CSIR-IIIM

CSIR – INDIAN INSTITUTE OF INTEGRATIVE MEDICINE-JAMMU

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ANNUAL REPORT 2021-2022

CSIR-Indian Institute of Integrative Medicine

(Council of Scientific & Industrial Research)

CONTENTS

OVERVIEW OF CSIR-IIIM

The Laboratory was established in 1941 as a research and production centre, known as Drug Research Laboratory of J&K State and was later taken over by Council of Scientific & Industrial Research (CSIR) of Govt. of India in December 1957 as Regional Research Laboratory, Jammu. In view of its core strength in natural products based drug discovery, the mandate of Institute was redefined in 2005 and its name changed to Indian Institute of Integrative Medicine (IIIM). The current mandate of IIIM is to discover new drugs and therapeutic approaches from Natural Products, both of plant and microbial origin, enabled by biotechnology, to develop technologies, drugs and products of high value for the national and internationalmarkets.

Mission

To become a Centre of Excellence in Natural Products chemistry and biotechnology driven drug discovery, integrating modern biology with chemistry.

Vision

The vision of the Institute is to position IIIM as an International center of excellence for natural products chemistry, chemical biology, pharmacology and biotechnology to discover new chemical entities (NCEs) as drugs for unmet medical needs and provide scientific rationale and validity to various Indian systems of medicine. The institute aspires to achieve leadership position as a research Institute for creating a broad knowledge base, a work force of dedicated and trained scientists and a technology development center through scientific exploration of secondary metabolites from plants and microbial biodiversity, at the same time generating awareness for their conservation and protection.

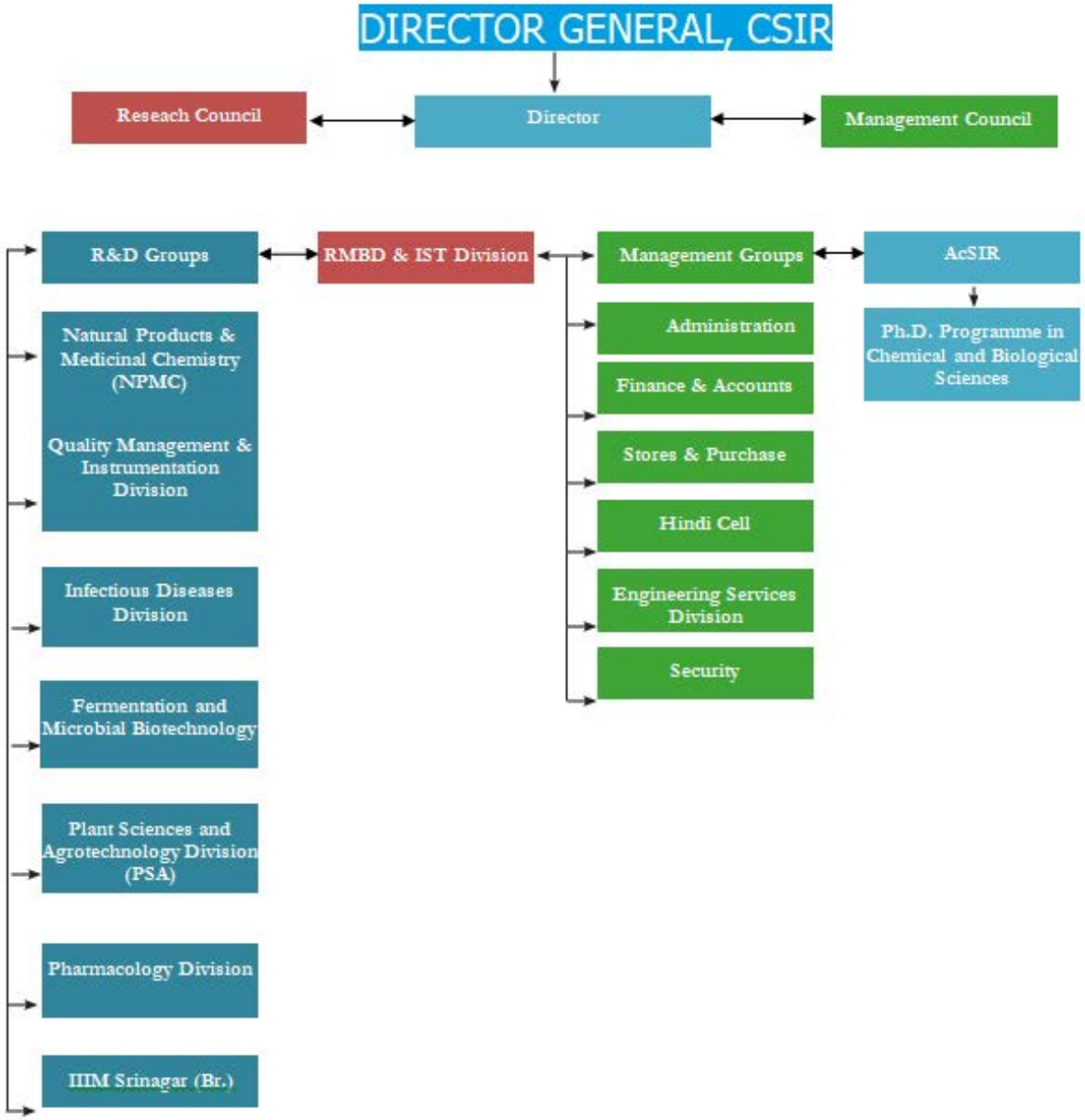
Mandate

The mandate of IIIM is to be an internationally competitive centre of excellence in all facets of natural products research and technology, including (a) discovery of novel pharmacologically active natural products from plants and microbial species and translating them into drug leads and candidates by medicinal chemistry, preclinical pharmacology and clinical development. This approach is pursued both in NCE as well as botanical herbal mode; (b) Preclinical and clinical validation and establishment of mechanism of action of drugs used in various Indian systems of Medicines (Ayurveda, Unani, Siddha and other Indigenous systems of medicine); (c) develop agro-technologies and commercial cultivation of high value medicinal and aromatic plants from Western Himalayas including Kashmir Valley and Ladakh for national and international markets; and (d) to work with Indian and global pharmaceutical industry to out-license new products and technologies.

Current Focus Areas

- Medicinal Chemistry (Hit to pharmacokinetics, formulation and Preclinical development).
- Biotechnology of plants and microbial secondary metabolites.
- Fermentation based technologies of Industrial products.
- Phytopharmaceutical drug discovery (GAP, GLP, GMP, GCP).
- NABL accredited QC/QA of drugs, foods, essential oils etc.
- Pharmacology of Cancer, Inflammation, Infection (Clinical microbiology) and Neurodegenerative disorders.
- Societal outreach programme in cultivation of Medicinal and Aromatic crops for better income and livelihood to rural poor and employment generation.

ORGANISATIONAL SETUP



The New Research Council of IIIM

w.e.f 1st September 2020

Prof. Sudhir K. Sopory
(Chairman)
Ex-Vice chancellor JNU

Dr. Javed Iqbal
Founder and Chairman
Cosmic Discoveries,
Hyderabad

Dr. Satyajit Mayor
Director,
National Centre for
Biological Sciences,
Bengaluru

Dr. Vidya S. Gupta
Former CSIR Emeritus
Scientist, Chair & Chief
Scientist

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Managing Director,
Penam Laboratories Ltd.
New Delhi

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Professor & Head,
Department of Pharmacology
Jamia Hamdard University
New Delhi

Dr. Tanuja Nesari
Director,
All India Institute of
Ayurveda (AIIA), New Delhi

Dr. Viswajanani Sattigeri
Head, CSIR-Traditional
Knowledge Digital Library,
New Delhi

Dr. Rupinder Kaur
Staff Scientist,
CDFD, Hyderabad

Dr. Debnath Bhuniya
Independent Consultant,
Medicinal Chemistry &
Process Development of
NCE

Dr. Srikanta Kumar Rath
Senior Principal
Scientist, Division of
Toxicology, CDRI Lucknow

Management Council of IIIM

(01.01.2020 – 31.12.2021)

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Director, CSIR-IIIM, Jammu

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Controller of Finance & Accounts
Member
CSIR-IIIM, Jammu

Dr. Amit Sharma
Member
Pr. T. O. (Medical Officer),
CSIR-IIIM, Jammu

From the Director's Desk

It gives me an immense pleasure to present the annual report of CSIR-IIIM for the year 2021-22. This report summarizes the achievements in all facets of Natural Products Research, Covid-19 Pandemic, Technologies including discovery of Novel Pharmacologically Active Natural Products from plants and Microbial species and translating them into drug leads, Preclinical Pharmacology and Clinical development in both NCE as well as botanical herbal mode. Based on our research performance, innovation outputs and societal impact, CSIR-IIIM, Jammu has been ranked 7th within the country among the Indian Institutes as per ratings released by Scimago Institutions ranking-2021. CSIR-IIIM Jammu has been ranked 3rd among CSIR laboratories, and ranked 1st within biology cluster of CSIR. During the year 2021-22, we have been able to file 14 new patent applications and 18 patents were granted to CSIR-IIIM during the same period. During this calendar year 2021-22, IIIM published a total of 158 scientific publications with an average impact factor of 4.13. A total number of 23 Skill Development Programs under CSIR-Integrated Skill Initiatives have been organised in same year, benefitting 1211 participants all over the country.

Several important events took place during this financial year. Firstly, Institute has licenced two technologies, one with M/s Hempstreet Medicare Pvt Ltd on transdermal patches for pain management and second technology to M/S Viridis Biopharma Pvt Ltd Mumbai on *Bergenia ciliata* Nutraceutical product IIIM-160 for pain management in Rheumatoid Arthritis. A two day Lavender festival was organised by our Institute at Bhaderwah which saw participation of thousands of farmers, Govt. Officials as well as NGO's from different parts of the country. CSIR Floriculture Mission was also inaugurated by Hon. Minister of Science & Technology as well as inaugurating BioNest Bioincubation centre at CSIR-IIIM Jammu. DG CSIR visited our Jammu and Srinagar campuses and also took evaluation of our farms located at different agroclimatic zones in J&K. DG CSIR also visited Ladakh and reviewed CSIR initiatives for Ladakh region. A one day workshop on CSIR initiatives for Science & Technology led development in J&K UT was also inaugurated by Hon. Minister of Science & Technology.

I wish to thank the Research and Management Council of CSIR-IIIM, for their constant support and cooperation. Lastly, I acknowledge the role of stakeholders, the scientists, staffs and the students of CSIR-IIIM who made possible this outstanding output for inclusion in this annual report. My special thanks to IIIM Annual Report Committee for coming up with this report for all stakeholders of the Institute. Last but not least my appreciations for Editor of Annual Report 2021-22 for editing and covering all facets of R&D, Extension and Societal programs of our Institute.

(D. Srinivasa Reddy)

1 MAJOR COVID-19 CONTRIBUTIONS

1.1. COVID-19 RT-PCR testing

CSIR-IIIM (Jammu) was among the first few research institutes which started RT-PCR based COVID-19 testing, as early as the first week of April 2020 and has been continuing since then. Centers for COVID-19 RT-PCR testing were established at Leh and Kargil as well. Manpower was recruited at CSIR-IIIM (Jammu), trained and then sent to work at the centers at Leh and Kargil. Equipment such as biosafety laminar hoods, realtime PCRs, centrifuges, etc. were procured and dispatched to these centers. The road route was closed at that time, hence help from Indian Air Force was sought to send these equipment so that the testing centers could be made functional.

A total of 26,203 samples from Jammu, 83,987 samples from Kargil and 1,22,453 samples from Leh, were tested using RT-PCR, for COVID-19, from 1st April 2021 to 28th March 2022. A total of more than two lakh samples (2, 32,643) have been tested at the three centers combined in the reporting period (1st April 2021 to 28th March 2022). In total, since the starting of COVID-19 testing by CSIR-IIIM (April 2020), in the three centres combined we have tested, 3, 39, 191 samples by RT-PCR.

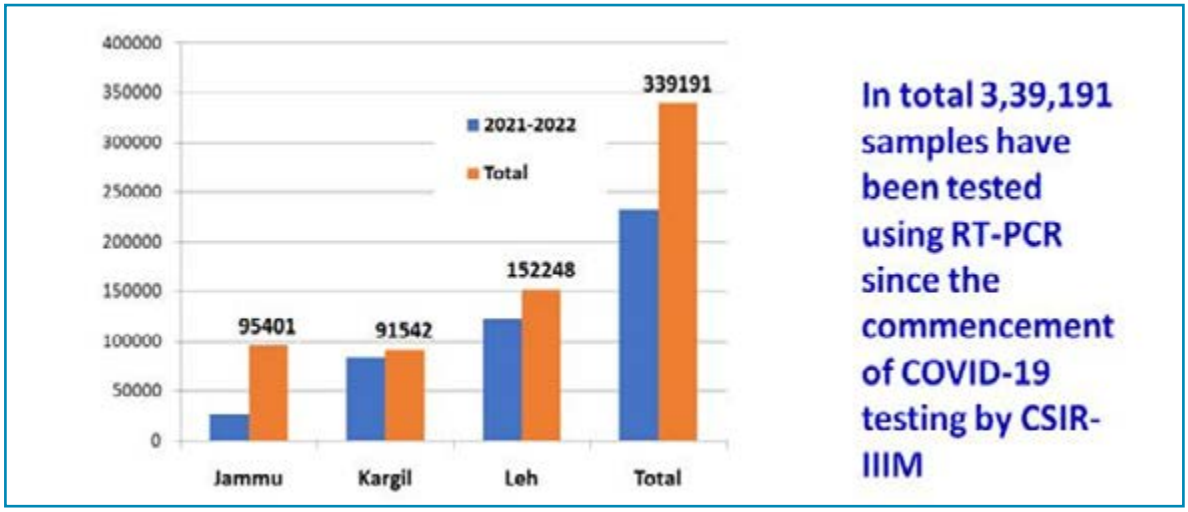


Figure 1.1.1: COVID-19 RT PCR Testing

Figure 1.1.2: Transport of critical equipments to Kargil and Leh with the help of Indian Air Force, for setting up COVID-19 RT-PCR Testing Labs.

1.2. Sero-Survey for SARS-CoV2 antibodies under the CSIR Phenome Project:

Under the "Phenome India- A long term longitudinal observational cohort study of health outcomes" project, blood samples were collected from staff and students working at CSIR-IIIM and their families, as well as contractual workers working at CSIR-IIIM, who volunteered for the study. Sampling was done on 29-30 June 2021 (at Jammu) and 6-7 July 2021 (at Srinagar) during the reporting period. 280 samples were collected from Jammu and 55 samples were collected from Srinagar and sent to IGIB for further analysis. This survey helped initially in identifying individuals who had already developed antibodies against SARS-CoV2 as well as the antibody levels, and eventually other parameters such as SGOT, SGPT, Albumin, Bilirubin, Creatinine, Folate, Urea, Uric acid, Vit B12, Vit D were also measured. With respect to sero-survey for anti-SARS-CoV2 antibodies, correlates were drawn with respect to usage of public transport, smoking, blood group, etc., thus identifying groups that are more prone to infection. Further, this may also help the individuals in deciding when to get vaccinated.

Figure 1.2.1: Sero-survey for SARS-CoV2 antibodies under CSIR Phenome Project

1.3. Vaccination Camps at CSIR-IIIM

During the reporting period, with the help of various agencies of the Jammu and Kashmir administration, three vaccination camps (15th June, 17th July and 11th September 2021) were organized at CSIR-IIIM for the employees and their families, as well as for the students and workers hired through contractor. All the staff, students and contractual workers at IIIM are now fully vaccinated against SARS-CoV2 with two doses of covishield vaccine. Further, efforts were also made to arrange Covaxin for those who wanted to get vaccinated with inactivated SARS-CoV2 viral vaccine. More than 1300 doses of vaccine were administered.

Figure 1.3.1: COVID-19 Vaccination Camps

1.4. Analysis of single nucleotide polymorphisms between 2019-nCoV genomes and its impact on codon usage.

Suruchi Gupta, Ravail Singh and Prosenjit Paul

The spread of COVID-19 is a global concern that has taken a toll on entire human health. We performed the bioinformatics analysis to understand the genetic variability which was necessary to design effective drugs and vaccines. The study entails the information regarding the genome-wide mutations detected in the 108 SARS CoV-2 genomes worldwide. Genomic sequences from different Indian states have been phylogenetically analyzed to gain insight into the genetic variation prevalent in India (Figure 1.4.1). Based on the phylogenetic tree we grouped the 2019-nCoV genome sequences of Indian states into 13 major groups. These 13 representative groups (states) of India were then phylogenetically analyzed along with SARS CoV-2 genomes (95 coronavirus sequences) from different countries around the world. We identified a few hypervariable regions localized in orf1ab, spike, and nucleocapsid gene. Our findings revealed the existence of high mutation rates in 2019-nCoV genomes sequenced from different parts of the world. Phylogenetic analysis confirms the migratory context of 2019-nCoV and its spread. Based on phylogeny, 69 states of India were assembled into 13 groups and finally 95 countries along with Indian states into 27 groups. The presence of hypervariable region was discovered in genomic locations coding for three genes namely orf1ab, S and nucleocapsid N gene. In orf1ab gene, we found two hypervariable amino acid changing regions (1068 and 11092 genomic locations) worldwide and three hypervariable regions (6312, 11083, and 13730 genomic locations) in Indian states when compared with the Wuhan strain. In addition, across the Indian states, we found another non-synonymous mutation in S protein where methionine was replaced by tyrosine. Non-synonymous mutation affects the overall conformation of proteins. S protein plays a crucial role in viral infection and pathogenesis. We may, therefore, believe that this altered amino acid may have made a major contribution to the

pathogenesis and transmission of 2019-nCoV.These nucleotide polymorphisms demonstrated their effect on both codon usage as well as amino acid usage pattern.

Our analysis confirms high variability among 2019 - nCoV sequenced quasispecies, highlighting hypervariable positions within three key protein-coding regions. Such variability in proteins might have affected the patient's clinical outcomes because the viral genome that infects them is slightly different. Nevertheless, there is a chance that these mutational variants might have modulated the disease's spread. Our results provide positive light on the prospect of developing 2019-nCoV therapy for patients from different locations. Altogether the present study provides valuable information that would be helpful to ongoing research on 2019-nCoV vaccine development.

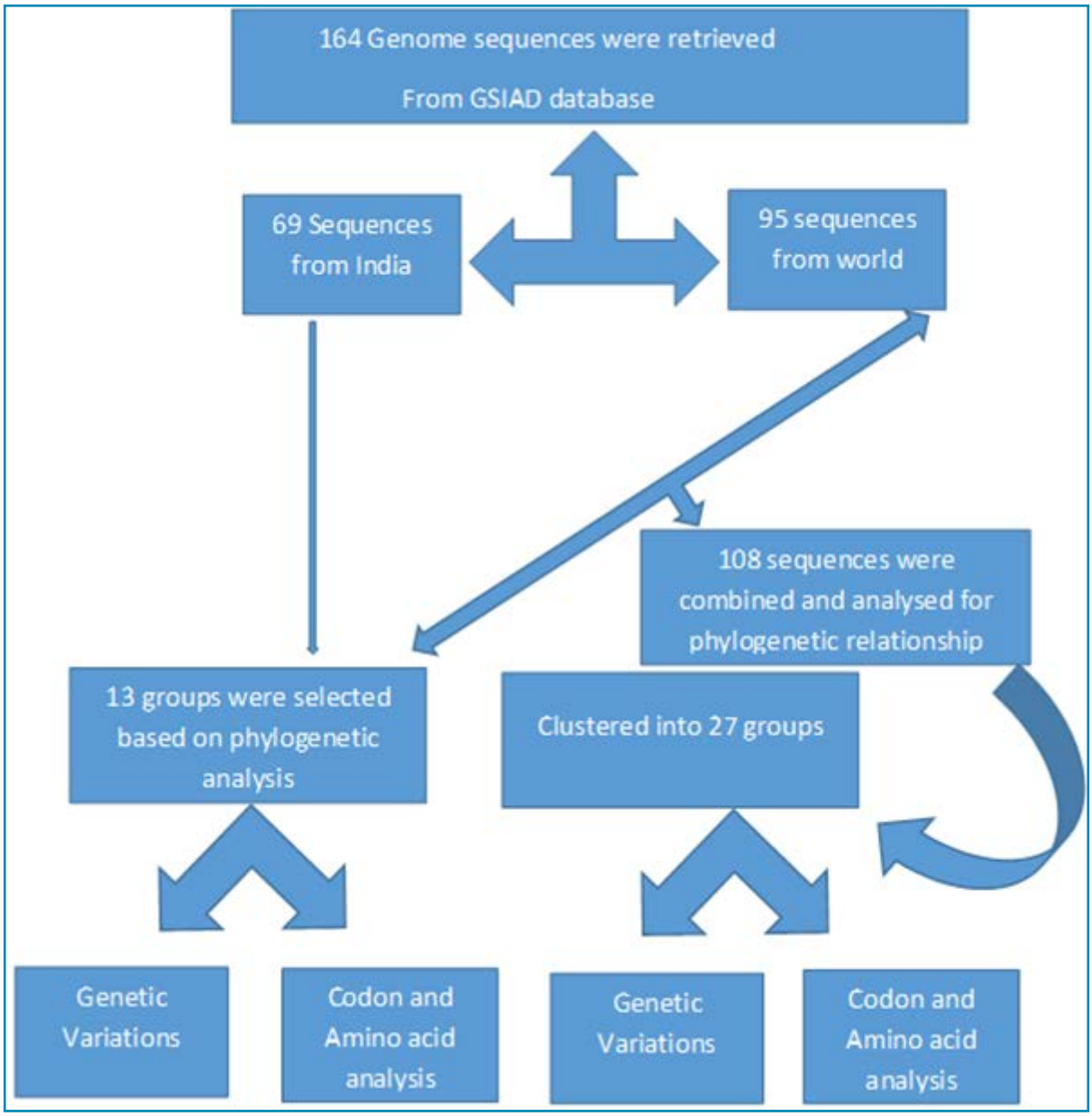
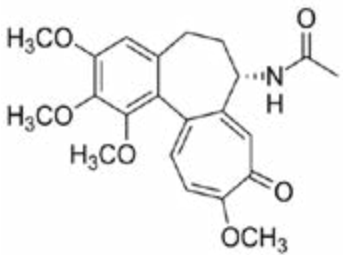


Figure 1.4.1: GSAID database was used to fetch 164 SARS CoV-2 genomic sequences which comprised of 69 genomic sequences from India and 95 from other countries of the World.

1.5. Clinical trials of natural products & Ayurvedic drugs in COVID-19.

IIIM has taken initiative in conducting the phase II clinical trials of a natural product FDA approved drug colchicine and three ayurvedic drugs in COVID-19 patients.



The phase II clinical trial of colchicine in high-risk COVID19 patients with co-morbidities is completed in 84 patients. The results of the trial are under analysis.

Phase	Phase II (sample size = 84)
Intervention	Colchicine 0.5mg tablets plus SoC (28 Days) vs. SoC
Industry	Laxai Life Sciences Pvt. Ltd.
CRO	Insignia Clinical Services Pvt. Ltd
Study sites	• MedantaMedicity Gurgaon • Santosh Medical College, Ghaziabad • PCMC Yashwantrao Chavan Memorial Hospital, Pimpri, Pune • Lady Hardinge Medical College & hospital, Delhi • St. Georges Hospital, Mumbai

The clinical trials of three ayurvedic drugs are also completed. Analysis is ongoing.

- *Withaniasomnifera* (Ashwagandha) for the Prophylaxis against SARS-CoV-2 Infection.
- Ayurvedic Formulation of *Tinospora cordifolia* + *Piper longum* (Guduchi + Pippali) as an Adjunct Treatment to Standard of Care for the management of Mild to Moderate COVID-19 Patients.
- *Glycyrrhiza glabra* (Yashtimadhu) as an Adjunct Treatment to Standard of Care for the management of Mild to Moderate COVID-19 Patients.

2 SIGNIFICANT SCIENCE AND TECHNOLOGY ACTIVITIES

2.1 Understanding the nutraceutical potential of Cannabis seeds from two different environments through metabolomics approach.

Aatif Rashid, Villayat Ali, Manu Khajuria, Sheenam Faiz, Sumeet Gairola and Dhiraj Vyas (Plant Sciences and Agrotechnology Division)

Cannabis belonging to family Cannabaceae is an important plant since times immemorial. Metabolomics is an important analytical approach to detect numerous metabolites at a given point and has been widely used in food and nutritional research. An untargeted metabolomic study based on Gas chromatography mass spectrometry was conducted in seeds of two accessions from different environments. Results reveal a total number of 121 metabolites were detected at least three times in both the accessions. This included 98 and 103 metabolites in CAN1 and CAN2, respectively. The principal component analysis (PCA) revealed 69% variation, and the cluster for both the accessions did not overlap with each other suggesting altered levels of metabolites between the two accessions. PCA1 showed 50.6% and PCA2 detected 18.4% of variation (Fig. 2.1.1 A). According to the loadings plot, the separation in Factor 1 and 2 are not mainly due to specific metabolites and is a combined effect of a variety of metabolites (Figure 2.1.1B). Partial least squares discriminant analysis (PLS-DA) identified the most important metabolites based on the VIP values of five component model (Figure 2.1.1 C). Using *Arabidopsis thaliana* as a source for the pathway libraries, a total of 56 pathways were identified in both the accessions. Out of these, 20 pathways were found to have been impacted in the present study (Figure 2.1.1 D). The metabolic accumulation in both the accessions becomes evident from hierarchical clustering with the heat map generated from the top 50 metabolites present in both the accessions (Figure 2.1.2). The accumulation of the nutraceutically important amino acids, cannabinoids, alkaloids, and fatty acids, the high altitude temperate Himalayan accession (CAN2) was found to have an advantage over the low altitude subtropical accession (CAN1). The DNA nicking assay on the methanolic extracts is corroborated with the metabolic content of phenols and flavonoids (Figure 2.1.3) and suggested higher antioxidant and nutraceutical potential in CAN2 (Figure 2.1.4) and Thus the environment may have played an important role in defining the exclusiveness and concentration of these specific metabolites.

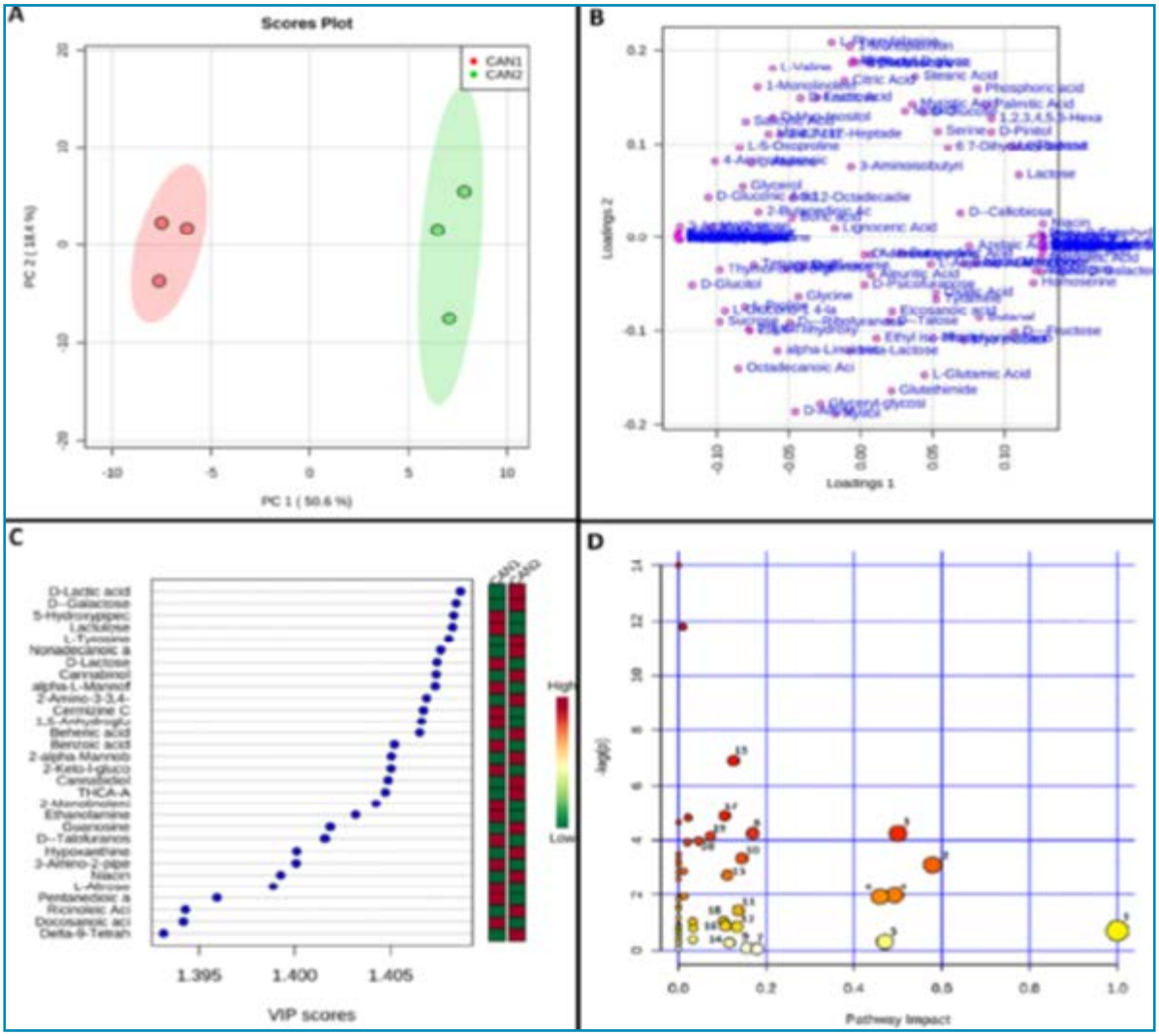


Figure 2.1.1: Metabolome analysis of two different accessions of Cannabis using GC–MS approach and analysed using MetaboAnalyst 4.0 online tool. (A), Principal component analysis; (B), Loading plots highlighting the metabolites contributed for the differences observed among two samples; (C), Key compounds separating the two accessions types based on variable importance in projection (VIP) in partial least squares discriminant analysis (PLS-DA) analysis; (D), Summary of pathway topology analysis. 1. Linoleic acid metabolism; 2. Alanine, aspartate and glutamate metabolism; 3. Isoquinoline alkaloid biosynthesis; 4. Starch and sucrose metabolism; 5. Phenylalanine metabolism; 6. Glycine, serine and threonine metabolism; 7. Glyoxylate and dicarboxylate metabolism; 8. Tyrosine metabolism; 9. TCA cycle; 10. Arginine and proline metabolism; 11. Butanoate metabolism; 12. Glutathione metabolism; 13. Cutin, suberine and wax biosynthesis; 14. Arginine biosynthesis; 15. Aminoacyl-tRNA biosynthesis; 16. alpha-Linolenic acid metabolism; 17. Galactose metabolism; 18. Inositol phosphate metabolism; 19. Pyruvate metabolism; 20. Glycerophospholipid metabolism.

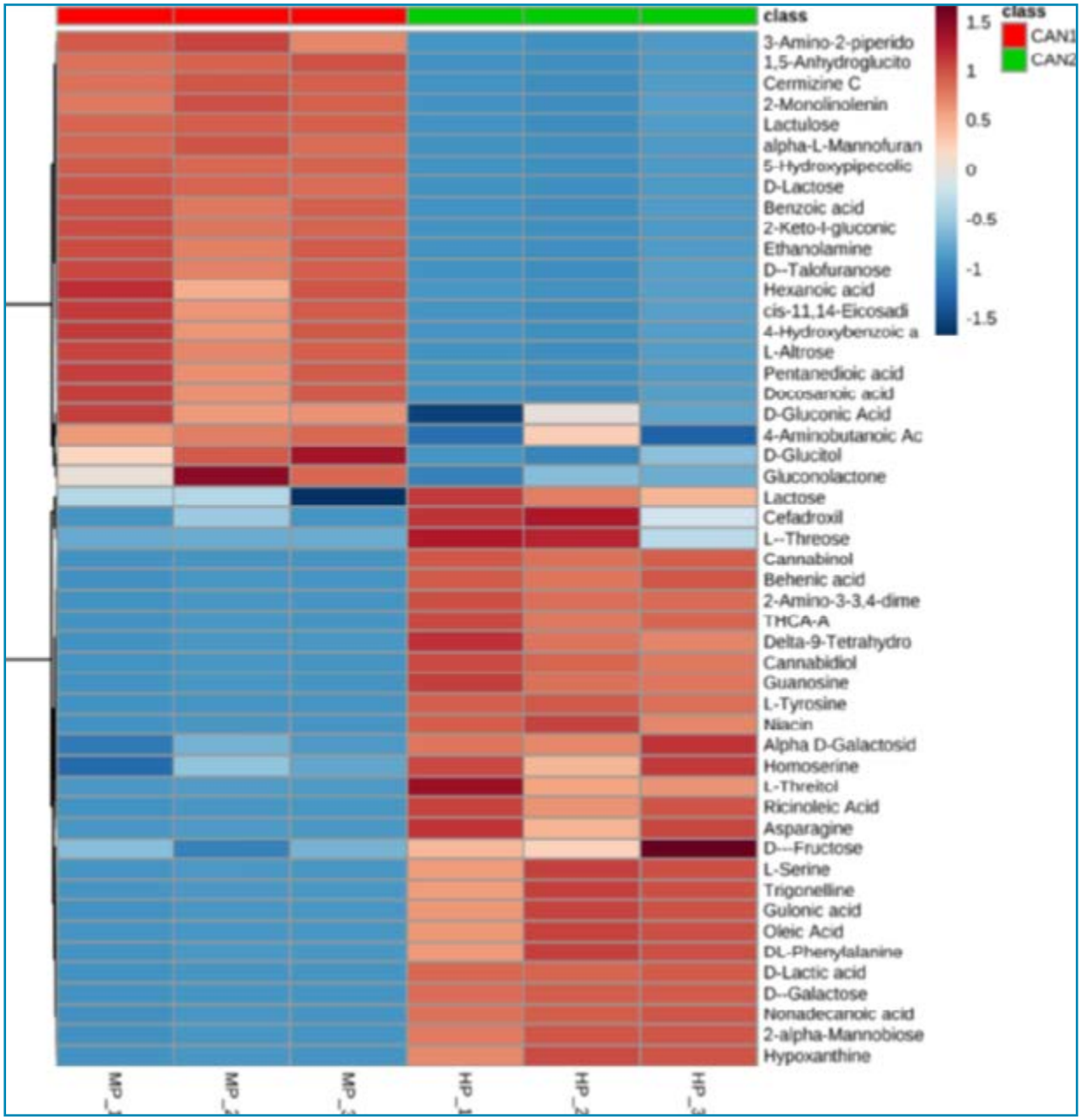


Figure 2.1.2: Heat map illustrating levels of top metabolites in Cannabis seeds according to the partial least square discriminant analysis. Cell colors indicate normalized compound concentrations, with samples in rows, and compounds in columns. The color scale at the right indicates the relative metabolite concentrations with high concentrations in red and low concentrations in blue.

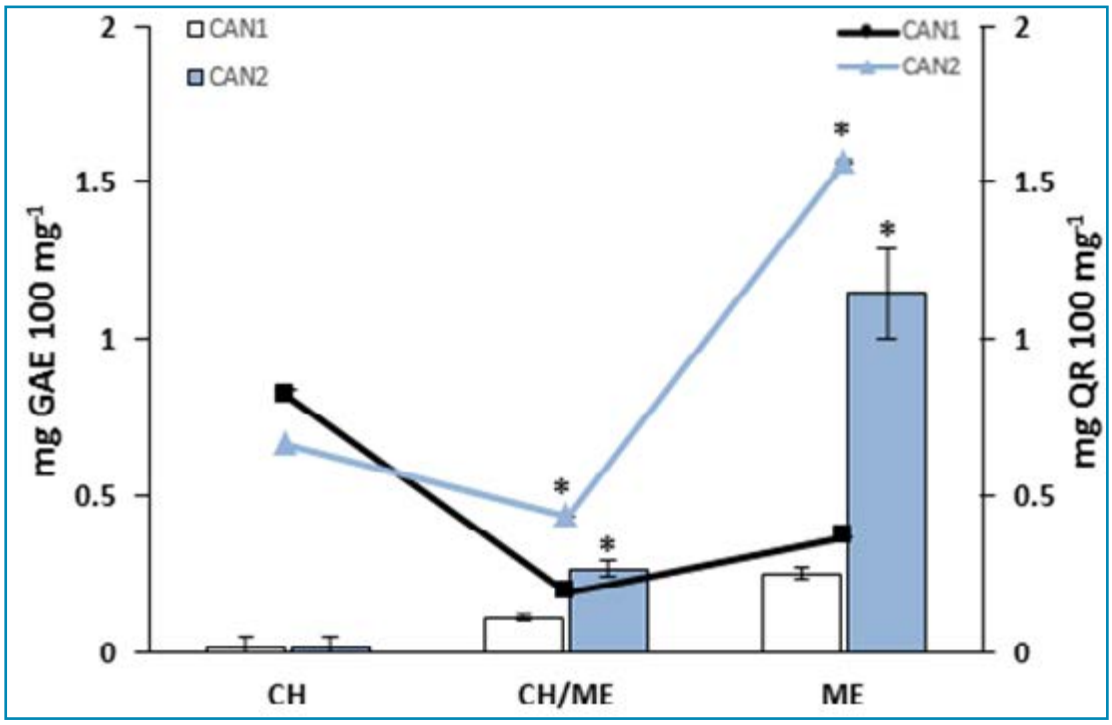


Figure 2.1.3: Total phenol and flavonoid content in the extracts of *Cannabis sativa expressed as mg GAE 100mg-1* and mg QR 100mg-1 respectively, Primary axis (Bar) represents the phenol while as secondary axis (line) represents flavonoid content in accessions.

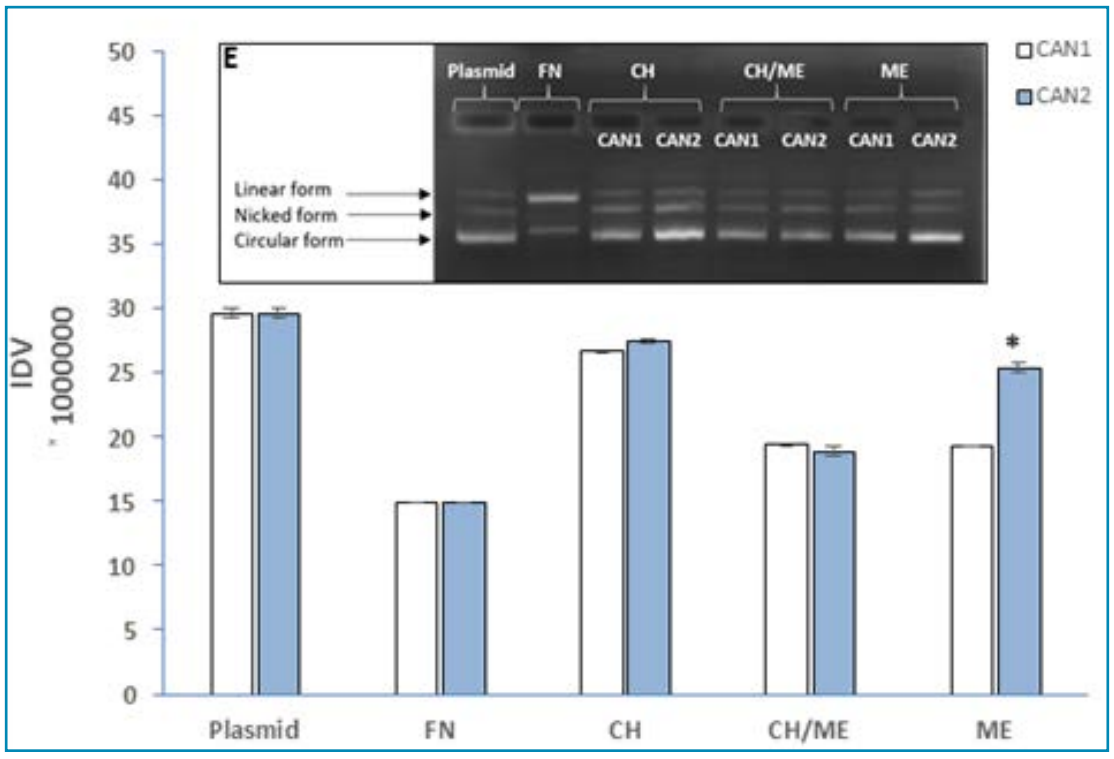


Figure 2.1.4: DNA protective activity using pUC18 and integrated density value of the bands that were run on 1.2% agarose gel stained with ethidium bromide.

2.2 Studying the correlation between photochemical efficiency and the Δ9-tetrahydrocannabinol content in *Cannabis sativa L.*

Manu Khajuria, Vishav Prakash Rahul, Dhiraj Vyas (Plant Sciences and Agrotechnology Division)

Cannabis sativa L is an important plant, which is a source of durable fibers, nutritious seeds, and medicinally important phytocannabinoids including Δ9-tetrahydrocannabinol (THC) and cannabidiol (CBD). Light has shown to be a key modulator of biomass and cannabinoid yield suggesting responsive photochemical machinery. The present study was envisaged to understand the effect of the increasing levels of metabolic THC on the photochemical efficiency in Cannabis. The chlorophyll a fluorescence kinetics, photosynthetic pigments and immunodetection of the photosynthetic machinery was analyzed on seven accessions from different environments (Table 2.2.1), in conjunction with the cannabinoid content. All the accessions were clearly divided into three groups based on their relative content of CBD and THC (Figure 1.2.1). Group I with (CBD/THC > 1) had a clear advantage in terms of the damage to the D1, RbCL and Lhc1 protein holo-complex (Figure 1.2.2). Performance indicators of photochemistry based on the OJIP kinetics suggested a stoichiometrically negative correlation with the THC content (Figure 1.2.3). Zeaxanthin-dependent quenching is primarily responsible for lower NPQ in Group III with high THC content (THC > 6%) as shown in Figure 1.2.4. The THC treatment on *Arabidopsis thaliana* also suggested dose-dependent decrease in the photochemical efficiency suggesting the exclusivity of THC in causing the response (Figure 1.2.5). The accessions with CBD content greater than THC, provides protection to the photosynthetic machinery in Cannabis. High THC content showed a strong negative correlation to the photochemical efficiency of PSII and a weak zeaxanthin dependent NPQ component. Importantly, the chlorophyll a fluorescence measurement can be used as a quick tool for high throughput screening of Cannabis, based on the cannabinoid content.

S. No.	Nomenclature	State/UT	Site	Altitude	Co-ordinates
1.	UKN	Uttrakhand	Narendra Nagar	1320	N 30°16'12.6" E 78°28'81.3"
2.	UPB	Uttar Pradesh	Bijnor	230	N 29°32'77.3" E 78°27'78.8"
3.	JKC	Jammu and Kashmir	Chatha	330	N 32°39'57.0" E 74°48'53.0"
4.	ODMB	Odisha	Mayurbhanj	550	N 22°10'38.2" E 46°40'56.0"
5.	WBD	West Bengal	Durgapur	70	N 23°50'11.1" E 87°32'88.1"
6.	ODD	Odisha	Deogarh	195	N 21°53'88.5" E 84°71'26.4"
7.	ODML	Odisha	Malkangiri	180	N 18°37'10.3" E 81°88'83.1"

Table 2.2.1: Description of sites from where the Cannabis seeds were collected. The collection was based on their local knowledge of physcoactive properties.

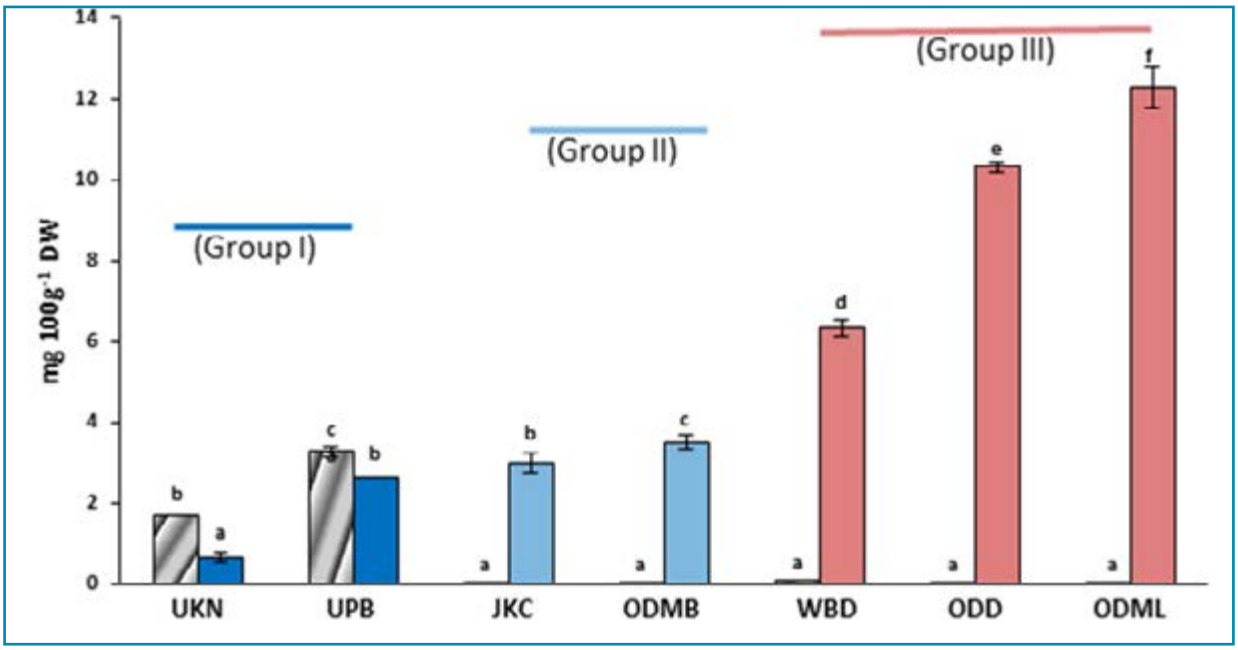


Figure 2.2.2: Metabolic content of total CBD (gradient fill) and THC (solid fill) present in the main inflorescence of seven different accessions of Cannabis grown in controlled conditions. The concentration was expressed as mg 100 g−1 DW ± SD.

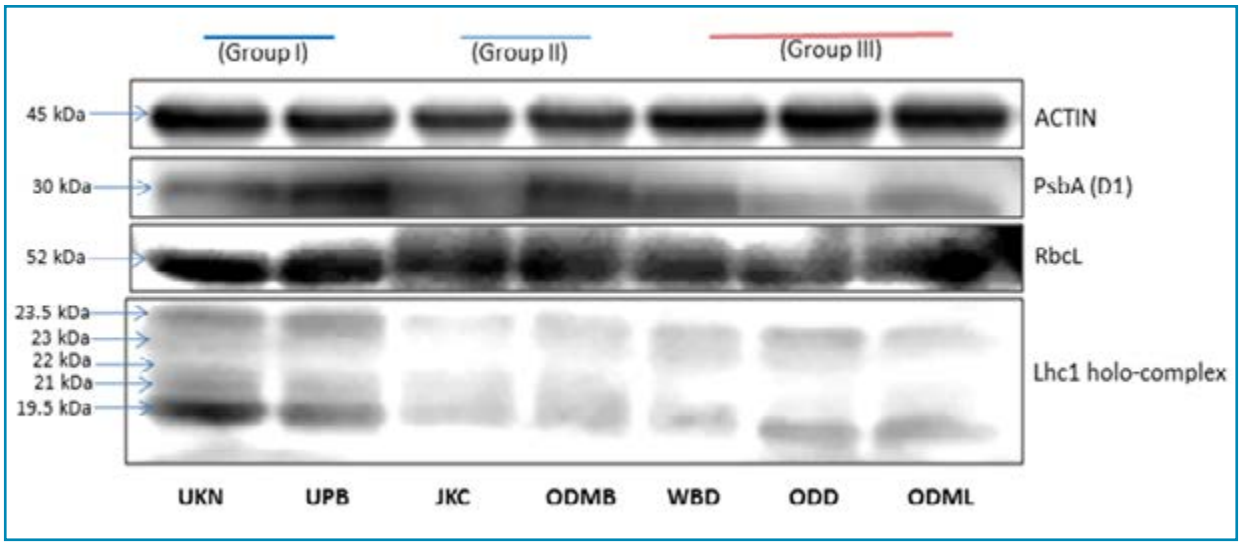


Figure 2.2.3: Immunodetection of PsbA (30 kDa), RbcL (52 kDa) and Lhc1 (19–25 kDa) after SDS-PAGE separation of 20 µg protein from the leaves of seven different accessions of Cannabis. The antibody was diluted to a final conce-ntration of 1:10000. Actin was used as a loading control.

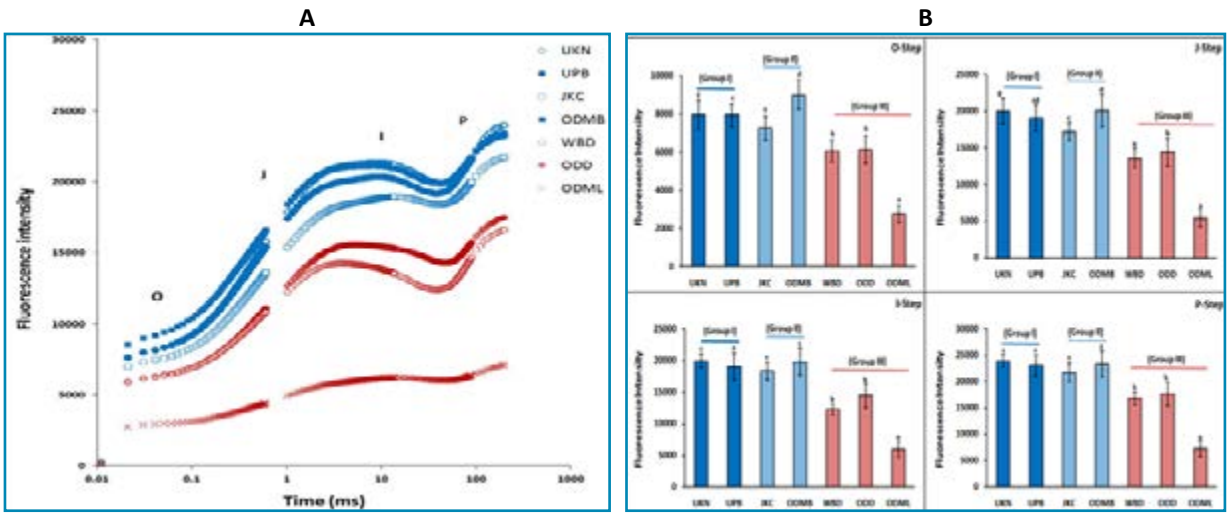


Figure 2.2.4: Kinetics of the OJIP transients measured on leaves of seven different accessions of Cannabis having differential THC content. The measurements represent the means of more than 10 independent readings. Minimum fluorescence (Fo) was measured at 50 µs when all PSII reaction centers are open and it is defined as the O step, followed by the J step (at 2 ms), the I step (at 60 ms) and at maximum fluorescence (Fm) when all PSII reaction centers are closed, known as the P step. A, OJIP curves; B, fluorescence at O, J, I and P step.

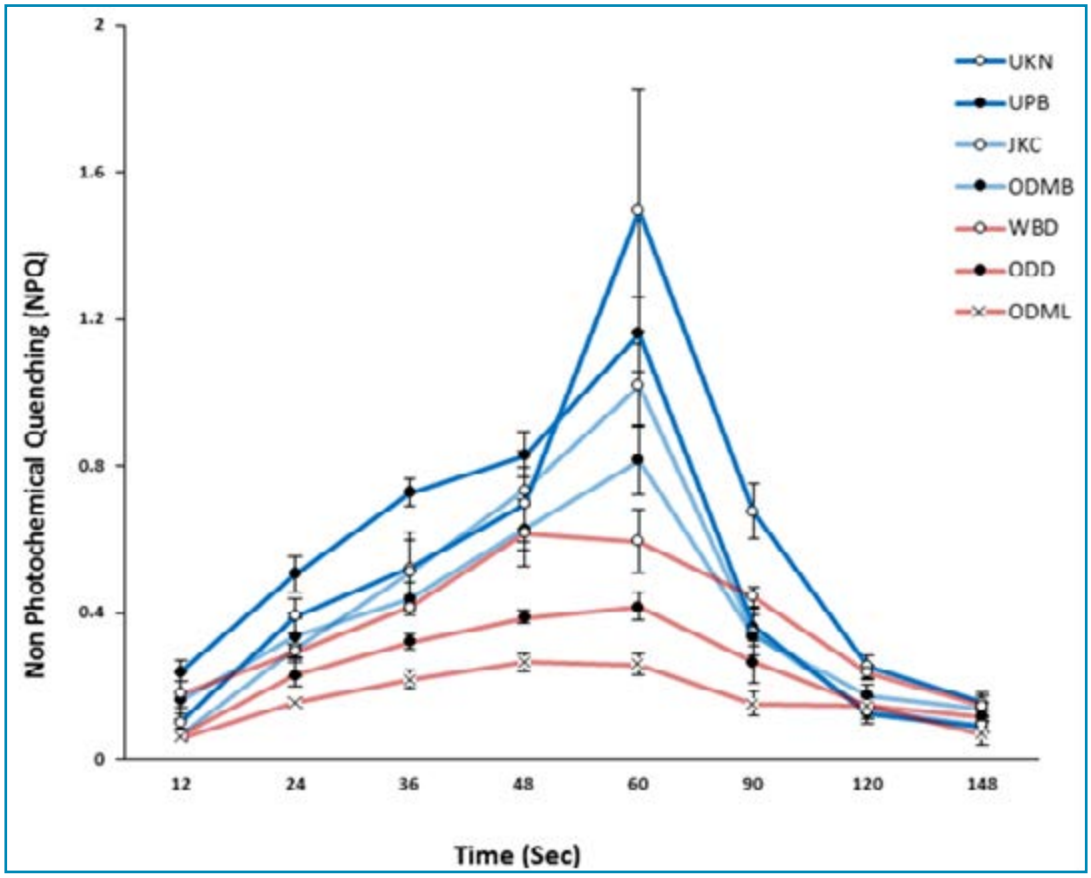


Figure 2.2.5: Non-photochemical quenching kinetics measured on leaves of seven different accessions of Cannabis having differential THC content.

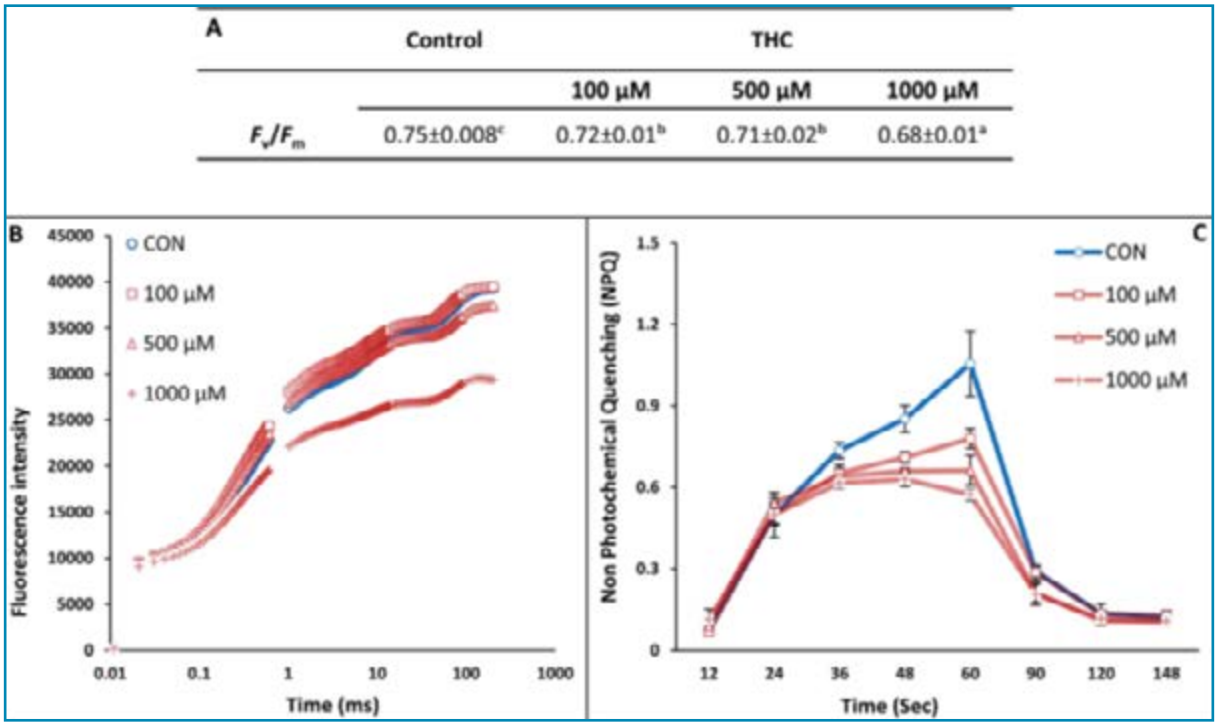


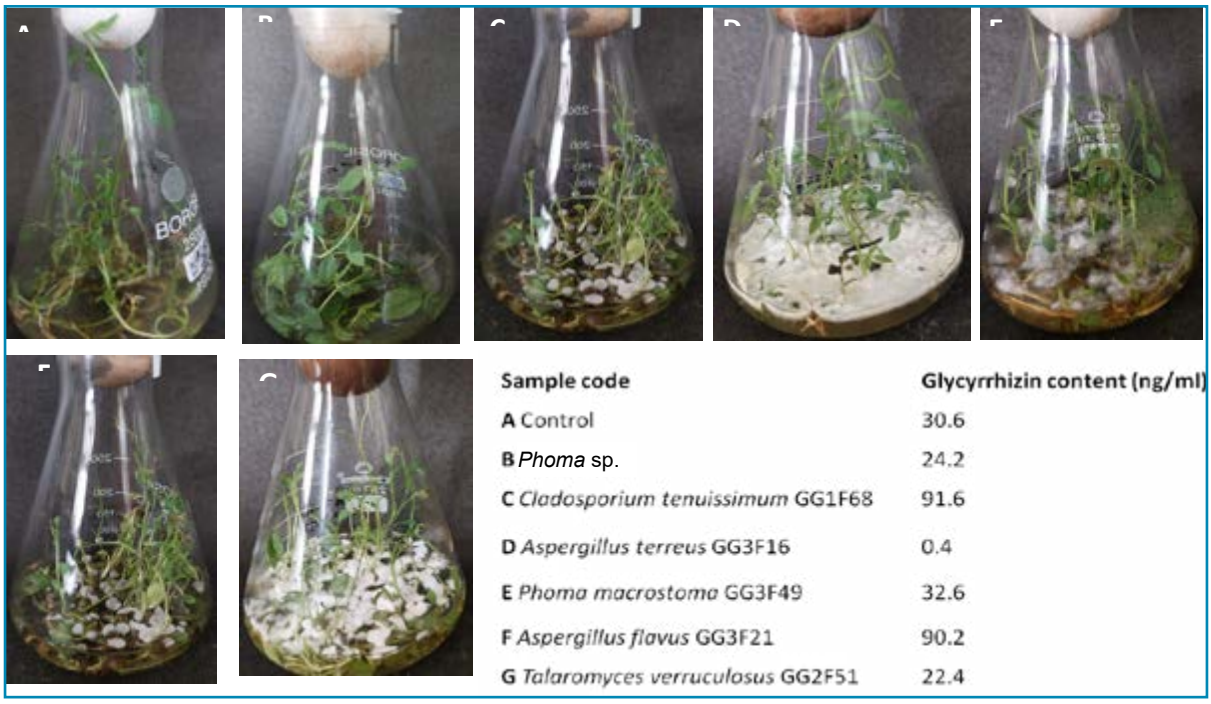
Figure 2.2.6: Fv/Fm (A), OJIP kinetics (B) and NPQ (C) observed in Arabidopsis thaliana (Col 0) plants treated with different concentrations of THC. The measurements were taken 24 h after the treatment

2.3 Identification of an endophyte for hyper-accumulation of glycyrrhizin in *Glycyrrhiza glabra.*

Palak Arora, Rubeena Tabasum, Ajai Prakash Gupta, Riyaz-ul-Hassan, Asha Chaubey and Suphla Gupta (Plant Sciences and Agrotechnology Division)

Glycyrrhiza glabra Linn., (licorice) a member of the Leguminosae family, is a well known medicinal plant used in traditional medicine across the globe for its ethano-pharmacological value to cure human illness (Hosseinzadeh and Nassiri-Asl, 2015). Modern scientific investigations have authenticated various medicinal properties of this plant. The pharmaceutical importance of *Glycyrrhiza* lies mainly in its capacity to produce Glycyrrhizin and Glycyrrhetinic acid in addition to a variety of other secondary metabolites (Seki et al., 2011). The medicinal value of *Glycyrrhiza* and its bioactive secondary metabolites has led to its increased demand worldwide. The robust growth of any plant, including *G. glabra*, and its resistance to phytopathogens may be attributed to its genetic makeup, chemical constituents as well as the microbiome associated with it, particularly the endophytic microbiome which remains intimately associated with the host.

Endophytes are a class of diverse microorganisms, including fungi, bacteria, yeast and actinomycetes that colonize the internal tissues of plants without causing any apparent symptoms of disease. Endophytes influence plant nutrition, growth rate, survival, secondary metabolism and resistance to stress conditions (Arora et al. 2019). They have potential to produce diverse secondary metabolites, related or unrelated to the host plant. In view of the above, we explored the endophytes as elicitors/modulators for the enhanced production of secondary metabolite (Glycyrrhizin) and their role for the sustainable cultivation and conservation.



Sample code	Glycyrrhizin content (ng/ml)
A Control	30.6
B *Phoma* sp.	24.2
C *Cladosporium tenuissimum* GG1F68	91.6
D *Aspergillus terreus* GG3F16	0.4
E *Phoma macrostoma* GG3F49	32.6
F *Aspergillus flavus* GG3F21	90.2
G *Talaromyces verruculosus* GG2F51	22.4

Fig 2.3.1: Co-culture of *G. glabra* plants with endophytes under in vitro conditions. In the control, blank PDB broth and in the endophyte treatment, 1.5×108 spores were inoculated with the explants. Table represents the content of Glycyrrhizin quantified by HPLC in each of the treatments.

2.4 Understanding promoter-driven phytohormone induced modulation of glycyrrhizin biosynthesis in *Glycyrrhiza glabra* L.

Pooja Goyal, Malik Muzafar Manzoor, Ajai P. Gupta, Pankaj Pandotra, and Suphla Gupta (Plant Sciences and Agrotechnology Division)

Glycyrrhiza species has gained global attention due to large number and broad spectrum pharmacological and cosmaceutical activities (Wang et al. 2001). The root extracts of licorice (*Glycyrrhiza glabra* and *G. uralensis*) is a rich source of triterpenoid saponins especially glycyrrhizin and glycyrrhitinic acid. In the present context glycyrrhizin and its derivative is focus on pharmacological studies, against disease viz. HIV syndrome, Hepatitis, H1N1 flue, cancer and diabetes etc. Glycyrrhizin has been recently recruited to treat COVID-19 symptoms. Liquorice production depends on the collection of rhizome from wild resources, which has resulted into decrease in licorice reserves and an increased desertification of plants in wild (Sudo et al., 2009). Moreover the chemical synthesis of glycyrrhizin is difficult (Baltina et al., 2003), both in terms of quantity and cost. Considering the potent pharmacological activities of glycyrrhizin, it is desirable to develop a complete base pertaining to the enzymatic steps and genes involved in its biosynthesis, development of alternate heterologous host systems for glycyrrhizin.

One of the strategies to intensify glycyrrhizin production is using different biotic and abiotic elicitors. Against this backdrop cloning and characterization of complete biosynthetic gene cluster committed to glycyrrhizin biosynthesis along with their corresponding promoter regions from Glycyrrhiza glabra was carried out. The identified genes namely, β-amyrin synthase, β-amyrin-11-oxidase, 11-oxo-beta-amyrin 30-oxidase and UDP-dependent glucosyltransferase, were hetrologously expressed in *Nicotiana benthamiana* for functional validation. Further, the study assessed the role of phytohormones in regulating the molecular machinery committed to glycyrrhizin biosynthesis. The findings of the study will be useful in understanding the regulation and consequently manipulation of glycyrrhizin biosynthesis in *G.glabra* in particular, and tri-terpenoid biosynthesis in general.

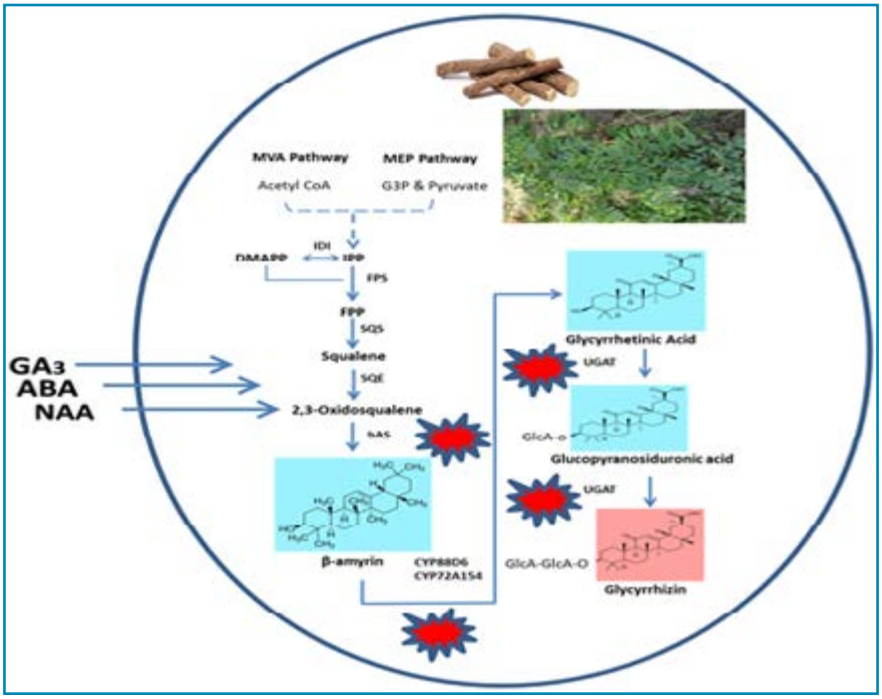


Figure 2.4.1: Scheme of proposed glycyrrhizin biosynthesis pathway. One step catalytic reactions are indicated with solid arrows, and multi-step catalytic reactions are indicated with dashed arrows. MVA pathway, mevalonate pathway; MEP pathway, plastid-localized 2-C-methyl-derythritol 4-phosphate pathway; IPP, isopentenyl diphosphate; DMAPP, dimethylallyl diphosphate; FPP, farnesyl pyrophosphate; IDI, isopentenyl diphosphate isomerase; FPS, farnesyl pyrophosphate synthase; SQS SQS, squalene synthase; SQE, squalene epoxidase; bAS, β-amyrin synthase; CYP88D6, β -amyrin 11-oxidase (P450); CYP72A54, 11-oxo-beta-amyrin 30-oxidase (P450) ; UGAT, UDP- glycosyltransferase.

2.5 Dynamic insight into evolution of WRKY transcription factors in plants.

Pooja Goyal and Suphla Gupta (Plant Sciences and Agrotechnology Division)

WRKY is one of the largest protein family of transcription factors involved in plant defence mechanism. The WRKY protein family is characterized by its signature sequence "WRKYGQK" and zinc finger motif. Phylogenetic studies revealed that evolution and expansion of WRKY gene can be linked with a single WRKY domain (from incertaesedis fungi). The evolutionary lineage can be traced back to green algae, charophyte (*Ostreococcuslucimarinus and Volvox carteri*) that inhabited land about 430 to 470 million years ago, and have both double and single WRKY domain proteins (Rinerson, et al. 2015). Due to the huge global climatic change over the ages, gene duplication leads to structural divergence in WRKY genes resulting in various groups and subgroups.

Wang et al. (2005) offered classification of the earlier three groups based on the comparative genomic study of a dataset of 13 million sequences comprising 110,000 organisms. According to re-classification, WRKY protein family categorized in five independent Groups: Group I, Group IIa+IIb, Group IIc, Group IId+IIe and Group III. Later, Rinerson et al. (2015) put forth the "Group I' and "IIa + b Separate Hypothesis" of WRKY gene evolution. Based on the conclusion of phylogenomics, "Group I Hypothesis" states that all WRKY genes have evolved from the C-terminal domain of Group I WRKY proteins. Contrary to this, "IIa + b Separate Hypothesis" assumed that Groups IIa and IIb originated from the single algal domain; distinct from Group I-derived lineage. It was assumed that the sub-group IIc members could have originated from Group Ic and consequently the N-terminal WRKY domain of Group I WRKYs would have been lost over time (Zhang et al. 2015). Further, Chen et al. 2019 demonstrated that WRKY members of Group II and III share sequence similarity with the C-terminal of Group I WRKY domain, suggested their evolvement from Group I.

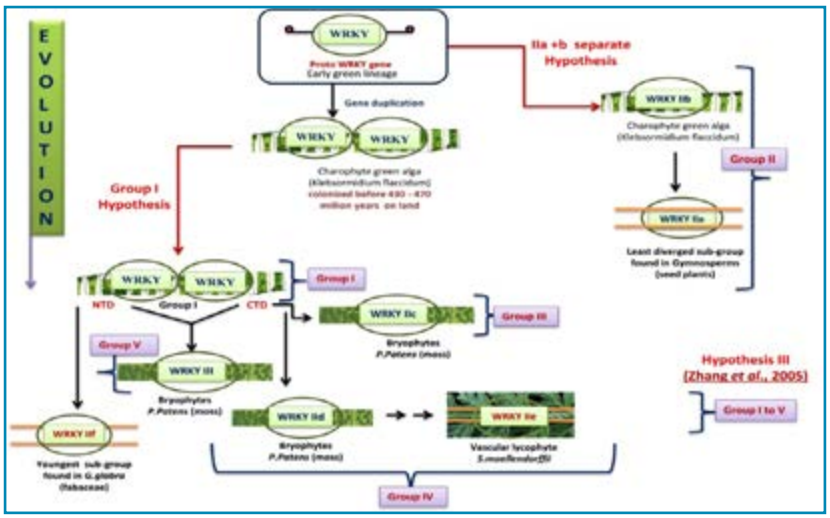


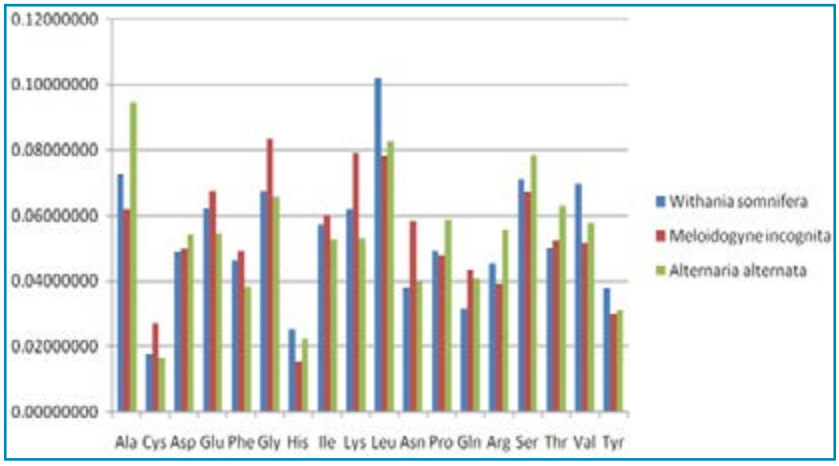
Figure 2.5.1: Complete overview of the evolution of WRKY transcription factor genes from unicellular early green lineage to multi-cellular plants (Goyal et al. 2022, Protoplasma).

2.6 Influence of Natural Selection and Host-Specificity in Codon Usage Bias Patterns in the *Withania somnifera* and its associated pathogens: *Meloidogyne incognita* and *Alternaria alternata*

Jyoti Chandan, Suruchi Gupta and Ravail Singh

(https://doi.org/10.1007/s10709-022-00154-w) (Plant Sciences and Agrotechnology Division)

Root-knot nematode, *Meloidogyne incognita* and *Alternaria alternata* (fungus) were found to be the most dominant parasites of the medicinal plants such as *Withania somnifera*. Despite the fatal nature of their infection, a comprehensive study to explore their evolution and adaptation in different hosts is lacking. A study of codon usage patterns between the host-parasite may provide some fruitful insight into their evolutionary processes of synonymous codon usage and host-adapted evolution. Here, we performed a systematic evolutionary and codon usage bias analysis of *W. somnifera* (host plant), *M. incognita* (root-knot nematode) and *A. alternata* (fungal parasite). We found a weak Codon Usage Bias and dominant influence of natural selection on CUB in the host as well as pathogens. However, an in-depth study revealed more host-specific codon usage patterns and codon usage adaptability in *M. incognita* as compared to A. alternata. This suggests that *M. incognita* might have coevolved with *W. somnifera* and similarity in their CUB might play an important role in plant –nematode interaction and pathogenesis. Also, identification of preferred and avoided codons as well as codon pairs in *W. somnifera* and pathogens may provide novel insights into the mutational experiments targeted at specific codons to combat pathogenesis.



2.7 Analyzing the codon usage pattern of protein coding sequences in *Crocus sativus* and its relation with gene expression

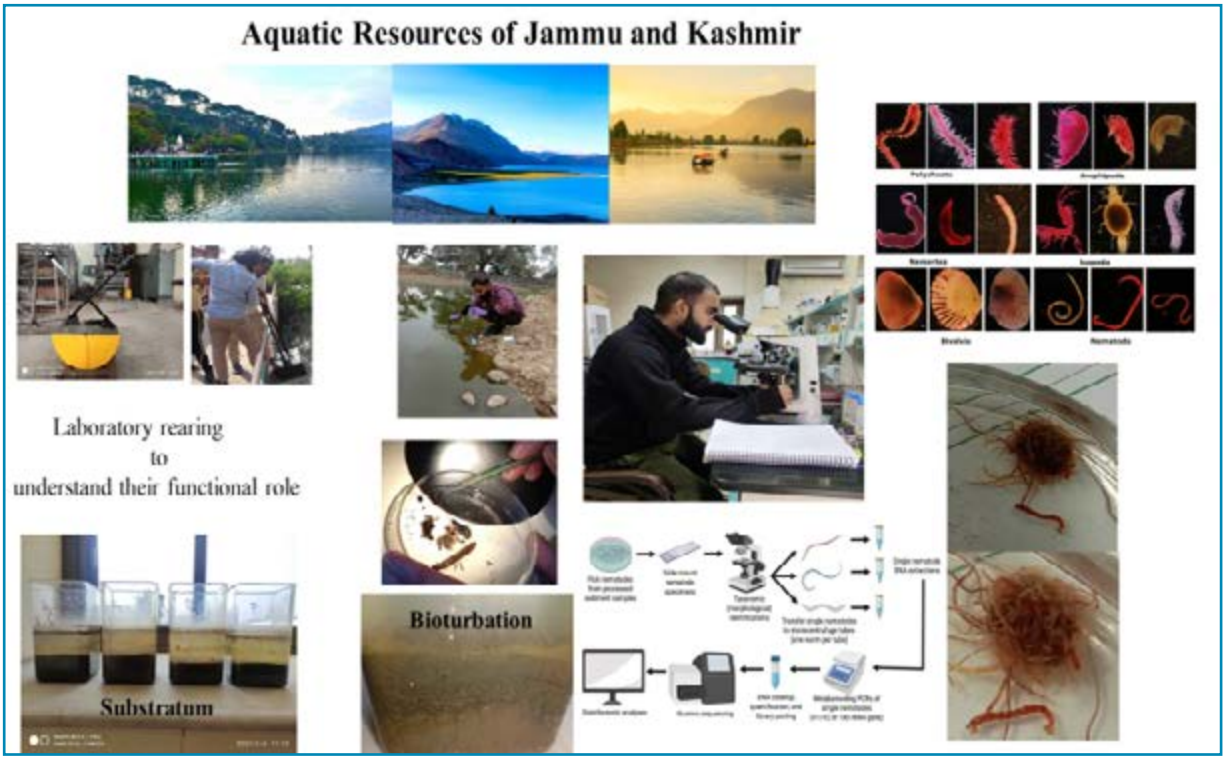
Shamsun Nisa, Suruchi Gupta, Waqas Ahmed and Ravail Singh (Plant Sciences and Agrotechnology Division)

Codon usage bias (CUB) is a ubiquitous phenomenon that perseveres in genome of all the organisms. It impinges the gene expression and other genetic intricacies within a genome. The present study explicates the pattern of codon usage in the protein coding sequence of *Crocus sativus* and its relation with gene expression. Genome of C. *sativus* was GC biased with high percentage of G/C nucleobases and proclivity towards G/C ending codons. Genes with high expression had a preference of G base at third position. CUB had an inverse relation with gene expression. Coding sequences with ENC<50 had low FPKM value while low codon bias group (ENC>50) possessed high FPKM value. Different CUB indices reflected overall weak codon bias in the *C. sativus* genome. ENC and PR-2 plot revealed mutation pressure and natural selection played role in shaping CUB. However, neutrality plot conclusively depicted the dominance of natural selection in regulating the configuration of codons in C. *sativus* genome. The low tAI values showed the low translation efficiency of genes in *C. sativus*. The non-significant MELP and ENC correlation analysis suggested that expression of genes might not be associated with CUB. Our study would help to build a comprehensive profile on codon usage in *C. sativus* that aids in future genomic studies.

2.8 Insight of genetic features prevalent in three Echinoderm species (*Apostichopus japonicus*, *Heliocedaris erythrogramma* and *Asterias Rubens*) and their evolutionary association using comparative codon pattern analysis.

Waqas Ahmed, Suruchi Gupta, Deepika Singh, Ravail Singh (Plant Sciences and Agrotechnology Division)

The goal of my research group is to study the biodiversity of aquatic ecosystem and screen these unique organisms for the bioactive compounds. Biodiversity contributes to our knowledge in ways that are both informative and transformative. Knowledge about the components of biodiversity is valuable in stimulating technological innovation and improving the connection with human society and ecology. We are purposing to study all the ecological aspects of benthic invertebrate fauna especially regarding species distribution patterns and biogeography, diversity and functional interaction among the different components of the food web. Benthic organisms provide important ecosystem services including mixing the sediment, nutrient cycling, and channeling energy to higher trophic levels (Covich et al., 1999). Zoobenthic species are sensitive to ecological and environmental change, and are used as indicators of environmental quality (Hilsenhoff, 1987). Chemical studies on some of the benthic organisms (molluscs) have accumulated evidence that they are well protected by chemical metabolites. These chemical weapons are obtained by bioaccumulation or biotransformation of dietary compounds. These molluscs have the unique ability to assimilate and maintain the photosynthetically active endosymbionts by synthesis of chloroplast proteins in the cytoplasmic ribosomes of the mollusks. Some nematodes are well known for their feeding and defense strategy by changing their population dynamic. Benthic organisms are well known for using these functional strategies although there are very few studies has been attempted on this issue. Our knowledge of the about all these aspects is very poor and there is a strong need to carry forward such work in these particular study sites of Jammu & Kashmir. I am attempting a new area where my group is focusing on benthic fauna from three different regions, Jammu, Kashmir and Ladakh. Our study sites are composed of three different habitats and each habitat is composed of unique ecosystem which ultimately supports unique biota. For instance, high altitude lakes (Ladakh: mostly they are saline and often contain very low temperature), low land lakes (Jammu: Mansar and Surinsar Lakes) where temperature in summer goes close to 50°c and the oxygen minima should develop from water column to bottom depth. This will be an amazing contribution to present day science.



Structural and Functional characteristics of the benthic fauna from the freshwater ecosystem

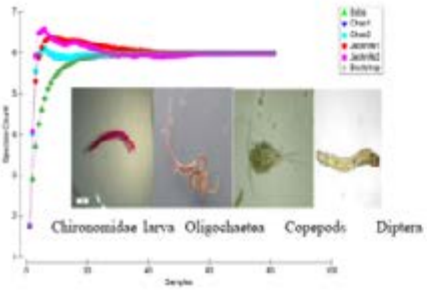
Oligochaete (*Tubifex*)
Microcosm Experiment.

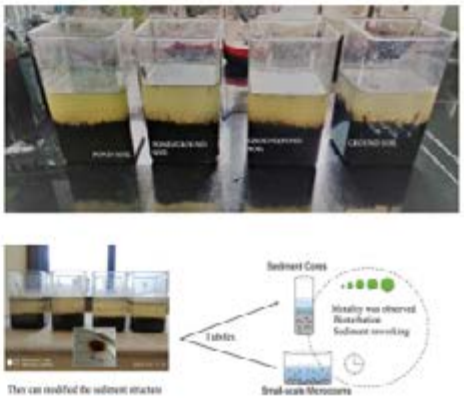
Functional aspects : Tube building, Bioturbation, Sediment reworking observed (calculated)

Mortality rate
Survival rate
Different sediment gradient
Ecosystem model

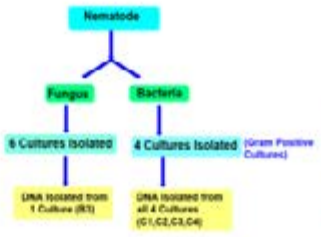
Counting of animals in each sections

Screening of sediment sample for secondary metabolite extraction (in process)





Screening of nematodes gut microbes for secondary metabolite extraction (in process)



Anti-cancer activity

	Cytotoxicity activity (MTT Assay)			
Cell line	A-549	HCT-116	MCF-7	MDA-MB-231
IC$_{50}$ (µM)	47.68	<50	24.3	39.58

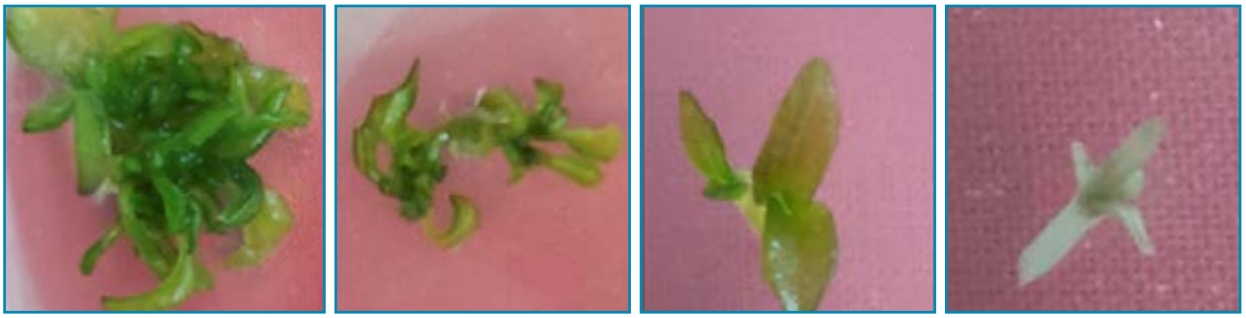
A549: Adenocarcinomic human alveolar basal epithelial cells. Cell models for the study of Lung cancer.
SUM-1: Cell models for the study of Breast cancer.
MCF-7: Michigan Cancer Foundation-7 Cell models for the study of breast cancer.
MDA-MB-231: Epithelial, human breast cancer cell line

2.9 Micropropagation studies of *Monarda citriodora* (Jammu monarda)

Yadunandan Sen, Sabha Sarwar, Vanila Sharma and Kota Srinivas (Plant Sciences and Agrotechnology Division)

Monarda citriodora wildly grows in southeastern Missouri from Texas and northern Mexico. Our Institute has domesticated the crop in subtropical and temperate regions in Jammu and Kashmir. It is an important aromatic annual herb with high rich sources of Thymol. *Monarda citriodora* flowers are the main source of essential oils with high medicinal properties like antibacterial activity (Lu Zhan-gou et al, 2011) and also important for food industries to perfume and flavor. These commercial important essential oils attracted scientific and agriculture communities for commercial cultivation and production of Monarda *citiodora*. Commercial exploitation and cultivation required quality planting material. Plant tissue culture and genetic transformation techniques will provide enough platforms to produce quality planting material through tissue culture by establishing in vitro regeneration and mass propagation. Genetic improvement will be achieved by genetic transformation. In vitro cultures were established by inoculating nodal explants on MS media supplemented with BAP. MS media supplemented with BAP initiated multiple shoots using nodal explants. 15 to 20 multiple shoots were initiated with single nodal explant. After 3 subcultures single shoots were excised and inoculated on basal MS media for rooting. Various hormonal concentrations and combinations (BAP, NAA, TDZ, KN, 2, 4-D) were used to establish regeneration from leaf explant. MS media supplemented with BAP and NAA initiated callus cultures and continuous callus subcultures on the same media triggered in vitro roots (in direct organogenesis). For genetic transformation antibiotic sensitivity was optimized. Different concentration of Kanamycin was tested using nodal explants. Starting from 40 mg/L, 50 mg/L, 60 mg/L and 70 mg/L. At 70 mg/L Kanamycin inoculated explants growth was arrested.

In vitro establishment and multiple shoot induction from nodal explants of Monarda



Optimization of antibiotic sensitivity

Callus induction and indirect root initiation from callus on MS media supplemented with BAP and NAA

2.10 Heterologous expression of Cannabis sativa MYB33 (CsMYB33) leads to activation of anthocyanin biosynthesis in *Nicotiana tabacum*

Maridul Kundan, Umar Gani, Mohd. Fayaz, TseringAngmo, V.P.Rahul, Sumeet Gairola and Prashant Misra (Plant Sciences and Agrotechnology Division)

Cannabis sativa R2R3-MYB transcription factor gene, CsMYB33 was constitutively expressed in *Nicotiana tabacum*. The resulting transgenic tobacco lines were found to have massive anthocyanin pigmentation on leaves and stem (Fig. 1). The expression of all the genes committed to the anthocyanin biosynthesis (e.g., CHS, DFR, ANS/LDOX, and UFGT) was reported to be upregulated in the leaves of CsMYB33-expressing transgenic tobacco as compared to WT (Wild-type) and EV (Empty vector) control plants (Fig. 2). Apart from the structural genes, the expression of the transcription factors genes (NtAn1A and NtAn1B) was also significantly upregulated in the CsMYB33-expressing transgenic tobacco lines. The expression of flavonol synthase genes (FLS1 and FLS2) was not significantly different among CsMYB33-expressing transgenic tobacco, EV control and WT plants suggesting that CsMYB33 doesn't regulate flavonol biosynthesis. The expression of PAL genes involved in the general phenylpropanoid pathway was also unregulated in the CsMYB33-expressing transgenic lines as compared to WT and EV control plants. The total flavonoid and anthocyanin content were enhanced in the CsMYB33-expressing lines as compared to WT and EV control plant (Fig. 3). Taken together, these results suggested that CsMYB33 play an important role in the transcriptional regulation of anthocyanin biosynthesis in *C. sativa*, and can be used for metabolic engineering of anthocyanin in plants.

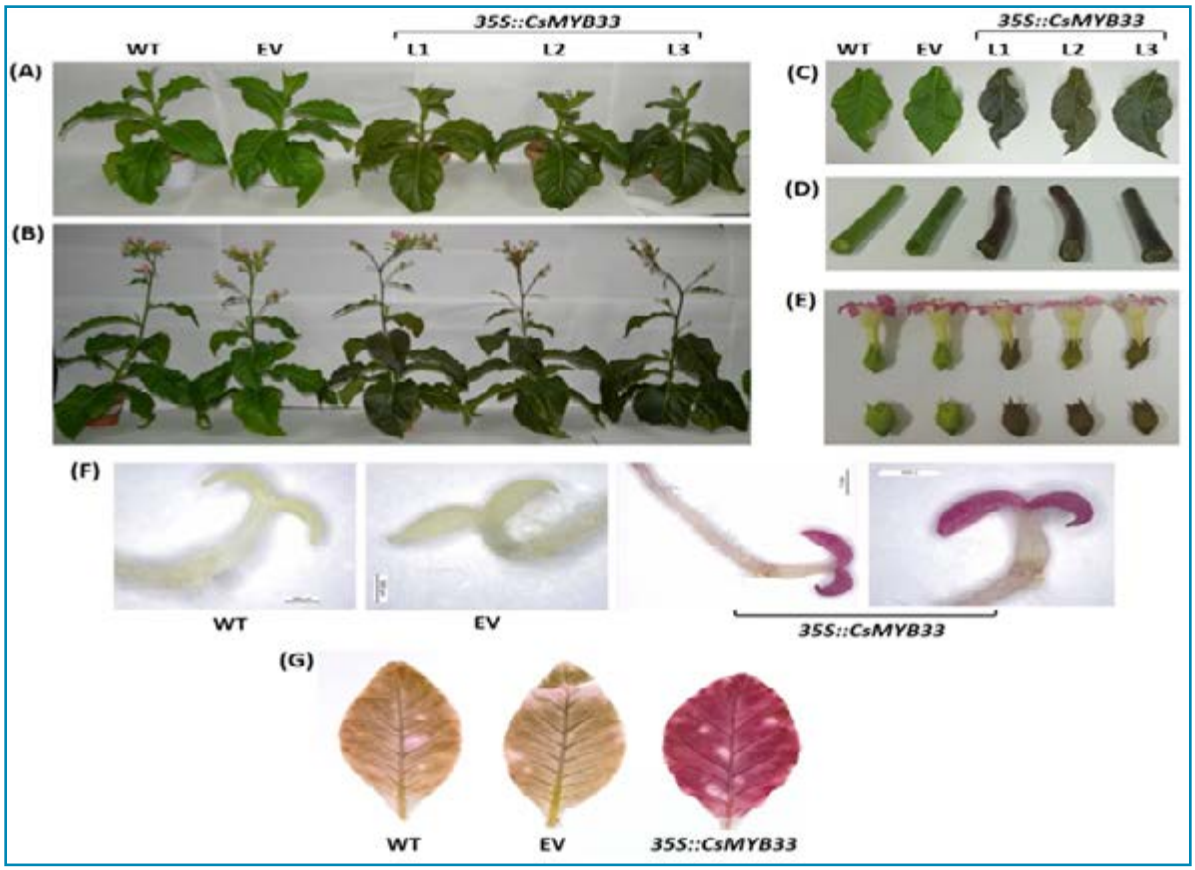


Figure 2.10.1: Visible anthocyanin accumulation in different tissues of CsMYB33 expressing *N. tabacum* transgenic lines at different growth stages. (A) 8-weeks old plants, (B) flowering stage, (C) leaf, (D) stem, (E) flower and flower bud (F) norflurazon bleached seedlings, and (G) bleached leaves (ethanol: glacial acetic acid; 3:1, v/v). L1, L2, and L3 represent the three independent transgenic lines.

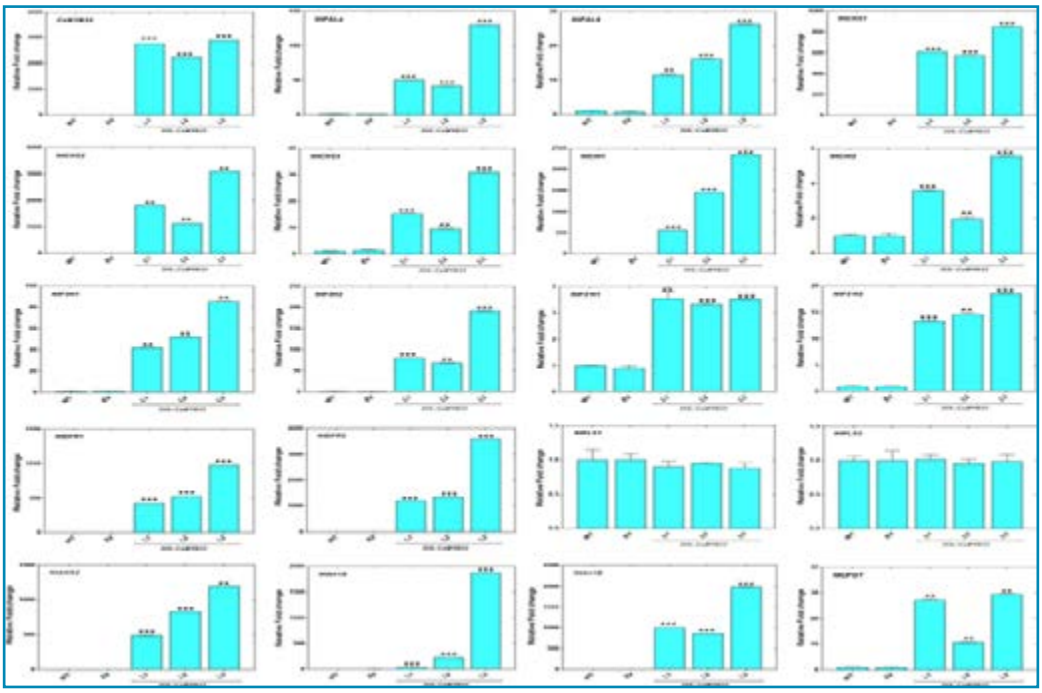


Figure 2.10.2: The expression analysis of key flavonoid biosynthetic structural genes along with anthocyanin biosynthesis pathway genes in CsMYB33 expressing N. *tabacum* transgenic lines. The relative expression of genes (NtPALa, NtPAL4, NtCHS1, NtCHS2, NtCHS3, NtCHI1, NtCHI2, NtF3H1, NtF3H2, NtF3'H1, NtF3'H2, NtDFR1, NtDFR2, NtFLS1, NtFLS2, NtANS2, NtAn1a, NtAn1b, and NtUFGT) was analyzed in the leaf sample by qRT-PCR. The relative expression level in WT was taken as reference and the expression of NtUbiquitin gene was used for normalization. The results are the mean of three replicates depicting mean±SD values. The calculation of the statistical significance was carried out by Student's t-test. The asterisks ***P, **P, and *P denote the significance of the fold change at the p-values < 0.001, <0.01, and <0.05, respectively, with respect to the WT control. L1, L2, and L3 represent the three independent transgenic lines.

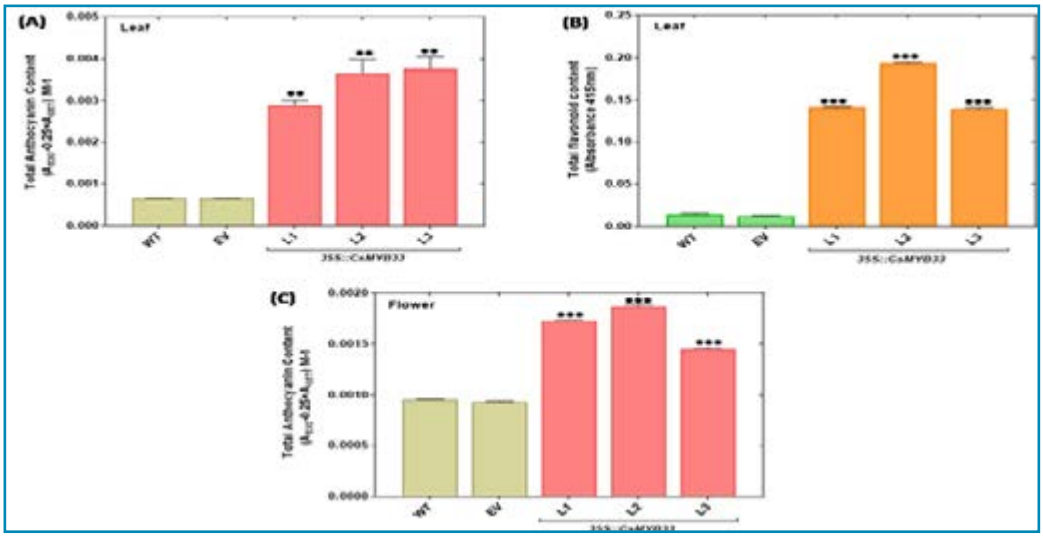


Figure 2.10.3: The anthocyanin (A)(C) and flavonoid content (B) in leaf and flower sample of control and CsMYB33 expressing *N. tabacum* transgenic lines. The Significant difference was carried out by Student's t-test. Astrisks ***P, **P, and *P represent the significance of the fold change at the p-values < 0.001, <0.01, and <0.05, respectively, with respect to WT. L1, L2, and L3 are the three independent transgenic lines.

2.11 Lipoxygenase gene family in *Cannabis sativa*: Identification and characterization

Mohd. Fayaz, Maridul Kundan, Sumeet Gairola and Prashant Misra (Plant Sciences and Agrotechnology Division)

Lipoxyegenase (LOX) enzyme play important role and have been implicated in diverse aspects of plant biology including in stress response. In addition, the biosynthesis of hexanoic acid, one of the precursors for the phenolic backbone of cannabinoids is thought to involve lipoxygenase activity. For obvious reasons, it is desirable to study lipoxygenase gene repertoire of *C. sativa*. To this end, using homology-basedapproach; we identified 21 putative LOX (CsLOX1 to CsLOX21) from *C. sativa* genome. The expression analysis of CsLOXs suggested that these genes express differentially in different plant parts (young leaf, mature leaf, flower bud, stem and root) (Fig. 1). The upstream promoter regions of CsLOX genes were predicted to contain phytohormone responsive elements (Fig. 2).

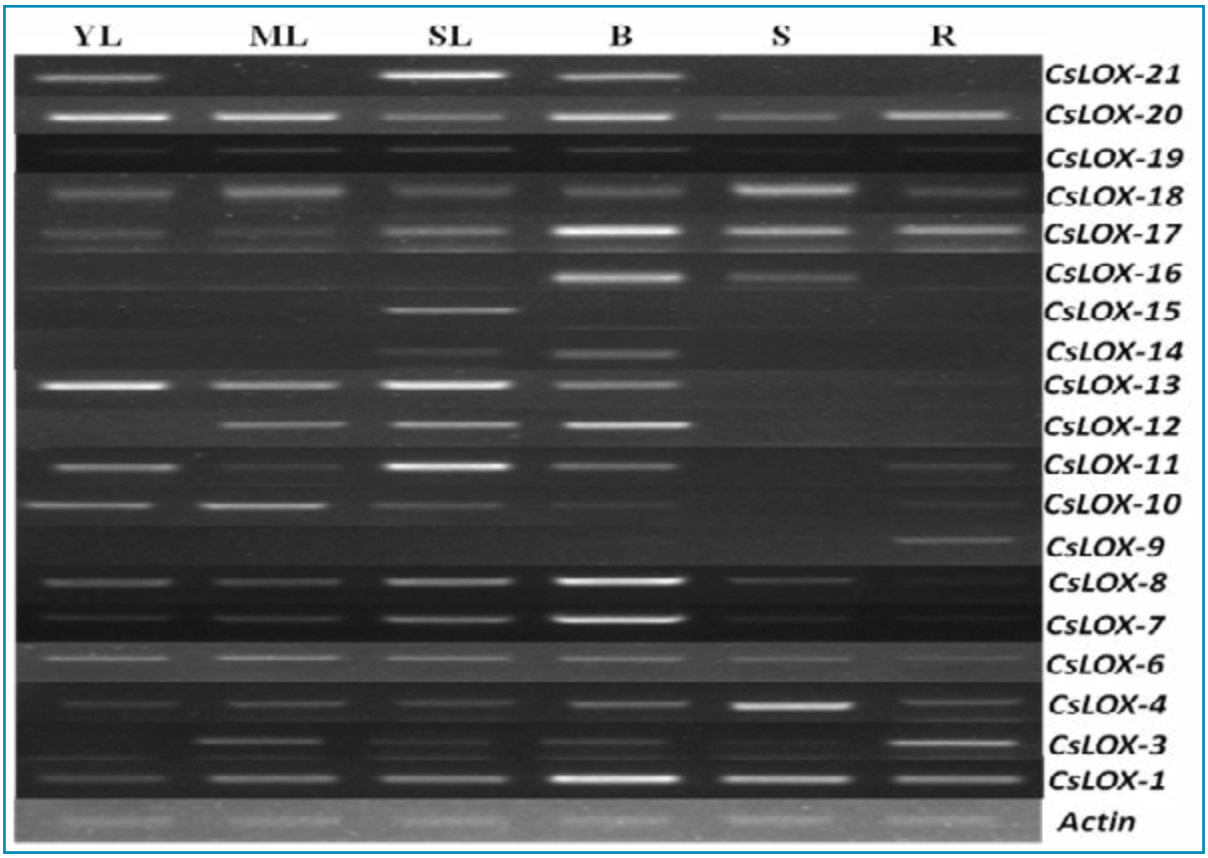


Fig. 2.11.1: Expression analysis of LOX genes in different plant parts of *C. sativa*. RNA was isolated from different plant parts and subjected to semiquantitative RT-PCR analysis. The Actin gene has been taken as internal control. Young leaf, YL, Mature leaf, ML, SL, sugar leaf, B, flower bud, S, stem and R, root.

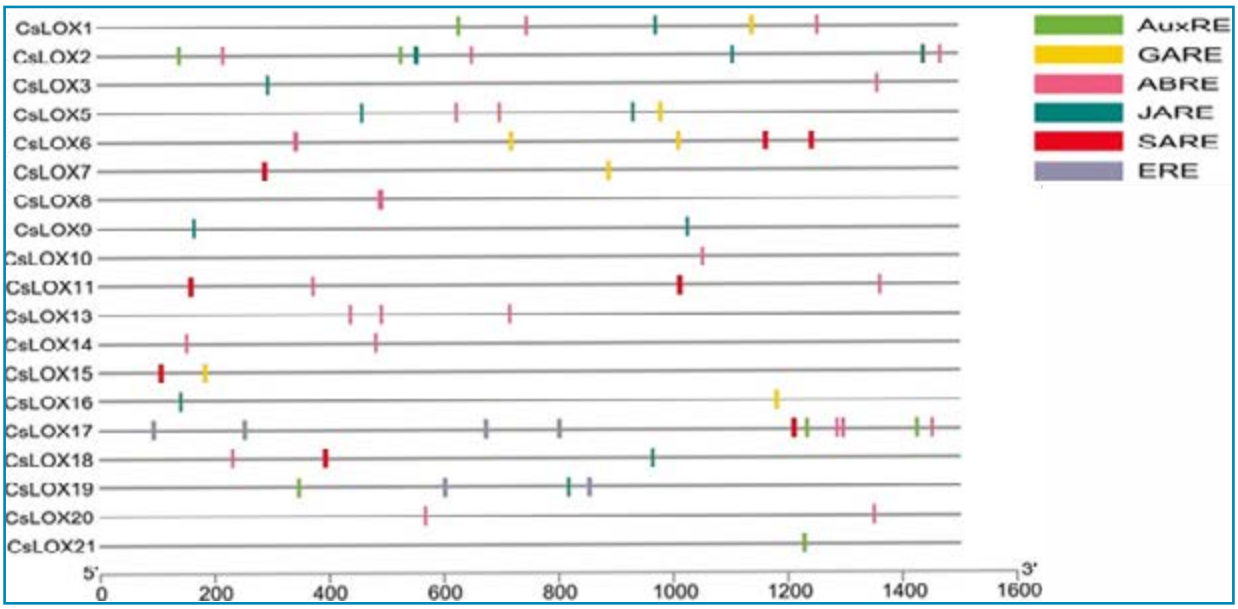
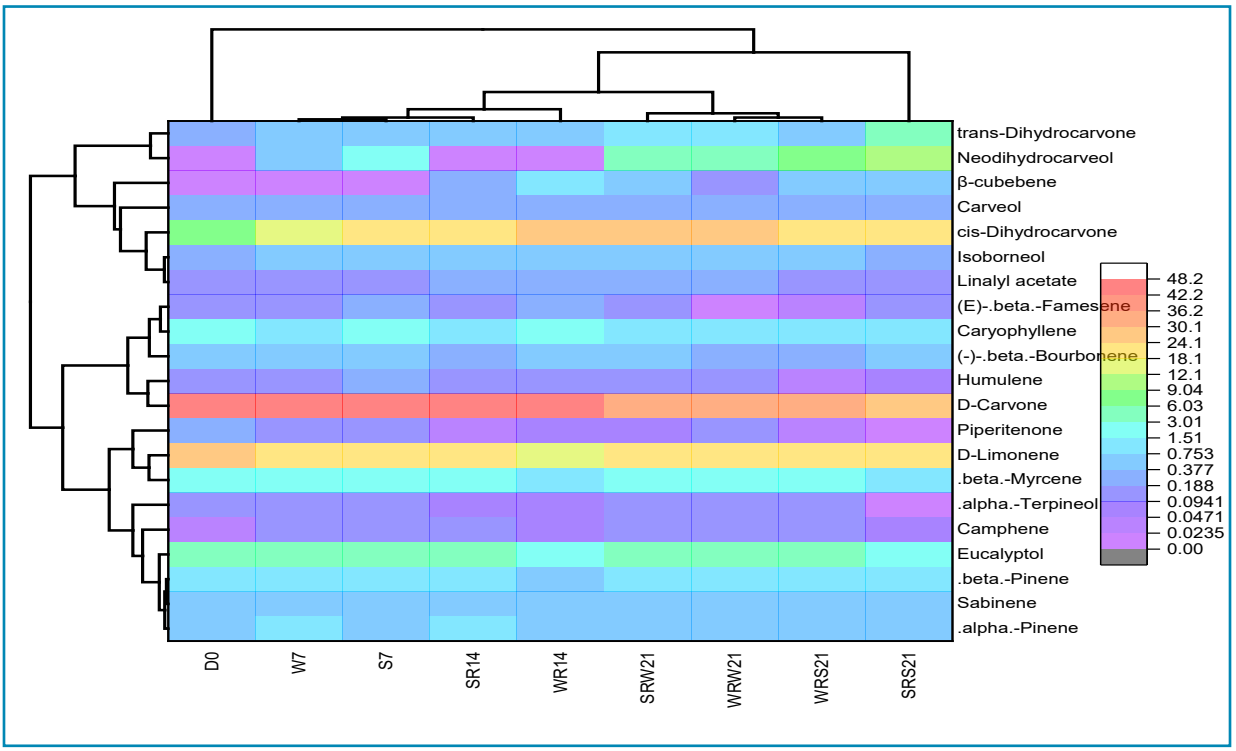


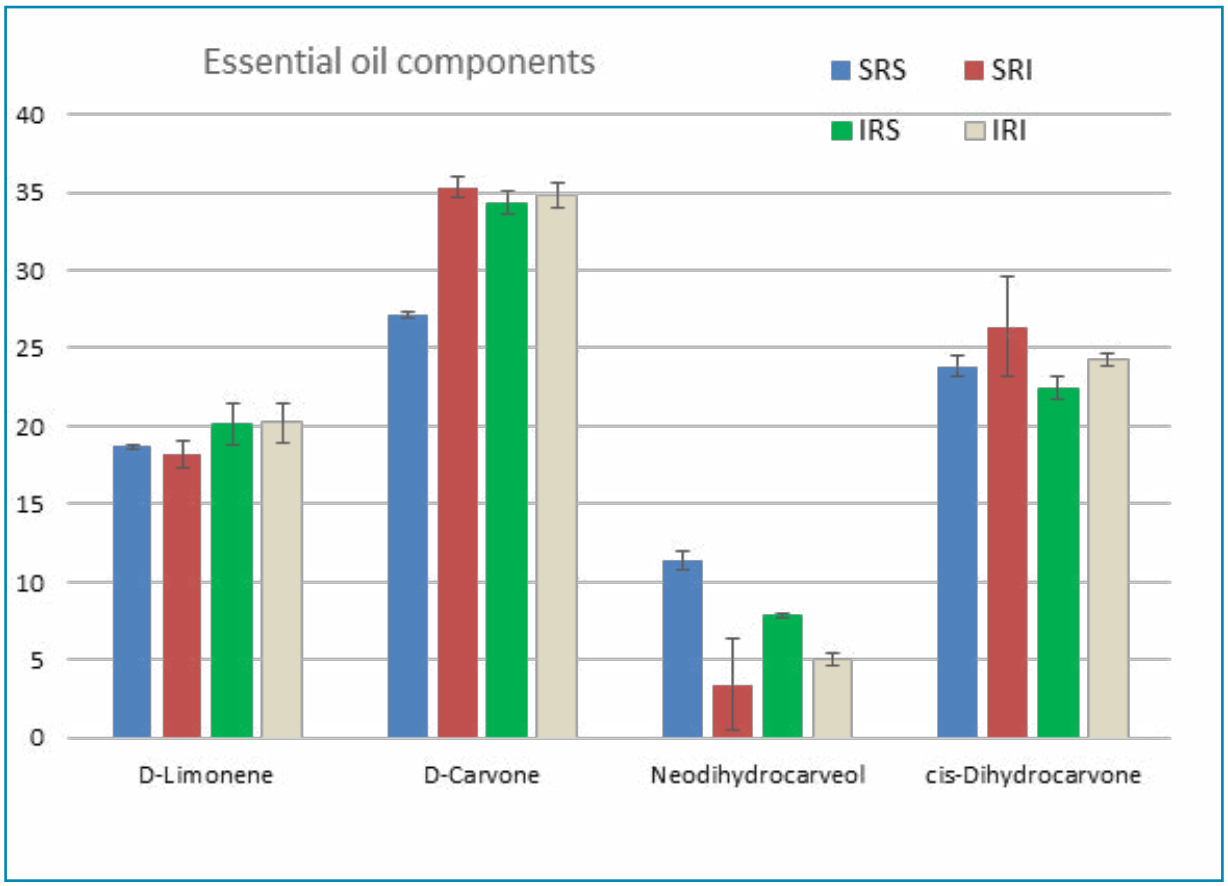
Fig. 2.11.2: Prediction of phytohormone responsive elements in the promoter regions of CsLOX genes. The 2000 bp upstream promoter regions of CsMYB genes were retrieved and analyzed to predict the cis-acting regulatory elements involved in phytohormone response using the PlantCARE database. AuxRE, auxin responsive element, GARE, GA-responsive element, ABRE, ABA-responsive element, JARE, Jasmonic acid-responsive element, SARE, Salicylic acid-responsive element, ERE, Ethylene responsive element.

2.12 Effect of water deficiency on essential oil yield and composition of *Mentha longifolia* (L.) Huds.

Ruby Singh, Savita Luxmi, Aditi Charak, Rajendra Gochar, Amit Kumar, Sumit G. Gandhi and Rajendra Bhanwari (Plant Sciences and Agrotechnology Division)

The *Mentha longifolia* is one of the important aromatic crops in the Lamiaceae family grown for its essential oil. A study was conducted to determine how recurrent drought affected the essential oil yield, composition, and nutrient status of *M. longifolia*. At first, experimental plants were divided into two groups: 'irrigated' and 'drought'. A normal watering schedule was followed for the irrigation group, while one for the drought group did not occur for seven days. Following recovery, both groups were irrigated. Moreover, both groups were divided into two subgroups with irrigated and non-irrigated plants for seven days. During each cycle, samples were taken at 0, 7, 14, and 21 days (first, second, and third cycle). It was found that regulated water stress increased essential oil yield in *M. longifolia*. Furthermore, neodihydrocarveol and c-dihydrocarvone (a reduced form of carvone) were increased, improving essential oil quality. Our results show that nitrogen percentage declined with drought stress and potassium levels a little improved at the end of the first and second cycles of regulated water stress. Our results will find enormous use in progress of appropriate agrotechnology, decisions pertaining to fertilizer use, regulation of irrigation schedule and deciding the correct harvesting time in *M. longifolia*. Other aromatic plants can also benefit from these methods for increasing essential oil yield and quality.


trans-Dihydrocarvone
Neodihydrocarveol
β-cubebene
Carveol
cis-Dihydrocarvone
Isoborneol
Linalyl acetate
(E)-.beta.-Famesene
Caryophyllene
(-)-.beta.-Bourbonene
Humulene
D-Carvone
Piperitenone
D-Limonene
.beta.-Myrcene
.alpha.-Terpineol
Camphene
Eucalyptol
.beta.-Pinene
Sabinene
.alpha.-Pinene
48.2
42.2
36.2
30.1
24.1
18.1
12.1
9.04
6.03
3.01
1.51
0.753
0.377
0.188
0.0941
0.0471
0.0235
0.00
D0
W7
S7
SR14
WR14
SRW21
WRW21
WRS21
SRS21


Essential oil components
SRS
SRI
IRS
IRI
40
35
30
25
20
15
10
5
0
D-Limonene
D-Carvone
Neodihydrocarveol
cis-Dihydrocarvone

2.13 Identification of antimicrobial against recent clinical isolates of ESKAPE pathogens

Rakshmi Manhas, Shavi Mahajan, Ujwal Havelikar, Bharti Raina and Avisek Mahapa

The acronym ESKAPE stands for six nosocomial pathogens that exhibit multidrug resistance and virulence: *Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa*, and *Enterobacter* spp. These bacteria commonly cause life-threatening nosocomial infections to critically ill and immunocompromised hospitalized patients. Excessive use of antibiotics has provoked the emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) bacteria, which turn into the most effective drugs ineffective. Extended-spectrum β-lactamase (ESBL) and carbapenemase-producing Gram-negative bacteria have emerged as an important therapeutic challenge. The need of the hour is to develop novel therapeutics to treat drug-resistant infections, especially those caused by ESKAPE pathogens.

Under this objective, we aim to identify novel antibacterial compounds from the Chem-div library against recent clinical isolates of ESKAPE pathogens. We first choose BSL-2 strains of one Gram-positive and Gram-negative member of the ESKAPE family pathogens to establish and screen compounds. So far, five thousand compounds against *Pseudomonas aeruginosa and three thousand compounds against Staphylococcus aureus (MRSA)* were screened from the ChemDiv library using a resazurin reduction (REMA) assay. Out of the screened compounds, we identified 18 compounds with an inhibition percentage of 70%. With those identified compounds, we further performed MIC analysis against *Pseudomonas aeruginosa*. Results are shown in the following graphs:

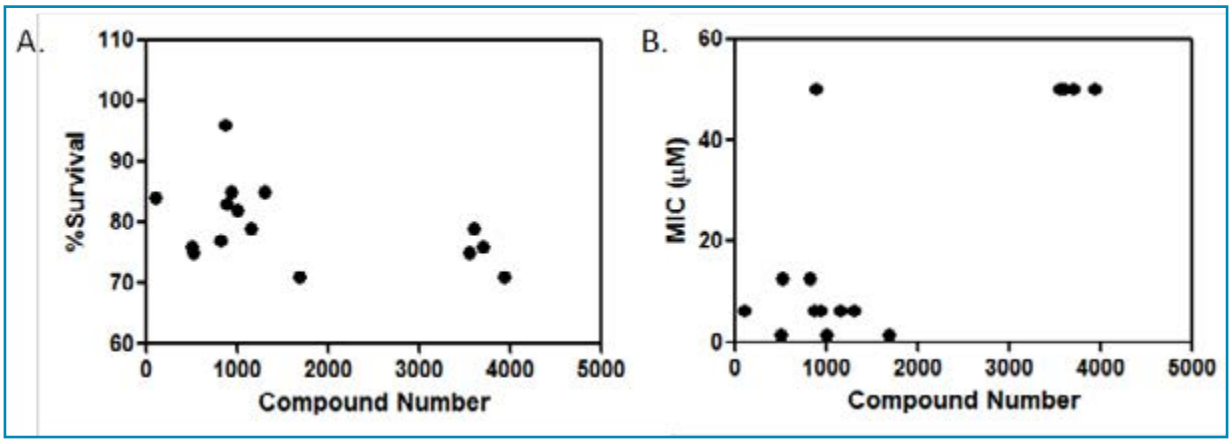


Figure 2.13.1: Scatter diagrams showing survival percentage (A) and MIC (B) values of the identified compounds from ChemDiv libraries. We used 50µM of the compounds as starting concentrations for whole-cell screening/ MIC assays.

2.14 Identification of anti-leishmanial compounds through target-based enzymatic assay and whole cell screening

Diksha Kumari, Parampreet Kour and Kuljit Singh

To check the proper growth of the parasite, the growth curve was prepared using two methods, namely, optical density measurement (OD) and a cell counting experiment. 0.5x106 cells/ml cells were used as starting point, and regular growth monitoring via the OD method and cell counting was carried out for eight days. The experiment was done five times, and the average readings with standard deviation were plotted as shown in the figure below. However, as indicated in the result analysis in the form of graphical representation, the cell counting method is more accurate with minor deviations in values.

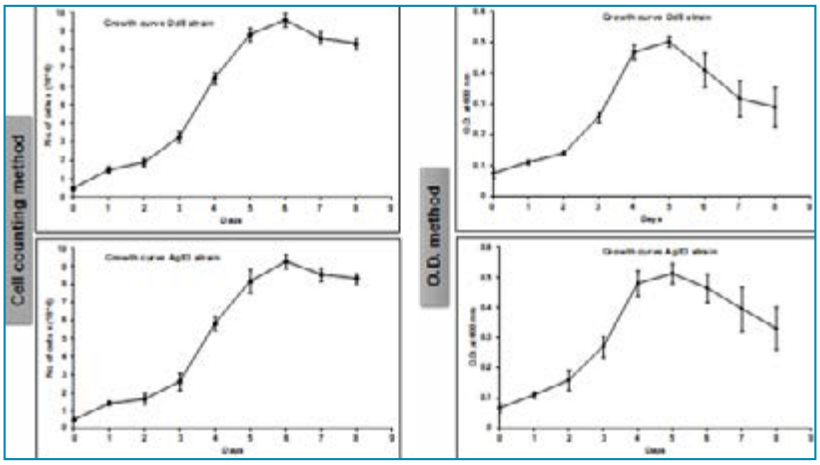


Figure 2.14.1 : Parasite growth analysis

2.15 Standardization of anti-leishmanial screening assay using Alamar blue dye

Diksha Kumari, Parampreet Kour and Kuljit Singh

The screening of the compounds for their potential as anti-leishmanial agents was assessed using Alamar blue cell viability assay. Alamar blue is a resazurin-based solution in which resazurin is present as an active cell-permeable ingredient, blue and virtually non-fluorescent. When the dye penetrates the living cells, resazurin is reduced to resorufin, which is highly fluorescent and red. In contrast, in non-viable cells, the color of the dye remains blue. Thus, changes in viability can be detected by using a fluorescence-based multimode plate reader to measure the fluorescence. Before proceeding towards screening the compound library, the first-line drug, Amphotericin B, was used as a standard to perform cell viability assay. Different drug concentrations were used, inhibitory concentration (IC50) was determined, and the final concentration of the Alamar blue dye used was 20 µg/ml. Experiments were performed in triplicates, and percentage viability at different drug concentrations was plotted.

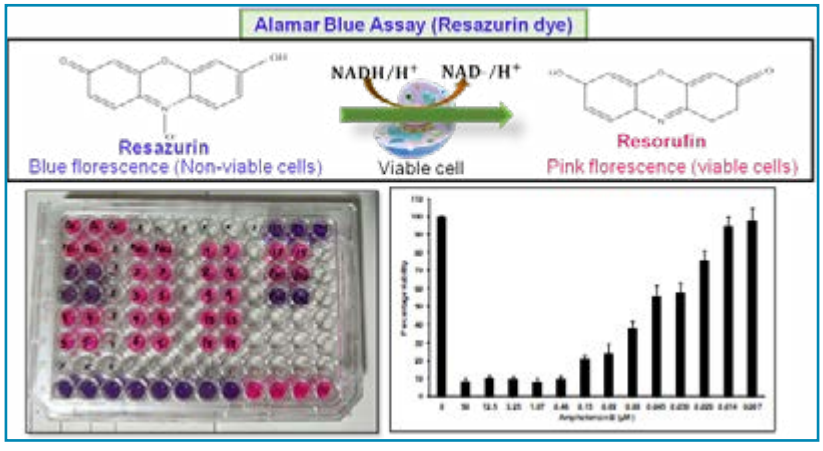


Figure 2.15.1: Anti-leishmanial screening assay using Alamar blue dye

2.16 Screening of CHEMDIV library

Diksha Kumari, Parampreet Kour and Kuljit Singh

More than 10,000 compounds from the in-house CHEMDIV library have been screened against the Leishmania donovani parasite using the standardized Alamar blue cell viability assay. Single point assay of the compounds was performed by seeding 2x106 cells/ml with the final concentration of compounds at 50 μM in flat-bottom 96-well plates in triplets. The standard drug Amphotericin B was also platted as drug control. Further, the plates were kept for 24 hours of incubation in a 24°C BOD incubator. After 24 hours of incubation of parasites with the compounds, 10 μL (20 μg/ml) of Alamar blue was added to all the wells, including growth and media controls. It was further incubated for 24 hours, and then the fluorescence readings were taken using a Tecan multi-mode plate reader at the wavelength of λex 550 nm and λem 590 nm. The blank correction was done from the readings by subtracting the media control from all the other experimental values. The respective percentage cells viability of all the wells with respect to growth control was calculated and plotted. More than 250 compounds were active, killing 50% of the Leishmania parasite. Among them 85 compounds was active displaying percentage inhibition of > 80% in Leishmania parasite at the 50 μM concentration. These active compounds will be further assessed by minimum inhibitory concentration (MIC) measurements.

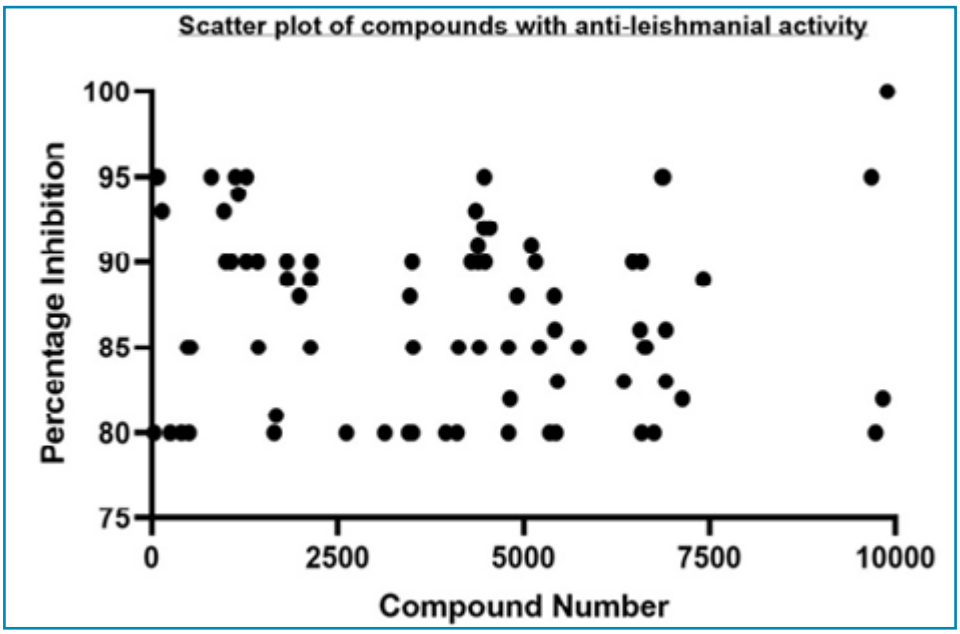


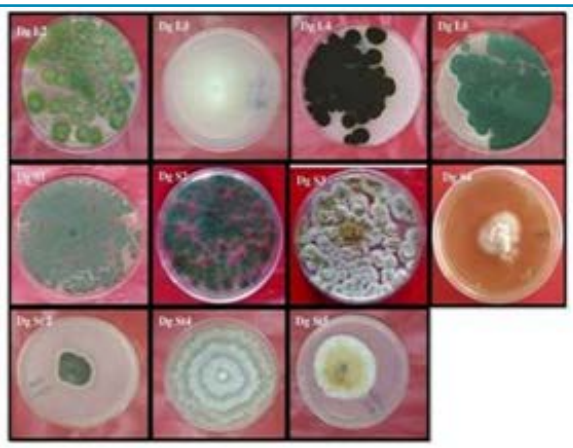
Figure 2.16.1: Scatter diagram of compounds with anti-leishmanial activity

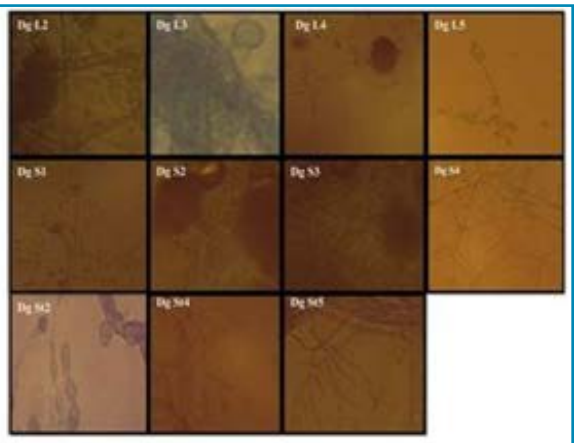
2.17 Anti-phytopathogenic and plant growth promoting potential of endophytic fungi isolated from *Dysoxylum gotadhora*

Nitika Kapoor, Augustin Ntemafack, Rekha Chouhan & Sumit G. Gandhi*

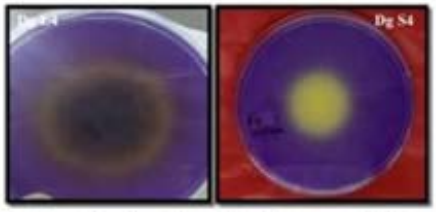
Phytopathogens have negative impact on crop growth and production. Biological control of plant pathogens, is a safer alternative to chemical treatments, and may also provide additional advantages through plant-growth promotion activities. Recently, endophytes have received due attention to be used as biocontrol agents and plant growth promoters. The present study was designed to determine the antagonistic potential of endophytic fungi isolated from *Dysoxylum gotadhora* (Buch. Ham.) Mabb. against soil borne phytopathogens, *Verticillium dahliae* and *Fusarium oxysporum*, as well as to identify their plant growth promoting features. Dual culture method was used to assess the growth inhibition of phytopathogens *in vitro*.

Results showed that *Aspergillus* sp. and *Porostereum* sp. reduced the growth of the phytopathogens with 40–70% inhibition and also produced high indole acetic acid (IAA) content with 19.237 ± 0.253 µg/mL and 18.60 ± 0.098 µg/mL, respectively. This signifies that fungal endophytes can be effectively used as biological control agents and growth promoters.

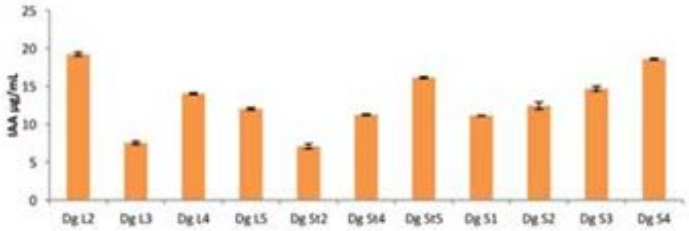




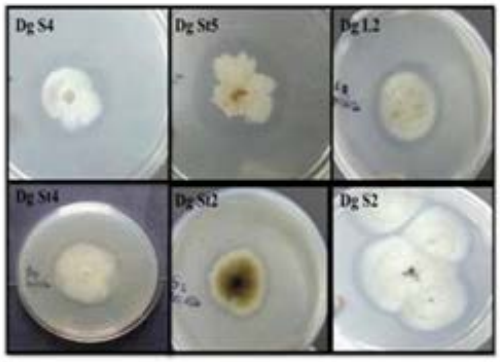
Cultural morphology of endophytic fungi



Phosphate solubilization activity



IAA production of isolated fungi

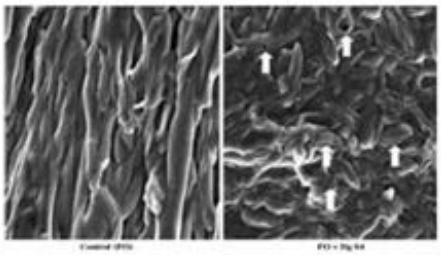


Protease activities of different fungi.

Isolates	*Fusarium oxysporum*	*Verticillium dahliae*
	% growth inhibition	
Aspergillus flavus (Dg L2)	52.678 ± 1.351[b]	59.980 ± 0.889[b]
Mucor sp. (Dg L3)	12.494 ± 1.468 [e]	29.380 ± 1.825[e]
Aspergillus niger (Dg L4)	42.863 ± 0.657 [d]	52.964 ± 1.369[d]
Penicillium thomii (Dg L5)	58.914 ± 1.943[a]	44.137 ± 1.141[a]
Phoma sp. (Dg St 2)	16.974 ± 1.697[f]	19.104 ± 2.315[f]
Diaporthe sp. (Dg St4)	24.110 ± 0.369[g]	50.000 ± 2.173[bc]
Fusarium sp. (Dg St5)	16.073 ± 0.246[f]	58.827 ± 2.185[b]
Aspergillus fumigatus (Dg S1)	40.184 ± 0.615[b]	48.550 ± 1.255[bc]
Aspergillus flavus (Dg S2)	50.030 ± 1.351[b]	51.449 ± 1.255[bc]
Aspergillus sp. (Dg S3)	45.542 ± 0.698 [d]	47.035 ± 1.136[cd]
Porostereum sp. (Dg S4)	66.974 ± 1.026[a]	66.205 ± 1.711[a]
Control	0.00 ± 0.000[g]	0.00 ± 0.000 [g]

Values with different letter are significantly different ($p < 0.05$).

Biocontrol potential of endophytic fungi by *in vitro* antagonistic ass

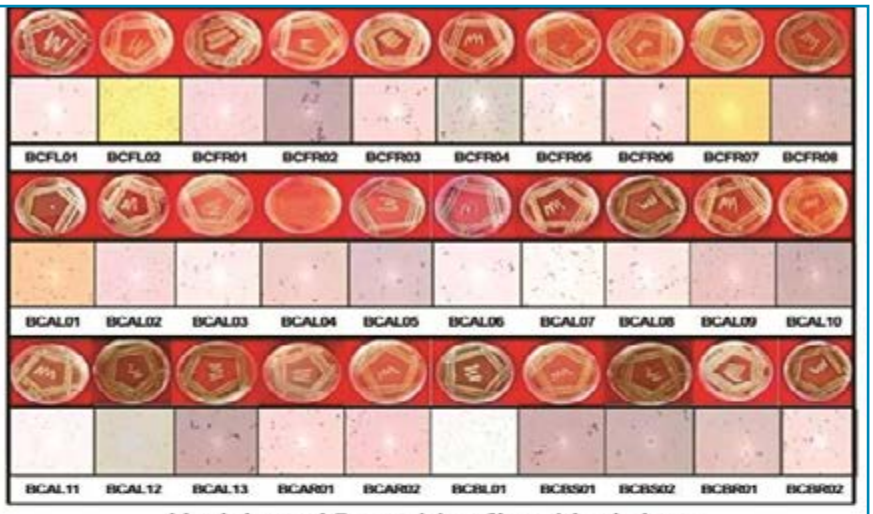


SEM image of *Fusarium oxysporum* *F. oxysporum* co-cultured with Dg

2.18 Estimation of bioactive potential of culturable bacterial endophytes from *Coleus*

Vijay Lakshmi Jamwal, Augustin Ntemafack, Arem Qayum, Nitika Kapoor, Sheikh Gulfam, Shashank K Singh, Sumit G Gandhi*

Endophytic microflora is source of several bioactive compounds. Endophytes isolated from *Coleus* species are yet to be fully explored for their bioactive potential. In this study, bacterial endophytes were isolated from three different species of *Coleus*. Isolated endophytes were characterized by using Gram staining and by sequencing 16S rRNA region. Further, solvents with different polarities were used to prepare extracts which were used for assessment of different bio-activities including in vitro cytotoxicity, anti-microbial and anti-oxidant activities. Also, the pure endophytic bacterial cultures were evaluated for their antiphytopathogen potential as well as indole-3-acetic acid (IAA) and protease production. Advanced studies on the endophytes with promising activities may lead to the isolation of novel natural products for drugs as well as in industrial and agricultural applications.



Morphology and Gram-staining of bacterial endophytes

Sample code	Inhibition zone (diameter of zone in mm)								
	ML	SP	BC	CA	SA	KP	EC	SC	BS
BCAL10-E	-	-	-	-	6	-	-	-	15
BCBR01-E	-	-	-	-	20	-	-	-	-
BCFL01-B	16	-	-	-	-	-	-	-	-
BCFR01-B	14	-	-	-	-	-	-	-	-
BCAL10-B	8	12	13	-	16	-	-	7	8

ML- *Micrococcus luteus*, SP- *Streptococcus pyogenes*, BC- *Bacillus cereus*, CA- *Candida albicans*, SA- *Staphylococcus aureus*, KP- *Klebsiella pneumonia*, EC- *Escherichia coli*, SC- *Saccharomyces cerevisiae*, BS- *Bacillus subtilis* E after sample code denotes the ethylacetate extract, M for methanolic extracts and B for butanolic extracts

Sample Code	IAA production (µg/ml)		
BCFL01	6.79	±	0.17
BCFL02	5.67	±	0.10
BCFR01	44.51	±	2.32
BCFR02	36.67	±	1.71
BCFR03	23.58	±	0.30
BCFR04	27.87	±	0.64
BCFR05	46.36	±	1.31
BCFR06	47.02	±	0.84
BCFR07	54.98	±	0.27
BCFR08	28.11	±	0.77
BCAL01	17.31	±	0.49
BCAL02	23.56	±	0.67
BCAL03	8.07	±	0.34
BCAL04	34.91	±	0.73
BCAL05	42.82	±	0.29
BCAL06	9.16	±	0.13
BCAL07	11.94	±	0.57
BCAL08	21.29	±	8.20
BCAL09	31.07	±	0.39
BCAL10	10.89	±	0.31
BCAL11	50.67	±	1.43
BCAL12	8.91	±	0.32
BCAL13	63.45	±	0.66
BCAR01	37.91	±	0.74
BCAR02	12.80	±	0.68
BCBL01	30.34	±	1.13
BCBS01	10.58	±	0.49
BCBS02	30.31	±	1.75
BCBR01	13.29	±	0.73
BCBR02	20.47	±	0.98

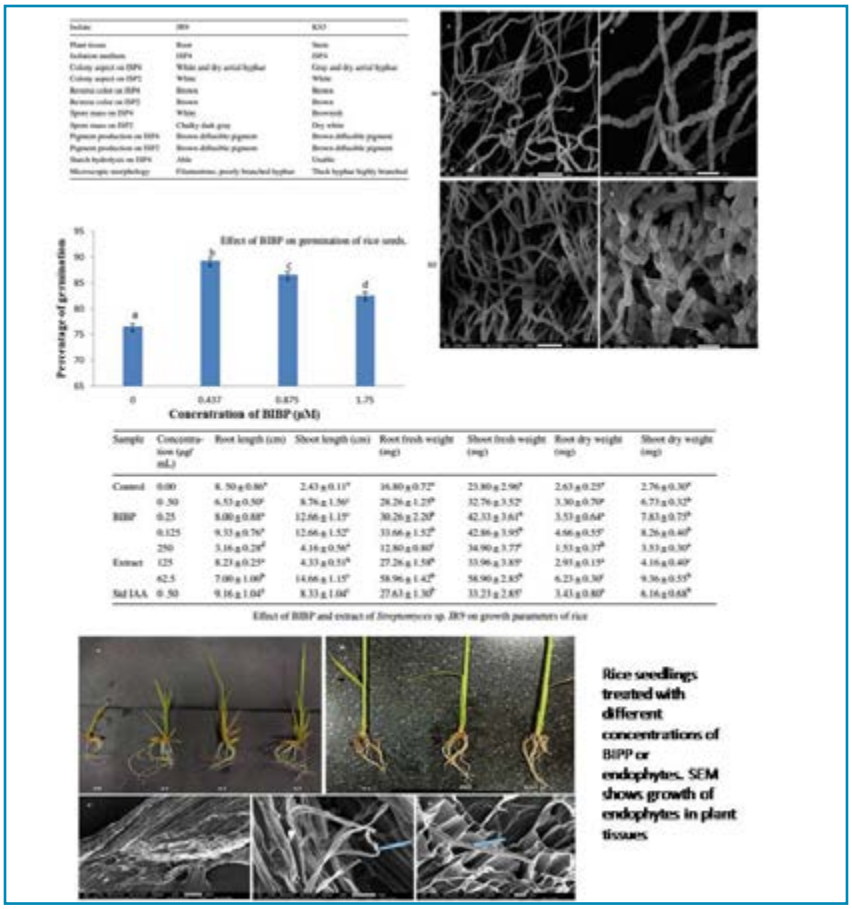
Sample code	Percentage inhibition (%)	
	Fo	Vd
BCFL01	46.67	40
BCFL02	40.00	26.67
BCFR01	53.33	53.33
BCFR02	33.33	33.33
BCFR03	56.67	40
BCFR04	53.33	26.67
BCFR05	46.67	00
BCFR06	50.00	66.67
BCFR07	50.00	40
BCFR08	33.33	00
BCAL01	33.33	33.33
BCAL02	33.33	40
BCAL03	43.33	40
BCAL04	46.67	66.67
BCAL05	36.67	33.33
BCAL06	43.33	66.67
BCAL07	40.00	66.67
BCAL08	50.00	46.67
BCAL09	53.33	46.67
BCAL10	26.67	20
BCAL11	40.00	66.67
BCAL12	26.67	33.33
BCAL13	40.00	66.67
BCAR01	33.33	33.33
BCAR02	30.00	26.67
BCBL01	43.33	46.67
BCBR01	36.67	40
BCBS01	40.00	33.33
BCBS02	30.00	20
BCBR01	16.67	00
BCBR02	60.00	46.67

Fo: *Fusarium oxysporum* Vd: *Verticillium dahliae*

2.19 Plant growth promoting potential of butyl isobutyl phthalate and *Streptomyces* sp. from *Rumex* dentatus on rice

Augustin Ntemafack, Sajad Ahmed, Amit Kumar, Rekha Chouhan, Nitika Kapoor, Sandip B Bharate, Qazi Parvaiz Hassan* & Sumit G Gandhi*

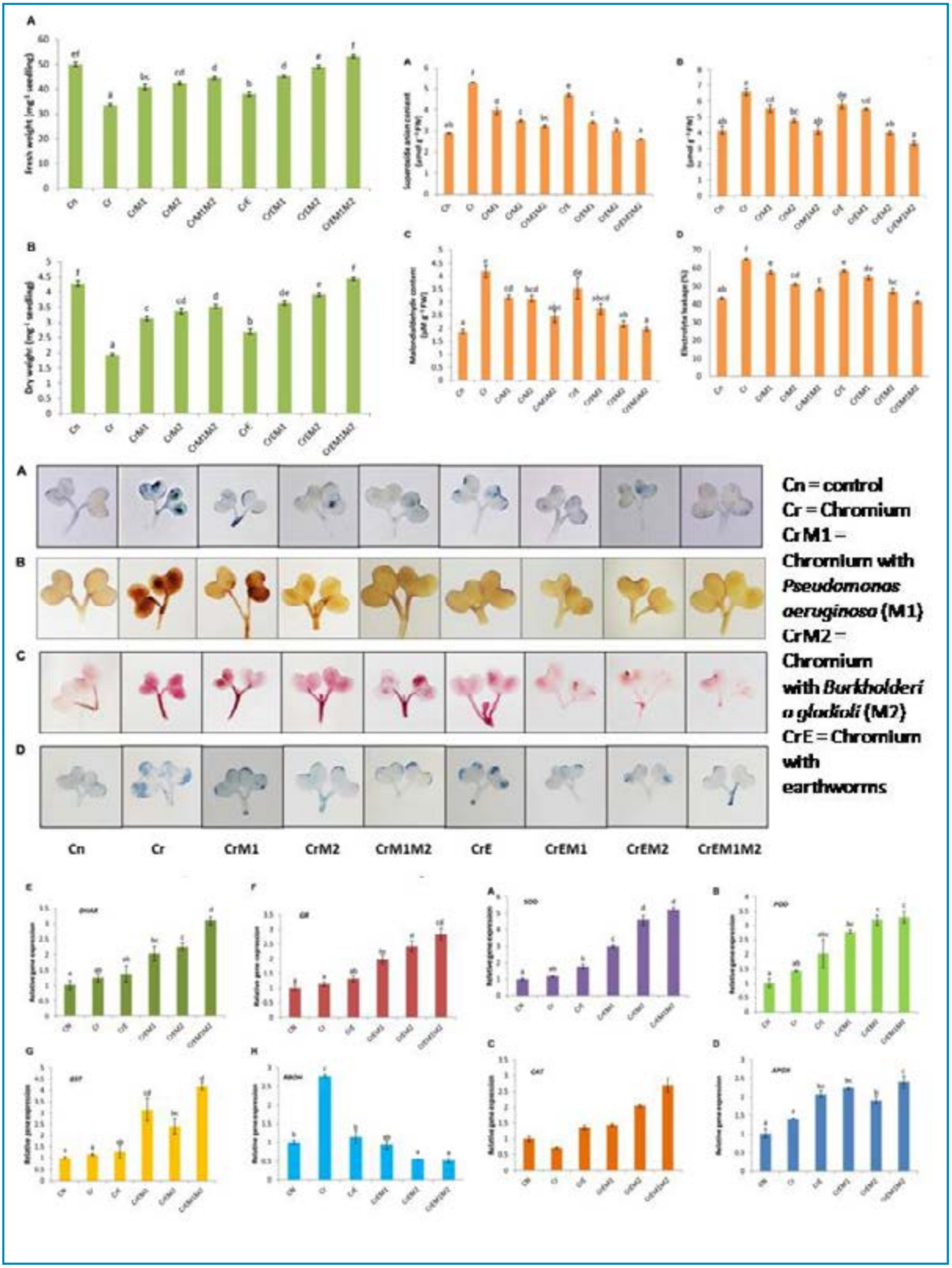
Rice (*Oryza sativa* L.) is one of the most important staple foods consumed in many countries of the world. It is mostly consumed in developing countries where different chemical fertilizers are used to improve the productivity of the crop plant. In the present study, endophytic actinomycetes isolated from *Rumex dentatus* were identified morphologically and by scanning electron microscopy. Butyl isobutyl phthalate (BIBP) was isolated from the root endophyte *Streptomyces* sp. JR9 using column chromatography and HPLC methods. The compound was tested for its effect on rice seed germination. BIBP extracts and isolates were evaluated for their plant growth effect on rice in a growth chamber. Isolates were also screened in vitro for phosphate solubilization activity and enzyme production. Indole-3-acetic acid (IAA) and BIBP produced in extracts were quantified and detected using high performance liquid chromatography (HPLC) and liquid chromatography-mass spectrometry (LC-MS) methods, respectively. BIBP was found to increase the germination of rice seeds by 6 to 12% in treated samples and displayed potent effect at lowest concentration (0.437 µM). Both the compound and the extract depicted significant increases in almost all growth parameters at lowest concentration of 0.125 µg/mL and 62.5 µg/mL, respectively. BIBP also increased significantly shoot length, fresh root, fresh shoot, and dried shoot weight at high concentrations and was more potent than the standard phytohormone IAA. HPLC quantification showed 7.952 µg/mg and 0.371 µg/mg of IAA in extracts of Streptomyces sp. JR9 and the stem endophyte Streptomyces sp. KS3, respectively. IAA containing extract of JR9 increased significantly most growth parameters at lowest concentration (125 µg/mL). The extract of KS3 depicted significant increases in almost all growth parameters at high concentration (500µg/mL). Our investigation showed that *Streptomycetes* isolated from *R. dentatus* and BIBP are potent growth promoting agents and can be used in agriculture as bio-fertilizer to improve the growth and productivity of rice.



2.20 Amelioration of Chromium-Induced Oxidative Stress by Combined Treatment of Selected Plant-Growth-Promoting Rhizobacteria and Earthworms in *Brassica juncea*

Pooja Sharma, Rekha Chouhan, Palak Bakshi, Sumit G. Gandhi*, Rupinder Kaur, Ashutosh Sharma* and Renu Bhardwaj*

Chromium (Cr) toxicity leads to the enhanced production of reactive oxygen species (ROS), which are extremely toxic to the plant and must be minimized to protect the plant from oxidative stress. The potential of plant-growth-promoting rhizobacteria (PGPR) and earthworms in plant growth and development has been extensively studied. The present study was aimed at investigating the effect of two PGPR (*Pseudomonas aeruginosa* and *Burkholderia gladioli*) along with earthworms (*Eisenia fetida*) on the antioxidant defense system in *Brassica juncea* seedlings under Cr stress. The Cr toxicity reduced the fresh and dry weights of seedlings, enhanced the levels of superoxide anion (O2•-), hydrogen peroxide (H2O2), malondialdehyde (MDA), and electrolyte leakage (EL), which lead to membrane as well as the nuclear damage and reduced cellular viability in *B. juncea* seedlings. The activities of the antioxidant enzymes, viz., superoxide dismutase (SOD), guaiacol peroxidase (POD), ascorbate peroxidase (APOX), glutathione peroxidase (GPOX), dehydroascorbate reductase (DHAR), and glutathione reductase (GR) were increased; however, a reduction was observed in the activity of catalase (CAT) in the seedlings under Cr stress. Inoculation of the PGPR and the addition of earthworms enhanced the activities of all other antioxidant enzymes except GPOX, in which a reduction of the activity was observed. For total lipid- and water-soluble antioxidants and the non-enzymatic antioxidants, viz., ascorbic acid and glutathione, an enhance accumulation was observed upon the inoculation with PGPR and earthworms. The supplementation of PGPR with earthworms (combined treatment) reduced both the reactive oxygen species (ROS) and the MDA content by modulating the defense system of the plant. The histochemical studies also corroborated that the combined application of PGPR and earthworms reduced O2•-, H2O2, lipid peroxidation, and membrane and nuclear damage and improved cell viability. The expression of key antioxidant enzyme genes, viz., SOD, CAT, POD, APOX, GR, DHAR, and GST showed the upregulation of these genes at post-transcriptional level upon the combined treatment of the PGPR and earthworms, thereby corresponding to the improved plant biomass. However, a reduced expression of RBOH1 gene was noticed in seedlings supplemented under the effect of PGPR and earthworms grown under Cr stress. The results provided sufficient evidence regarding the role of PGPR and earthworms in the amelioration of Cr-induced oxidative stress in *B. juncea*. (Figure 6) (Collaborative work).

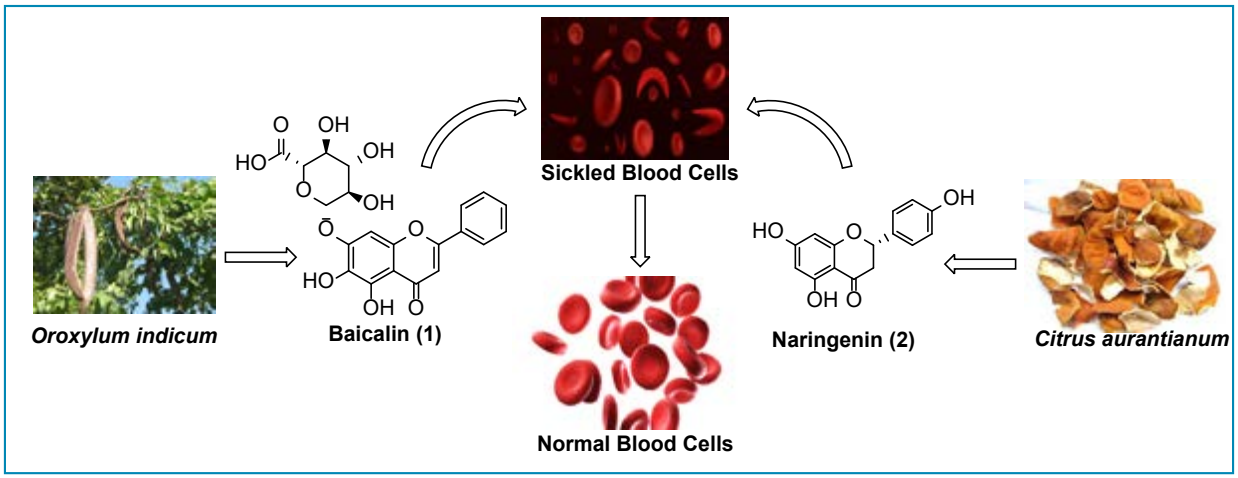

Cn = control
Cr = Chromium
CrM1 – Chromium with Pseudomonas aeruginosa (M1)
CrM2 = Chromium with Burkholderia gladioli (M2)
CrE = Chromium with earthworms
Cn
Cr
CrM1
CrM2
CrM1M2
CrE
CrEM1
CrEM2
CrEM1M2

3 SIGNIFICANT SCIENCE AND TECHNOLOGY CONTRIBUTIONS

3.1. Natural products chemistry/ phytopharmaceuticals / nutraceuticals

a) In-vitro anti-sickling potential of Baicalin and Naringenin isolated from *Oroxylum indicum* and *Citrus aurantium* on human sickle red blood cells.

Bashir Ahmad Lone, Nitika Sharma, DilpreetKour, Anil Bhushan, Dixhiya Rani, Ajay Kumar and Prasoon Gupta



Sickle cell disease (SCD) is a rare inherited disorder in which red blood cells (RBCs) under oxidative stress have altered sickle shape resulting in clinical complications. In this study, a library of 63 pure natural products were screened to see their effectiveness in preventing sickling induced in blood samples of SCA pateints, ex-vivo. The results indicated that baicalin and naringenin, reduced sickling by 46.3 and 37.48%, respectively, compared to positive control, 4-hydroxybenzoic acid (4-HBA), which inhibited RBC sickling by 56.87%. Study has clearly shown promising role of flavonoids for the management of SCD crisis for that not effective therapy is available. These phytochemicals or plant extract can be further explored as an alternative anti-sickling remedy, owing to their high efficacy in the management of SCD crisis.

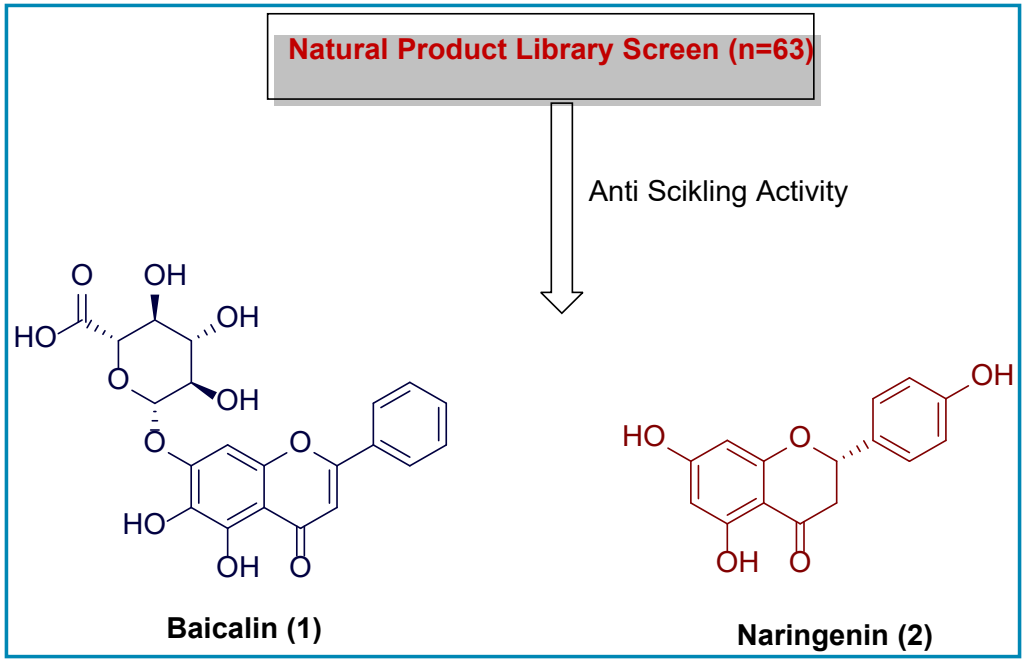


Figure 3.1.2: New SCD hits identified from NP library.

Anti-sickling activity

A. Human blood samples: Human blood samples of sickle cell anaemia patients were collected from GMC hospital Jammu. Fresh blood samples were collected in citrate-phosphate-dextrose buffer with adenine. All the protocols for working on human blood samples were approved by the Ethical clearance committee of Govt. Medical College, Jammu (Institutional Ethics Committee approval number: IEC/GMC/Cat A/2020/267).

B. *Ex-vivo* anti-sickling activity: To analyze the anti-sickling activity of compounds, whole blood samples were diluted in HBSS (Hanks balanced salt solution) to obtain the appropriate working density of erythrocytes (5×104 cells/well of 96 well plates). 4-Hydroxybenzoic acid was used as standard. Cells were treated with 50µM concentration of each compound and standard for one hour at 37°C in CO2 incubator. Sickling was induced by generating hypoxia chemically using combination of 0.5% sodium metabisulphite and 1.5mM CoCl2.6H2O. Cells were immediately observed under light microscope using 40X magnification (Make: Magnus Opto Systems; Model: INVI). The cells were differentiated into normal or sickled on the basis of morphology. Biconcave or disk-like shapes were taken to be normal while the elongated, star-like, or wrinkled shapes were designated as sickled. The percentage of sickled cells was calculated using the following formula:

Percent sickling (%) = (number of sickled cells / the total number of counted cells) × 100.

C. Statistical analysis: All the data are from three independent experiments (n=3), error bars represent standard deviation (SD). Statistical analysis was performed by using one-way analysis of variance (ANOVA) followed by Bonferroni test as post-hoc. Statistical significance, p value<0.05 between different treatments was considered significant with ***p<0.001, **p<0.01, *p<0.05.

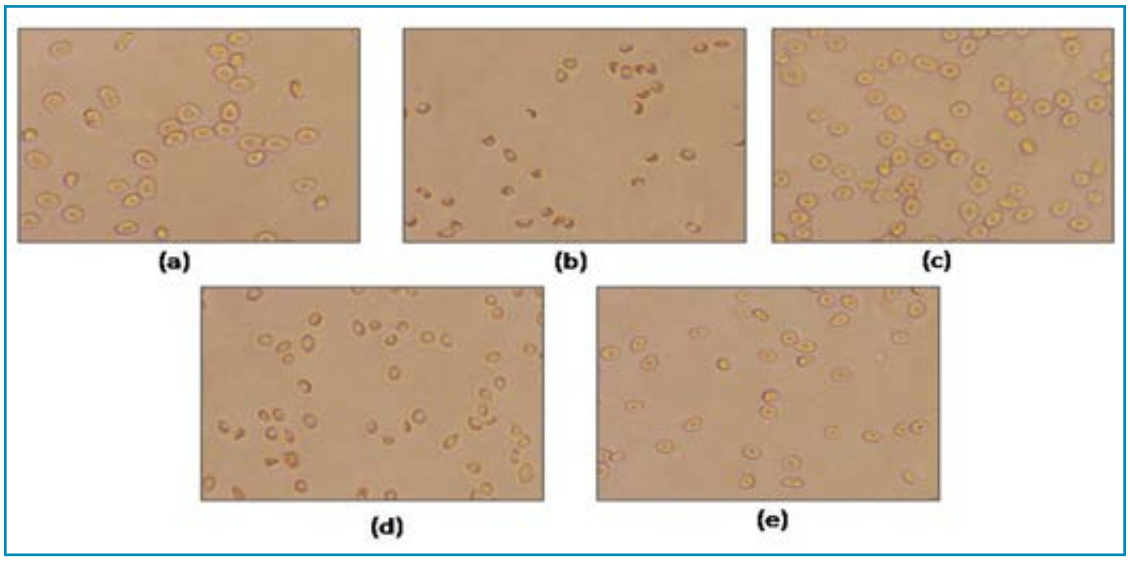


Figure 3.1.3: Effect of baicalin and naringenin on erythrocytes; to induce sickling blood samples diluted in HBSS were treated with SMB+$CoCl_2$. Untreated blood from sickle cell anaemia patients is taken as (a) control; (b) treated with SMB+$CoCl_2$; (c) pretreated with 4-hydroxybenzoic acid; (d) pretreated with 50µM of baicalin; (e) pretreated with 50µM of Naringenin, before inducing sickling.

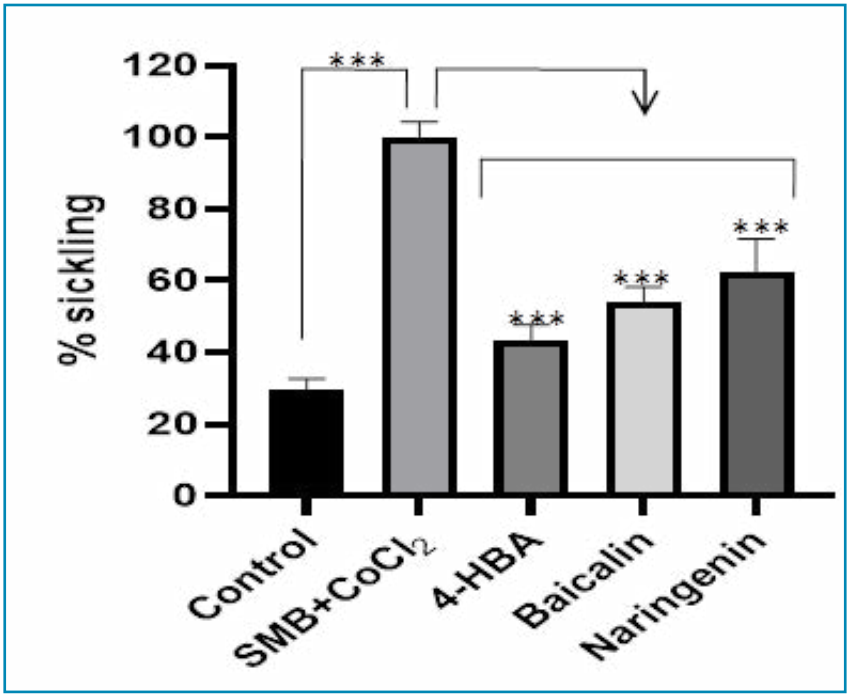


Figure 3.1.4: Anti-sickling activity of baicalin and naringenin; control represents % sickling of untreated blood sample. SMB+CoCl2 represents % sickling in the blood sample treated with sickling inducing agent and is considered as 100% sickling.4-HBA is taken as standard and Baicalin and Naringenin are test groups which represents % sickling with reference to SMB+CoCl2 treated group, and are pre-treated with 50 µM 4-HBA, Baicalin and Naringenin for 1 hour, respectively. Data are represented as mean ± SD (n=3). Statistical significance, p <0.05/0.01/0.001 denotes statistical significance (*//***).**

b) Coronarin K and L: Two Novel Labdane Diterpenes from *Roscoea purpurea:* An Ayurvedic Crude Drug

Venugopal Singamaneni, Bashir Lone, Jasvinder Singh, Pankaj Kumar, Sumeet Gairola, Shashank Singh, Prasoon Gupta

The main objective of cancer treatment with chemotherapy is to kill the cancerous cells without affecting healthy normal cells. In the present study, bioactivity-guided purification of n-chloroform soluble fraction from the methanol extract of *Roscoea purpurea* resulted in the isolation of two new labdane diterpenes, coronarin K (**1**) and coronarin L (**2**) along with eight known compounds, coronarin A (**3**), bisdemethoxycurcumin (**4**), kaempferol 3-O-methyl ether (**5**), kaempferol (**6**), fenozan acid (**7**) 3-(3-methoxy,4-hydroxyphenyl)-2-propenoic acid (ferulic acid, **8**), caffeic acid (**9**) and gallic acid (**10**). The structures of new compounds (**1–2**) were determined by detailed analysis of 1D and 2D NMR spectroscopic data and the relative configurations were determined with the help of NOESY data and comparison of optical rotations with similar compounds with established stereochemistry, while known compounds were confirmed by direct comparison of their NMR data with those reported in literature. This is the first report of isolation of this labdane diterpenes and phenolic classes of secondary metabolites in *Roscoea purpurea.* In the preliminary screening the methanol extract and its fractions were tested for the cytotoxic activity against a panel of four cancer cell lines (A549, HCT-116, Bxpc-3 and MCF-7), extract and its chloroform fraction were found to be active against lung cancer cell line, A-549 with IC_{50} value of <25 µg/mL. Owing to the notable cytotoxic activity of the chloroform fraction, the isolated compounds (**1-5**) were evaluated for their cytototoxicity against all the cell lines by MTT assay. Coronarin Kshowed significant cytotoxic potential against lung cancer cell lines (A-549), with IC_{50} value of 13.49 µM, while other compounds did not show activity below 22 µM.

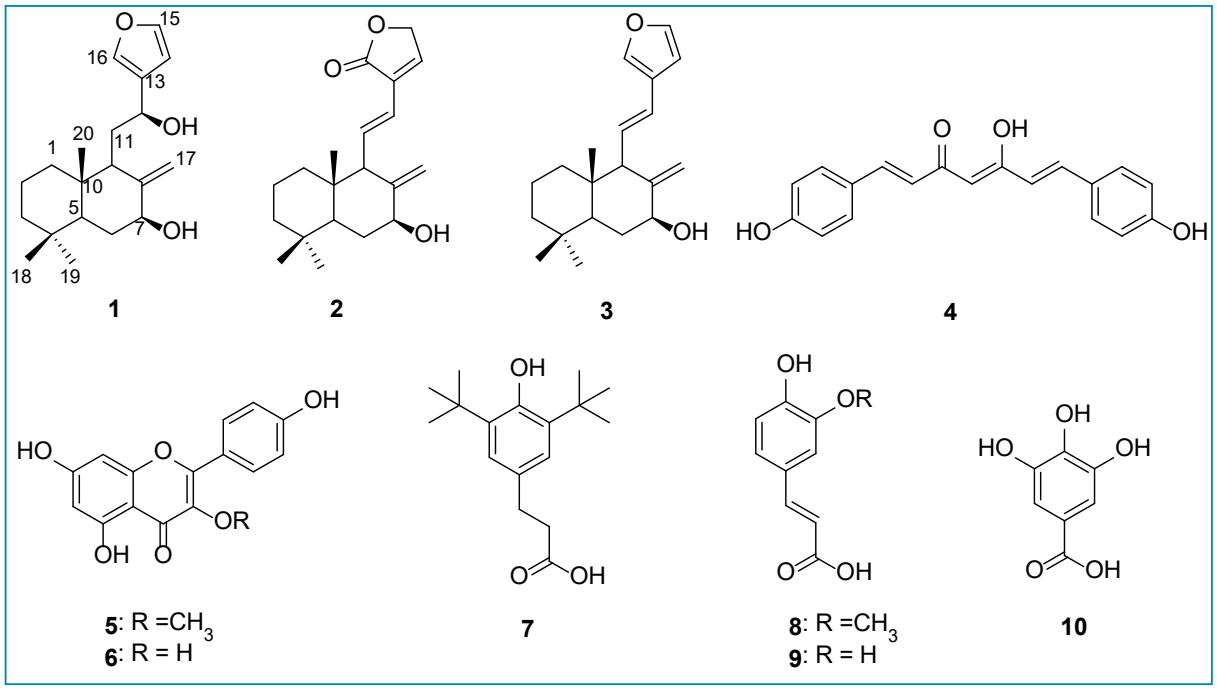


Figure 3.1.5. Structure of compounds from R. purpurea rhizomes (1-10)

Anticancer activity. Secondary metabolites isolated from plants of Zingiberaceae family have wide use as a new pharmacophore in anticancer drug discovery. In our bio-assay guided isolation of novel anticancer agents from *R. purpurea*, crude extract and fractions were evaluated for their anticancer activity using the MTT assay. Methanol extract and its chloroform fraction showed cytotocxic activity against lung cancer cell line (A549) at IC_{50} 27.71 and 21.35 (µg/ml) respectively. After purification of chloroform fraction, compounds **1-10** were isolated. Only compounds **1-5** were evaluated for panel of cancer cell lines. Amongst tested compounds Coronarine K (**1**) showed prominent anticancer activity against lung cancer cell lines (A549) and also showed moderate cytotoxic activity against colon cancer cell line HCT-116 (IC_{50} value of 26.03 µM) but had no effect on Bxpc-3 and MCF-7 in acceptable limits. Compounds **2** and **3** were ineffective against all the cell lines except pancreatic cancer cell line (Bxpc-3) at IC_{50} value of 26.03 µM. The remaining tested compounds displayed less activity (Table 2). In further study, the A549 cells were treated with compound **1** at 7.0, 13.0, 18.0µM and ROS generation was detected in 48 h. H_2O_2 was taken as a positive control. After exposing the cells with compound **1** the fluorescence intensity of DCF was increased in a dose dependent manner. The results showed that compound **1** exhibited prominent cytotoxicity against human lung cancer cell lines (A-549) with IC_{50} value of 13.49 µM and and thereby confirmed the ROS generation is crucial for cell death.

Table 2. Cytotoxicity of extract, fraction and isolated compounds (**1-5**)[a]

Compound	IC_{50}, µM, in different human cancer cell lines			
	A549	**HCT-116**	**Bxpc-3**	**MCF-7**
MeOH extract (µg/ml)	25.71±0.21	90.92±0.46	62.72±1.23	48.96±2.36
$CHCl_3$ fraction (µg/ml)	21.35±0.83	>100	68.95±3.21	46.64±0.42
1	13.49±0.62	26.03±1.46	56.70±2.17	56.24±0.83
2	33.78±1.37	>50	56.83±1.92	49.84±2.61
3	61.80±2.82	>50	22.83±1.47	>50
4	>50	>50	68.15±2.41	>50
5	>50	>50	>50	>50
Paclitaxel	6.2±0.20	8.6±0.04	5.46±0.74	3.81±0.32

[a] Data are mean±SD

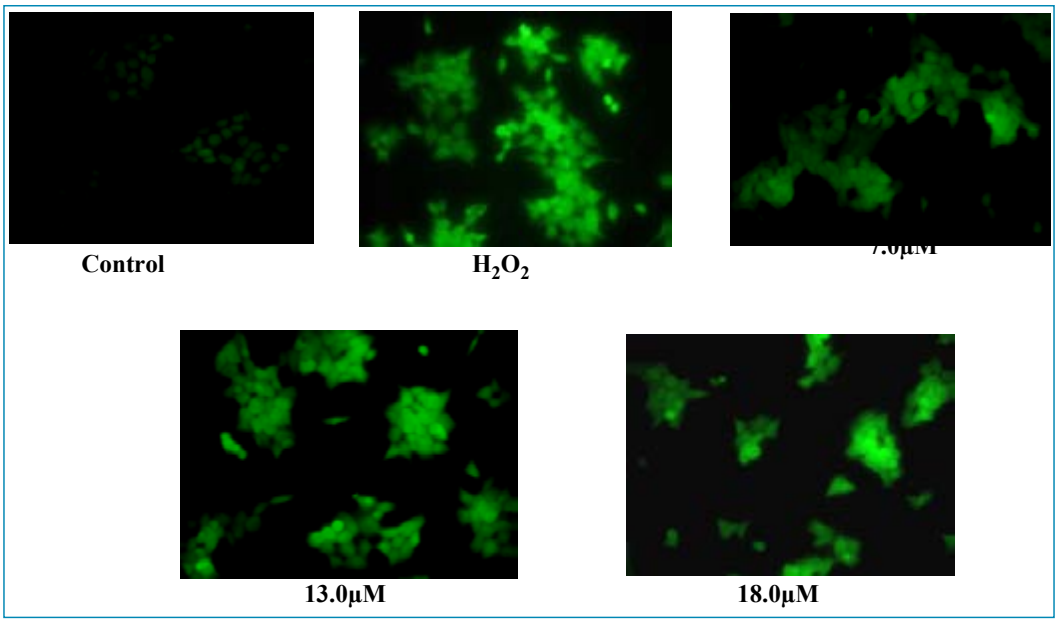
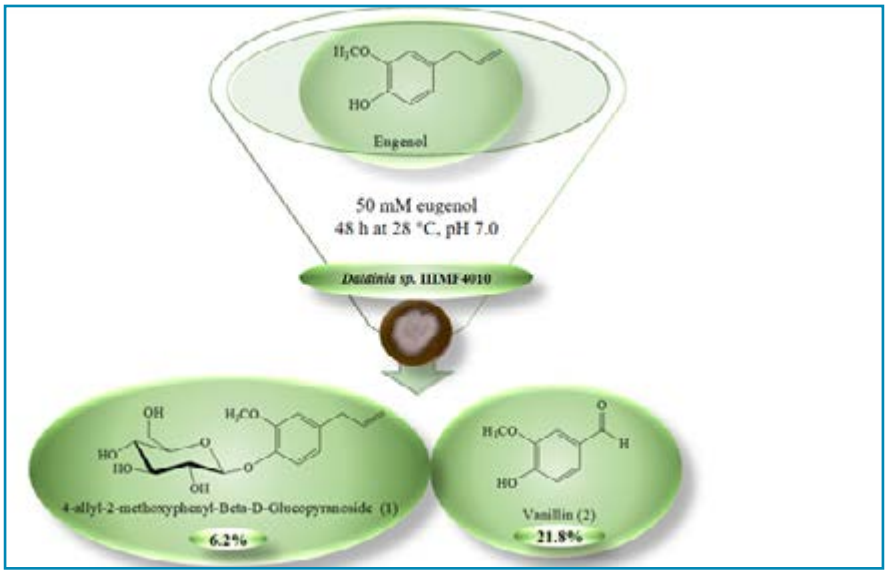


Figure 3.1.6: Effect of coronarin K (1) on cellular and nuclear morphology of A-549 in ROS production assessed from the oxidation of DCFDA by H2O2 through fluorescence microscopy at 48 hr post treatment.

c) Biotransformation of eugenol by an endophytic fungus *Daldiniasp.* IIIMF4010 isolated from *Rosmarinus officinalis*

Bashir A. Lone, Anil Bhushan, Ananta Ganjoo, Sumeet Gairola, Prasoon Gupta, Vikash Babu

Natural value-added compounds produced from biological sources have attained immense significance in medicinal, food, flavourings, and agrochemical industries. Further, biotransformation is a powerful tool used to produce value-added compounds cost-effectively and selectively. In the present study, biotransformation of eugenol using an endophytic fungus *Daldinia sp.* IIIMF4010 isolated from the fresh leaves of the plant *Rosmarinus officinalis* leads to the production of two known value-added compounds. The biotransformation reaction of eugenol (50 mM) resulted in the production of eugenol-β-D-glucopyranoside (6.2%) and vanillin (21.8%). These biotransformed products were further characterized by liquid chromatography-mass spectroscopy (LC-MS) and nuclear magnetic resonance (NMR).



In the present research, biotransformation of eugenol into its respective glycoside using an endophytic fungus *Daldinia sp.* IIIMF4010 has been carried out. The biotransformation of eugenol also resulted in the formation of vanillin. Vanillin, a characteristic aroma constituent of the vanilla pods, is used as a flavouring agent in foods, confectionery, and beverages, as a fragrance component in perfumes & cosmetics, and pharmaceuticals.

Results and discussion

Fifteen microbial cultures (12 fungal and 3 bacterial cultures) were screened for eugenol biotransformation and among them, only one strain (RL1) could bio-transform eugenol. The isolated strain was identified by ITS-based rDNA sequencing and phylogenetic tree was constructed by the neighbor-joining (N-J) method using MEGA 10.1.8 software. It exhibited 85% similarity with Daldiniaeschscholtzii (MT507840.1), and thus, the isolated strain was named as *Daldinia sp.* IIIMF4010. Thereafter, the biotransformation reaction of eugenol using the screened culture resulted in the production of two major products, i.e., Compound **1** (eugenol-β-D-glucopyranoside; β-D-glucopyranoside, 2-methoxyl-4-(2-propenyl) phenyl and Compound **2** (vanillin; 4-hydroxy-3-methoxybenzaldehyde). Compound **1** and **2** were identified using detailed spectroscopic data.

Experimental

- **Endophyte isolation:** Fresh leaves of the plant *Rosmarinus officinalis* were collected in sterile polythene bags from the experimental fields of CSIR-IIIM, India, and were processed immediately. For the isolation of endophytes, leaves were first washed under running tap water in order to remove dirt. Surface sterilization of the leaves was done by immersing them in 70% alcohol for 30 s, followed by 2% sodium hypochlorite for 2 min. The leaves were then cut into small segments with and without midrib using sterile forceps and blades. These segments were then placed on sabouraud dextrose agar (SDA) plates and incubated at 28 °C for 5-6 days. Microbial cultureswere purified, sub-cultured, and finally preserved on SDA slants at 4°C.

- **Screening and biotransformation procedure:** For the biotransformation of eugenol, isolated cultures were inoculated into 100 mL sterile sabouraud dextrose broth (SDB) medium supplemented with 10 mM eugenol and incubated at 28 °C for 4 days at 180 rpm. After 4 days of incubation, a reaction mixture for the biotransformation of eugenol was prepared. For reaction mixture, cell biomass (500 mg wet cell weight) was suspended in 5ml of 100 mM potassium phosphate buffer (pH 7.0) containing 50 mM eugenol and incubated for 48 h at 28 °C in a shaker incubator (180 rpm). The biotransformed reactions were analysed on TLC.

- **Extraction and purification:** After incubation, reactions were extracted by ethyl acetate twice, and the organic phase containing compound was filtered and dried under the reduced vacuum pressure at 40°C. The small amount of crude extract was reconstituted in 1mL of methanol and was spotted on TLC Silica gel 60 F254 plates for product analysis using the solvent system hexane /ethyl acetate (60:30). Extract exhibiting biotransformed products was then subjected to column chr omatography for purification on silica gel (100-200 mesh, 60g) using a gradient of ethyl acetate-hexane (100:0-100:0). Total twenty-five fractions (50 mL each) were collected, and analyzed by TLC, and the fractions showing same TLC profile were grouped together into five fractions (F1-F5). Compound **1** (5 mg), eugenol-β-D-glucopyranoside, was purified from the fraction F4 using semi-preparative reverse phase HPLC (column Merck RP-18 5 µm; 10 x 250 mm; 1.5 ml/min; 60-40% over 40 min. Thereafter, fraction F2 was further purified using semi-preparative RP-HPLC (column Merck RP-18 5 µm; 10 x 250 mm; 1.5 ml/min; 60-40% over 40 min to give compound **2** (7 mg), vanillin.

d) Development of a nutraceutical product for Sickle cell anaemia

Last five years have been remarkable as far as drug discovery in sickle cell anaemia is concerned. In the year 2017, the drug called Endari developed by Emmaus Medical, Inc. based on single amino acid i.e. L-glutamine was approved, which was based on the mechanism of reducing oxidative stress and acute complications in sickle cell anaemia. It also participates in the formation of proteins, glutamate, amino sugars and nucleotides. The drug is formulated as a white crystalline

powder for the patients age five and older. In November 2019, an antibody, Crizanlizumab (Adakveo) was approved by USFDA for the treatment to reduce the frequency of vaso-occlusive crisis – a common and painful complication of sickle cell disease that occurs when blood circulation is obstructed by sickled red blood cells. This antibody was developed by Novartis for the patients of 16 years and older. Another small molecule based drug got approval in December 2019 named Oxbryta (voxelotor). It is a hemoglobinS (HbS) polymerization inhibitor that binds to HbS with a 1:1 stoichiometry and exhibits preferential partitioning to red blood cells (RBCs). By increasing the affinity of Hb for oxygen, voxelotor demonstrates dose-dependent inhibition of HbS polymerization.

Apart from these approved drug candidates, there are several other molecules which are running in to various phases of clinical trials. However, for several years' hydroxyurea remained the only drug available to the sickle cell anaemia patients. This marked progress in the drug discovery signifies the active involvement of FDA and other Government agencies to expedite the approval of above drugs.

The complex pathophysiology of sickle cell disease involves different organ systems, which leads to multiple complications including vaso-occlussive crisis, Hemolysis and adherence of leucocytes with the endothelium leads to release of free haemoglobin and heme. Much of free haemoglobin and heme are scavenged by plasma proteins hemopexin (Hx) and haptoglobin (Hp). However, due to excessive hemolysis, SCA patients have large amount of free haemoglobin and heme in their blood. Extracellular heme is a potent inflammatory agonist and oxidant, and a classic damage associated molecular pattern (DAMP). Heme can induce the canonical pathway leading to NF-ϰB activation through TLR4 in SCA, followed by release of proinflammatory cytokines and chemokines. Additionally, heme has been reported to be an activator of NLRP3 inflammasome, and therefore, can lead to subsequent release of inflammatory cytokine IL-1β. Heme in the circulation induces another pathological effect by binding and depleting the NO levels in the endothelial cells resulting in vasoconstriction, [6] pulmonary hypertension, leg ulcers, priapism, and cerebrovascular disease. NO is known to regulate the expression levels of cell adhesive molecules and hence prevent the platelet aggregation. α4β1 integrin expressed on the erythrocytes surface is known to interact with the endothelium through fibronectin, vascular cell adhesion protein 1 (VCAM-1), intracellular adhesion molecule **1** (ICAM-1), and E-selectin. NO also regulates the activity of guanylyl cyclase (sGC) which further stimulates the expression of fetalhemoglobin (HbF) in erythroleukemic cells and primary erythroblasts. Proinflammatory cytokines such as tumor necrosis factor α (TNF-α), interleukin 1β (IL-1β), and IL-8 contribute to chronic inflammation and vaso-occlusive crises in SCA. The occlusion of blood capillaries due to increased interaction of sickle erythrocytes with other blood cells and endothelium is the main reason for the morbidity.

Even though, there are some drugs now available for the management of SCD complications, still it offers many opportunities to work on different targets. During the previous phase of this project, we identified selective targets, which included hemoglobin modifiers by targeting an anti-sickling phenomenon, new γ-globin inducers as an alternative to hydroxyurea, NO-conjugates as vasodilators and for pain management, NLRP3 inhibitors for management of inflammation related to hemolysis. During the span of this project, the hits/leads have been identified related to these targets. The summary of all major achievements has been provided as separate document.

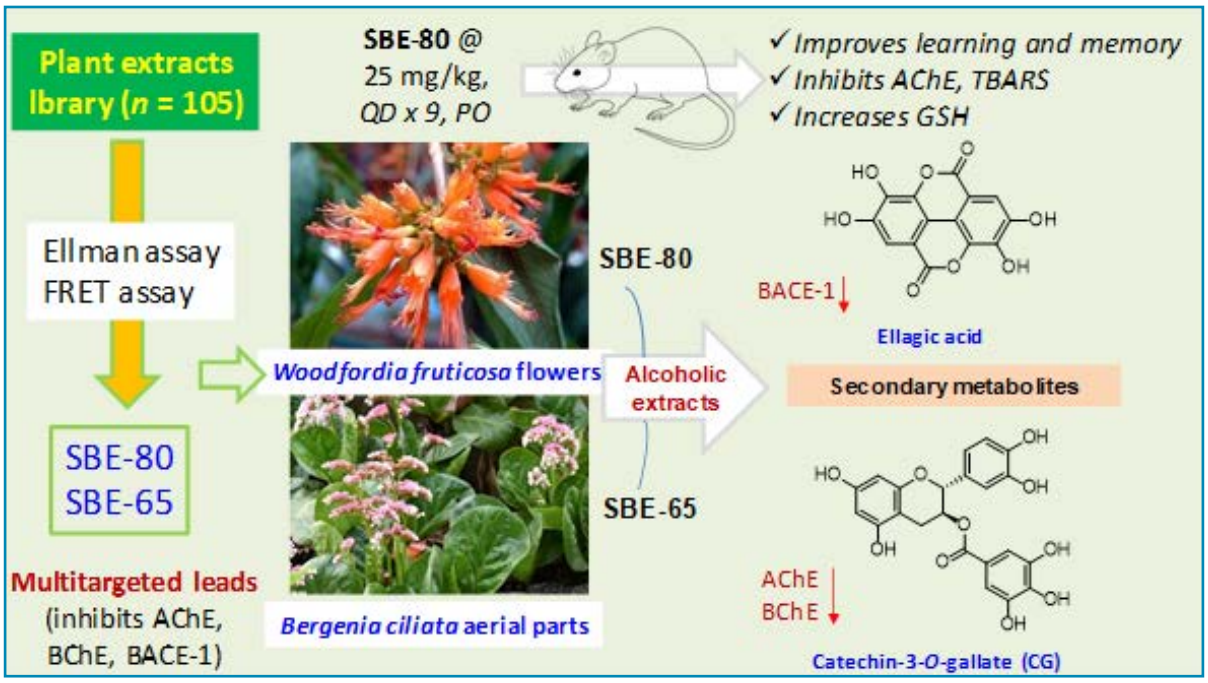
In the current phase of the project, the remaining part of work will be accomplished. We propose to continue with the hits/leads identified during the phase-1 of this project including Nutraceutical product development and preclinical development of NO-conjugates. The detailed objectives and the strategy to achieve the goals is described below.

1. DCGI approval of hydroxyurea for SCA patients.
2. Development of herbal formulation based on the selected Indian plants.
3. Preclinical development of NO-conjugates for pain management in SCA.

e) Identification of Plant-based Multitargeted Leads for Alzheimer's Disease: In-vitro and In-vivo Validation of *Woodfordiafruticosa* (L.) Kurz.

Raghuvanshi R, Nuthakki VK, Singh L, Singh B, Bharate SS, Bhatti R, Bharate SB

Alzheimer's disease (AD) is a complex neurodegenerative disease with no availability of disease-modifying therapeutics. The complex etiology and recent failures in clinical trials indicate the need for multitargeted agents. The present study aims to discover new plant-based multitargeted anti-AD leads. A library of plant extracts was screened for inhibition of acetylcholinesterase (AChE), butyrylcholinesterase (BChE), and beta-site amyloid precursor protein cleaving enzyme 1 (BACE-1). The secondary metabolites of active extracts were also tested, followed by enzyme-kinetics and molecular modeling to understand the mechanism of inhibition. The most active extract was investigated for *in-vivo* anti-dementia activity in behavioral mice models. Among the library of 105 extracts, *Woodfordiafruticosa* (SBE-80) and *Bergenia ciliata* (SBE-65) extracts displayed significant inhibition of all three enzymes. Gallic acid, one of the constituents of both plants, shows moderate inhibition of AChE and BACE-1. Catechin-3-O-gallate (CG), another constituent of SBE-65, inhibits EeAChE, rHuAChE, and eqBChE with IC_{50}'s of 29.9, 1.77, and 8.4 µM, respectively; along with a mild-inhibition of BACE-1. Ellagic acid, the constituent of SBE-80, inhibits BACE-1 with an IC_{50} value of 16 µM. The *W. fruticosa* extract SBE-80 at the dose of 25 mg/kg QD × 9 (PO) displayed memory-enhancing activity in Morris Water Maze and Passive Avoidance Test in Swiss albino mice. Treatment with SBE-80 also inhibits AChE in-vivo; whereas, a non-significant decrease in the serum TBARS was observed. *W. fruticosa* is identified for the first time as an anti-AD lead candidate. The in-vitro and *in-vivo* data presented herein and the documented safety profile of *W. fruticosa* indicate its strong potential for preclinical development as a botanical drug for dementia/AD.



3.2. Discovery informatics

The key highlights of the research work from discovery informatics laboratory are:

- With the enrichment analysis of cytoscape developed network, key signaling pathways targeted by the phytoconstituents of *Boswellia serrata* were identified.
- With the network analysis, synergistic interaction of boswellic acid and geraniol were identified in the treatment of inflammation.
- Molecular dynamics studies helped in elucidating the allosteric mode of inhibition of compound 3772-9534 (from commercial drug-like library) on MurA.
- Using computational studies and wet lab validation identified boswellic acid derivatives as MurA inhibitors and elucidated their mode of inhibtion.

Covid-19 contributions / Anti-viral Mission

- Molecular docking studies of setomimycin on Covid-19 target MPro, and its in vitro validation at CDRI.
- Computational studies of various compounds (from inhouse library and structures submitted by several PIs) on various Covid-19 targets.

Anti-cancer Mission

- Molecular docking analysis of imidazoanalogs on various cancer targets.
- Carried out similarity search of known drugs viz., olaparib, talazoparib, veliparib, niraparib and rucaparib, on the in-house compound library, and identified about 1000 compounds.
- Established the docking protocol, and understood the binding interactions of the known drugs with PARP1 and PARP2.
- Binding site analysis of the best docked compound was carried out and was compared with olaprib for carrying out structural modifications of the hit for better affinity.

Related Publications:

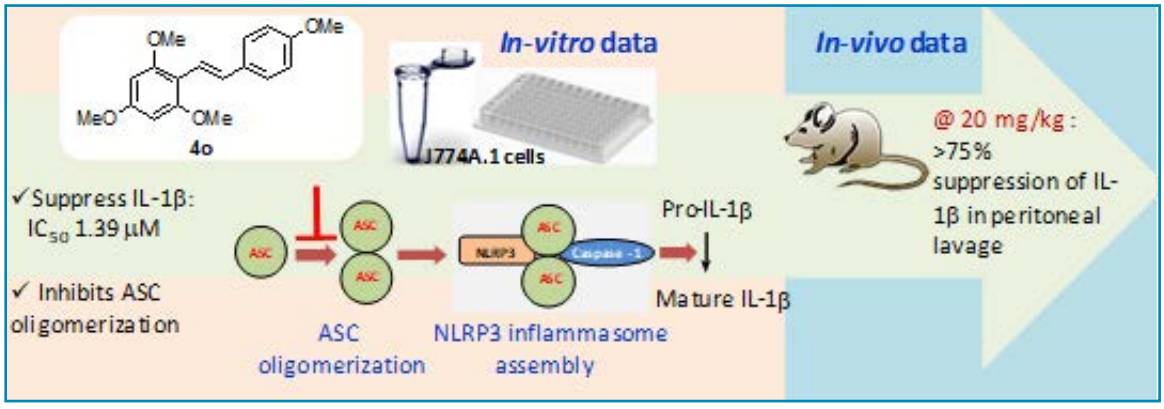
1. Bioorganic Chemistry, 125, August 2022, 105882. https://doi.org/10.1016/j.bioorg.2022.105882
2. Molecular Diversity, 2022 May 27; 1-15. doi: 10.1007/s11030-022-10441-5.
3. Journal of Biomolecular Structure and Dynamics, 2021 Dec 6; 1-12. doi: 10.1080/07391102.2021.2007793.

3.3. Medicinal Chemistry

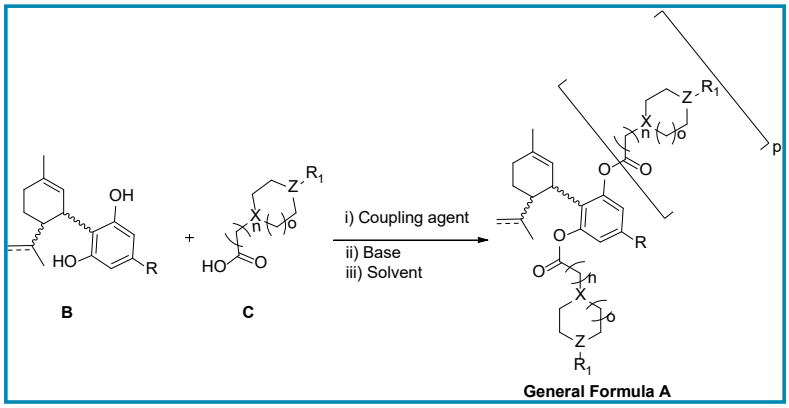
a) **Tetramethoxystilbeneinhibits NLRP3 Inflammasome Assembly via Blocking the Oligomerization of Apoptosis-associated Speck-like Protein Containing Caspase Recruitment Domain: In-Vitro and In-Vivo Evaluation**

Abdullaha M, Ali M, Kour D, Mudududdla R, Khajuria P, Kumar A, Bharate SB.

NLRP3 inflammasome complex regulates the caspase-1 activity and subsequent processing of IL-1β. Various inflammatory diseases involve the activation of inflammasome complexes; thus, the intervention in complex formation via small molecules offers a new therapeutic opportunity. The structure-guided design and synthesis of a series of methoxystilbenes and methoxy-2-phenylnaphthalenes identified new inhibitors of NLRP3 inflammasome complex. The tetramethoxystilbene **4o** and trimethoxy 2-phenylnaphthalene **1t** inhibit the release of a mature form of IL-1β in J774A.1 cells with IC_{50} values of 1.39 and 2.07 μM, respectively. Mechanistic investigation revealed that tetramethoxystilbene **4o** blocks the oligomerization of ASC, the vital step in formation of NLRP3 inflammasome assembly, thus preventing the activation of caspase-1 and the IL-1β release. Treatment of LPS+ATP challenged mice with 20 mg/kg of **4o** significantly suppressed the levels of IL-1β. The data presented herein warrants further investigation of methoxystilbenes in disease-specific models of different inflammatory diseases.



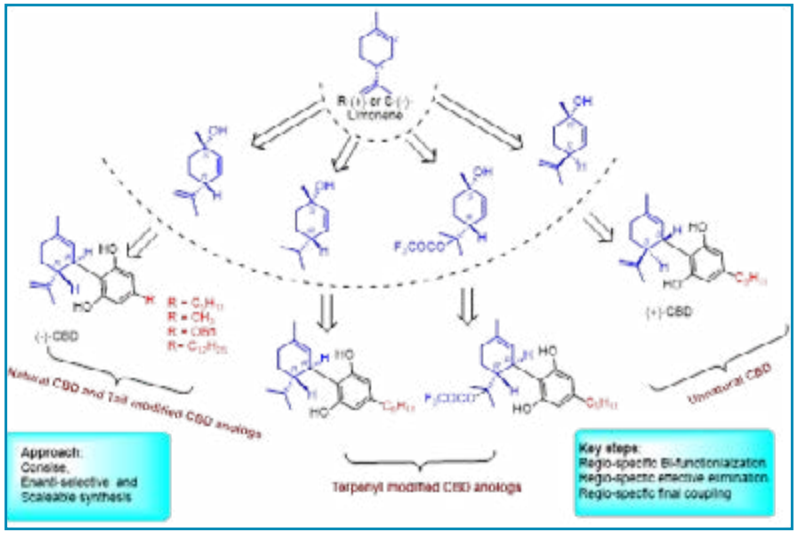
b) **Phytocannabinoids prodrugs**: A novel cannbidio-based phytocannabinoids prodrugs has been designed to improve their bio-availability, wherein some of the synthesized prodrugs have shown better oral bio-availability. The patent application has been filled recently (Ref no. 0081NF2022)



3.4. Synthetic chemistry

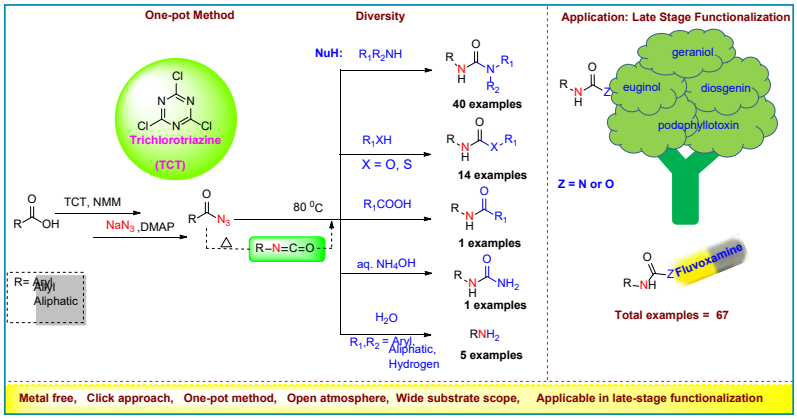
a) A new method for the synthesis of important non-psychotic phytocannaboids.

A three-step concise and stereoselective synthesis route to one of the most important phytocannabinoids, namely, (−)-cannabidiol (-CBD), from inexpensive and readily available starting material R-(+)-limonene. The synthesis involved the diastereoselective bifunctionalization of limonene, followed by effective elimination leading to the generation of key chiral p-mentha-2, 8-dien-1-ol. The chiral p-mentha-2,8-dien-1-ol on coupling with olivetol under silver catalysis provided regiospecific (−)-CBD, contrary to reported ones which gave a mixture. The newly developed approach was further extended to its structural analogues cannabidiorcin and other tail/terpenyl-modified analogues. Moreover, its opposite isomer (+)-cannabidiol was also successfully synthesized from S-(−)-limonene.



b) A new approach for converting carboxylic acids to carbamides, carbamates, carbamothioates, amides, and amines in one pot using s-Trichlorotriazine (TCT).

An s-trichlorotriazine (TCT, also known as cyanuric chloride) mediated one-pot general method for the conversion of carboxylic acids into ubiquitous functionalities such as carbamides, carbamates, carbamothioates, amides, and amines. The TCT-mediated activation of acids followed by azidation and heating led to the isocyanate formation via Curtius rearrangement which involves click chemistry in the presence of nucleophiles and provided the coupled product. The TCT was employed at ≤40 mol% with respect to the starting materials; however, its bulk availability and low cost provide a unique opportunity towards its applicability in the synthesis of functional molecules. The optimized conditions have also been successfully demonstrated for gram scale synthesis and late-stage functionalization of natural products and drugs such as podophyllotoxin, eugenol, diosgenin, geraniol and fluvoxamine.



4 RURAL SECTOR AND SUSTAINABLE DEVELOPMENT

4.1 Installation of Distillation Unit

Gajendra Kumar, Raj Singh Choudhary, Rajendra Gochar, Sumeet Gairola and Rajendra Bhanwaria (Plant Sciences and Agrotechnology Division)

Under aroma mission project phase –II different activities were undertaken including extension, research and development. The essential oil distillation unit involve high capital investment and small growers cannot afford to install this when they begin the cultivation of aromatic plants. As such keeping the problem of farmers under concern CSIR- IIIM had been continuously working for upliftment of rural society through various activities. During the work period, CSIR-IIIM (Jammu) has set up eight distillation unit, of capacity 500 kg in different location of country. The overall cost of installation of eight distillation unit was around 70 lacs. The eight locations are Vill. Dhar Payankoti, Uttarakhand, Vill. Dilwajan, Assam, Vill. Hirabatar, Chhattisgarh, Vill. Tikri, Manwah, Khellani, Tepri, Sars, of J&K UT. These locations are highly covered by cultivation of aromatic crops such as lemon grass, lavender and geranium. The setting up of distillation unit will be helpful to farmers for distillation of essential oil from aromatic crops.




4.2. Extension activities and Demonstration of Aromatic Crops

Manish K. Prajapati, Gajendra Kumar, Raj Singh Choudhary, Rajendra Gochar, Sumeet Gairola and Rajendra Bhanwaria (Plant Sciences and Agrotechnology Division)

CSIR-IIIM Jammu has undertaken approximately 354.82 acres of land under cultivation in various districts of Chhattisgarh (Gariyaband, Jagdalpur, Kondagaon, Kawardha and Mhasamund), Odisha (Sundargarh, Bargarh and Keonjhar) and J&K (Kathua, Jammu, Doda and Udhampur) of India. Diverse expertise development programme was organized under Aroma Mission Project phase-II in various districts of Chhattisgarh and Odisha and J&K. The focus of such programmes was on upliftment of rural society by providing rural employment through cultivation, processing, marketing and product development of aromatic crops. About 29 awareness cum training programme were organised to create awareness among the farmers community about high value medicinal and aromatic crops. The programme benefitted 2685 farmers including 748 women. During these programs, we demonstrated cultivation techniques and distributed planting material to various farmers cluster, i.e. 7,425,000 slips including Lemongrass var. CKP-25 geranium and lavender and covered about 354.82 acre of land under cultivation in Chhattisgarh, Odisha and J&K states.

5 GOVERNMENT OF INDIA MISSIONS

5.1 BIRAC BioNEST Project:

BIRAC (DBT) has approved the BioNEST project to CSIR-IIIM, Jammu on 31st of March 2022. The project was submitted on 24th Dec 2020 by IIIM- Technology Business Incubator (IIIM-TBI) and the title of the project is '*To strengthen and scale-up the facilities of the existing bio-incubator and focus on the creation of biotech-based startup ecosystem & skill development in the Union Territory of Jammu and Kashmir*'. The overall objective of the BioNEST Incubator is to produce successful business ventures that create jobs and wealth in the UT of Jammu & Kashmir, along with encouraging an attitude of innovation in the country as a whole.

Figure 5.1.1: Dr. Jitendra Singh, Hon'ble Union Minister inaugurated the BioNEST projectat CSIR-IIIM, Jammu

5.2. Atal Incubation Centre:

CSIR-IIIM, branch Srinagar has been shortlisted for Atal Innovation Centre by Atal Innovation Mission on 27th of Dec, 2021. The project was submitted on 12th Feb 2021 by IIIM- Technology Business Incubator (IIIM-TBI) and its objective is to promote startup culture in Kashmir region of Jammu & Kashmir. The project will focus on developing value addition products from essential oils, medicinal mushrooms, medicinal plants, leather waste and conducting skill development & entrepreneurship training programs.

5.3. SERB funded high end online workshop (Karyashala)

One-week online Karyashala on Industrial Biotechnology & Fermentation Technology was organised by CSIR-Indian Institute of Integrative Medicine (IIIM), Jammu from 4th to 9th October 2021 under the SERB's Accelerate Vigyan Karyashala Program where 74 students pursuing Masters or PhD in Biotechnology, Microbiology & Fermentation Technology registered from all over the country. Twenty-four guest speakers from CSIR-IIIM, Academia & Industry were invited to deliver keynote lectures on various topics. The purpose of the Karyashala is to provide a learning experience to the students primarily from universities, colleges, private academic institutions and newly established institutes in handling/ troubleshooting of high-end scientific instruments and such skill development on themes required for research work.

6 TECHNOLOGY LICENSED/ COMMERCIALISED

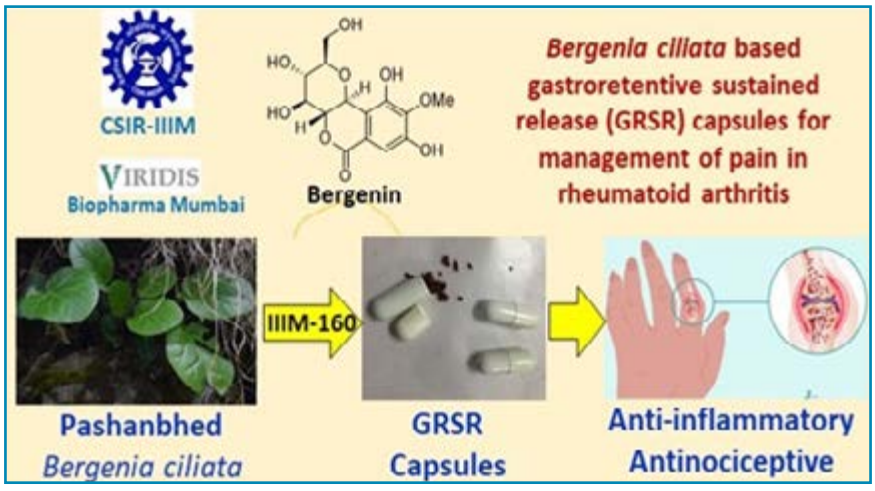
6.1. Transdermal patches for pain management:

M/s Hempstreet Medicare Pvt Ltd has successfully carried out technology transfer on transdermal patches using cellulose technology for pain management. Since 8th May 2019, the company is associated with IIIM-Technology Business Incubator as inhouse incubatee.

6.2. *Bergenia ciliata* based Nutraceutical Product IIIM-160 for theManagement of Pain in Rheumatoid Arthritis Licensed to M/S Viridis Biopharma Pvt Ltd Mumbai in October 2021.

Bergenia ciliata (Haw.) Sternb. is used in the Indian traditional system of medicine to treat various ailments including rheumatism and to heal wounds. Though the plant is reported for anti-inflammatory activity; however, the botanical product based on this plant is not yet been developed for managing inflammatory conditions. We performed a preclinical characterization of the *B. ciliata*-based botanical extract IIIM-160. The IIIM-160 was chemically standardized and analyzed for heavy metal content, aflatoxins, and microbial load. The in vitro and in vivo efficacies were determined in suitable models of inflammation, arthritis and nociception. An acute and repeat dose oral toxicity studies were performed in rodents. A suitable oral formulation was developed and characterized.

Bergenin was found to be the major component (9.1% w/w) of IIIM-160. The botanical lead displayed inhibition of lipopolysaccharide-induced production of cytokines in THP-1 cells, with selectivity toward interleukin-6 (IL-6) and had an excellent safety-window. It showed anti-inflammatory, anti-arthritic and anti-nociceptive activity in animal models and was not toxic at oral doses up to 2 g/kg in Swiss-albino mice. The gastroretentive, sustained-release capsule formulation showed sustained-release of the bergenin over the period of 24 h, resulting in improved plasma-exposure of bergenin in Sprague Dawley rats. The dual-activity of IL-6 inhibition and anti-nociception mark the suitability of IIIM-160 for treating rheumatoid arthritis.



7 ACSIR ACTIVITIES

7.1. List of the Students and activities conducted during the year:

CSIR-IIIM, Jammu is an important unit of Academy of Scientific and Innovative Research (AcSIR). Institute offers PhD program to eligible candidates in Biological Sciences and Chemical Sciences. The Institute provides state of art research facilities to the researchers. The PhD Programs at IIIM aims to upgrade and strengthen the skill and innovative capabilities among budding researchers in the fields of biological and chemical sciences under the mentorship of leading scientific fraternity. The program is structured in such a way so as to develop both personal & professional competencies of the students.

The admission takes place bi-annually i.e., for January & August sessions. A total of 31 students were selected for admission during the period - Biological Sciences: 22 and Chemical Sciences: 9 students.

The Academic Cell at IIIM is taking necessary initiatives to ensure smooth functioning of all AcSIR Academic activities, viz. student's admission processes, course work classes, DAC formation and arranging of its meetings, pre and post thesis submission formalities, etc. It acts as a liaison point between AcSIR Headquarter, AcSIR Lab Coordinator, Ph.D Supervisors, Students, DAC Members & other External Experts.

Keeping in view the COVID-19 restrictions, all the DAC Meetings, Course Work Classes and Viva Voce Examinations are being organized in an online mode.

During this period, 17 (Seventeen) AcSIR students successfully defended their doctoral viva voice (OEB) examination.

S. No.	Name & Enrollment No.	Supervisor/ Co-Supervisor	Title of Thesis	Date of viva-voce
1	Mr. Ntemafack Augustin (10BB17J37017)	Dr. Qazi Parvaiz Hassan/ Dr. Sumit G. Gandhi	Evaluation of bioactivities of secondary metabolites of Rumex species and their endophytes	April 6th, 2021
2	Mr. Souneek Chakraborty (10BB15J37006)	Dr. Anindya Goswami	Elucidating the molecular signaling activation attributable to drug induced DNA damages eventually leading to aberrant colon cancer metastasis	April 9th, 2021
3	Mr. Mubashir JavedMintoo (10BB14A37011)	Dr. D. M. Mondhe	Evaluation of new rohitukine analogues for their anticancer potential	April 28th, 2021
4	Ms. Suraya Jan (10BB15J37012)	Dr. Syed Sajad Hussain	Discovery of new G9a inhibitors and their anticancer activity l	May 12th, 2021
5	Mr. Masroor Ahmad (10BB15J37020)	Dr. Fayaz Malik	Exploring the molecular mechanism(s) of Trastuzumab resistance in HER2 positive breast cancers	June 23rd, 2021
6	Mr. Sumit Sharma (10CC14A37019)	Dr. Parvinder Pal Singh	Medicinal Chemistry around Nitroimidazole Scaffold to Discover New Generation Anti-TB leads	July 14th, 2021
7	Mr. Gurpreet Singh (10BB15J37002)	Dr. Meenu Katoch	Exploration of endophytic fungi from_Brugmansiaaurea for discovery of bioactive metabolites through conventional and epigenetic modulation approach	August 10th, 2021
8	Mr. Pankaj Chibber (10BB16J37007)	Dr. G. D. Singh	Preclinical evaluation of OA-DHZ, a lead as an anti-inflammatory and analgesic derivative of Dehydrozingerone	September 17th, 2021

S. No.	Name & Enrollment No.	Supervisor/ Co-Supervisor	Title of Thesis	Date of viva-voce
9	Mr. Umar Ahmad Sheikh (10BB17A37012)	Dr. Tasduq Abdullah	Understanding the Interplay of Autophagy and DNA Damage Response Mechanism in the Regulation of Ultraviolet-(B) – Induced Skin Photo damage	September 28th, 2021
10	Mr. Nazir Ahmad Lone (10BB15J37003)	Dr. Tasduq Abdullah	Exploring the Role of Endoplasmic Reticulum- Stress Mediated Autophagy Signalling Axis in Melanoma: Natural Product Based Analogues as Therapeutic Agents	October 4th, 2021
11	Ms. Mowkashi Khullar (10BB15J37018)	Dr. Zabeer Ahmed	The bioactivity of Colebrookeaoppositifolia extracts and its bioactive constituent, particularly against alcoholic hepatitis	October 25th, 2021
12	Ms. Archana Katoch (10BB15A37002)	Dr. Anindya Goswami	Explicating the role of small molecule inducer of tumor suppressor, Par-4, in controlling EMT/metastasis and, thereof, validation by relevant in vitro and in vivo models	December 16th, 2021
13	Mr. Sameer Ahmad Mir (10BB15J37017)	Dr. Fayaz Malik	Identification of novel stem cell modulator for its potential implication in drug resistant triple-negative breast cancer	January11th, 2021
14	Mr. Naveen Prakash Bakolia (10BB15J37013)	Dr. Inshad Ali Khan	Regulation of gene expression by non-coding RNA element in Mycobacterium tuberculosis H37Rv	February 28th, 2022
15	Ms. Sabeena Ali (10BB16J37001)	Dr. Qazi Parvaiz Hassan	Assessment of genetic diversity and chemoprofiling in selected species of *Aconitum* from North-Western Himalaya	March 8th, 2022
16	Mr. Zahid Yaqoob Bhat (10BB16A37010)	Dr. Nasheeman Ashraf	Cloning and characterization of MYB transcription factors involved in regulation of secondary metabolism in *Crocus sativus* L	March 10th, 2022
17	Mr. Tanveer Ahmad (10BB16A37004)	Dr. Syed Riyal Ul Hassan	Diversity, community structure and plant growth-promoting potential of bacterial endophytes associated with *Crocus sativus* Linn	March 15th, 2022

CSIR-IIIM Academic Cell is taking utmost care for proper record-keeping; to ensure that rules & guidelines are followed in a timely manner at local level; handling of students related issues; providing hospitality services to the invited external expert members; timely processing of their honorarium payment claims and other related matters.

8 LIST OF PUBLICATIONS (2021-22)

List of CSIR-IIIM Publications (Calendar Year: 2021)

(AIF= 4.13)

Accessed from Scifinder + Web of Science Database

S.No	Title	Author	Impact Factor
1	Identification of plant-based multitargeted leads for Alzheimers disease: In-vitro and in-vivo validation of *Woodfordiafruticosa* (L.) Kurz Phytomedicine (2021), 91, 153659	Raghuvanshi, Rinky; Nuthakki, Vijay K.; Singh, Lovedeep; Singh, Bikarma; Bharate, Sonali S.; Bhatti, Rajbir; Bharate, Sandip B.	5.34
2	Genetic risk prediction of COVID-19 susceptibility and severity in the indian population Frontiers in Genetics (2021), 12, 714185	Prakrithi, P.; Lakra, Priya; Sundar, Durai; Kapoor, Manav; Mukerji, Mitali; Gupta, Ishaan	4.27
3	Identification of novel MurA inhibitors using in silico approach, their validation and elucidation of mode of inhibition Journal of Biomolecular Structure and Dynamics (2021),	Tiwari, Harshita; Raina, Diksha; Gupta, Monika; Barik, Manas Ranjan; Khan, Inshad Ali; Khan, Farrah; Nargotra, Amit	3.392
4	Pharmacokinetic Assessment of Rottlerin from Mallotusphilippensis Using a Highly Sensitive Liquid Chromatography-Tandem Mass Spectrometry-Based Bioanalytical Method ACS Omega (2021), 6(48), 32637-32646.	Manhas, Diksha; Gour, Abhishek; Bhardwaj, Nivedita; Sharma, Deepak K.; Sharma, Kuhu; Vij, Bhavna; Jain, Shreyans K.; Singh, Gurdarshan; Nandi, Utpal	3.512
5	Conversion of N-acyl amidines to amidoximes: a convenient synthetic approach to molnupiravir (EIDD-2801) from ribose RSC Advances (2021), 11(57), 36143-36147.	Ahmed, Ajaz; Ahmed, Qazi Naveed; Mukherjee, Debaraj	3.245
6	Recent advances in Cu-catalyzed transformations of internal alkynes to alkenes and heterocycles Organic & Biomolecular Chemistry (2021),	Rasool, Javeed Ur; Ali, Asif; Ahmad, Qazi Naveed	3.876
7	Dereplication Based Strategy for Rapid Identification and Isolation of a Novel Anti-inflammatory Flavonoid by LCMS/MS from Colebrookeaoppositifolia ACS Omega (2021), 6(45), 30241-30259.	Sharma, Neha; Khajuria, Vidushi; Gupta, Shilpa; Kumar, Chetan; Sharma, Anjana; Lone, Nazir Ahmad; Paul, Satya; Meena, Siya Ram; Ahmed, Zabeer; Satti, Naresh Kumar; et al	3.512
8	Rosmarinic Acid: A Naturally Occurring Plant Based Agent Prevents Impaired Mitochondrial Dynamics and Apoptosis in Ultraviolet-B-Irradiated Human Skin Cells Photochemistry and Photobiology (2021),	Gupta, Divya; Archoo, Sajida; Naikoo, Shahid Hussain; Abdullah, Sheikh Tasduq	3.421
9	Antibody drug conjugates in gastrointestinal cancer: From lab to clinical development Journal of Controlled Release (2021), 340, 1-34.	Singh, Davinder; Dheer, Divya; Samykutty, Abhilash; Shankar, Ravi	9.776
10	Palladium(II) catalyzed site-selective C-H olefination of imidazo[1,2-a]pyridines Organic & Biomolecular Chemistry (2021), 19(43), 9401-9406	Tali, Javeed Ahmad; Kumar, Gulshan; Singh, Davinder; Shankar, Ravi	3.876
11	Metal-free oxidative decarbonylative halogenation of fused imidazoles New Journal of Chemistry (2021), 45(44), 20551-20555.	Singh, Davinder; Tali, Javeed Ahmad; Kumar, Gulshan; Shankar, Ravi	3.591

S.No	Title	Author	Impact Factor
12	Micelle-Mediated Trimerization of Ynals to Orthogonally Substituted 4H-Pyrans in Water: Downstream Rearrangement to Bioactive 2,8-dioxabicyclo [3.3.1] nona- 3, 6- diene Frameworks European Journal of Organic Chemistry (2021), 2021(48), 6646-6651	By Rashid, Showkat; Bhat, Bilal A.; Mehta, Goverdhan	3.021
13	Functional characterization of the two genes encoding 1-deoxy-D-xylulose 5-phosphate synthase in *Coleus forskohlii* International Journal of Current Microbiology and Applied Sciences (2021), 10(2), 1158-1175.	Pagoch, Sandeep Singh; Kumar, Ramesh; Bedi, Yashbir S.; Gupta, Suphla	3.021
14	Site selective synthesis and anti-inflammatory evaluation of Spiro-isoxazoline stitched adducts of arteannuin B Bioorganic Chemistry (2021), 117, 105408	By Ur Rasool, Javeed; Sawhney, Gifty; Shaikh, Majeed; Nalli, Yedukondalu; Madishetti, Sreedhar; Ahmed, Zabeer; Ali, Asif	5.275
15	Crocus transcription factors CstMYB1 and CstMYB1R2 modulate apocarotenoid metabolism by regulating carotenogenic genes Plant Molecular Biology (2021), 107(3), 207.	Quick View Other Sources By Bhat, Zahid Yaqoob; Mohiuddin, Tabasum; Kumar, Amit; Lopez-Jimenez, Alberto Jose; Ashraf, Nasheeman	4.076
16	Neuroprotective activity of natural products isolated from Senecio graciliflorus DC against corticosterone-induced impairment in SH-SY5Y cells Naunyn-Schmiedeberg's Archives of Pharmacology (2021), 394(12), 2389-2399.	By Jameel, Salman; Kaur, Loveleena; Bhat, Showkat Ahmad; Malik, Fayaz A.; Bhat, Khursheed Ahmad	3
17	Comparative transcriptome mining for terpenoid biosynthetic pathway genes in wild and cultivated species of Plantago Protoplasma (2021), Ahead of Print.	Gupta, Suruchi; Singh, Ravail; Sharma, Arti; Rather, Gulzar A.; Lattoo, Surrinder K.; Dhar, Manoj K.	3.356
18	Mutasynthesis of Medicinally Significant Natural Products Through Manipulation of Gene Governing Starter Unit Current Organic Chemistry (2021), 25(13), 1611-1625.	Grover, Parul; Sharma, Deepak K.; Chhalodia, Anuj K.; Mukherjee, Debaraj	2.18
19	BCG Vaccination Program Mitigates COVID19 Related Mortality: A Reality Check Current Pharmaceutical Biotechnology (2021), 22(12), 1574-1583	Pandita, Archana; Bhat, Audesh; Koul, Anita; Singh, Shashank K.	2.837
20	Sulfonyl-Promoted Michaelis-Arbuzov-Type Reaction: An Approach to S/Se-P Bonds Journal of Organic Chemistry (2021), 86(19), 13644-13663	Rather, Suhail A.; Bhat, Mohammad Yaqoob; Hussain, Feroze; Ahmed, Qazi Naveed	4.354
21	Optimization and validation of RT-LAMP assay for diagnosis of SARS-CoV2 including the globally dominant Delta variant Virology Journal (2021), 18(1), 178.	Jamwal, Vijay Lakshmi; Kumar, Natish; Bhat, Rahul; Jamwal, Piyush Singh; Singh, Kaurab; Dogra, Sandeep; Kulkarni, Abhishek; Bhadra, Bhaskar; Shukla, Manish R.; Saran, Saurabh; et al	3.616
22	Advancement in leishmaniasis diagnosis and therapeutics: An update European Journal of Pharmacology (2021), 910, 174436	Kumari, Diksha; Perveen, Summaya; Sharma, Rashmi; Singh, Kuljit	4.432

S.No	Title	Author	Impact Factor
23	Insights into the Endophytic Bacterial Microbiome of *Crocus sativus:* Functional Characterization Leads to Potential Agents that Enhance the Plant Growth, Productivity, and Key Metabolite Content Microbial Ecology (2021), Ahead of Print.	Ahmad, Tanveer; Farooq, Sadaqat; Mirza, Dania Nazir; Kumar, Amit; Mir, Raouf Ahmad; Riyaz-Ul-Hassan, Syed	4.552
24	Comparative study of codon usage profiles of *Zingiber officinale* and its associated fungal pathogens Molecular Genetics and Genomics	Gupta, Suruchi; Singh, Ravail	2.183
25	IIIM-941, a stilbene derivative inhibits NLRP3 inflammasome activation by i nducing autophagy Frontiers in Pharmacology (2021), 12, 695712.	Ali, Mehboob; Gupta, Mehak; Wani, Abubakar; Sharma, Ankita; Abdullaha, Mohd; Kour, Dilpreet; Choudhary, Sushil; Bharate, Sandip B.; Singh, Gurdarshan; Kumar, Ajay	5.81
26	Crocus transcription factors CstMYB1 and CstMYB1R2 modulate apocarotenoid metabolism by regulating carotenogenic genes Plant Molecular Biology (2021), 107(1-2), 49-62	Bhat, Zahid Yaqoob; Mohiuddin, Tabasum; Kumar, Amit; Lopez-Jimenez, Alberto Jose; Ashraf, Nasheeman From	4.076
27	Phytochemical add-on therapy to DMARDs therapy in rheumatoid arthritis: In vitro and in vivo bases, clinical evidence and future trends Pharmacological Research (2021), 169, 105618.	Kour, Gurleen; Haq, Syed Assim; Bajaj, Bijender Kumar; Gupta, Prem N.; Ahmed, Zabeer	7.658
28	Coronarin K and L: two novel labdane diterpenes from Roscoea purpurea: an ayurvedic crude drug Frontiers in Chemistry (Lausanne, Switzerland) (2021), 9, 642073	Singamaneni, Venugopal; Lone, Bashir; Singh, Jasvinder; Kumar, Pankaj; Gairola, Sumeet; Singh, Shashank; Gupta, Prasoon	4.62
29	Natural Products in Mitigation of SARS CoV Infections Current Medicinal Chemistry (2021), 28(22), 4454-4483.	Sharma, Venu; Sharma, Ankita; Bharate, Sandip B.	4.53
30	Whole-exome sequencing reveals a rare variant of OTOF gene causing congenital non-syndromic hearing loss among large muslim families favoring consanguinity Frontiers in Genetics (2021), 12, 641925	Fareed, Mohd; Sharma, Varun; Singh, Inderpal; Rehman, Sayeed Ur; Singh, Gurdarshan; Afzal, Mohammad From	4.27
31	Flavonoids as potential phytotherapeutics to combat cytokine storm in SARS-CoV -2 Phytotherapy Research (2021), 35(8), 4258-4283	Gour, Abhishek; Manhas, Diksha; Bag, Swarnendu; Gorain, Bapi; Nandi, Utpal	5.882
32	A rohitukine derivative IIIM-290 induces p53 dependent mitochondrial apoptosis in acute lymphoblastic leukemia cells Molecular Carcinogenesis (2021), 60(10), 671-683.	Mintoo, Mubashir; Khan, Sameer; Wani, Abubakar; Malik, Sumera; Bhurta, Deendyal; Bharate, Sandip; Malik, Fayaz; Mondhe, Dilip	4.784
33	Serine-glycine-betaine, a novel dipeptide from an endophyte Macrophominaphaseolina: isolation, bioactivity and biosynthesis Journal of Applied Microbiology (2021), 131(2), 756-767.	Singh, Gurpreet.; Singh, J.; Singamaneni, V.; Singh, S.K.; Gupta, P.; Katoch, Meenu.	3.772

S.No	Title	Author	Impact Factor
34	Whole-exome sequencing reveals a novel homozygous mutation in the COQ8B gene associated with nephrotic syndrome Scientific Reports (2021), 11(1), 13337.	Fareed, Mohd; Makkar, Vikas; Angral, Ravi; Afzal, Mohammad; Singh, Gurdarshan	5.133
35	*Capsella Bursa-pastoris* (L.) Medic: An Insight into its Pharmacology, Expository Traditional Uses and Extensive Phytochemistry Current Traditional Medicine (2021), 7(2), 168-179.	Dar, Mohd Akbar; Mir, Reyaz Hassan; Mohi-ud-din, Roohi; Mir, Prince Ahad; Masoodi, Mubashir Hussain; Akbar, Seema; Mir, Showkat Rasool; Sawhney, Gifty	0.208
36	Glabridin attenuates paracetamol-induced liver injury in mice via CYP2E1-mediated inhibition of oxidative stress Drug and Chemical Toxicology (1977) (2021), Ahead of Print	Bhatt, Shipra; Sharma, Ankita; Dogra, Ashish; Sharma, Priyanka; Kumar, Amit; Kotwal, Pankul; Bag, Swarnendu; Misra, Prashant; Singh, Gurdarshan; Kumar, Ajay; et al	3.356
37	Comparative study of codon usage profiles of *Zingiber officinale* and its associated fungal pathogens Molecular Genetics and Genomics (2021), 296(5), 1121-1134	Gupta, Suruchi; Singh, Ravail	2.183
38	Regioselective Base-controlled Pd-catalyzed Arylation of Imidazo[1,2-a]pyridines: leading selectivity at C8 position by N-chelation over O-chelation Asian Journal of Organic Chemistry (2021), 10(7), 1655-1659.	Quick View Other Sources By Tali, Javeed Ahmad; Singh, Davinder; Kumar, Gulshan; Shankar, Ravi From	3.319
39	In-vitro cytotoxicity in relation to chemotypic diversity in diploid and tetraploid populations of *Gentiana kurrooRoyle* Journal of Ethnopharmacology (2021), 274, 113966	Jeelani, Syed Mudassir; Singh, Jasvinder; Sharma, Arti; Rather, Gulzar A.; Ali, Sheikh Abid; Gupta, Ajai Prakash; Singh, Shashank; Lattoo, Surrinder K.	4.27
40	Mutation, Chemoprofiling, Dereplication, and Isolation of Natural Products from Penicillium oxalicum ACS Omega (2021), 6(25), 16266-16272.	Abrol, Vidushi; Kushwaha, Manoj; Arora, Divya; Mallubhotla, Sharada; Jaglan, Sundeep	3.512
41	Human genetic factors associated with pneumonia susceptibility, a cue for COVID-19 mortality MedRxiv (2021), 1-31	Guin, Debleena; Yadav, Saroj; Singh, Priyanka; Singh, Pooja; Thakran, Sarita; Kukal, Samiksha; Kanojia, Neha; Paul, Priyanka Rani; Pattnaik, Bijay; Sardana, Viren; et al	0
42	Tetramethoxystilbene Inhibits NLRP3 Inflammasome Assembly via Blocking the Oligomerization of Apoptosis-Associated Speck-like Protein Containing Caspase Recruitment Domain: In Vitro and In Vivo Evaluation ACS Pharmacology & Translational Science (2021), 4(4), 1437-1448	Abdullaha, Mohd; Ali, Mehboob; Kour, Dilpreet; Mudududdla, Ramesh; Khajuria, Parul; Kumar, Ajay; Bharate, Sandip B.	4.325
43	Safranal inhibits NLRP3 inflammasome activation by preventing ASC oligomerization Toxicology and Applied Pharmacology (2021), 423, 115582.	Gupta, Mehak; Wani, Abubakar; Ahsan, AitizazUl; Ali, Mehboob; Chibber, Pankaj; Singh, Surjeet; Digra, Sanjeev K.; Datt, Manish; Bharate, Sandip B.; Vishwakarma, Ram A.; et al	4.219

S.No	Title	Author	Impact Factor
44	Effect of Concomitant Hydroxyurea Therapy with Rutin and Gallic Acid: Integration of *Pharmacokinetic and Pharmacodynamic Approaches* ACS Omega (2021), 6(22), 14542-14550.	Gour, Abhishek; Dogra, Ashish; Kour, Dilpreet; Singh, Gurdarshan; Kumar, Ajay; Nandi, Utpal	3.512
45	Purification and characterization of thermoactive serratiopeptidase from *Serratia* marcescens AD- W2 Chander, Devtulya; Khousla, Jasmine AMB Express (2021), 11(1), 53.	Kour; Koul, Diksha; Hossain, Md. Mehedi; Dar, Mohd Jamal; Chaubey, Asha	3.298
46	Glabridin ameliorates methotrexate-induced liver injury via attenuation of oxidative stress, inflammation, and apoptosis Life Sciences (2021), 278, 119583.	Dogra, Ashish; Gupta, Divya; Bag, Swarnendu; Ahmed, Irfan; Bhatt, Shipra; Nehra, Ekta; Dhiman, Shakti; Kumar, Amit; Singh, Gurdarshan; Abdullah, Sheikh Tasduq; Sangwan Payare Lal; Nandi Utpal	5.037
47	Genetic risk prediction of COVID-19 susceptibility and severity in the Indian population The Indian Genome Variation Consortium MedRxiv (2021), 1-13.	Prakrithi, P.; Lakra, Priya; Sundar, Durai; Kapoor, Manav; Mukerji, Mitali; Gupta, Ishaan;	0
48	Plant aquaporins: A frontward to make crop plants drought resistant Physiologia Plantarum (2021), 172(2), 1089-1105	Ahmed, Sajad; Kouser, Shaista; Asgher, Mohd; Gandhi, Sumit G. From	4.04
49	Screening of compound library identifies novel inhibitors against the MurA enzyme of *Escherichia* coli Applied Microbiology and Biotechnology (2021), 105(9), 3611-3623.	Raina, Diksha; Tiwari, Harshita; Sharma, Smriti; Deepika; Chinthakindi, Praveen Kumar; Nargotra, Amit; Sangwan, Payare L.; Eniyan, Kandasamy; Bajpai, Urmi; Vishwakarma, Ram A.; et al	4.813
50	Catalyst free synthesis of 2-Aryl-2H-benzo[b][1, 4]oxazines and 3-Aryl-2H-benzo[b][1,4]thiazin-2-ones: An ultrasonication-assisted strategy Journal of Heterocyclic Chemistry (2021), 58(7), 1541-1545.	Teli, Bisma; Waseem, Malik Abdul; Rashid, Showkat; Ganaie, Bilal Ahmad; Bhat, Bilal A.	2.193
51	Tetrahydropiperic acid (THPA) conjugated cationic hybrid dipeptides as antimicrobial agents Journal of Antibiotics (2021), 74(7), 480-483.	Rahim, Junaid; Singh, Gurpreet; Shankar, Sudha; Katoch, Meenu; Rai, Rajkishor	2.649
52	Comprehensive genome-wide identification, characterization, and expression profiling of MATE gene family in *Nicotiana tabacum* Gene (2021), 783, 145554	Gani, Umar; Sharma, Priyanka; Tiwari, Harshita; Nautiyal, Abhishek Kumar; Kundan, Maridul; Wajid, Mir Abdul; Kesari, Ravi; Nargotra, Amit; Misra, Prashant	3.688
53	Amalgamation of in-silico, in-vitro and in-vivo approach to establish glabridin as a potential CYP2E1 inhibitor Xenobiotica (2021), 51(6), 625-635.	Bhatt, Shipra; Kumar, Vinay; Dogra, Ashish; Ojha, Probir Kumar; Wazir, Priya; Sangwan, Payare Lal; Singh, Gurdarshan; Nandi, Utpal	1.908
54	Temperature mitigation strategies in *Lepidium latifolium* L., a sleeper weed from Ladakh himalayas Environmental and Experimental Botany (2021), 184, 104352	Khajuria, Manu; Jamwal, Sumit; Ali, Villayat; Rashid, Aatif; Faiz, Sheenam; Vyas, Dhiraj	5.36

S.No	Title	Author	Impact Factor
55	Inhibition of Ultraviolet- B Radiation Induced Photodamage by Trigonelline Through Modulation of Mitogen Activating Protein Kinases and Nuclear Factor- κBSignaling Axis in Skin Photochemistry and Photobiology (2021), 97(4), 785-794	A. Nazir, Lone; Tanveer, Malik A.; Umar, Sheikh A.; Love, Sharma; Divya, Gupta; Tasduq, Sheikh A.	3.421
56	Effect of temperature and insect herbivory on the regulation of glucosinolate-myrosinase system in *Lepidium latifolium* Physiologia Plantarum (2021), 172(1), 53-63.	Bhat, Rohini; Faiz, Sheenam; Ali, Villayat; Khajuria, Manu; Mukherjee, Debaraj; Vyas, Dhiraj	4.04
57	Ready Access to Densely Substituted Furans Using Tsuji-Wacker-Type Cyclization The Journal of organic chemistry (2021).	MasalDattatraya P; Choudhury Rahul; Singh Aman; Reddy D Srinivasa; MasalDattatraya P; Choudhury Rahul;	4.354
58	Myxobacteria from animal dung pellets collected from northwestern Himalayas: A new source of di-isobutyl phthalate Journal of basic microbiology (2021)	Sharma Arushi; Babu Vikash; KatochMeenu; Sharma Arushi; Kumar Amit; Babu Vikash; Ali Asif; KatochMeenu; Kumar Amit; Ali Asif	2.281
59	Cocculus hirsutus-Derived Phytopharmaceutical Drug Has Potent Anti-dengue Activity Frontiers in microbiology (2021), 12, 746110.	Shukla Rahul; Poddar Ankur; Shanmugam Rajgokul K; Chaturvedi Shivam; Khanna Navin; Rajpoot Ravi Kant; Ahuja Richa; BeesettiHemalatha; Nayyar Kaushal; Jain Tapesh; et al	5.64
60	Coronarin K and L: Two Novel Labdane Diterpenes From *Roscoea purpurea*: An Ayurvedic Crude Drug Frontiers in chemistry (2021), 9, 798461	SingamaneniVenugopal; Lone Bashir; Gupta Prasoon; Lone Bashir; Singh Jasvinder; Kumar Pankaj; Gairola Sumeet; Singh Shashank; Gupta Prasoon; Singh Jasvinder; et al	4.62
61	Secondary Metabolite Profiling, Anti-Inflammatory and Hepatoprotective Activity of *Neptunia triquetra* (Vahl) Benth Molecules (Basel, Switzerland) (2021), 26(23)	Wagay Nasir Aziz; Wagay Nasir Aziz; Rafiq Shah; Rather Mohammad Aslam; Tantray Younas Rasheed; Lin Feng; Wani Shabir Hussain; El-Sabrout Ahmed M; ElansaryHosam O; Mahmoud Eman A	4.148
62	Identification of novel MurA inhibitors using in silico approach, their validation and elucidation of mode of inhibition Journal of biomolecular structure & dynamics (2021), 1-12.	Tiwari Harshita; Gupta Monika; Barik Manas Ranjan; Nargotra Amit; Tiwari Harshita; Raina Diksha; Barik Manas Ranjan; Nargotra Amit; Raina Diksha; Khan Inshad Ali; et al	3.392
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149	The modulation of PI3K/Akt pathway by 3β hydroxylup-12-en-28-oic acid isolated from *Thymus linearis* induces cell death in HCT-116 cells Chemical Biology & Drug Design, 2022, 99(1), pp.162-178.	Bashir R, Ahmad Zargar O, Hamid Dar A, Yedukondalu N, Parvaiz Q, Hamid R.	2.54
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151	Palladium catalyzed migratory heck coupling of arteannuin B and boronic acids: An approach towards the synthesis of antiproliferative agents in breast and lung cancer cells Bioorganic Chemistry, 2022, 122, p.105694.	Rasool JU, Mir KB, Shaikh M, Bhat AH, Nalli Y, Khalid A, Ahmad SM, Goswami A, Ali A.	5.275
152	Development of biocompatible nanoparticles of tizanidine hydrochloride in orodispersible films: In vitro characterization, ex vivo permeation and cytotoxic study on carcinoma cells Current Drug Delivery. 2022.	Sinha S, Thapa S, Singh S, Dutt R, Verma R, Pandey P, Mittal V, Rahman MH, Kaushik D.	2.79
153	Comparative transcriptome mining for terpenoid biosynthetic pathway genes in wild and cultivated species of Plantago Protoplasma, 2022, 259(2), pp.439-452.	Gupta S, Singh R, Sharma A, Rather GA, Lattoo SK, Dhar MK.	2.89
154	Synergistic antimicrobial and antibiofilm activities of piperic acid and 4-ethylpiperic acid amides in combination with ciprofloxacin The Journal of Antibiotics, 2022, 75(4), pp.236-242.	Singh G, Wani NA, Rahim JU, Shankar S, Rai R, Katoch M.	3.33
155	Anticancer Activity of *Cordia dichotoma* against a Panel of Human Cancer Cell Lines and Their Phytochemical Profiling via HPLC and GCMS Molecules,2022, 27(7), p.2185.	Raina S, Sharma V, Sheikh ZN, Kour N, Singh SK, Zari A, Zari TA, Alharby HF, Hakeem KR.	4.411
156	Burkholderia gladioli E39CS3, an endophyte of *Crocus sativus* Linn., induces host resistance against corm-rot caused by Fusarium oxysporum Journal of Applied Microbiology, 2022, 132(1), pp.495-508.	Ahmad T, Bashir A, Farooq S, Riyaz-Ul-Hassan S.	3.772

S.No	Title	Author	Impact Factor
157	Biochemical, genotoxic, histological and ultrastructural effects on liver and gills of fresh water fish Channa punctatus exposed to textile industry intermediate 2 ABS Chemosphere, 287, p.132103.	Sharma K, Sharma P, Dhiman SK, Chadha P, Saini HS.	7.06
			4.139664516

9 LIST OF PATENTS (2021-2022)

Patents Filed In Foreign Countries

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
1	0162NF2019/AU	AU	IIIM	PROCESS FOR THE SYNTHESIS OF CANNABIDIOL AND INTERMEDIATES THEREOF	Radhika Anand, Sumit Sharma, Pankaj Singh Cham, Veeranjaneyulu-Gannedi, Mukesh Kumar, Varun Pratap Singh, Vishav Prakash Rahul, Vishwakarma Ram Ashrey, Singh Parvinder Pal	---	14-Sep-21	2021235467	PP	---	---
2	0162NF2019/CA	CA	IIIM	PROCESS FOR THE SYNTHESIS OF CANNABIDIOL AND INTERMEDIATES THEREOF	Radhika Anand, Sumit Sharma, Pankaj Singh Cham, Veeranjaneyulu-Gannedi, Mukesh Kumar, Varun Pratap Singh, Vishav Prakash Rahul, Vishwakarma Ram Ashrey, Singh Parvinder Pal	---	15-Sep-21	3133788	PP	---	---
3	0029NF2019/ZA	ZA	IIIM	PROCESS FOR THE PREPARATION OF DERIVATIVES OF 1,1-DIALKY-LETHANE-1,2-DIOLS AS USEFUL INTERME-DIATES	SHARMA SUMIT, AHMED RIYAZ, RAINA SUSHIL, RAM ASREY VISHWAKARMA, SINGH PARVINDER PAL	---	17-Sep-21	2021/06931	PP	---	---
4	0029NF2019/CN	CN	IIIM	PROCESS FOR THE PREPARATION OF DERIVATIVES OF 1,1-DIALKY-LETHANE-1,2-DIOLS AS USEFUL INTERME-DIATES	SHARMA SUMIT, AHMED RIYAZ, RAINA SUSHIL, RAM ASREY VISHWAKARMA, SINGH PARVINDER PAL	---	30-Sep-21	2.0208E+11	PP/ PUB	---	---

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Pat-ent No.
5	0162NF2019/US	US	IIIM	PROCESS FOR THE SYNTHESIS OF CANNABIDIOL AND INTERMEDIATES THEREOF	Radhika Anand, Sumit Sharma, Pankaj Singh Cham, Veeranjaneyulu-Gannedi, Mukesh Kumar, Varun Pratap Singh, Vishav Prakash Rahul, Vishwakarma Ram Ashrey, Singh Parvinder Pal	---	15-Oct-21	17/594448	PP	---	---
6	0162NF2019/IL	IL	IIIM	PROCESS FOR THE SYNTHESIS OF CANNABIDIOL AND INTERMEDIATES THEREOF	Radhika Anand, Sumit Sharma, Pankaj Singh Cham, Veeranjaneyulu-Gannedi, Mukesh Kumar, Varun Pratap Singh, Vishav Prakash Rahul, Vishwakarma Ram Ashrey, Singh Parvinder Pal	---	27-Oct-21	287632	PP	---	---

Patents Granted In Foreign Countries

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
1	0169NF2015/GB	GB	IIIM	SUBSTITUTED AURONE ALKALOIDS AS ANTI-MYCOBACTERIAL AGENTS	Satish SonbaraoGudup, Sanjay Kumar, Hari Prasad Aruri, Umed Singh, GurunadhamMunagala, Kushalava Reddy Yempalla, Samsher Singh, Inshad Ali Khan, Vishwakarma Ram Asrey, Parvinder Pal Singh	---	04-Sep-18	17725779.7	IF/EP DESIG.	**07-Apr-21**	3423449
2	0169NF2015/EP	EP	IIIM	SUBSTITUTED AURONE ALKALOIDS AS ANTI-MYCOBACTERIAL AGENTS	Satish SonbaraoGudup, Sanjay Kumar, Hari Prasad Aruri, Umed Singh, GurunadhamMunagala, Kushalava Reddy Yempalla, Samsher Singh, Inshad Ali Khan, Vishwakarma Ram Asrey, Parvinder Pal Singh	---	04-Sep-18	17725779.7	RO/EP/NP/IF	**07-Apr-21**	3423449
3	0058NF2014/CA	CA	IIIM	ALKYLIDENE PHOSPHONATE ESTERS AS P-GLYCOPROTEIN INDUCERS	BHARATE SANDIP, KUMAR AJAY, MANDA SUDHAKAR, JOSHI PRASHANT, BHARATE SONALI, WANI ABUBAKAR, SHARMA SADHANA, VISHWAKARMA RAM	---	13-Mar-17	29,61,166	IF	**13-Apr-21**	29,61,166
4	0180NF2016/US	US	IIIM	INDOLYLKOJYL METHANE ANALOGUES, PROCESS OF PREPARATION THEREOF AND USE AS INHIBITOR OF CANCER CELL INVASION AND METASTASIS	DEBARAJ MUKHERJEE, ANINDYA GOSWAMI, DEEPAK SHARMA, DEBASIS NAYAK, SHREYANS KUMAR JAIN	---	23-Dec-19	16/626274	IF	**23-Nov-21**	11180486

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
5	0106NF2013/EP	EP	IIIM	NOVEL PYRAZOLOPYRIMIDINONES AS PDE-5 INHIBITORS	Sawant SanghapalDamodhar, GinnereddyLakshma Reddy, Mahesuni Srinivas, Syed Sajad Hussain, Dar MohdIshaq, Nargotra Amit, Mahajan Priya, Vishwakarma Ram Asrey	---	29-Jul-16	14824549.1	RO/EP/NP/IF	**26-Jan-22**	3099689
6	0106NF2013/GB	GB	IIIM	NOVEL PYRAZOLOPYRIMIDINONES AS PDE-5 INHIBITORS	Sawant SanghapalDamodhar, GinnereddyLakshma Reddy, Mahesuni Srinivas, Syed Sajad Hussain, Dar MohdIshaq, Nargotra Amit, Mahajan Priya, Vishwakarma Ram Asrey	---	04-Aug-16	14824549.1	IF/EP DESIG.	**26-Jan-22**	3099689
7	0106NF2013/FR	FR	IIIM	NOVEL PYRAZOLOPYRIMIDINONES AS PDE-5 INHIBITORS	Sawant SanghapalDamodhar, GinnereddyLakshma Reddy, Mahesuni Srinivas, Syed Sajad Hussain, Dar MohdIshaq, Nargotra Amit, Mahajan Priya, Vishwakarma Ram Asrey	---	04-Aug-16	14824549.1	IF/EP DESIG.	**26-Jan-22**	3099689
8	0106NF2013/DE	DE	IIIM	NOVEL PYRAZOLOPYRIMIDINONES AS PDE-5 INHIBITORS	Sawant SanghapalDamodhar, GinnereddyLakshma Reddy, Mahesuni Srinivas, Syed Sajad Hussain, Dar MohdIshaq, Nargotra Amit, Mahajan Priya, Vishwakarma Ram Asrey	---	04-Aug-16	14824549.1	IF/EP DESIG.	**26-Jan-22**	3099689

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
9	0211NF2015/GB	GB	IIIM	3-PYRIMIDINYL PYRROLO [2,3-b] PYRIDINE AS NEW ANTICANCER AGENTS AND THE PROCESS FOR THE PREPARATION THEREOF	UMED SINGH, GOUSIA CHASHOO, GIRISH MAHAJAN, THANUSHA THATIKONDA, PRIYA MAHAJAN, HARI PRASAD ARURI, SATISH SONBARAO GUDUP, AMIT NARGOTRA, DILIP MANIKRAO MONDHE, RAM ASREY VISHWAKARMA, PARVINDER PAL SINGH	---	21-Jun-18	16834200.4	IF/EP DESIG.	**09-Feb-22**	3383875
10	0211NF2015/FR	FR	IIIM	3-PYRIMIDINYL PYRROLO [2,3-b] PYRIDINE AS NEW ANTICANCER AGENTS AND THE PROCESS FOR THE PREPARATION THEREOF	UMED SINGH, GOUSIA CHASHOO, GIRISH MAHAJAN, THANUSHA THATIKONDA, PRIYA MAHAJAN, HARI PRASAD ARURI, SATISH SONBARAO GUDUP, AMIT NARGOTRA, DILIP MANIKRAO MONDHE, RAM ASREY VISHWAKARMA, PARVINDER PAL SINGH	---	21-Jun-18	16834200.4	IF/EP DESIG.	**09-Feb-22**	3383875
11	0211NF2015/EP	EP	IIIM	3-PYRIMIDINYL PYRROLO [2,3-b] PYRIDINE AS NEW ANTICANCER AGENTS AND THE PROCESS FOR THE PREPARATION THEREOF	UMED SINGH, GOUSIA CHASHOO, GIRISH MAHAJAN, THANUSHA THATIKONDA, PRIYA MAHAJAN, HARI PRASAD ARURI, SATISH SONBARAO GUDUP, AMIT NARGOTRA, DILIP MANIKRAO MONDHE, RAM ASREY VISHWAKARMA, PARVINDER PAL SINGH	---	21-Jun-18	16834200.4	RO/EP/NP/IF	**09-Feb-22**	3383875

Patents Filed in India

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
1	0207NF2020/IN	IN	IIIM	NON INFRINGING PROCESS FOR THE SYNTHESIS OF N4-HYDROXYCYTIDINE AND ITS DERIVATIVES	Debaraj Mukherjee, Qazi Naveed Ahmed, Ajaz Ahmed, Junaid ShafiBanday	06-May-21	---	202111020678	PP	---	---
2	0227NF2020/IN	IN	IIIM	A COMPOSITION FOR ANTI-BACTERIAL BIO-CELLULOSIC PATCHES USEFUL FOR TRANSDERMAL DRUG DELIVERY AND A PROCESS FOR THE PREPARATION THEREOF	SARAN SAURABH, KUMAR MANOJ, CHIB SHIFALI, BHAT RAHUL, NANDI UTPAL, DOGRA ASHISH, KHAN INSHAD ALI	---	01-Oct-21	202111044817	PP	---	---
3	0228NF2020/IN	IN	IIIM	Cannabinoids C- and O-glycosides possessing anti-proliferative and anti-metastatic properties and process for preparation thereof	GOSWAMI ANINDYA, ALI ASIF, CHAKRABORTY SOUNEEK, MIR BASHIR KHALID, GENNEDI VEERANJANEYULU, LONE IQBAL WASEEM, NALLI YEDUKONDALU	---	01-Oct-21	202111044828	PP	---	---
4	0085NF2021/IN	IN	IIIM	A PROCESS FOR THE PREPARATION OF TETRAHYDROANTHRACENES FROM STREPTOMYCES CURACOI (MTCC-25420) AND ANTICANCER ACTIVITY THEREOF	Asha Chaubey, Ravi Singh Manhas, Jasmine Kour Khosla, Ajaz Ahmed, Syed Mudabir Ahmad, Harshita Tiwari, Amit Nargotra, Debaraj Mukherjee, Anindya Goswami	---	20-Oct-21	202111047805	PP	---	---

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
5	0217NF2021/IN	IN	IIIM	PROCESS FOR THE PREPARATION OF NAFAMOSTAT, CAMOSTAT AND THEIR DERIVATIVES	Riyaz Ahmed, Gulshan Kumar, Sheena Mahajan, Praveen Kumar Verma, Pankaj Singh Cham, Amit Kumar, Qazi Naveed Ahmed, Dumbala Srinivasa Reddy, Ravi Shankar, Parvinder Pal Singh	07-Feb-22	---	202211006599	PP	---	---
6	0086NF2021/IN	IN	IIIM	SYNTHESIS OF GLIFLOZINS VIA PALLADIUM CATALYZED STEREOSELCETIVE OXIDATIVE COUPLING OF GLYCALS WITH ARYL HALIDES	DEBARAJ MUKHERJEE, IRSHAD ZARGAR AHMAD, AJAZ AHMED, NAZAR HUSSAIN	---	18-Feb-22	202211009236	PP	---	---
7	0192NF2021/IN	IN	IIIM	PIPERIC ACID-CONJUGATE WITH HOMOCHIRAL AND HETEROCHIRAL DIPEPTIDES CONTAINING PHENYLALANINE AND PROCESS FOR PREPARATION THEREOF	RAJKISHOR RAI, ANINDYA GOSWAMI, JUNAID RAHIM UR, MIR FAHEEM MOHD, SHAH NAWAZ	29-Mar-22	---	202211019289	PP	---	---
8	0040NF2022/IN	IN	IIIM	Phialomustin B (1) for treatment of Parkinson's disease (PD) and Amyotrophic lateral sclerosis (ALS)	B Padmanabhan, Ali Asif, Prashant Deshmukh, Sruthi Unni, NalliYedukondalu, M M Srinivas Bharath, Riyaz-Ul-Hassan Syed, Wani Zahoor Ahmed	30-Mar-22	---	202211019288	PP	---	---

Patents Granted in India

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
1	0225NF2012/IN	IN	IIIM	6-NITRO-2,3-DIHYDRO-IMIDAZO[2,1-b]OXAZ-OLES AND A PROCESS FOR THE PREPARATION THEREOFANTI-MYCO-BACTERIAL AGENTS	Parvinder Pal Singh, GURUN-ADHAM MUNAGALA, KUSHALAVA REDDY YEM-PALLA, INSHAD ALI KHAN, NITIN PAL KALIA, VIKRANT SINGH RAJPUT, AMIT NARGOTRA, SANGHAPAL DAMODHAR SAWANT, RAM ASREY VISHWAKARMA	---	04-Oct-13	2954DEL2013	IF	**26-Apr-21**	365339
2	0176NF2014/IN	IN	IIIM	SUBSTITUTED 1,2,3-TRI-AZOL-1-YL-METH-YL-2,3-DIHYDRO-2-METH-YL-6-NITROIMIDAZ-O[2,1-b]OXAZOLES AS ANTI-MYCOBACTERIAL AGENTS AND A PROCESS FOR THE PREPARATION THEREOF	YEMPALLA KUSHALA-VA REDDY, MUNAGALA GURUNADHAM, SINGH SAMSHER, SHARMA SUMIT, KHAN INSHAD ALI, VISH-WAKARMA RAM ASREY, SINGH PARVINDER PAL	---	21-Oct-14	3009DEL2014	IF	**01-May-21**	365908
3	0059NF2014/IN	IN	IIIM	10-SUBSTITUTED COLCHICINOIDS AS POTENT ANTICANCER AGENTS	VISHWAKARMA RAM, BHA-RATE SANDIP BIBISHAN, KUMAR AJAY, SINGH BAL-JINDER, KUMAR ASHOK, BHUSHAN SHASHI, HAMID ABID, JOSHI PRASHANT, GURU SANTOSH KUMAR, KUMAR SURESH, HUSSAIN AASHIQ, QAZI ASIF KHUR-SHID, BHARATE SONALI SANDIP, SHARMA PARDU-MAN, SAXENA AJIT KUMAR, MONDHE DILIP MANIKRAO, MAHAJAN GIRISH, WANI ZA-HOOR	---	14-Oct-14	2929DEL2014	IF	**27-Jun-21**	370382
4	0117NF2013/IN	IN	IIIM	6-ARYL-4-PHENYLAMI-NO-QUINAZOLINE ANALOGS AS PHOSPHO-INOSITIDE-3-KINASE INHIBITORS	VISHWAKARMA RAM ASREY, BHARATE SANDIP BIBIS-HAN, BHUSHAN SHASHI, YADAV RAMMOHAN RAO, GURU SANTOSH KUMAR, JOSHI PRASHANT	---	27-Feb-14	0554DEL2014	IF	**26-Jul-21**	372693

SNo	NFNO	Country	Lab	Title	Inventors	Prov. Filing Date	Comp. Filing Date	Application No.	Status	Grant Date	Patent No.
5	0294NF2015/IN	IN	IIIM	FURANOCHALCONES AS INHIBITORS OF CYP1A1, CYP1A2 AND CYP1B1 FOR CANCER CHEMOPREVENTION	BHARATE SANDIP BIBISHAN, SHARMA RAJNI, JOSHI PRASHANT, VISHWAKARMA RAM, CHAUDHURI BHABATOSH	---	12-Aug-16	2.01611E+11	IF	**09-Aug-21**	374132
6	0288NF2005/IN	IN	IIIM	AN ENZYMATIC PROCESS FOR THE PREPARATION OF CATALPOL	PARSHAD RAJINDER, SURI KRISHAN AVTAR, RAINA CHAND JI, SATTI NARESH KUMAR, QAZI GHULAM NABI	22-Mar-06	15-Dec-06	0776DEL2006	AB/No Commercial	**08-Sep-21**	376700
7	0218NF2015/IN	IN	IG-IB+IIIM	Synthetic melanin nanoparticles for skin pigmentation and method of preparation thereof	ManikaVij, Ritika Grover, VishvabandhuGotherwal, Aanchal Gupta, Naiem Ahmad Wani, Prashant Joshi, Munia Ganguli, Rajkishor Rai, Vivek Tirunelveli Natarajan, Rajesh Sudhir Gokhale	29-Apr-16	25-Apr-17	201611014933	IF/2023	**14-Feb-22**	389146

S. No.	Reference No.	Trademark/ Word/logo name	Class	Trademark Type	Application no. with Date	Status as on 31.12.2021
			TRADEMARKs GRANTED			
1	**21/TM/2017**	Bosvita (Nutra)	5 and 31	Word	3779782 Dt. 16/March/2018	Registered on Jan 26, 2021
2	**33/TM/2017**	**Colepro**	5 and 31	Word	3782605 Dt. 20/March/2018	Registered on Jan 26, 2021
			TRADEMARKs Filed			
1	**008TM2021**	Zinc Gluconate - Acerola cherry extract (capsules)	5 and 31	Word	1-Oct-21	Application Filed
2	**009TM2021**	Zinc Gluconate - Acerola Cherry Vitamin C (capsules)	5 and 31	Word	1-Oct-21	Application Filed

10 CSIR-SKILL DEVELOPMENT INITIATIVES

CSIR-IIIM has a special focus towards skill development to cater to the growing scientific sector. This sector requires special skills to carry out research & innovation like big experimental analysis, operation of special equipment and so on. Development of such skills can remove disconnect between demand and supply of skilled manpower in Science & Technology, building the vocational and technical training framework, skill up-gradation, building of new skills, and innovative thinking not only for existing jobs but also jobs that are to be created in this sector.

CSIR-IIIM Jammu this year has successfully trained 1211 participants through Hybrid mode which involved capacity building, Workshops in thrust areas as well as Skill Development Cum Entrepreneurshipprogrammes. Several Programmes were tailor made to suit corresponding skills of participants and the SDP's ranged from different fields of Microbiology, Industrial Microbiology, Health care including Phytopharma Drug Development, Floriculture through Cultivation of High value Aromatic plants, Hands on Training (BSL-3) for Armed Forces in Covid testing. Entrepreneurship of women through Lavender and Rose production & processing and Rosemary & Clatystsage production & processing. Other Health care programmes under CSIR-Skill Initiatives like Training on cGMP pilot plant, Drug Discovery & Development, Manufacturing of Phyto-pharmaceutical Drugs, GeneCloning and Cell Culture Techniques in Anti-Cancer Discovery were helpful for different range of participants.

A Novel CSIR-IIIM Research and Training programme was launched by Institute to ameliorate the stagnancy created in the academic scenario of the nation due to Covid-19 pandemic. The same endeavor under CSIR-SDP was planned for reinvigorating and revitalizing the student fraternity with knowledge and motivation during these tough times of pandemic. Around 6993 Students and Researchers in PG/PhD applied for same Research& Training internship in which 126 participants were selected all over India for advance training for Two months. The same Research & Training Programme was widely appreciated by different group of participants on Social media Channels (screenshots attached in Annexure II).

In Chemical Sciences Theme, Workshop on Upstream and Downstream Processing Techniques in Fermentation was organized benefiting participants from Chemical Engineering, Microbiology and Process Design Engineers. One more workshop for two weeks was organized on Theme Advanced Techniques in Natural Products & Medicinal Chemistry, Another Programme in Biotechnology and Fermentation Technology was organized to suit allied sectors/themes.

IIT Jammu students were trained for one month in Renewable Energy Theme in Design and Development of Active Dryers on Solar Energy for Fruits & vegetable Drying.

In Biotechnology and Microbiology Theme, Several programmes were conducted in Molecular Biology techniques and Microbiology.

An important workshop on Intellectual property Rights was also organized catering to different fields in Science & technology with participation from All over India.

Programs Conducted

S.No.	Date(s)		Title of SDP	Sector/ Discipline	No. of Trainees				Category (SC/ST/ OBC/ EWS/ Gen)	Educational Qualifications	Name(s) of Faculty
	From	To			Total	M	F	TG			
1	03 May	07 May	Basic Techniques on Industrial Microbiology	Microbiology	49	10	39		All Inclusive	PG/PhD/ faculty/Researchers	Dr. Saurabh Saran, Dr. Asha Chaubey Dr. Vikash Babu Dr. Vinod Kumar Er. Ankush Varma
2	07 June	10 June	Phytopharma Drug Development	Health care	99	32	67		All Inclusive	PG/PhD	Dr. Saurabh Saran, Er. Anil K Katare Er. Ankush Varma,
3	02 July	02 July	One day Skill Development Program on " Prospectus of Commercial Cultivation of High Value Aromatic Crops	Floriculture	40	12	28		All Inclusive	PG/PhD	Dr Shahid Rasool Dr Padma Lay
4	02 July	17 July	Hands on training in BSL-3 Laboratory Practices & RT-PCR Testing of Clinical Samples for Covid-19	Health care/ Covid-19	07	05	02		All Inclusive	Security Forces	Dr Sumit Gandhi Dr Kuljit Singh Dr Rashmi
5	15 July	15 July	One Day capacity Building programme on the "Scope of Lavender & Rose Production & processing in Entrepreneurship Development	Entrepreneurship	42	17	25		All Inclusive	Pg/PhD/ self Help Groups	Dr shahid Rasool Dr Qazi Parvaiz Dr Phalistein
6	03 Aug	03 Aug	One day capacity building programme on the "Scope of Rosemary &Clatysage production & processing in Entrepreneurship Development"	Capacity Building/ Entrepreneurship	40	11	29		All Inclusive	Self Help Groups/ Entrepuners/ Women Entrpuners	Dr Shahid Rasool Dr Padma Lay
7	23 Aug	22 Oct	Two months "CSIR-IIIM Research & Training Programme 2021" for Post Graduate Students	Biological/ Chemical Sciences	126	38	88		All Inclusive	PG Students	All Scientists of CSIR-IIIM Jammu

S.No.	Date(s)		Title of SDP	Sector/ Discipline	No. of Trainees				Category (SC/ST/ OBC/ EWS/ Gen)	Educa-tional Qualifica-tions	Name(s) of Faculty
	From	To			Total	M	F	TG			
8	29 Sep	03 Oct	Five Days Skill Develop-ment Training Programme on "cGMP Pilot Plant"	Healthcare	05	05	00		All Inclusive	Faculty/ Researchers	Dr Anil Katare
9	12 Oct	14 Oct	Three Days Training Pro-gramme cum Workshop on "Molecular Biol-ogy Techniques"	Science/ Biological Sciences	54	25	29		All Inclusive	PG/PhD/ faculty/ Researchers	Dr Nasheman Dr Nazia
10	12 Aug	11 Oct	Two months Internship on Renewable Energy, AI/ML fermentation with IIT Jammu	Renewable Energy	04	04	00		All Inclusive	UG Students	Dr Nasir ul Rasheed Dr Saurabh Saran
11	04 Oct	09 Oct	Industrial Bio-technology and Fermentation Technology	Chemical Engg.	74	52	22		All Inclusive	PG/PhD students	Dr. Saurabh Saran, Dr. Asha Chaubey Dr. Sumit Gandhi Dr. Vikash Babu Dr. Vinod Kumar Dr. Meenu Katoch Dr. Syed Riyaz-Ul-Hassan Dr. Sandeep Jaglan Er. Ankush Varma
12	04 Oct	09 Oct	Basic Techniques in Industrial Biotechnology & Fermentation Technology	Biotech-nology	45	20	25		All Inclusive	PG/UG students	Dr. Asha Chaubey
13	16 Dec	21 Dec	Basic Techniques involved in Industrial Micro-biology for prod-uct development	Microbiol-ogy	30	21	9		All Inclusive	PG/UG students	Dr. Saurabh Saran, Er. Ankush Varma,
14	26 Dec	28 Dec	cGMP/ Phytopharma Drug Develop-ment	Health care	78	38	40				Dr. Anil katare
15	27 Dec	29 Dec	cGMP Man-ufacturing of Phyto-Pharma-ceutical Drug	Health care	88	35	53		All Inclusive	PG/UG students	Dr. Saurabh Saran, Er. Anil K Katare Dr. Vikash Babu Er. Ankush Varma,
16	19 Jan	22 Jan	Basic Techniques in Industrial Microbiology & Biotechnology	Industrial Biotech-nology	69	27	42		All Inclusive	PG/UG students	Dr. Saurabh Saran, Dr. Asha Chaubey, Er. Ankush Varma, Mr. Abhishek Magotra,

S.No.	Date(s)		Title of SDP	Sector/ Discipline	No. of Trainees				Category (SC/ST/ OBC/ EWS/ Gen)	Educational Qualifications	Name(s) of Faculty
	From	To			Total	M	F	TG			
17	19 Jan	22 Jan	Basic Techniques in Industrial Microbiology & Biotechnology	Industrial Microbiology/ biotechnology	30	11	19		All Inclusive	PG/UG students	Dr. Saurabh Saran, Dr. Asha Chaubey, Er. Ankush Varma, Mr Abhishek Magotra,
18	16 Feb	18 Feb	Principles & Applications of Advanced Analytical Techniques	IT & Data Analytics	59	20	39		All Inclusive	PG/UG students	Dr. Saurabh Saran Dr. Deepika Singh Er. Ankush Varma
19	19 Feb	20 Feb	Entrepreneurship Development Opportunities in Cultivation &processing of High Value AROMA Cash Crop	Entrepreneurship	73	35	38		All Inclusive	Pg/PhD/ self help Groups/ Entreneurpers	Dr. shahid Rasool Dr. Padma Lay
20	07 Mar	08 Mar	Two Days Online Skill Development Program in IPR	Intellectual Property Rights	106	30	76		All Inclusive	PG/UG/ Faculty/Researchers	Dr. Kanchrela Prasad Dr. Nasir
21	14 Mar	16 Mar	Three Day workshop on "Gene Cloning & Cell Culture Techniques in Anti-Cancer Discovery	Healthcare	07	01	06		All Inclusive	Post Doc/ PhD/PG/ Researchers	Dr. Zabeer Dr. Shashank Dr. Goswami Dr. Jamal
22	15 Mar	22 Mar	Hands-on Workshop on Advanced Techniques in Natural Products & Medicinal Chemistry	Chemical Sciences	26	14	12		All Inclusive	PhD/PG students	Dr. Momo Dr. Bharate Dr. Prasoon Dr. Qazi Naveed
23	28 Mar	29 Mar	Two Days online workshop on Up-Stream and Down-Stream processing Techniques in fermentation	Chemical Sciences	60	12	48		All Inclusive	UG/PG students	Dr. Asha Dr. Saurabh Dr. Vinod
			Total	**23**	**1211**	**475**	**736**				

Glimpses of SDPs

Three Day workshop on "Gene Cloning & Cell Culture Techniques in Anti-Cancer Discovery

Hands on training in BSL-3 Laboratory Practices & RT-PCR Testing of Clinical Samples for Covid-19

Entrepreneurship Development Opportunities in Cultivation &processing of High Value AROMA Cash Crop

Karyashala: Industrial Biotechnology and Fermentation Technology

Five Days Skill Development Training Programme on "cGMP Pilot Plant"

Three Days Workshop on Entrepreneurship in Cultivation, processing , Post-harvest management and marketing of Aromatic Crops

Certificate distribution inThree Day workshop on "Gene Cloning & Cell Culture Techniques in Anti-Cancer Discovery

Five Days Skill Development Training Programme on "cGMP Pilot Plant"

Three days Workshop on Molecular Biology Techniques under CSIR-SDP

SDP on Cultivation and Processing of Aromatic & Medicinal Plants

SDP on Entrepreneurship on MAP's

Five Day SDP cum Workshop on Covid 19 Testing/ Sampling in BSL3 Lab

cGMP Workshop

Capacity Building Programme in Floriculture and MAP's

Workshop on Intellectual Property Rights

Workshop cum Capacity Building on Phytopharama Drug Discovery

11 KEY ACTIVITIES DURING THE FINANCIAL YEAR

11.1 Top Events of Institution in 2021-2022

Two Days Lavender Festival at Bhaderwah

On the 2nd day of the event, Minister for Science and Technology and MoS in PMO Dr. Jitinder Singh formally inaugurated the lavender festival.

Inauguration Ceremony of BioNEST Bioincubation Centre by Dr. Jitendra Singh, Hon'ble Union Minister at CSIR-IIIM, Jammu

The BioNESTBioincubation Centre has been graciously inaugurated by Dr. Jitendra Singh, Hon'ble Union Minister at CSIR-IIIM, Jammu today. The biotech incubator is supported by BIRAC DBT, Govt of India.

CSIR Floriculture Mission Activities launched in J&K

11.2 CSIR-Indian Institute of Integrative Medicine (CSIR-IIIM), Jammu launched activities of CSIR Floriculture Mission in the Jammu and Kashmir UT on 5th November 2021 in a day long programme at CSIR-IIIM (Br.) Srinagar. Dr Jitendra Singh, Union Minister of State, Science & Technology and Earth Sciences (Independent Charge); MOS in Prime Minister's Office; Personnel, Public Grievances and Pensions; Department of Atomic Energy and Department of Space was the Chief guest at the event and Dr. Shekhar C. Mande, Director General CSIR and & Secretary to Govt. of India, DSIR, Dr. J. P. Sharma, Vice Chancellor, SKUAST- Jammu and SKUAST- Kashmir, Dr D.S Reddy, Director CSIR-IIIM, Prof. Sarfaraz Ahmad Wani, Director Research SKUAST-K, Prof. D.M. Makhdoomi, Director Extension SKUAST-K, Prof. Gul Zaffar, Registrar SKUAST-K, Er. Abdul Rahim Head, RMBD&IST and Dr.Zabeer Ahmed, Head, CSIR-IIIM (Br.) Srinagar were also present on the occasion. More than 100 farmers from different districts of Kashmir valley attended the event and later interacted with the Minister.

DG, CSIR visited Ladakh UT from 07 to 10 Oct' 21; Reviewed CSIR Initiatives for Ladakh, Held meetings with LG and Administrative Secretaries of Ladakh UT

Dr. Shekhar C. Mande, Director General, CSIR visited Union Territory of Ladakh from 7th-10th October. 2021, during which he took a review of S&T Initiatives of CSIR in Ladakh UT. The Team CSIR under the dynamic leadership of Director General, Dr. Shekhar C. Mande, has envisaged a structured proposal to provide better scientific, technical, medical and societal support to Ladakh. In the first phase, six CSIR Institutes viz. CSIR-IIIM, CSIR-IHBT, CSIR-NBRI, CSIR-NGRI, CSIR-CMERI and CSIR-CLRI have evolved the areas & need based proposals to be implemented in the Ladakh Union Territory.

11.3 One-day Workshop on CSIR initiatives for Science & Technology led development in J&K (UT)

Technology developed by CSIR will be implemented in J&K UT

One-day workshop on CSIR initiatives for Science & Technology led development in the Union Territory of Jammu & Kashmir under the aegis of Council of Scientific and Industrial Research (CSIR) and J&K Science & Technology Department was held on 19th September 2021 at Sher-e-Kashmir International Convention Center. Dr Jitendra Singh, Hon'ble Union Minister of State (Independent Charge) Science & Technology; Minister of State (Independent Charge) Earth Sciences; MoS PMO, Personnel, Public Grievances, Pensions, Atomic Energy and Space inaugurated the workshop whileas distinguished scientists, academicians and bureaucrats, faculties of various Colleges and Universities from across Union Territory of J&K have attended this workshop.

11.4 Farmers interaction with Dr. Jitendra Singh under CSIR Aroma Mission Phase-II

An interaction with aromatic crop-growing farmers was conducted under CSIR-Aroma Mission Phase-II at CSIR-Indian Institute of Integrative Medicine, Jammu today. Dr. Jitendra Singh, Hon'ble Minister of State for S&T, Earth Sciences (Independent Charge), was Chief Guest of the program. The program was attended by Shri. Navin Kumar Chaudhary, Principal Secretary to Government of J&K, Dr. J.P. Sharma, Vice-Chancellor, SKAUST, Jammu, Dr. Raghav Langer, Divisional Commissioner Jammu, Dr. K.K. Sharma, Director Agriculture, Jammu, Dr.MahendraDarokar, Sr. Principal Scientist, CSIR-HQ.

11.5 Director General, CS IR Visit to CSIR-IIIM Branch Srinagar (09th – 13th July 2021)

DG, CSIR calls on Lt Governor of J&K

Dr. Shekhar C. Mande, Director General CSIR along with Dr. D Srinivasa Reddy, Director CSIR-IIIM called on Lieutenant Governor J&K Sh. Manoj Sinha and apprised him about the introduction of lavender and other high value cash crops by CSIR in J&K for which a complete model is established in Pulwama District. Dr. Mande expressed his satisfaction to share that this initiative of CSIR has visible impact on the income of the farmers and employment generation particularly for women and unemployed educated youths. DG CSIR also informed the Lieutenant Governor about the other CSIR S&T initiatives in J&K and rest of the country and offered implementation of the CSIR Technologies relevant to the J&K especially societal development and rural empowerment.

11 CONFERENCES / WEBINARS / SEMINARS / SYMPOSIUM / BOOKS / BOOK CHAPTERS / INVITED TALKS / WORKSHOPS ETC.

12.1 Conferences / Webinars

- **Dr. J S Momo Hmungshel Anal, Scientist** organised workshop as event organiser on the title

  High-End Workshop (HEW): "Hands-on Workshop on Advanced Techniques in Natural Products & Medicinal Chemistry" under SERB's Accelerate Vigyan initiative Organized by Natural Products & Medicinal Chemistry Division, CSIR-IIIM, Jammu.

- **Dr. Malik Muzafar Manzoor** has been awarded Ph D on the Thesis entitled, "Functional and biochemical characterization of glycyrrhizin biosynthetic pathway in Glycyrrhiza glabra L." under the guidance of Dr.Suphla Gupta, Principal Scientist. Mr Malik was registered with Jammu University. He was selected as ICMR Research Fellow and currently working in our Srinagar Lab.

- **Dr. Suphla Gupta, Principal Scientist,** attended workshop on "Innovative Applications of Metagenomics Data Analysis in Life Sciences" jointly organized by Biokart India Pvt. Ltd. & Centre for Innovation, Incubation and Entrepreneurship (CIIE) Babasaheb Bhimrao Ambedkar University, Lucknow, India (2022).

- **Dr. Suphla Gupta, Principal Scientist,** presented poster in I-Connect on "*Identification of endophytes for the hyper acuumulation of glycyrrhizin in Glycyrrhiza glabra"* under the Biostimulant theme for Industrial application.

12.2 Book Chapter

- **Kuljit Singh,** Tejinder Kaur and Alka Rao. Therapeutic Applications of Probiotics and its Regulatory Framework (2022) Biomedical Product and Materials Evaluation: Standards and Ethics. Woodhead Publishing (Elsevier) https://doi.org/10.1016/B978-0-12-82396-7.00027-X.

12.3 Invited Talks

- **Dr. J S Momo Hmungshel Anal, Scientist** delivered an invited talk on "Communication and popularization of Science and Technology – Promote Scientific Thinking organised by Institute of Bioresources and Sustainable Development (IBSD)", Imphal targeting students the all Schools and Colleges of Manipur on 20th January 2022.

- **Dr. Kota Srinivasa, Scientist** delivered seminar lecture on "Plastome engineering technology" at SRR Govt Degree and PG College (Autonomous)" on 12.05.2022.

- **Dr. Ravail Singh, Senior Scientist** delivered following invited talks during the seminar at Senckenberg Institute of Biodiversity, Germany: "Benthic biodiversity and the role of machine learning" on 16.05.2021.

- **Dr. Nasir ul Rasheed, Senior Scientist** was invited by Principal Degree College for Women Baramulla, to deliver invited lecture on Solid Waste Management. 09.08.2022.

12.4 Workshops / Training Programmes

- **Dr. Saurabh Saran,** Basic Techniques on Industrial Microbiology.

- **Dr. Shahid Rasool,** One day Skill Development Program on "Prospectus of Commercial Cultivation of High Value Aromatic Crops" on 02 July 2021.

- **Dr. Sumit Gandhi** organized "Hands on training in BSL-3 Laboratory Practices& RT-PCR Testing of Clinical Samples for Covid-19" on 02 July to 17 July 2021.

- **Dr. Shahid Rasool, Dr. Qazi Parvaiz, Dr. Phalistein** organized One Day capacity Building programme on the "Scope of Lavender & Rose Production & processing in Entrepreneurship Development" on 15 July 2021.

- **Dr. Shahid Rasool, Dr Padma Lay** organized One day capacity building programme on the "Scope of Rosemary &Clatysage production & processing in Entrepreneurship Development" on 03 Aug 2021.
- **All Scientists of CSIR-IIIM Jammu** organized Two months "CSIR-IIIM Research & Training Programme 2021" for Post Graduate Students on 23 Aug to 22 Oct2021.
- **Dr. Anil Katare** organized Five Days Skill Development Training Programme on "cGMP Pilot Plant" on 29 Sep to 03 Oct 2021.
- **Dr. Nasheman, Dr Nazia** organized Three Days Training Programme cum Workshop on "Molecular Biology Techniques" on 12 Oct to 14 Oct 2021.
- **Dr. Nasir ul Rasheed, Dr Saurabh Saran**organized "Two months Internship on Renewable Energy, AI/ML fermentation with IIT Jammu" on 12 Aug to 11 Oct 2021.
- **Dr. Saurabh Saran, Dr. Asha Chaubey, Dr. Sumit Gandhi, Dr. Vikash Babu, Dr. Vinod Kumar, Dr Meenu Katoch, Dr. Syed Riyaz-Ul-Hassan, Dr. Sandeep Jaglan, Er. Ankush Varma** organized Industrial Biotechnology and Fermentation Technology on 04 Oct to 09 Oct.
- **Dr. Asha Chaubey** organized "Basic Techniques in Industrial Biotechnology & Fermentation Technology" on 04 Oct to 09 Oct 2021.
- **Dr. Saurabh Saran, Er. Ankush Varma** organized "Basic Techniques involved in Industrial Microbiology for product development" on 16 Dec to 21 Dec 2021.
- **Dr. Anil katare** organized "cGMP/Phytopharma Drug Development" on 26 Dec to 28 Dec 2021.
- **Dr. Saurabh Saran, Er. Anil K Katare, Dr. Vikash Bab, Er. Ankush Varma,** "cGMP Manufacturing of Phyto-Pharmaceutical Drug" on 27 Dec to 29 Dec 2021.
- **Dr. Saurabh Saran, Dr. Asha Chaubey, Er. Ankush Varma, Mr Abhishek Magotra** "Basic Techniques in Industrial Microbiology & Biotechnology" on 19 Jan to 22 Jan 2022.
- **Dr. Saurabh Saran, Dr. Deepika Singh, Er. Ankush Varma** "Principles & Applications of Advanced Analytical Techniques" on 16 Feb to 18 Feb 2021.
- **Dr. Shahid Rasool, Dr Padma Lay** "Entrepreneurship Development Opportunities in Cultivation &processing of High Value AROMA Cash Crop" 19 Feb to 20 Feb 2021.
- **Dr. Kanchrela Prasad, Dr Nasirul Rasheed** organized "Two Days Online Skill Development Program in IPR." from 07 March to 08 March 2022.
- **Dr. Zabeer, Dr Shashank, Dr Goswami, Dr Jamal** organized Three Day workshop on "Gene Cloning & Cell Culture Techniques in Anti-Cancer Discovery." from 14 March to 16 March 2022.
- **Dr. Momo, Dr Bharate, Dr Prasoon, Dr Qazi Naveed** organized "Hands-on Workshop on Advanced Techniques in Natural Products & Medicinal Chemistry." from 15 March to 22 March 2022.
- **Dr. Asha Chaubey, Dr Saurabh, Dr Vinod** organized "Two Days online workshop on Up-Stream and Down-Stream processing Techniques in fermentation." from 28 March to 29 March 2022.

13 MOUS / AGREEMENTS

LIST OF AGREEMENTS AND MOU'S/CDA'S SIGNED BY CSIR-IIIM

April 2021 to March 2022.

S.No.	MOU/Agreements	Dates
1	CDA Between CSIR-IIIM, Jammu and Raspa Pharma Pvt. Ltd., office at 204, Second Floor, Shri Hari Tower, Mira Bhai Marg, Lucknow	June 01, 2021
2	Mou Between CSIR-IIIM And Department Of Biotechnology, Ministry Of Science & Technology, Govt. Of India, New Delhi *(PROJECT ENTITLED,* "Exploiting chemical ecology for IPM: Deciphering the phyto-chemiochemicals involved in Insect-Plant interactions of major crop pests of North East Region-India	June 01, 2021
3	MOU between CSIR-IIIM, AND M/s Famy Life Sciences Pvt. Ltd., office at A, 803, Narnarayan Complex, opp. Navrangpura Post Office , Navrangpura, Ahmedabad-380009	June 02, 2021
4	MOU between CSIR-IIIM, AND Unity Pulp and Papers Pvt., 13-14, Industrial Estate Kheda, Itarsi, M.P.	June 04, 2021
5	MOU between CSIR-IIIM, AND M/S TerraphillicInnoventuresPvt. Ltd., Office at 1309 P, Sector-43, Gurgaon, Haryana-122001	June 15, 2021
6	MOU between CSIR-IIIM, AND Department of Forests and Wildlife Preservation, SAS Nagar, Punjab.	June 16, 2021
7	CDA Between CSIR-IIIM, Jammu and Dabur Research Foundation 22, Site-IV, Sahibabad, Ghaziabad-201 010, U.P.	June 17, 2021
8	CDA between CSIR-IIIM, Jammu and Kumar Organic Products Ltd., KOPL, Bangalore	June 24, 2021
9	Two sets of Agreement between CSIR-IIIM, Jammu and (i) Agreement for collaboration in Phytopharma project and (ii) Agreement for Bergenia ciliate in nutraceutical segment, Viridis Biopharma Pvt. Ltd., 1503, Universal Majestic, P.L. Lokhande Marg, Ghatkopar Mankhurd Link Road, Govandi, Mumbai	June 28, 2021
10	CDA Between CSIR-IIIM, Jammu and Renovis Pharma Labs. Hyderabad	July 1, 2021
11	MOU Between CSIR-IIIM , Jammu and The Jammu Institute of Ayurveda and Research College, (JIAR) Nardani, Raipur, Bantalab Road, Jammu.	July 6, 2021
12	MOU Between CSIR-IIIM, Jammu and Department of Biotechnology Govt. of India, New Delhi and Indian Institute of Integrative medicine, Jammu.	July 13, 2021
13	CDA Between CSIR-IIIM and NutodayPvt. Ltd., Bangalore., Karnataka, Nutrify Today office at PG51, MGM, 81, CHIKALSANDRA, Bangalore, India-560061	July 30th, 2021
14	CDA Between CSIR-IIIM, Jammu and String Bio Pvt. Ltd., Bangalore, Karnataka	August 05, 2021
15	MOU Between CSIR and Ministry of Food Processing Industries (MOFPI) and Panchsheel Bhawan, August Krantmarg, New Delhi-110001	August 26, 2021
16	Agreement Between CSIR-IIIM and Viridis Biopharma Pvt. Ltd., 1503, Universal Majestic, P.L. Lokhande Marg, Mumbai.	September 28, 2021
17	CDA Between CSIR-IIIM and Zeon Lifesciences Ltd., Paonta Sahib, H.P.	October 05, 2021

S.No.	MOU/Agreements	Dates
18	MOU Between CSIR-IIIM, Jammu and Institute of Bioinformatics and Applied Biotechnology, Bengaluru	October 13, 2021
19	MOU Between CSIR-IIIM and The National Medicinal Plants Board, Ministry of AYUSH-New Delhi	October 13, 2021
20	MOU Between CSIR-IIIM and Institute of Bioinformatics and Applied Biotechnology Office at Biotech Park, Electronic City, Phase I, Bengaluru-560 100.	October 13, 2021
21	CDA Between CSIR-IIIM , Jammu and M/s ExtrovisPvt. Ltd., Hyderabad	October 14, 2021
22	CDA Between CSIR-IIIM and Aurobindo Pharma Ltd., office at Plot No. 2, MaitriVihar, Amarpreet, Hyderabad	October 18, 2021
23	MOU between CSIR-IIIM, Jammu and Zeon Life Sciences Ltd., Paonta Sahib H.P.	November 22, 2021
24	CDA Between CSIR-IIIM and Dabur Research Foundation Ghaziabad, UP	November 23, 2021
25	CDA Between CSIR-IIIM, Jammu and Cira Herbal LLP, Office at 3A, Aneesh Apartment CHSL, Azad Lane, S.V. Road, Andheri West (Mumbai) Maharashtra-400058	January 11, 2022
26	CDA Between CSIR-IIIM, Jammu and Cepham Inc., New Jersey, USA, corp. Office at 142, Belmont Drive, Unit 14, somerset. NJ-08873	January 12, 2022
27	CDA Between CSIR-IIIM, Jammu and J.B. Khokhani and Co. Reg. Office and corporate Office at B-207, Needam Centre, Hind Cycle Marg, Worli, Mumbai Maharashtra-400030.	January 28, 2022
28	MOU between CSIR-IIIM, Jammu and All India Institute of Medical Sciences (AIIIMS), Jammu	January 29, 2022
29	CDA Between CSIR-IIIM, Jammu and Fortis Life Sciences LLP Office at Unit No. 407, Aggarwal Prestige Mall, Plot No. 02, Road No. 44, Pitampura, Northwest Delhi, New Delhi-110034	February 16, 2022
30	MOU between CSIR-IIIM, Jammu and Technology Information Forecasting and Assessment Council (TIFAC) and Sher-E-Kashmir University of Agricultural Sciences and Technology, Kashmir (SKUAST-K)	March 18, 2022
31	CDA Between CSIR-IIIM, Jammu and Accuprec Research Labs. Pvt. Ltd., office at opposite Zydus Pharmez, Changodar, Bavla Highway, Dr.Matoda, Ahmedabad-382213, Gujrat, India	May 23, 2022
32	MOU between CSIR-IIIM, Jammu and Lyallpur Khalsa College, Jalandhar, Punjab	May 26, 2022
33	MOU between CSIR-IIIM, Jammu and Agrovoltic Power Solutions Pvt. Ltd., office at 31 Dimri Niwas Picture Place, Mussorie, Distt. Dehradun, Uttarakhand (APSPL)	May 26, 2022
34	MOU Between CSIR-IIIM, Jammu and Fine Fragrance Pvt. Ltd., office at No-2, Jolly Maker Chambers 11, 119, 11th Nariman Point, Mumbai (Maharashtra)-400021	May 26, 2022

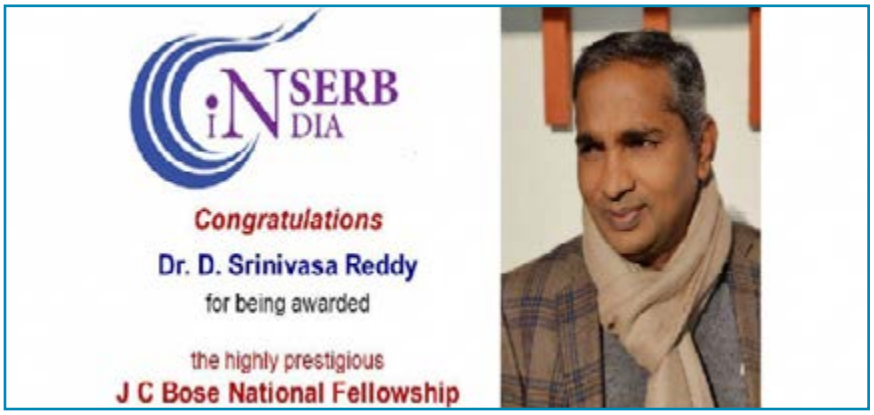
14 HONOURS / AWARDS

14.1 Honours / Awards

- **Dr. D. Srinivasa Reddy:** Selected for Darshan Ranganathan Memorial Lecture 2023.
- **Dr. Zabeer Ahmed:** Awarded by Govt. of J&K for meritorious contributions in the field of Science and Technology.
- **Dr. Sandip Bharate:** Elected as Fellow of Royal Society of Chemistry, London elected as Member of National Academy of Sciences India (NASI).
- **Dr. Sandip B. Bharate:** Appointed as an Editorial Board Member, Medicinal Research Reviews (IF 12.94; Wiley) from October 2021.
- **Dr. Debaraj Mukherjee:** Bronze Medal-2023, Chemical Research Society of India.
- **Dr. Nasheeman:** Selected as SERB Power Fellow.
- IIIM Received CSIR Technology Award 2021 Certificate of Merit (Category: Innovation) for the discovery, development and out-licensing of Saffron-based nutraceutical product on 26th Sept 2021.

Top Fellowships & Awards

Dr. D. Srinivasa Reddy has been selected for the highly prestigious J C Bose Fellowship



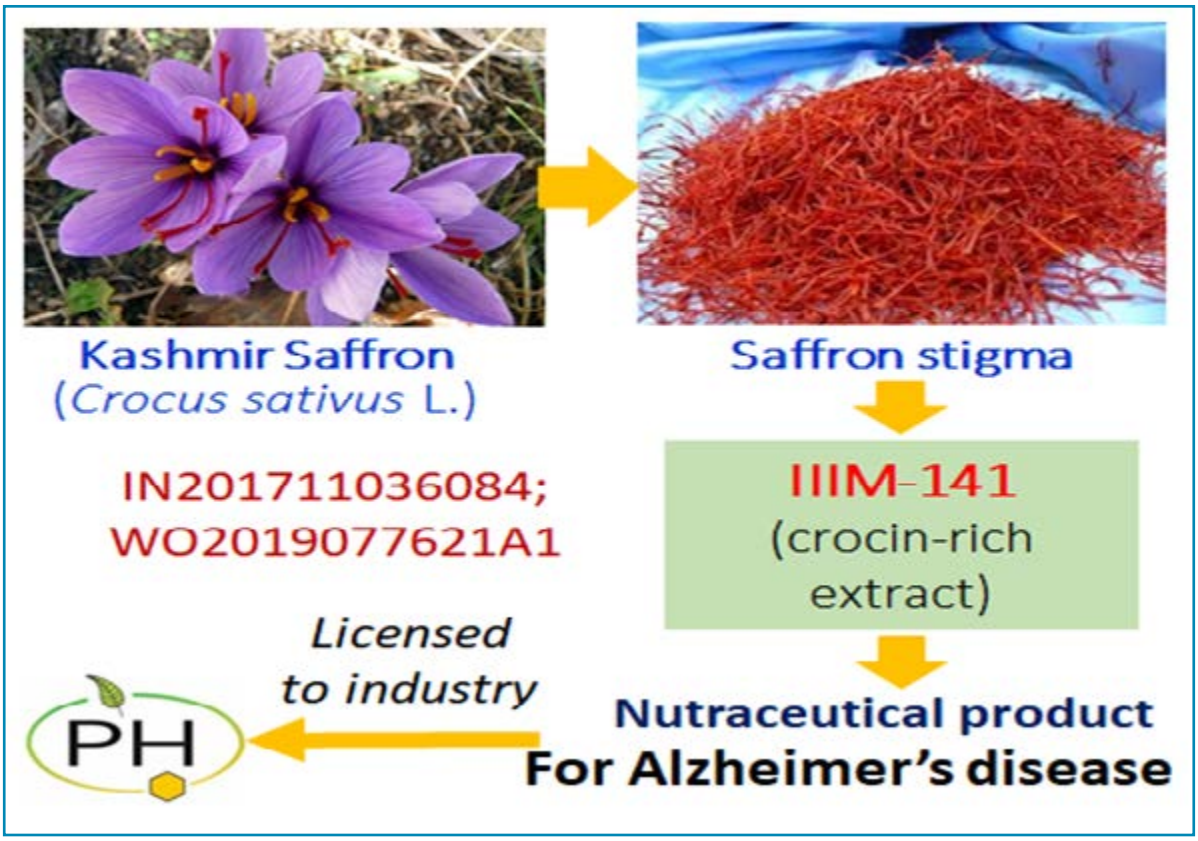
Dr. D. Srinivasa Reddy, Director, CSIR-Indian Institute of Integrative Medicine, Jammu, has been selected for the highly prestigious J C Bose Fellowship by Science & Engineering Research Board (SERB), Department of Science and Technology, Government of India.

Dr. D Srinivasa Reddy, Director elected as fellow of the prestigious Indian Academy of Sciences

Dr. D Srinivasa Reddy, Director CSIR-IIIM Jammu elected as fellow of the prestigious Indian Academy of Sciences, Bengaluru. Dr. Reddy's research interests include natural product synthesis, medicinal chemistry and drug discovery.

CSIR-Technology Award 2021 (Category: Innovation) Certificate of Merit has been awarded to CSIR-IIIM

CSIR-Technology Award 2021 (Category: Innovation) Certificate of Merit has been awarded to **CSIR- Indian Institute of Integrative Medicine** for discovery, preclinical development and out-licensing the Saffron-based nutraceutical product/ dietary supplement for people who are at higher risk of developing Alzheimer's disease, including the patients with early onset of disease.


Kashmir Saffron
(Crocus sativus L.)
Saffron stigma
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WO2019077621A1
IIIM-141
(crocin-rich
extract)
Licensed
to industry
PH
Nutraceutical product
For Alzheimer's disease


80th CSIR Foundation Day
CSIR Technology Awards 2021
Sandip B. Bharate, Ajay Kumar, Sonali S. Bharate, Ram A. Vishwakarma, G.D. Singh and Deepika Singh
Certificate of Merit
CSIR- Indian Institute of Integrative Medicine, Jammu
For significant work in discovering preclinical development and out-licensing the Saffron-based nutraceutical product/ dietary supplement. The product is aimed at people who are at higher risk of developing Alzheimer's disease, including patients with early onset of disease.
Innovation
स्थापना दिवस
समारोह
FOUNDATION DAY

CHEMICAL RESEARCH SOCIETY OF INDIA

CSIR-IIIM

CONGRATULATIONS

Dr. Debaraj Mukherjee
Principal Scientist
Department of NPMC
CSIR-IIIM Jammu

to

Dr. Debaraj Mukherjee *for his selection to receive the* ***CRSI Bronze Medal-2023****. This honour is given to young researchers who have made significant contributions to research in Chemical Science*

RSC Advances

CSIR-IIIM

CONGRATULATIONS

to

Ajaz Ahmed
CSIR-SRF
NPMC-Division
CSIR-IIIM Jammu

Mr. Ajaz Ahmed, *a 5th year PhD student who has submitted his thesis under the supervision of Dr. Debaraj Mukherjee, principal scientist, NPMC-division, CSIR-IIIM jammu for winning RSC. Advances outstanding student paper award 2021 in which the substantial component of the research was conducted by the student. Out of over 900 nominations all over the world, Mr. Ajaz has been selected in the organic chemistry category by the Royal Society of Chemistry editorial board and associate editors. The research work is related to the development of a non-infringing route for the synthesis of Molnupiravir (EIDD-2801), an oral drug for the treatment of COVID-19 from cheaper and easily available starting materials. CSIR-IIIM Jammu has secured patent on the route for the synthesis of this nucleoside drug.*

https://blogs.rsc.org/ra/2022/07/15/rscadvancesoutstandingstudentpaperawards2021/?doing_wp_cron=1657898891.6148290634155273437500

15 Hindi Cell Activities

राजभाषा हिन्दी अनुभाग

सीएसआईआर-भारतीय समवेत औषध संस्थान, जम्मू राजभाषा के कार्यान्वयन के लिए सदैव तत्पर रहा है। संघ की राजभाषा हिन्दी के प्रगामी प्रयोग के लिए निरंतर प्रयास कर यह सुनिश्चित किया जाता है कि संस्थान का अधिकाधिक कार्य हिन्दी में ही किया जाए।

राजभाषा हिन्दी से जुड़े मुख्य लक्ष्य :

- हिन्दी अनुभाग द्वारा राजभाषा विभाग, भारत सरकार के दिशानिर्देशों व हिन्दी के वार्षिक कार्यक्रमों का उचित पालन करना।
- संस्थान के प्रत्येक कार्य को निष्ठापूर्वक करते हुए राजभाषा हिन्दी को कार्यालय की मुख्य भाषा के रूम में बढ़ावा देना।
- हिन्दी दिवस/सप्ताह, पखवाड़ा, हिन्दी कार्यशालाओं, नगर राजभाषा कार्यान्वयन समिति (नराकास) एवं राजभाषा कार्यान्वयन समिति की विभिन्न बैठकों को समयबद्ध तरीके से आयोजित कर उचित कार्यवाही सुनिश्चित करना।
- नराकास जम्मू के अंतर्गत आने वाले विभिन्न केन्द्रीय कार्यालयों के राजभाषा हिन्दी कार्यान्वयन पर निगरानी रखना।

राजभाषा हिन्दी के प्रगामी प्रयोग हेतु संस्थान द्वारा उठाए गए प्रमुख कदम :-

1. वार्षिक कार्यक्रमों में हिन्दी सप्ताह का आयोजन:

भारत सरकार, राजभाषा विभाग द्वारा जारी किए गए वार्षिक कार्यक्रम के अंतर्गत सितंबर के महीने में दिनांक 08.09.2021 से 14.09.2021 को हिन्दी सप्ताह का आयोजन किया गया जिसमें विभिन्न प्रतियोगिताएं जैसे निबंध लेखन, स्लोगन (नारा) लेखन, हिन्दी में मूलकार्य आदि शामिल थीं।

2. हिन्दी कार्यशालाओं का आयोजन:

समय-समय पर राजभाषा हिन्दी से संबंधित कार्यशालाओं का आयोजन किया जाता है। वित्तीय वर्ष 2021-22 में संस्थान में कुल 4 हिन्दी कार्यशालाओं का आयोजन किया गया।

3. अन्य कार्य:

सीएसआईआर-भारतीय समवेत औषध संस्थान, नराकास, जम्मू का एक अहम सदस्य है। आई.आई.आई.एम. के निदेशक, नराकास, जम्मू की अध्यक्षता भी संभालते हैं तथा इनकी अध्यक्षता में साल में दो अर्द्धवार्षिक बैठकें आयोजित की गईं। वर्तमान में, नराकास जम्मू के अधीन करीब 88 केन्द्रीय कार्यालय हैं।

संस्थान में राजभाषा हिन्दी के उपयोग को बढ़ावा देने के लिए अधिकारियों/कर्मचारियों के प्रोत्साहन हेतु समय-समय पर इन्हे उचित प्रशिक्षण के लिए नामित करा जाता है जिसके अंतर्गत पुरस्कार राशि की भी व्यवस्था की गई है।

4. संसदीय राजभाषा दूसरी उप-समिति द्वारा निरीक्षण:

समस्त कार्यों को ध्यान में रखते हुए, समय-समय पर संसदीय राजभाषा की दूसरी उप-समिति द्वारा संस्थान के हिन्दी अनुभाग का निरीक्षण किया जाता है।

वित्तीय वर्ष 2021-22 में संसदीय राजभाषा की दूसरी उप-समिति द्वारा संस्थान के राजभाषा से संबंधित सभी कार्यों एवं हिन्दी अनुभाग का निरीक्षण दिनांक 17.07.2021 को किया गया।

उपरोक्त निरीक्षण में संस्थान को माननीय संसदीय राजभाषा की दूसरी उप-समिति द्वारा राजभाषा हिन्दी में उत्कृष्ट कार्य करने के लिए प्रशंसा प्रमाण पत्र प्रस्तुत किया गया (माननीय संसदीय राजभाषा की दूसरी उप-समिति द्वारा प्राप्त प्रशंसा पत्र)

(संसदीय राजभाषा उप-समिति के समक्ष निदेशक महोदय द्वारा संस्थान की राजभाषा प्रगति रिपोर्ट प्रस्तुती)

5. वित्तीय वर्ष 2021-22 में हिन्दी अनुभाग की गतिविधियों एवं अन्य ऑनलाइन बैठकों का ब्यौरा नीचे दिया गया है:

क्रमांक	गतिविधि का विवरण	तिथि	अन्य विवरण
1.	**राजभाषा कार्यान्वयन समिति की बैठकें :**		
	पहली बैठक (अप्रैल से जून)	16.06.2021	
	दूसरी बैठक (जुलाई से सितम्बर)	28.12.2021	
	तीसरी बैठक (अक्टूबर से दिसम्बर)		
	चौथी बैठक (जनवरी से मार्च)	30.03.2022	
2.	**नगर राजभाषा कार्यान्वयन समिति की बैठकें :**		
	पहली छमाही बैठक	24.06.2021	
	दूसरी छमाही बैठक	22.11.2021	
3.	**संसदीय राजभाषा उप-समिति द्वारा निरीक्षण**	17.07.2021	
4.	**हिन्दी सप्ताह-2021 का आयोजन**	08.09.2021 से 14.09.2021 तक	निबंध लेखन, स्लोगन (नारा) लेखन, हिन्दी में मूल कार्य का मूल्यांकन, इत्यादि प्रतियोगिताओं का आयोजन।
5.	**हिन्दी कार्यशालाओं का आयोजन :**		
क.	विषय: "राजभाषा क्रियान्वयन हेतु अनुपालन किए जाने वाले जाँच बिन्दु।"	11.06.2021	मुख्य वक्ता: श्री अशोक कुमार दीक्षित, पूर्व प्राध्यापक, प्रशासन, गाँधी सेवा सदन, जम्मू व् प्राचार्य कौशल विकास केन्द्र, जख, जम्मू।
ख.	विषय: "नई शिक्षा नीति में हिन्दी का महत्व।"	14.09.2021	मुख्य वक्ता: डॉ. रजनी बाला, प्रमुख, हिन्दी अनुभाग, जम्मू विश्वविद्यालय, जम्मू।
ग.	विषय: "राजभाषा हिन्दी की बढ़ती उपयोगिता।"	24.12.2021	मुख्य वक्ता: श्री सुकृति कुमार शर्मा, सहायक निदेशक, दूरदर्शन केन्द्र, जानीपुर, जम्मू।
घ.	विषय: "मानक देवनागरी लिपि एवं हिन्दी वर्तनी।"	25.03.2022	मुख्य वक्ता: डॉ. राम कुमार श्रीवास्तव, प्राचार्य, केन्द्रीय विद्यालय सुन्दरबनी।

16 ANNUAL REPRESENTATION OF SC/ST & PWD's.

SC/ST/OBC REPORT-I

Annual statement showing the representation of SCs, STs and OBCs as on first January of the year and number of appointments made during the preceding calender year 2021-22

	Representation of SCs/STs/OBCs (As on 01.01.2022)				Number of appointments made during the calendar year 2021-22									
		By	Direct Recruitment			By	Promotion			By	Deputation			
Groups	Total number of Employees	SCs	STs	OBCs	Total	SCs	STs	OBCs	Total	SCs	STs	Total	SCs	STS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Group A	85	11	6	12	3	-	-	-						
Group B	65	12	4	13	6	-	1	2						
Group C	59	28	-	7	-	-	-	-						
Group D (Excluding Sweepers)														
Group D (Sweepers)														
TOTAL	209	51	10	32	9	-	1	2						

SC/ST/OBC REPORT-II

Annual statement showing the representation of SCs, STs and OBCs in various group'a' services as on first January and number of appointments made in the service in various grades in the calender year 2021-22

	Representation of SCs/STs/OBCs (As on 01.01.2022)				Number of appointments made during the calendar year 2021-22									
		By Direct Recruitment				By Promotion			By Deputation					
Pay Band and Grade Pay	Total number of Employees	SCs	STs	OBCs	Total	SCs	STs	OBCs	Total	SCs	STs	Total	SCs	STS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PB-3 Rs.5400	3	1	-	-	-	-	-	-						

	Representation of SCs/STs/OBCs (As on 01.01.2022)	Number of appointments made during the calendar year 2021-22												
		By Direct Recruitment				By Promotion			By Deputation					
PB-3 Rs.6600	21	1	4	5	3	-	-	-						
PB-3 Rs.7600	20	4	-	3	-	-	-	-						
PB-4 Rs.8700	34	4	-	2	-	-	-	-						
PB-4 Rs.8900	6	1	1	-	-	-	-	-						
PB-4 Rs.10,000	1	-	1	-	-	-	-	-						
HAG+Above														
TOTAL	85	11	6	10	3	-	-	-						

PWD Report I

Annual statement showing the representation of the persons with disabilities in services (as on 1st January 2022)

Group	Number of Employees				
	Total	In Identifiedposts	VH	HH	OH
1	2	3	4	5	6
Group A	85				
Group B	65				
Group C	59				
Group D					
TOTAL	209				

Note:

i. VH stands for Visually Handicapped (persons suffering from blinders or low vision).

ii. HH stands for Hearing Handicapped (persons suffering from hearing impairment).

iii. OHstands for Orthopaedically Handicapped (persons suffering from locomotor disability or cerebral palsy).

17 HUMAN RESOURCE

Director

Dr. D. Srinavasa Reddy

Scientist-G/Chief Scientist

Er. Abdul Rahim

Scientist-F/Sr. Pr. Scientist

- Dr. Gurdarshan Singh
- Dr. Zabeer Ahmed
- Dr. Anindya Goswami
- Dr. Fayaz Ahmed Malik
- **Dr. (Ms.) Asha Chubey**
- Dr. Shashank Kr. Singh

Scientist-E II/Pr. Scientist

- Dr. Muzamil Ahmad
- Dr. Sandeep B. Bharate
- Dr. S.D. Sawant
- Dr. P.N Gupta
- Dr. Zahoor Ahmad Parry
- Dr. Mohd. Jamal Dar
- Dr. Qazi Naveed Ahmad
- Dr. Prasoon Kumar Gupta
- Dr. Sheikh Tasduq Abdullah
- Dr. Dhiraj Kumar Vyas
- Dr. Sumit G. Gandhi
- Dr. QaziParvaiz Hassan
- Dr. Syed Riyaz- Ul Hassan
- Dr. Khursheed A. Bhat
- **Dr. (Mrs.) Suphla Bajpai Gupta**
- Dr. Debaraj Mukherjee
- Dr. AmitNargotra
- Dr. Parvinder Pal Singh
- **Dr. (Mrs.) Deepika Singh**
- Dr. Bhahwal Ali Shah

- Dr. Saurabh Saran
- Sh. Anil Kumar Katare
- Dr. Govind Yadav
- Dr. Sundeep Jaglan
- Dr. Syed Sajad Hussain
- **Dr. (Mrs.) Nasheeman Ashraf**
- Dr. Sumeet Gairola

Scientist-E I/Sr. Scientist

- Dr. Rajkishore Rai
- **Dr. (Mrs.) MeenuKatoch**
- Dr. Bilal Ahmad Bhat
- Dr. Prashant Misra
- Sh. Shaghaf Mobin Ansari
- Dr. Vikash Babu
- Dr. Ravi Shankar
- Dr. Nasir ul Rasheed
- Dr. Utpal Nandi
- Dr. Rajendra Bhanwaria
- Dr. Shahid Rasool
- Dr. Vishav Prakash Rahul
- Dr. Sabha Jeet
- Dr. Ravail Singh
- Dr. Sreedhar Madishetti
- Dr. Avisek Mahapa
- Dr. Kancherla Prasad
- Dr. Kanhaiya Kumar

Scientist-C/ Scientist

- **Dr. (Ms.) Nazia Abbas**
- Dr. Firdous Ahmad Mir
- Dr. Syed Khalid Yousuf
- **Dr. (Ms.) Rashmi Sharma**
- Sh. Kuljit Singh

- Dr. Vinod Kumar
- Dr. Srinivas Kota
- Dr. Boobalan G
- Dr. Jatinder Kumar
- Dr. (Ms.) Padma Lay
- Dr. J.S. Momo Hmungshel Anal
- Dr. Bharitkar Yogesh Pandharinath
- Dr. Ramajayan P.
- Dr. Love Sharma

Principal Technical Officer

- Mrs. Urmila Jamwal
- Dr. Ajai P. Gupta

Medical Officer

- Dr. Amit Sharma
- Dr. (Mrs.) Anju Gupta

Sr. Technical Officer(3)

- Mrs. Asha Devi
- Sh. Rajinder Kumar
- Dr. Buddh Singh
- Dr Ajay Kumar

Sr. Technical Officer(2)

- Dr. Phalisteen Sultan
- Dr. Siya Ram Meena
- Sh. Sanjay Sharma

Superintending Engineer(Elect.)

- Sh. Ashwani Chopra

Sr. Technical Officer(1)

- Dr. M.K Verma

Assistant Executive Engineer (Civil)

Technical Officer

- Mrs. Bhavan Vij

- Sh. Gourav Sharma
- Er. Manish Kumar
- Sh. Sumit Kumar
- Sh. Arvind Kr. Yadav
- Sh. Vikrant Awasthi
- Sh. Yogesh Kumar
- Sh. Amit Kumar
- Sh. Rajinder Gocher
- Sh. Niteen Ashok Narkhede
- Sh. Uma Shankar

Assistant Engineer(Mechanical)

- Sh. Mukesh Jhangra

Technical Assistant

- Mrs. Monika Gupta
- Sh. Chandra Pal Singh
- Sh. Durga Prasad Mindala
- Mrs. Priya Wazir
- Sh. Sumit Roy
- Sh. Habibullah
- Sh. Yadumandan Sen

Junior Engineer(Electrical)

- Sh. Bikram Singh

Junior Engineer(Mechanical)

- Sh. Narinder Kumar

Senior Technician (3)

- Sh. Vikram Bhradwaj
- Mrs. Shabnam Khan

Sr. Technician (2)

- Mrs. Raj Kumari
- Sh. Vikram Abrol
- Sh. P.R.Mehta
- Sh. Partap Chand

- Mrs. KiranKoul
- Sh. Satya Bhushan
- Sh. Rajinder Kumar
- Sh. Vijay Kumar
- Mrs. AnjumVashist
- Sh. Rajesh K. Sehdev

Technician (1)

- Sh. Asad Ullah
- Sh. Rahul Kalgotra
- Sh. Karan Pal
- Sh. Kirshan Kumar

Lab Assistant

- Sh. Neel Kamal
- Sh. Rishi Kumar
- Sh. Balwinder Singh
- Sh. Manoj Kumar
- Sh. Ajit Ram
- Sh. Bhushan Lal
- Sh. Balwant Raj
- Sh. Tara Chand

Lab. Attd.

- Sh. Ashok Kumar
- Sh. Nagar Lal
- Sh. Kuldeep Kumar

Sr. COA

- Sh. Anjum Sharma

CoF&A

- Sh. I.B. Dixit

F&A

- Sh. R.P. Tripathi

SPO

- Sh. Dilip Kumar Gehlot

AO

- Sh. Ashish Bahuguna
- Sh. Rajesh Gupta

SO(G)

- Sh. Romesh Kr. Mottan
- Sh. U.S. Thappa
- Sh. Ashok Kumar
- Sh. Ranjeet Kr. Gupta

SO (F&A)

- Sh. Shiv Avtar Gupta

SO(S&P)

- Sh. Satish Sambyal

(SO (S&P)

- Sh. Praveen Kumar

ASO(G)

- Mrs. Nisha Vij
- Sh. Rajinder Singh
- Mrs. Rekha Gupta
- Sh. Mohd. Ayub Bhat

ASO (G) DTQ

- Sh. Rishu Sharma
- Sh. Vinod Kumar

ASO(F&A)

- Sh. Vinod Kr. Meena
- Mrs. Lovely Ganjoo

ASO(S&P)

- Mrs. Rajni Kumari

Receptionist

- Mrs. Jyoti Prabha

Security Asstt.

- Sh. Bhupinder Singh
- Sh. Balkrishan
- Sh. Subash Chander

SSA(F&A)

- Sh. Sanchit Sharma
- Sh. Roshan Lal

SSA(S&P)

- Sh. Bua Ditta
- Sh. Angrez Chand

SSA (G)

- Sh. Tarsem Kumar
- Sh. Kartik Kapoor
- Sh. Rankush Pandita
- Sh. Ishan Dogra

SSA (S&P)

- Sh. Rakesh Choudhary

JSA (S&P)

- Sh. Parshotam Kumar

Halwai

- Sh. Janak Raj

Jr. Steno

- Sh. Abhishek Gupta
- Sh. Satish Kumar
- Sh. Sahil Salotra
- Ms. Jyoti Devi

Driver

- Sh. Mohit Kumar
- Sh. Tarun Kashyap

M.T.S

- Sh. Mohd Farooq Bhat
- Sh. Ram Lal
- Sh. Chaman Lal
- Sh. Ashok Kumar Balgotra
- Sh. Pawan
- Sh. Rajesh Kr. Tandon

- Sh. Moses Tegi
- Sh. SubashChander
- Sh. Mangal Dass
- Sh. Girdhari Lal
- Sh.Sukhdev Raj
- Sh. Sat Pal
- Sh. Bua Ditta
- Sh. Ashokkumar
- Sh. Ashok Kumar
- Sh. Dev Raj
- Sh. Sham Lal
- Sh. Kali Dass
- Sh. Sodagar Lal
- Sh. Ashok Kumar
- Sh. Karnail
- Sh. Surinder
- Sh. Munna
- Sh. Sodagar Lal
- Sh. Bachan Lal
- Sh. Daleep Raj
- Smt. Kirti

Notes