired heterosis:>Atleast 20% in the ideotype direction over the Better parent / Midparent / Maternal parent

Input: Jhang T, Gupta AK, Shankar K

High fresh and dry biomass yielding strain RK-1 of *Centella asiatica*

Mandukparni (*Centella asiatica*) is a small herbaceous creeping plant of the family Apiaceae and native of India/Sri lanka used in traditional and Ayurvedic medicines. The isolated steroids from the plant have been used to treat leprosy and re-vitalize the brain and nervous system. It has anti-oxidant properties also. From half sib family selection a high herb yielding strain RK-1 has been identified having fresh biomass yield of 101.55 q/ha and dry herb of 11.29 q/ha. Asiaticoside content ranged from 4.8-6.9% and was highest in the month of April over two locations at Lucknow and Bengaluru.

Strain RK-1 of Centella asiatica

Input: Lal RK

Genetic diversity analysis in half sib seed progenies of *Mentha piperita*

Mentha piperita is the natural source of menthofuran which possesses a characteristic note and is used as an important marker phytomolecule of peppermint oil. Menthofuran rich eight half-sib seed progenies of *Mentha piperita* (MPS-36) were studied for various genetic parameters of various plant and oil quality attributes. Maximum genotypic coefficient of variation and genetic advance as percentage of mean were recorded for pulegone, followed by menthofuran and 1,8-cineole. The genotypic correlation in general was higher than phenotypic; positive significant correlation was recorded for limonene with 1,8-cineole and menthone, b-myrcene with limonene, and 1,8-cineole and menthofuran with neo-menthol. A high direct positive effect on menthofuran was of neo-menthol.

Considered together, the correlation and path results led for predicting high menthofuran content in indirect selection, the neo-menthone would be reliable major parameter for selection of elite half-sib genotypes having desirable menthofuran content. With respect to percent improvement of oil content and herb yield in eight half sib progenies over its parent MPS-5 ranged from 13 to 50% and 14 to 70%, respectively.

MPS-36 (Menthofuran rich)

Input: Kumar B

BioMed Research International http://dx.doi.org/10.1155/2014/150830,7. IF: 2.88

Prediction of seed germination potential in *Ocimum basilicum*

Indian basil (*Ocimum basilicum* L.) is an essential oil and aromatic chemical-producing crop of India. Seed germination tests of variety CIM-Saumya were carried out in Petri dishes at constant temperatures of 15°C, 20°C, 25°C, 30°C, 35°C, and 40°C at 16 h light / 8 h dark daily regimes. The temperature of 25°C was found to be optimal, and germination percentage and seedling vigor indexes I and II were 75.6, 496.7, and 0.358, respectively. Seeds produced abnormal seedlings at 40°C. Significant decreases in germination percentage and seedling vigor indexes I and II were observed at 15°C, 20°C, 30°C, and 35°C. Days 2–3 and days 6–7 after seed sowing were ideal times for first and final count, respectively, for seed germination of Indian basil. The results are useful for the Indian basil-producing industry for producing good yield and to researchers for developing high standards for seed quality.

Journal of Crop Improvement 26:532-539.

Assessment of compatible substrate for varietal germination potential of Palmarosa seed

Palmarosa (*Cymbopogon martinii*) is an aromatic crop widely cultivated for its industrially important essential oil in India. The present study was aimed to determine seed germination potential and seedling vigor of Palmarosa varieties PRC-1, Trishna, Tripta and CIMAP-Harsh under six substrates viz. filter paper, peat, soil, vermi-compost, vermiculite and silica sand in Petri dish at constant temperature of 25°C.

Among substrate, filter paper was found optimally suitable for mean germination percentage (34.2) and mean seedling vigour index I (154.9) while soil for mean seedling vigor index II (0.004009). The mean germination percentage was highest for variety Trishna (36.5%), and was followed by Tripta (30.2%) accompanied by the highest mean seedling vigor index I (142.2) for variety Trishna (142.2), and followed by Tripta (126.0). However, variety Tripta has highest mean vigor index II (0.003797), followed by Trishna (0.003689), and CIM-Harsh (0.003562). The finding of this study suggests that growers can use soil / peat / vermi-compost as substrate for nursery raising as well as for seed germination testing for their satisfaction while for seed germination testing of Palmarosa varieties for scientific purpose, filter paper would be the best substrate.

Journal of Essential Oil Bearing Plants 2014:
DOI: 10.1080 / 0972060X.2014.905760 [IF 0.187]

Input: Kumar B

Genetic improvement of Spearmint *(Mentha spicata)*

A total of 62 half sib seed progenies were developed in *M. spicata* cv. Neera. These progenies were established for multiplication and assessment for morpho metric traits like herbage yield, L:S ratio and oil content. Only 11 elite progenies were selected as high oil yielding genotypes which varied between 21g to 25.5g / plot as against 0.18.5g of the parent variety cv. Neera.

Input: Singh VR

Seed germination behavior of *Withania* spp. under different temperature regimes

The genus *Withania* comprises of 23 species among which only two (*Withania somnifera* and *Withania coagulans*) are reported from India and its dried roots are widely used in traditional system of medicine. Maximum germination percentage (92%) and seedling vigor index II (0.2583) was observed at alternate temperature of 15/35^{0}C and followed by constant temperature of 15^{0}C (91% and 0.1207, respectively) while vigor index I recorded maximum (344.5) at 15^{0}C, followed by 15/35^{0}C (319.7) in *W. somnifera*. Maximum germination percentage (65%), seedling vigor index I (499.9) and vigor index II (0.0609) was recorded at 15^{0}C, followed by 20^{0}C (55%, 450.01 and 0.0516, respectively) in *W. coagulans*. The information emerged out from this study would help the growers in healthy nursery raising at appropriate conditions

Input: Kumar B

Non-dormant seed in cleistogamous strains of Periwinkle (*Catharanthus roseus*)

Periwinkle is the source of anti-cancer and anti-hypertension alkaloids. It is an out-crossed species in which pollination occurs mainly through butterflies. Artificial selfing or seed production in isolation is required for maintaining genetic purity. In addition, periwinkle seeds show dormancy of about three weeks, with an average germination of about 60 to 70%.

Cleistogamous strains were developed in periwinkle to facilitate maintenance of genetic purity and seed production in the absence of pollinators. These strains did not exhibit any seed dormancy, with seeds germinating on the second day after their harvest. Mean germination time ranged from 2.8 to 3.6 days and days taken for final germination ranged from 3.9 to 4.7. Final germination was 91 to 96%. No germination was observed in non-cleistogamus genotypes even two weeks after their harvest and sowing.

Arrows show absence of opening of corolla lobes in a cleistogamous plant

Cleistogamy developed in periwinkle appeared to confer twin advantages of maintaining genetic purity and no seed dormancy. Low seed dormancy would be useful in reducing the occurrence of volunteer plants in periwinkle fields. Cleistogamy coupled with low seed dormancy would be ideal for development of transgenics in periwinkle.

Input: Kulkarni RN, Baskaran K

Development of true breeding lines for early flowering and cleistogamy in opium poppy

Early flowering and cleistogamy are important agronomic traits influencing crop productivity. These are also useful for genetic and developmental studies. True breeding cleistogamous line has been identified in the normal flower background as a recombinant in the F_3 generation of the cross of two homeotic mutants Pps-1 (with partially petaloid sepals) and OM (closed flowers with sepaloid petals) in opium poppy. Early flowering lines which flower in about 60 days after sowing as compared to normal (85-90 days) have been stabilized. Both these lines have been involved in hybridization programmes for genetic and molecular characterization of the genes involved in early flowering and cleistogamy. Useful recombinants in the segregating generations would be screened for evaluation and development of high yielding varieties.



Input: Dhawan OP

Selection of open pollinated seed progenies and yield evaluation in menthol mint (*M. arvensis* L.)

The efforts were made through deployment of genetical selections from open pollinated seed progenies (OPSPs) of menthol mint. A total of 120 half sib

progenies of *M. arvensis* cv. Kosi were collected and raised for multiplication. The important morphological and yield characters including quality character data were recorded and selected genotypes (OPSPs) having 0.78- 0.90 percent oil with 78 percent menthol. Among these promising genotypes, MAS-07, was found to be the most superior genotype with 54.0g oil yield / plot ($24m^2$) and 78 percent menthol in oil.

Input: Singh VR

Technology transfer, survey and business development activities

Kisan Mela

Annual Kisan Mela organised on 31st January, 2014 was attended by about 3000 people including farmers, entrepreneurs, representatives of leading industries, manufacturers and buyers of medicinal and aromatic plants, scientists and students. The farmers were apprised of the improved agro-technologies and plant varieties of various economically important medicinal and aromatic plants and exposed to various recent developments through interaction, field demonstrations and published literature. A large numbers of the farmers procured planting material of improved variety of *Mentha* and other medicinal and aromatic plants and women learnt the technique of making of incense sticks using floral bio-resource and production of rose water on cottage scale.

Business Meet

Scientist-Industry-Farmers Business meet was organized on the occasion of National Technology Day on 11th May, 2013. A new formulation 'Herbi Chew', jointly developed by CSIR-CIMAP and CSIR-NBRI, was released in the function. Herbal Products (Lip balm jointly developed with CSIR-NBRI and Pain balm licensed previously to M/s Chiara Herbals were launched in the business meet.

Technology licensing

1	Technologies of three herbal products (mosquito repellent body lotion, floor disinfectant and mosquito repellent spray)	M/s Bhartiya Agrow Pharma Pvt. Ltd. Kanpur	11.00

Consultancy and technical services

1	Providing technical consultancy for designing and setting up a 500 Kg/batch directly fired type improved stainless steel unit	ICAR Research Complex of NEH region, Gangtok, Sikkim	6.00
2.	Sponsorship for organization of Kisan Mela -2014	Ipca Lab, Jindal Drugs and Sharp Menthol	3.00

Survey Feedback & Training

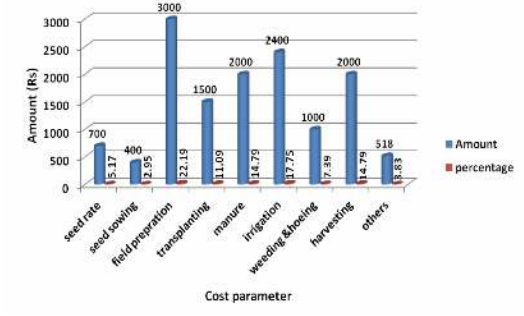
Production and economics of organic tulsi

CSIR-CIMAP conducted survey for production, evaluation and economics of organically grown *Ocimum sanctum* and *Ocimum gratissimum* herbage under rainfed condition in 29 villages of Hamirpur District of Uttar Pradesh. The study revealed that majority of farmers with medium land holding (2-4 ha) produced 79 percent of total production followed by small (1-2 ha) and marginal (0-1 ha) with 16.4 and 3.28 percent, respectively. Out of 29 surveyed sites, the maximum production (7.96 quintal/ha), production value (43480 Rs/ha), net return (30332 Rs/ha) and cost-benefit ratio 1.00:2.25 were observed in the site HO-10 (Hamirpur Ocimum-10) followed by HO-17 and HO-16 while the maximum cost of

Input: Singh AK, Tomar VKS, Krishna A, Bansal RP, Kumar S, Suresh R

Farmer's categories according to growing areas and % of production

Types of Growers	Land Area (ha.)	No. of Farmers	Area (ha.)	Total Production (q)	% of farmer	% area of Growers	% of Production	Total Income In (Rs)	% Income of growers
Marginal Growers	<1	34	26.26	201.8	10.17	3.25	3.32	740120	3.28
Small growers	1-2	85	125.27	989.53	25.44	15.53	16.32	3692988	16.4
Medium growers	2-4	214	650.87	4841.39	64.07	80.70	79.85	17961102	79.8
Large growers	>4	1	4.09	30.07	0.29	0.50	0.49	111855	0.49

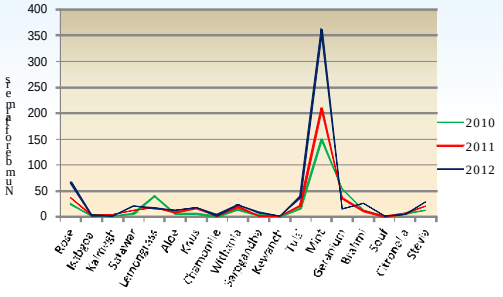


Average cost of cultivation of Ocimun species per hectare

production of Rs. 13786.73 per hectare was observed in HO-23 and minimum (13340.49 Rs / ha) in HO-24, respectively.

Varietal performance and adoption pattern studies

CSIR-CIMAP, the knowledge gateway of medicinal and aromatic plants related services and technologies, organizes Kisan Mela every year and display new varieties / technologies and innovative cultivation practices of commercially viable MAPs for its users. Three years (2010, 2011 and 2012) data collected during Kisan Mela showed that 76 percent farmers of UP, Bihar, Jharkhand, Maharashtra, MP, and Chhattisgarh preferred aromatic crops and only 24 percent farmers were in favour of medicinal crops. A total of 1429 farmers from different states showed interest to collect the planting materials and propagules according to their choice, suitability and economics of the crops. During the year 2010 to 2012, the aromatic crops were quite popular among the farmers and increment pattern of aromatic crops were 40.00% and 71.90 in Mint, 48.00% and 78.37% in Rose. Menthol mint still dominate as the prime choice of the farmers, while in case of medicinal plants, the adoption pattern increment shows 75.00% and 38.09% in Stevia, 35.71% and 21.05% in Withania, 37.50% and 77.27% in Tulsi, respectively.



Number of farmers with their adoption pattern of MAPs

Economics and Informatics 5: 91-97

On-farm performance of geranium under semi-arid condition in Bundelkhand

Rose scented geranium (*Pelargonium graveolens*) has been transplanted in Kumhrar and Uldan sites of district Jhansi for possibility of its cultivation under semi arid climates. It performed well then it will be multiply for wider adoption. Crop harvested in the month of March., 2013. It exhibited good result in first year. In 1000

Geranium crop and its harvesting

Collected Geranium crop

Sq.mt produced two quintals herb and yielded 250 gm oil. The quality evaluation of the oil has been done in CIMAP analytical laboratory. The oil reported to be of good quality and contains mainly Pinene<alpha-> (0.54%), Myrcene (0.17%), Para-cymene (0.47%), Limonene (0.001%), E-b ocimene (0.15%), Linalool (2.38%), Rose oxide (cis) (1.66%), Rose oxide (trans) (0.78%), Menthone(0.83%), Isomenthone (9.90%), Menthol (0.17%), Isomenthol (0.47%), Citronellol (40.19%), Neral (0.66%), Geraniol (13.94%), Geranial (1.17%), Citronellyl formate (7.99%), Geranyl formate (2.59%), Citronellyl acetate (0.58%), Beta bourbonene (0.95%), Beta cubebene (0.28%), constituents.

Trainings imparted

- More than 400 people were trained on the improved production technologies for economically important medicinal and aromatic plants through 14 training programmes conducted at various locations in the country such as Lucknow(UP), Pune (Maharashtra), Angole (Odisha) and Hyderabad (AP)
- About 100 participants including women and physically challenged people were imparted entrepreneurial training on making incense sticks using floral bio-resource through 4 training courses conducted at CIMAP campus and at Women Entrepreneurial Training Facility(WETF) of CSIR-CIMAP, near Chandrika Devi Temple, village Kathwara, Lucknow.

Training programme on medicinal and aromatic plants production technology

SN	Date	Place	Partici-pants	Sponsored by
1	27-29 May, 2013	Lucknow	17	SIDBI / ATMA Samastipur
2	18-21 June, 2013	Lucknow	43	SIDBI
3	4 July, 2013	Vill- Bamur Dist. Angole (Odisha)	72	CSIR-CIMAP
4	16 July, 2013	Mahoba	71	NABARD
5	11-13 November, 2013	Hyderabad	29	SIDBI
6	14-15 November, 2013	Vill- Bamur Dist. Angole (Odisha)	122	CSIR-CIMAP
7	4-6 December, 2013	Lucknow	26	ATMA Patna Bihar
8	10 -12 December, 2013	NCL, Pune	33	SIDBI
9	16-17 December, 2013	Lucknow	13	CSIR-HRDG
10	18-20 December, 2013	Lucknow	30	ATMA West Champaran
11	7-10 January, 2014	Lucknow	71	ATMA Buxer & SIDBI
12	28-30 January, 2014	Lucknow	32	ATMA Siwan
13	1 & 2 February, 2014	Lucknow	20	NABARD
14	13 March, 2014	Dudhawa National Park	120	PPV&FRA, New Delhi

CSIR-HRDG training programme

Under a scheme of CSIR-HRDG, institute organised two-day training programme for teachers on 16-17 December, 2013 in which 13 science teachers from various local schools / colleges participated. In this programme, the lectures were arranged on the various topics such as identification of medicinal and aromatic plants, fascinating world of soils, agro-technology of medicinal and aromatic plants, primary processing and quality control, microbes for plants health, DNA-finger printing, disease causing micro-organisms, plant tissue culture, bioinformatics and knowledge based herbal formulations.

A group of women learning agarbatti making technique

Physically challenged school students learning agarbatti making technique

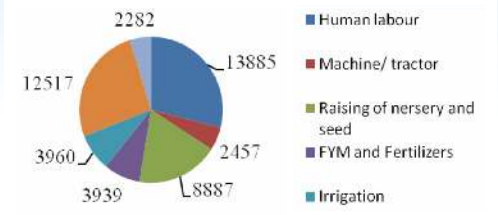
Economic analysis of palmarosa cultivation

The study conducted on the economics of palmarosa cultivation on the farmers' field

has shown that the major portion of operational cost was shared among human labour, distillation charges and preparation of nursery. Total variable cost was found to be Rs. 47926 per hectare per year. The gross return was found to be Rs. 124000 per hectare per year. The net return over variable cost was Rs. 76074 per hectare. The benefit–cost ratio was found to be 2.59 indicating a higher profit to the farmers. The independent variables like human labour, planting material and distillation charges were positive indicating significant impact on the returns from the crop. There is need for effective market intelligence system to ensure remunerative price of the produce to the farmers.

Visitors

About seven thousand five hundred visitors including students, entrepreneurs, government officials, representative of industries, NGO and common people visited CSIR-CIMAP and were apprised about cultivation, processing and marketing and entrepreneurial aspects of medicinal and aromatic plants.



Cost structure of palmarosa cultivation (Rs./ ha)

Publicity and extension literature

- Video films on Menthol mint, lemongrass, vetiver, Tulsi and palmarosa cultivation
- 'Aus- Gyanya'- Booklet on medicinal and aromatic plants
- CSIR-CIMAP Information Brochure
- Booklet on economically viable medicinal and aromatic plants suitable for Tribal areas of Dudhwa Tiger Reserve
- Booklet on the medicinal and aromatic plants for Bundelkhand region
- Booklet on 'Purvanchal main Krishi Bibidhikaran Ke Liye Upyukta-CIMAP Sarju - Menthal Mint'.

Out reach and Exhibitions

- Participated in 13 exhibitions and displayed its products, technologies and services to thousands of visitors who visited the stall.
- *Introduction of medicinal and aromatic crops in new areas*

  Three training cum awareness programme organized. 150 persons were trained on the cultivation and processing aspects of the medicinal and aromatic plants. About 50

demonstrations of menthol mint and artemisia were organized on tribal farmers field. Knowhow for cultivation of menthol mint, Artemisia, lemongrass, vetiver, kalmegh, satavar, etc. adopted by more than 50 farmers of the selected villages. Technology of mentha oil distillation was adopted by about 32 farmers.

- Demonstration of aromatic crops in newer areas in eastern region of the country Palmarosa, Vetiver and Tulsi were demonstrated in the Angul and Sambalpur district of Odisha.
- *Mentha arvensis* var. Kosi and Saryu were demonstrated in about 4 acres area in two villages of Gorakhpur. This was supported by NABARD.

New varieties in new areas in Purvanchal/ Bundelkhand region

Mentha, lemongrass, palmarosa, kalmegh and basil were introduced in the fields of farmers belonging to SC & Sahariya tribal community in different villages in Gorakhpur, Jhansi, Lalitpur and Mahoba, U.P. Two hundred eighty farmers were trained for commercial cultivation of MAPs. Due to continuous efforts of dissemination of MAPs under rainfed condition of Bundelkhand, farmers have started commercial cultivation of lemongrass, Palmarosa and Basil. Tribal communities of Sahariya of district Lalitpur, U.P. have now started cultivation of palmarosa.

Adoption/area under cultivation of new varieties in year 2014

Crop variety	Area under cultiva-tion	Farmers trained	Village, District
Mint var. Saryu	5 acres	100	Gorakhpur, U.P
Lemongrass var. krishna	15 acres	50	Jhansi / Lalitpur, U.P
Palmarosa-PRC-1	5 acres	60	Mahoba / Jhansi, U.P
Kalmegh-CIM-Megha	05 acres	50	Mahoba, U.P
Basil-CIM Saumya	05 acres	20	Mahoba, U.P

Socio-economic strengthening of growers

Setting up of Community distillation facilities in the SC/ST/small farmers' fields

- Jhansi-Village Uldan & Moth: Two MS distillation unit capacity 500kg / 200kg
- Lalitpur- Villages-3 : Three units MS distillation unit capacity 500 Kg each
- Mahoba – Village-1 : One MS distillation unit capacity 500 Kg.
- Gorakhpur-Rajdhani : One MS distillation unit capacity 500kg

Rajdhani, Gorakhpur

Balabehat, Lalitpur, U.P.

Imaliya, Lalitpur, U.P.

Gauna, Lalitpur, U.P.

Recognitions

1. Dr Sanjay Kumar selected for Khorana Programme for Technology Transfer Course 2013 (18 July to 6 August, 2013) supported by Department of Biotechnology (DBT), Univ. of Wisconsin and Indo-US S&T Forum.
2. NABARD, Lucknow honoured CSIR-CIMAP on 12 July, 2013 for its commendable performance in the field of MAPs .

Entrepreneurial Trainings

Input: Tandon S, Ahmad J

Training on Essential Oil Processing Technology - EOPT-2013, 6th to 11th May 2013

No of Participants: 12 from Maharashtra, Gujarat, MP, Bihar and U.P.; ECF generated: 1.44 lakhs

The six day training course was specially designed to impart step by step knowledge on the processing technologies for aromatic plants covering all aspects related to pilot and commercial scale production of essential oils using different distillation techniques, fractional distillation of essential oils for isolation of aroma chemicals, production of concretes and absolutes from flowers, menthol flakes crystallization, derivitisation of aroma chemicals for value addition, Quality analysis procedures for the essential oils including GLC, physico chemical parameters like optical rotation, refractive index, solubility, specific gravity etc

Training on *Aloe vera* processing technologies - AVPT-2013, 26th – 29th November 2013

No of Participants: 17 from Karnataka, Gujarat, Andhra Pradesh, Bihar, Rajasthan, Uttarakhand and U.P.; ECF generated: 1.70 lakhs

The fourth training course was specially designed to impart knowledge on the different processing technologies for production of *Aloe vera* juice, decolorized juice or sap, aloe gel and cream and familiarize the participants with the technical and practical aspects of the technologies including details of plant and machinery, economics of production, details of preservatives, stabilizers, quality monitoring etc.

Designing, fabrication and installation of boiler operated cum field distillation

Under the Emami consultancy project, designing, installation and commissioning of 10 x 2.0 ton capacity dual type directly fired cum boiler operated improved distillation units for the mentha crop was undertaken. The distillation units were successfully

installed and commissioned at Village Neelagiri, District Balasore, Orissa. Beforehand, detailed design drawings of the units, layout of the units, specifications of auxiliary setups were prepared and given to client. Onsite visit was undertaken to provide technical support and consultancy during the fabrication, installation and trial runs of the units.

Other inputs under tech transfer

Fabrication and setting up of dual type 500 kg x 2 directly fired field distillation units under consultancy project for empowering of tribal families in the cultivation and processing of economically important aromatic plants in the high altitude areas of Andhra Pradesh at East Godavari

District, Chintalapudi and Village Kodapalli near Padaru, for improving their livelihood have been carried out.

CSIR-800 (Rural Development)

Designing, installation and commissioning of a 500 kg capacity directly fired type FDU at Tech Village Dau, District Unnao, UP was carried out for the distillation of the aromatic crops being grown by the beneficiary farmers under the Tech Vill and CSIR 800 project. The distillion units was inaugurated on 14th August 2013 by the Director, CIMAP.

1. Designing of 1.0 ton capacity improved directly fired type field distillation unit for Mr. Nitin Pathak, Kangra, H.P.

2. Designing of dual type 1.0 ton capacity improved boiler operated type steam distillation unit for Mr. Prauna Agro Industries, Hyderabad.

Technology enabled villages (Tech Vill) under rural development programme

This project aims at providing complete agrotechnology package of high income generating MAPs and an easy accessibility to primary processing facilities. Emphasis is on under-utilized and marginal lands for additional income generation.

TechVill Inauguration (14 August 2013)

Training and awareness program in progress

Techvill was inaugurated at Dau, Unnao (UP) on 14 August 2013. An awareness program was conducted for the villagers. Besides, MAPs nurseries viz., Mentha, Palmarosa and Vetiver were planted. In subsequent awareness program held on 25 January 2014 improved planting material of suitable MAPs for the region was distributed among the local farmers. For processing facilities, two distillation units have been installed at the Techvill.

Distillation unit

Demonstration plot

Input: Chauhan HS, Singh HP

Initiative to combat malnutrition

Dissemination of the tested, validated and certified food products developed by the CSIR laboratories to the selected villages

Three villages Dewarai Kala, Tulsipur and Ahmadpur in Uttar Pradesh were targeted for the distribution and dissemination of the products made by the participating CSIR labs namely CFTRI (Mysore), CIMAP (Lucknow), NBRI (Lucknow) and NEIST (Jorhat). The participants of the villages were informed about the program through awareness meets. The anganbadi workers and school teachers were also approached. As per the model taken in study, the profile of children and women were prepared. The weight and height were taken and the primary findings for any prior or persisting disease were also noted down.

The data revealed that 15 out of the 15 children were underweight and 4 out of 15 women were underweight. Besides, 20% of sampled women were severely anaemic. Due to their meager income the could not afford nutrient rich food like milk, vegetables and fruits. Besides, their own cultivation was cash-crop oriented rather that catering their own health needs. In the light of above facts, the village residents were sensitized towards the herbal remedies from homegrown medicinal plants and neutraceutical products of CSIR laboratories to be provided to them under the project.

Sr. No.	Village Name	Population	Visit Dates
1.	Tulsipur, Amethi (UP)	Population:1224 (Male-674; Female-550) Children-212	29.09.2013, 26.11.2013
2.	Ahmadpur, Raebareli (UP)	Population:1036 (Male-529; Female-507) Children-212	29.09.2013, 29.11.2013
3.	Dewarai Kala, Near BKT (UP)	Population:1293 (Male-704; Female-507) Children-182	13.09.2013, 28.3.2014

Tulsipur, district- Amethi (UP)


Health Mela @ Ahmadpur, district- Raebareli (UP)




Health Mela @ Dewarai Kala, Near BKT (UP)

Khus Gosthi 27-28th Feb. 2014

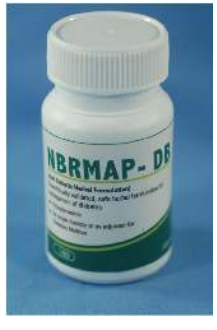
A khus-Gosthi (Meet) was organised under rural development program. Gosthi was attended by 65 farmers and entrepreneurs. During the Gosthi various aspects of Khus agro-technologies, distillation, value adddition, quality and marketing were deliberated. Interactive session was arranged with traders of essential oil to create a linkage between industry (market) and farmers. The planting material of newly released high yielding Khus Variety i.e.CIM Khus-15 and CIM Khus-22 were distributed to the farmers.

Herbal formulations and products

A herbal composition with tobacco de-addiction and health rejuvenating properties: A tobacco and chemical free herbal formulation was jointly developed by CSIR-CIMAP and CSIR-NBRI which gives the feeling in taste and aroma like Gutkha but doesn't contain tobacco or nicotine. Herbal mixture is a good mouth freshener with anti-oxidants and possesses anti-bacterial and digestive properties. On the basis of feedback data, the product has shown tobacco de-addiction property and people have stopped or reduced the use of tobacco based formulations. Product was released on May 11, 2013 on the occasion of "Technology Day".

Anti-inflammatory pain relieving oil: Relaxomap - an aromatherapeutic topical formulation, in the form of oil that utilizes unique combination of plant extracts, medicinally proven aromatic oils for relieving pain resulting from exhaustion and also reducing the inflammation and swellings. The product was released on the occasion of Kisan Mela -2014 on January 31, 2014.

Anti-diabetic formulation: Scientifically validated and safe herbal formulation NBRMAP-DB for the management of diabetes, was jointly developed by CSIR-CIMAP and NBRI and released on February 21, 2014 by Hon. Vice-President of India at Vigyan Bhawan, New Delhi.



CIM-Kranti – new variety of *Mentha arvensis*

A new improved variety of *Mentha arvensis* named CIM-Kranti has been developed through half-sib selection in variety 'Gomti'. The variety yields more than 100 kg/ha oil with 80% menthol during winter sucker producing crop alongwith 250-300 q sucker/ha whereas the main summer crop of this plant also yields 10-12% more oil yield than CIM-Saryu. It has erect growth behaviour, stem is hardy hairy and green. It's suckers are white in colour, soft and fibrous in nature.

Patents granted

1. Process for isolation of hepatoprotective agent oleanolic acid from *Lantana camara*.

   Patent No. Europe 1732875, 15.05.2013 *(SK Srivastava, Merajuddin Khan, SPS Khanuja)*

   An economical process has been developed for the isolation of oleanolic acid from the roots of *Lantana camara* which completely omits the use of expensive and tedious column chromatography and gives 1% yield which is three times more than the previously reported methods (US Patent No. 6,884, 908). Whole root biomass can be used in the new method as only root bark could be used in previous reports thereby making it further economical. Use of single solvent for extraction is also beneficial as solvent can be reused and / or recycled. The method uses simple precipitation and crystallization processes which are easy, quick and highly economical.

2. An improved formulation for the preparation of multi-purpose insect repellent Dhoop Agarbatti. Patent No. Indonesia IDP 0034051B, 10.07.2013 *(Dinesh Kumar, YN Shukla, Shikha Tiwari, RP Bansal, JR Bahl, Sushil Kumar)*

   The herbal insect repellent composition of the invention contains natural essential oils of citronella, cedarwood, pyrethrum flower powder and *Artemisia annua* oil which have been found to have synergistic action for insect repellency. Natural essential oils used in the composition has repellency against housefies and mosquitos and also have pleasant odour. Many oxygenated terpenes like carvacrol, citral, citronellol, eugenol, farnesol and geraniol isolated from various essential oils have been found effective against *Aedes aegypti*. Some of these essential oils also bring about inhibition in the orientation and development of housefly eggs in which acute toxicity and inhibition in metamorphosis have been observed. Cedarwood oil is also considered as having very good insecticidal activity against housefly *Musca domestica* L.

3. Use of the root extract of *Vetiveria zizanioides* in curing fluoro-quinolone and multidrug resistant bacterial infections. Patent No. Canada 2480284, 30.07.2013 *(SPS Khanuja, Suchi Srivastava, TRS Kumar, MM Gupta, AK Tripathi, Monika Singh, JR Bahl, RK Lal, MP Darokar, AK Shasany, Sushil Kumar)*

   The invention relates to a hexane bioactive fraction obtained from the roots of an aromatic plant named *Vetiveria zizanioides* commonly found in India for inhibiting the growth of drug resistant bacterial infections in humans and animals. It also relates to a pharmaceutical composition comprising the bioactive extract with other additives for inhibiting the

growth of drug resistant bacterial infections in humans and animals and a process for the isolation of said bioactive extract.

4. Process for one pot conversion of artemisinin into artelinic acid. Patent No. India 258450, 09.01.2014 *(RS Bhakuni, Tarun Singh, Rinku Singh, AP Kahol, SPS Khanuja)*

   The invention relates to an improved process for one pot conversion of artemisinin into artelinic acid, which reduces the three step (Three pots) conversion of artemisinin to artelinic acid in one step (one pot). Artelinic acid and sodium artelinate are customary names for p[(12-dihydroartemisininoxy)methyl] benzoate and sodium p-[12-dihydroartemisininoxy]methyl] benzoate, respectively. The sodium artelinate is considered to be the best candidate drug amongst the available water soluble analogues of this class for the treatment of multi drug resistant and cerebral malaria.

5. Benzylidene indanones and processes for preparation and use thereof. Patent No. US 8633242, 21.01.2014 *(AS Negi, AP Prakasham, AK Saxena, S Luqman, D Chanda, Tandeep Kaur, Atul Gupta)*

   The invention provides a new series of gallic acid based 2-benzylidence indanones possessing potent anticancer activity against several human cancer cell lines. More particularly, the invention relates to the potent anticancer and tubulin polymerization inhibition activity of new benzylidene idanones synthesized from gallic acid. The invention also provides a new process for the preparation of the said molecules and testing these for *in vitro* cytotoxic activity against various human cancer cell lines using Sulphorhodamine B Assay. Compounds were evaluated for acute oral activity in Swiss albino mice and were found to be safe up to 300mg / kg body weight.

6. Improved process for the isolation of 'calliterpenone' a natural plant growth promoting phyllocladane diterpenoid from genus *Callicarpa*. Patent No. Australia 2006340617, 06.03.2014 *(AK Singh, SPS Khanuja, Sudeep Tandon, Alok Kalra, Deeptanjali Sahoo, AP Kahol, MM Gupta, RK Verma, AK Kukreja, Mansoor Alam, GD Bagchi RP Bansal, MP Darokar, AK Gupta)*

   The invention provides a simple method for isolation of calliterpenone, a phyllocladane deterpenoid with the plant growth regulating properties from plant genus *Callicarpa.*

Externally funded projects

Project Title	Grant in lakhs
Tissue culture & secondary metabolite production studies in *Janakia aryalpathra* (a critically endangered plant of southern forests) Department of Science and Technology, New Delhi (Ms. Shikha Srivastava)	14.94
Identification of immunodominant epitopes of HLA B*2705 binding *Salmonella typhimurium* outer membrane proteins (OMP) A and D in patients with reactive arthritis and undifferentiated spondyloarthropathy by Department of Biotechnology (Dr AK Shasany)	4.65
Seed storage impact on longevity in palmarosa (*Cymbopogan martini*) seeds by UP Council for Science and Technology (Dr Birendra Kumar)	5.44
Income maximization through MAP seeds and propagules production and cluster development in small and marginal farmer fields of district Mohoba, U.P. by Natioanl Bank for Agriculture and Rural Development (Dr Alok Krishna)	3.57
Introduction of menthol mint variety Saryu in Purvanchal U.P. by Natioanl Bank for Agriculture and Rural Development (Dr Alok Krishna)	3.50
Isolation, purification and X-ray diffraction studies of plant cyclotides by Department of Science and Technology (Dr PG Vasudev)	24.40
Development of integrated nutrient management practices for the cultivation of medicinal and aromatic plants using fly ash as a source of nutrients by Department of Science and Technology (Dr KP Sastry)	41.38
Empowering of tribal families in the cultivation and processing of aromatic grasses citronella and Vetiver in high altitude hill tribal areas of Andhra Pradesh by Department of Science and Technology (Dr KP Sastry)	62.65
Molecular and Biochemical investigation in antidiabetic plant *Gymnema sylvestris* R.Br. by Department of Science and Technology (Dr AK Verma)	22.00
Chemical and biological investigation of *Malus sikkimensis* for novel biological activities by Department of Science and Technology (Dr Shalini Dixit)	20.10
Characterization and chemotyping of germplasm collections of cultivated curcuma species for tagging of demethoxy curcumin rich elite lines by National Medicinal Plants Board, New Delhi (Dr AK Gupta)	22.50
Chemical investigation of *Zanthoxylum armatum* (Timmor) for identification & isolation of potent biologically active molecules by National Medicinal Plants Board, New Delhi (Dr Ateeque Ahmad)	22.68
Monitoring and evaluation of crop clusters Andhra Pradesh Medicinal and Aromatic Plants Board (Dr KP Sastry)	10.00
Development of model nursery for production and supply of quality planting material of commercially important medicinal crops in Andhra Pradesh Andhra Pradesh Medicinal and Aromatic Plants Board (Dr.KP Sastry)	20.00
Development of small nursery for production and supply of quality seed / planting material of some important medicinal crops in Andhra Pradesh by Andhra Pradesh Medicinal and Aromatic Plants Board (Dr KP Sastry)	4.00
Fuel Properties and emission profiling of Bio-char prepared from aromatic plant spent by Department of Science and Technology (Mrs. Nidhi Nigam)	12.54
Technical consultancy for designing and setting up directly fired type distillation unit by Indian Council of Agricultural Research (Er. Sudeep Tandon)	6.00

HRD activities at a glance

Students enrolled for Ph.D. (AcSIR and JNU Ph.D. programmes): 27

Ph.D. degrees awarded: 5

Ph.D. thesis submitted: 4

Graduate Trainees: 45

Project Assistants : 108

Awards & Recognitions

Dr Suchitra Banerji: Fellow of National Academy of Sciences, India.

Dr M M Gupta: Dr P D Sethi Annual Award-2013 for Best Research Papers (3rd Prize).

Dr Karuna Shanker : Fellow of Indian Council of Chemists (FICC) and Academic Brilliance Award-2014.

Dr Birendra Kumar : Fellow of Indian Society for Spices, ICAR-IISR, Calicut, Kerala.

Dr DD Patra : Member, Research Advisory Council, ICAR Research Complex for North East Hill Region, Shillong.

Ph.D. degrees awarded

Molecular interaction studies to identify antibacterial phytomolecules active against *Staphylococcus aurous*.

Awarded to Ms. Amandeep Kaur Kahlon by Jawaharlal Nehru University, New Delhi. (May 2013)

QSAR model development for anti-cancer activity (*in vitro/in vivo*) of natural compounds/ derivatives.

Awarded to Mr. Dharmendra Kumar Yadav by Jawaharlal Nehru University, New Delhi. (July 2013)

Isolation and characterization of leaf-abundant secondary metabolism-related genes and their promoter/regulatory regions from *Artemisia annua*.

Awarded to Ms. Alka Singh by Jawaharlal Nehru University, New Delhi. (August 2013)

Activity-guided isolation of bioactive phytomolecules from Indian medicinal plants and synthetic modifications of major constituents.

Awarded to Ms. Shikha Gupta in Jawaharlal Nehru University, New Delhi. (March 2014)

Evaluation of arbuscular mycorrhizal (AM) fungi and plant growth promoting *Rhizobacteria* (PGPRs) for consortium development for medicinal and aromatic plants.

Awarded to Mr. Ashutosh Awasthi by Lucknow University, Lucknow. (August 2013)

CIMAP welcomes new staff members

Prof. Anil Kumar Tripathi
Director
w.e.f. 17 Feb. 2014

Sri B.D. Vashisth
Controller of Administration
w.e.f. 2 Jul. 2013

Sri M.S. Mehra
Finance and Accounts Officer
w.e.f. 3 Dec. 2013

Smt Sudha Agarwal
Senior Technical Officer
w.e.f. 17 Oct. 2013

Sri G.S. Verma
Section Officer (S&P)
w.e.f. 1 Aug. 2013

Sri Ashish Kumar Shukla
Junior Technical Assistant (Electrical)
w.e.f. 10 Oct. 2013

Sri Manoj Kumar Yadav
Junior Technical Assistant
14.10.2013
w.e.f. 14 Oct. 2013

Sri P.P.Singh Verma
Junior Technical Assistant
w.e.f. 11 Oct. 2013

Sri Amit Kumar Tiwari
Junior Technical Assistant
w.e.f. 21 Oct. 2013

Sri Ashish Kumar
Junior Technical Assistant
w.e.f. 23 Oct. 2013

Sri Ayush Singhal
Assistant (F&A) 1
w.e.f. 11 Dec. 2013

Ms Sanyogita Sainger
Assistant (G) 1
w.e.f. 19 Dec. 2013

Sri Mohd Shameem
MTS (NT-D)
w.e.f. 26 Jul. 2013

Staff Superannuated

Mr. Baby Yohannan, Administrative Officer superannuated on 31.03.2013

Mr. Vikram Singh, Senior Technical Officer superannuated on 30.04.2013

Mr. Dhirendra Kumar, Controller of Administration, superannuated on 31.05.2013

Dr H.O. Mishra, Chief Scientist superannuated on 30.06.2013

Dr K.V. Syamasundar, Chief Scientist superannuated on 31.07.2013

Dr Muni Ram, Senior Principal Scientist superannuated on 31.07.2013

Dr A.K. Kukreja, Chief Scientist superannuated on 31.07.2013

Mr. M.R. Khan, Senior Technician superannuated on 31.07.2013

Dr Munnu Singh, Senior Principal Scientist superannuated on 31.08.2013

Dr G.D. Bagchi, Chief Scientist superannuated on 31.10.2013

Mr. Dhani Ram, Lab Attendant superannuated on 31.01.2014

Dr A. Chattopadhyay, Senior Principal Scientist, superannuated on 28.02.2014

Dr Kambod Singh, Senior Principal Scientist superannuated on 31.03.2014

Mr. Vishwanath Rao, Assistant (S&P) superannuated on 31.03.2014

Scientific contributions of superannuated scientists*

Dr Hari Om Misra

Dr H.O. Misra joined CIMPO (now CSIR-CIMAP) in Genetics & Plant Breeding Division at Lucknow on 13th Feb., 1978. He contributed his R&D services to the Division for about 35 years. During this period, he had successfully carried out basic and applied research on 36 medicinal and aromatic plants. He was Principal Investigator / Active member of the team which developed and released 38 high yielding varieties of MAPs. Variety Poshita of Ashwagandha commercialized in various parts of South and North India, CIM-Megha of Kalmegh, Shyama of opium poppy, CIM-Saumya of *Ocimum* are some important varieties worth mentioning. He has 114 research papers to his credit in SCI and peer reviewed national and international reputed journals, 53 conference abstracts and 5 US patents. He was designated as Professor in Biological Sciences in ACSIR and faculty member for the JNU Ph.D. course on plant science and guided one Ph.D. student. As Principal Investigator of Project GAP-123, NMPB, Deptt. of AYUSH, New Delhi, he managed quality planting material production in six important medicinal plants. He was involved in delivering lectures to farmers / entrepreneurs on production and agrotechnology of MAPs. He actively participated in project formulation for the XI and XII five year plans.

Dr KV Syamasundar

Dr Syamasundar joined CIMAP in Aug. 1982 as Scientist B in Medicinal Plants Chemistry Division. Later he was transferred to CRC Bangalore in Nov. 1984 and to CRC, Hyderabad in November 2010. He superannuated in July 2013 as Chief Scientist. During his tenure he developed lab-scale isolation process technologies for 18 commercially and medicinally important compounds, colchicine and colchicoside from *Gloriosa*

Based on the inputs received from the concerned scientists

superba; stevioside & rebaudioside-A from *Stevia rebaudiana*; forskolin, diacetyl forskolin, iso-forskolin from *Coleus forskohlii*; ajmalicine, vindoline, from *Catharanthus roseus;* bacosides from *Bacopa monnieri*, asiaticoside from *Centella asiatica*, arjunolic acid from *Terminalia alata* and *T. arjuna*; camptothecin from *Mappia foetida*; lawsone from *Lawsonia inermis*; withaferin from *Withania somnifera;* aloin and Aloe-emodine from *Aloe vera*; artemisinin from *Artemisia annua* and andrographolide from *Andrographis paniculata*.

He successfully developed and maintained the infrastructure facility of quality cell at CIMAP, RC, Bangalore with modern instruments like GC, HPLC and UV-Visible spectrometer, which meets the need of quality analysis. Analytical support for the GC and HPLC analysis of experimental samples was given to CIMAP Scientists at Regional centers and also some at Headquarters.

He was instrumental in developing process technologies for concrete and absolute from Jasmine and Tuberose flowers, colourless sap from *Aloe vera.* Processing technology for colchicine, ajmalicine was transferred to Southern herbals, Bangalore and Nilagiri phytochemicals, Madurai; technology of jasmine absolute from concrete were transferred to M/S Yes Yen Aromatic P Ltd, Madurai.

He conducted phytochemical investigations of wild and cultivated aromatic plants led to the identification of new compounds and oils as new sources of aroma substances for flavour and fragrance industries. Chemical profiling of the more than 60 essential oils from aromatic plants was carried out from Western Ghats, Himalayas and cultivated sources. Several of these oils were investigated for the anti-bacterial and anti-oxidative properties.

He undertook systematic chemical investigation of several Indian medicinal plants for isolation of new compounds. Several new compounds were isolated and their structures were established using modern instrumental techniques.

He worked as PI in two and co-PI in 6 DST, NMPB and NABARD sponsored projects which earned 139.5 lakhs as ECF to the institute.

He has published 72 papers in International and national journals. One of his publications on *Phylanthus niruri* has been cited 171 times, total citation of his publications is 969, i 10 index 31 and h- index18 till date as per the Google search.

Dr AK Kukreja

Dr Kukreja joined CIMAP in December 1979 as a post doctoral fellow and was assigned the job of multiplication of *Duboisia mypporpides* a solanaceous tree which he successfully accomplished. He was promoted to the post of research associate (RA) in 1981 and appointed as Scientist-B on 1 October, 1984. He superannuated as Chief Scientist (Scientist G) and Head Plant Biotechnology on 31 July, 2013. During these years he guided a number of students for their PhD / M.Sc. / M.Tech / B.Tech degrees. He was successful in establishing micro, macro-propagation protocols, developing new varieties for a number of medicinal and

aromatic plants through somaclonal breeding and had developed expertise in scaling up of these *in vitro* raised tissues by using biofermetors. During this period he handled a number of projects and presently is life member of many societies.

Dr Munnu Singh

- Developed efficient intercropping systems to improve land use efficiency, yield and economic returns in aromatic crops i.e. Citronella Java, lemongrass, patchouli, geranium and palmarosa.
- Rosemary crop was introduced from high elevation (Kodaikanal) to Bangalore plains and complete production technology was developed.
- To improve water use efficiency and save irrigation water, broad bed and furrow method of irrigation was developed which saves 30% of water when compared to conventional method of irrigation.
- Corkwood tree was introduced for the first time in India and complete production technology was developed and transferred to M/S Cipla for alkaloid production.
- Integrated nutrient management technologies were developed for aromatic crops to reduce the consumption of inorganic fertilizer to maintain the environment.
- Efficient carbon sequestered aromatic crop vetiver was identified which sequestered maximum organic carbon (15.0 tons / hectare / year) compared to other many species which sequestered less than 2 tons / hectare / year.
- First time study conducted on yield and quality of MAPs in relation to soil and environment which had positive correlation.
- Published 95 research paper in National and International Journals and presented 40 research papers in symposia and conferences.

Dr. G.D. Bagchi

Dr. G.D.Bagchi joined CIMAP on 2 Dec. 1980 in Botany and Pharmacognosy Department and retired as Chief Scientist and Head Plant Biology Division on 31 Oct., 2013. Some of his significant scientific contributions are as follows:

- Pharmaconostically characterized and standardized more than 50 herbal drugs for publication, inclusion in Ayurvedic and Indian Pharmacopoeia and as CSIR-CIMAP BRS. Received appreciation from Indian Pharmacopoeia Commission for scientific contribution to the Indian Pharmacopoeia in 2007.
- Solved the seed formation problem, developed cultivation method for subtropical conditions and identification of camphor rich genotype in *Artemisia annua*. The study helped in the production of 1500kg seeds, which was used in CIMAP's bio-village mission. For this CSIR- CIMAP received FICCI award in 2004-05.

- Resolved the identity problem in *Phyllanthus* species and development of cultivation method for *P.amarus* (a hepatoprotective plant) and economic extraction procedure for phyllanthin from the plant. This was adjudged best paper by IDMA, Mumbai in 1998.
- After extensive testing, seeds of coprophillous plants were identified as rich source of anti-microbial compounds. This work published in Pharmaceutical Biology has been extensively cited.
- With the help of electron microscopy, identified new storage structure 'Cytoplasmic vesicles' containing secondary metabolites in the roots of *Coleus forskohlii*, revealed exceptional process of essential oil secretion in the seeds of *Abelmoschus moschatus* (Muskdana), determined unique process of mucilage production in *Cissus quadrangularis* and revealed a distinctive phenomenon, the engulfment of mitochondria by chloroplast, in the normal mesophyll cells of *Wedelia calendulacea*.
- Identified arteether as a potent plant growth inhibitor from *Artemisia annua*. The paper published in Phytochemistry has been cited extensively.
- Proper harvesting time of *Adhatoda vasica* was determined and economical extraction procedure for higher yield of vascicine was developed.
- Several important wild/ exotic/ endangered medicinal/ aromatic plants (e.g. *Artemisia* species, *Commiphora wightii*, *Ruta chalepensis*, *Cineraria maritime*, *Eleocarpus ganitrus*, *Cinnamomum camphora*, *Eucalyptus globulus* etc.) were evaluated for cultivation at North Indian Plain conditions.
- Contributed for the development of commercial varieties of important medicinal plants e.g. *Artemisia annua* (2 varieties), *Withania somnifera* (2 varieties) and *Phyllanthus amarus* (1 variety).
- Guided 5 students for Ph.D degree, published more than 100 scientific research papers in reputed / SCI journals and filed 8 patents.

Dr Amitabha Chattopadhyay

The scientific contribution of Dr. Amitabha Chattopadhyay during his 32 year R&D career in CSIR-CIMAP was focused on soil fertility assessment with fertilizer and nutrients management for the cultivation of medicinal and aromatic plants with main emphasis to provide balanced fertilization for the crops while maintaining soil health. His main contributions are:

- Conceptualized the idea to convert crop residue (Spent) of mint and geranium into nutrient enriched compost for its use as supplement for commercial fertilizer with a benefit of recycling the nutrients to maintain the soil productivity.
- Patented a bio formulation with the isolated bioactive substances from the

mint spent compost for its use as plant growth enhancer (Indian patent No.225333 in 2007)

- Investigated the significance of providing secondary and micro-nutrients for cultivation of medicinal and aromatic plants for better yield and maintenance of soil productivity.
- Provided a lead to the institute (CSIR) to recommend different aromatic grasses with their varying levels of tolerance for heavy metals like Ni, Cd and Cr in soil for plantation in metal contaminated land with necessary management practices.
- Initiated the investigation on the Carbon sequestration potential of some of the economically important aromatic crops that would benefit growers to earn carbon credit in future.
- Published 62 research papers in various national and International journals and credited with one Indian patent.

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Dr HP Singh, Pr. T.O.
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Mr. MS Mehra
Finance & Accounts Officer
CSIR-CIMAP, Lucknow

Mr. BD Vashisth
Controller of Administration
(Member Secretary)
CSIR-CIMAP, Lucknow

Budget at a Glance

	Rupees in Lakhs
Pay & Allowances	2288.943
Contingencies (P-04)	243.129
H.R.D. (P-05)	-
Lab Maintenance (P-06)	120.306
Staff QRS, Maintenance (P-701)	15.005
Chemicals / Consumables & Other Research Expenditures (P-07)	178.486
Works & Services (P-50)	76.144
Apparatus & Equipments - Scientific (P-50)	54.822
Office Equipments (P-50)	-
Furniture & Fittings (P-50)	11.172
Library Books (P-50)	-
Library Journals (P-50)	49.911
Staff Qtrs. (Construction) (P-702)	-
CSIR Network Projects	796.314
Total	3834.232
Pension (P804)	949.665
EMR (P81)	174.976
External Budgetary Resource	
Lab Reserve Fund (LRF)	77.067
External Cash Flow (ECF)	473.827

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(as on 31.3.2014)

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Prof. AK Tripathi

Chief Scientist
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Dr BRR Rao
Dr RN Kulkarni
Dr DD Patra
Dr LN Mishra
Dr AK Singh
Dr SK Chattopadhyay
Dr MM Gupta
Dr Ashok Sharma
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Shri Anil Kumar
Dr AK Mathur
Dr RS Sangwan
Dr SK Srivastava
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Dr Atul Gupta

Junior Scientist
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Er. Ashwsin D Nannaware

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Mr. AM Khan
Mr. Prem Singh

Dr DK Rajput
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Mrs. Sudha Agarwal
Dr Ateeque Ahmad

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