CSIR – INDIAN INSTITUTE OF INTEGRATIVE MEDICINE- JAMMU

Canal Road, Jammu-180001 | 0191-2584999, 2585222 | director@iiim.res.in | www.iiim.res.in

2020-21 ANNUAL REPORT

Annual Report:

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 international markets.

Mission

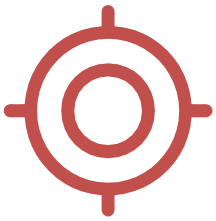
To become a Centre of Excellence in natural products chemistry and biotechnology driven drug discovery, integrating modern biology with chemistry

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

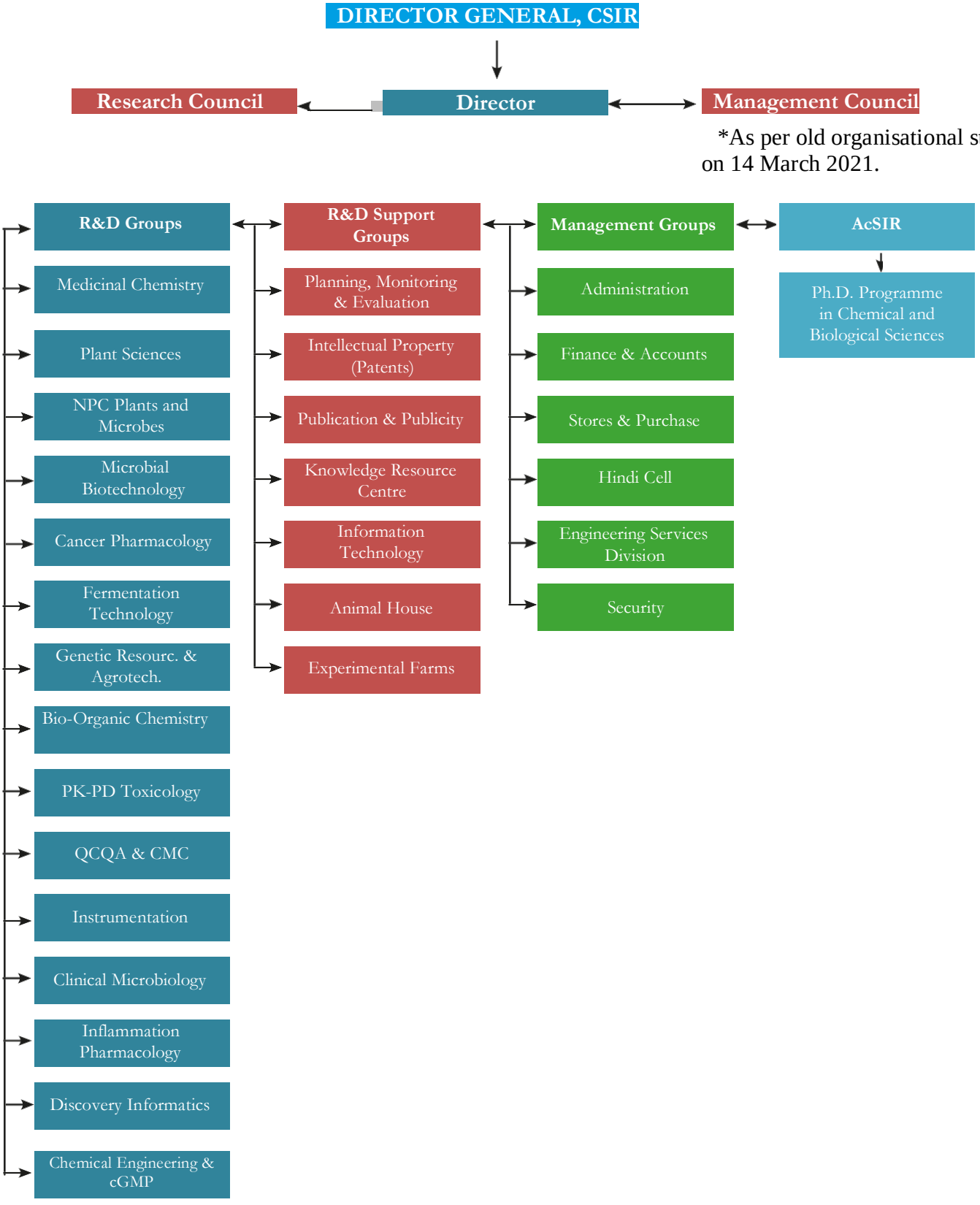
The mandate of IIIM is to be an internationally competitive centre of excellence in all facets of natural products research and technology, including (a) discovery of novel pharmacologically active natural products from plants and microbial species and translating them into drug leads and candidates 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 Laddkh 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 lively hood to rural poor and employment generation.

ORGANISATIONAL SETUP



*As per old organisational structure as on 14 March 2021.

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

Dr. P. N. Pandey
Managing Director,
Penam Laboratories Ltd.
New Delhi

Dr. Nilanjan Saha
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

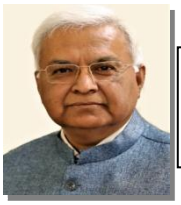
Dr. Srikanta Kumar Rath
Senior Principal
Scientist, Division of
Toxicology, CDRI Lucknow

Management Council of IIIM

(01.01.2020 – 31.12.2021)

Dr. D. Srinivasa Reddy
Chairman
Director, CSIR-IIIM, Jammu

Dr. D.M. Mondhe
Member
Chief Scientist, CSIR-IIIM, Jammu



Dr. Sanjay Kumar
Member
Director, IHBT, Palampur, H.P

Dr. Suphla B. Gupta
Member
Principal Scientist,
CSIR-IIIM, Jammu

Er. Abdul Rahim
Member
Chief Scientist & Head,
RMBD & IST Div., CSIR-IIIM,

Dr. Amit Nargotra
Member
Principal Scientist,
CSIR-IIIM, Jammu

Sh. Anjum Sharma
Sr. Controller of Administration
Member
CSIR-IIIM, Jammu

Dr. Prashant Misra
Member
Senior Scientist,
CSIR-IIIM, Jammu

Sh. I. B. Dixit
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 immense pleasure to present the annual report of CSIR-IIIM for the year 2020-21. 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 seventh within the country as the best Indian institutes as released by Scimago Institutions ranking-2020. CSIR-IIIM Jammu has been ranked third among CSIR laboratories, and ranked first within biology cluster of CSIR. Due to the pendamic situation we were only able to file 07 patent applications and 09 patents were granted to CSIR-IIIM. During this calender year 2020, IIIM published a total of 149 scientific publications with an average impact factor of 3.24.

Several important events took place during this financial year. Firstly, institute has licenced two technologies, one with M/s Anphar Pharma Pvt. Ltd., Jammu on Process Development of Favipiravir and the other with M/S Hemp Street Medicare Private Limited, Delhi on Development of Trans-dermal patches using bacterial cellulose. Secondly, CSIR-Indian Institute of Integrative Medicine, Jammu has launched CSIR-Aroma Mission Phase-II on 9th February 2021 for development and extension of Aromatic and Medicinal plants in J&K and other parts of country in tandem with our Honourable Prime Minister's vision of doubling of farmers income. Thirdly, CSIR-Indian Institute of Integrative Medicine, Jammu has entered into an agreement with National Institute of Sowa Rigpa, Leh, an autonomous organization under the Ministry of AYUSH, Govt of India. Another agreement was signed between CSIR-IIIM and National Dope Testing Laboratory (NDTL), Ministry of Youth Affairs & Sports, Government of India on 11th January 2021 for research collaboration by combining their respective research capabilities in the areas of synthesis of reference standards and *in-vitro* and *in-vivo* studies (PK studies) on the metabolites with main emphasis on the national goals in area of Dope testing and Global positioning. With the aim to explore potential in medicinal and aromatic plants in Ladakh, CSIR-IIIM is Nodal lab for implementation of CSIR Technologies for Ladakh initiatives.

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.

(D. Srinivasa Reddy)

1. MAJOR COVID-19 CONTRIBUTIONS

1.0 MAJOR COVID-19 CONTRIBUTIONS

1.1. Novel Coronavirus (2019-nCov) Testing in human clinical samples at CSIR-IIIM (Jammu)

Kuljit Singh and Rashmi Sharma, Inshad Ali Khan*, Saurabh Saran*, GD Singh*and Sumit G. Gandhi*

Diagnostic testing is the hallmark to track community transmission of virus and prevent its transmission. In response to the Covid19 pandemic, CSIR-Indian Institute of Integrative Medicine (IIIM), Jammu was amongst the first few CSIR labs that started COVID-19 testing. The facility started RT-PCR testing since 6th April, 2020, in collaboration with Government Medical College, Jammu. These samples were mostly received from various sample collection centres and mobile units operating through the Directorate of Health Services (Jammu). Samples were also received from the Air Force Station (Satwari, Jammu) and Military Hospital (Satwari, Jammu). Apart from this, in order to carry out regular surveillance and prevent the spread of infection at CSIR-IIIM campus, active contact tracing was carried our and samples from staff, students and families were also tested through RT-PCR. So far, we have tested more than about 95000 samples, among which 1900 samples were collected from CSIR-IIIM.

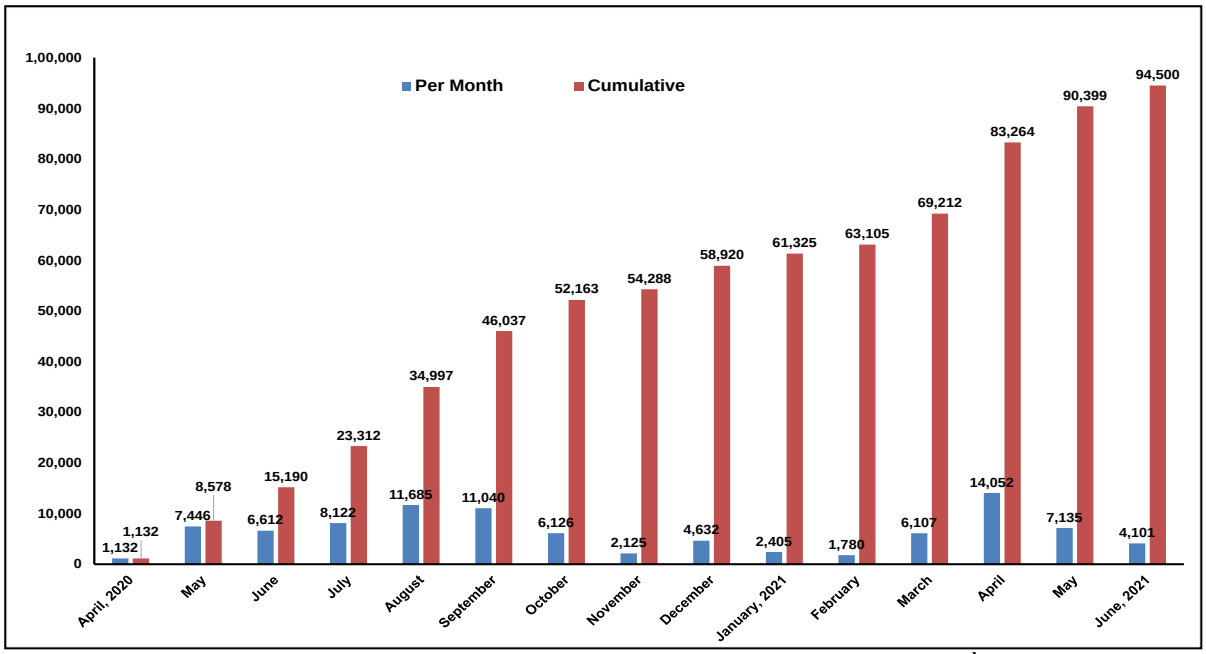


Figure 1.1.1: An overview of the total samples tested at CSIR-IIIM since 6th April, 2020

1.2 Optimization and validation of RT-LAMP assay for diagnosis of SARS-CoV2

Vijay Lakshmi Jamwal, Natish Kumar1, Rahul Bhat, Piyush Singh Jamwal, Kaurab Singh, Sandeep Dogra, Abhishek Kulkarni, Bhaskar Bhadra, Manish R Shukla, Saurabh Saran, Santanu Dasgupta, Ram A Vishwakarma and Sumit G. Gandhi*

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV2), the causative agent of COVID-19 pandemic, has infected millions of people worldwide, leading to deaths of 3.5 million people. India is the second most affected country due to the pandemic. Testing of infected individuals is crucial for identification and isolation, thereby preventing further spread of the disease. Presently, Taqman^{TM} Reverse Transcription Real Time PCR is considered gold standard, and is the most common technique used for molecular testing of COVID-19, though it requires sophisticated equipments, expertise and is also relatively expensive. We developed and optimized a method for alternate molecular testing of COVID-19, through a two step Reverse Transcription Loop-mediated isothermal AMPlification (RT-LAMP). Primers for LAMP were carefully designed for discrimination from other closely related human pathogenic coronaviruses. Care was also taken that primer binding sites are present in conserved regions of SARS-CoV2 so that its variants including fast-spreading UK B117 strain, can be diagnosed. Various DNA polymerases with strand displacement activity were evaluated and conditions were optimized for LAMP amplification and visualization. Different LAMP primer sets were also evaluated using synthetic templates as well as patient samples.

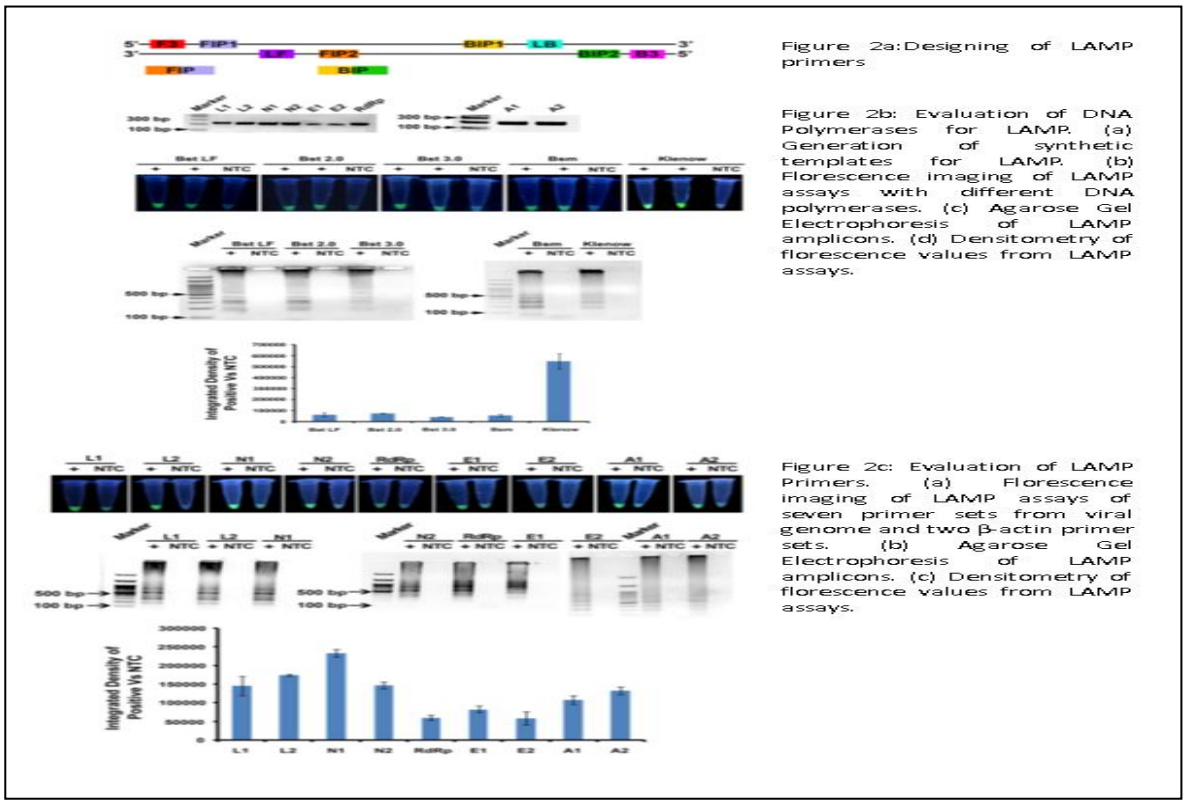


Figure 2a:Designing of LAMP primers

Figure 2b: Evaluation of DNA Polymerases for LAMP. (a) Generation of synthetic templates for LAMP. (b) Florescence imaging of LAMP assays with different DNA polymerases. (c) Agarose Gel Electrophoresis of LAMP amplicons. (d) Densitometry of florescence values from LAMP assays.

Figure 2c: Evaluation of LAMP Primers. (a) Florescence imaging of LAMP assays of seven primer sets from viral genome and two β-actin primer sets. (b) Agarose Gel Electrophoresis of LAMP amplicons. (c) Densitometry of florescence values from LAMP assays.

1. 3 Development of Dye based Reverse Transcription Real Time PCR Assay for Molecular Diagnosis of COVID-19

Vijay Lakshmi Jamwal, Piyush Singh Jamwal, Rahul Bhat, Kaurab Singh, Sandeep Dogra, Saurabh Saran, Ram A Vishwakarma and Sumit G. Gandhi*

COVID-19 has infected millions of people worldwide leading to death of a very large numbers of individuals. The socio-economic impact of COVID-19 pandemic is manyfold, with one of the components being the cost involved in testing of suspected individuals. Several scientific and medical organizations around the world have stressed on the fact that increased testing rate, contact tracing and isolation of infected individuals is critical to the control of infection. Presently most of the molecular diagnostic testing for COVID-19 is carried out using Taqman™ reverse transcription real time PCR (rt-RT-PCR). The test is very sensitive and accurate, but at the same time, expensive. For developing and underdeveloped countries with a very large population this could be one of the major constraints in increasing the testing numbers. SYBR Green I dye based rt-RT-PCR assays for sensitive and accurate testing of COVID-19 were developed in this study. Several primer sets were designed and tested experimentally and finally two sets of primers with binding sites in two different genes of the SARS-CoV2 genome were optimized. Calibration curves were plotted, reproducibility of assays was ascertained and the results of SYBR Green I assays were validated on patient samples and compared with the results of Taqman™ rt-RT-PCR assays. SYBR Green I assays developed by us showed a 100% match with the results from Taqman™ assays for COVID-19 diagnosis.

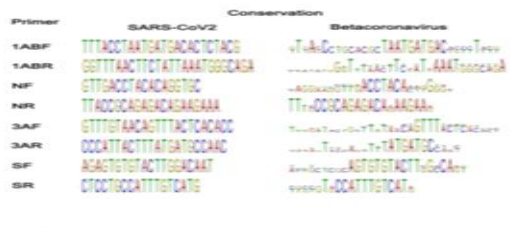


Figure 3a: The primer binding sites are well conserved in the genomes of SARS-CoV2 while they are quite divergent in the genomes of other betacoronoaviruses, thus permitting specificity of amplification.

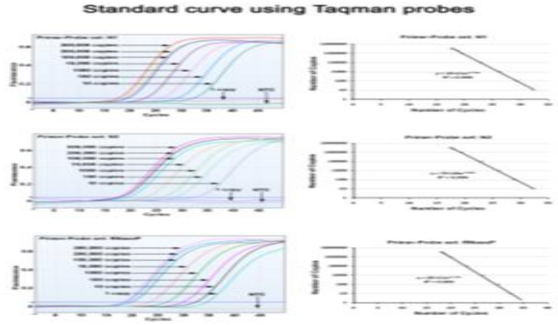


Figure 3b: Standard curves plotted using commercial SARS-CoV2 Taqman Primer-Probes, using different dilutions of synthetic template

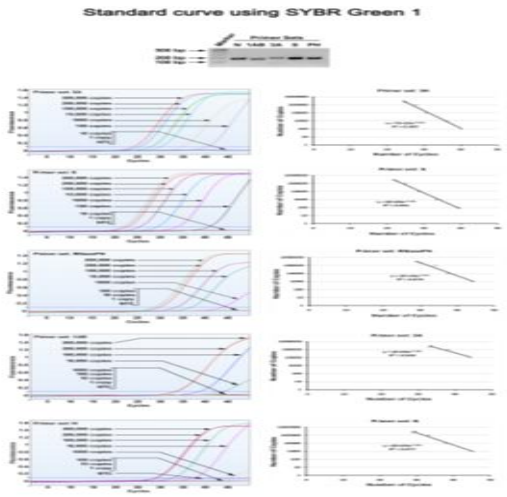


Figure 3c: Preparation of synthetic templates by cloning the primer binding regions from reverse-transcribed SARS-CoV2 RNA and Standard curves plotted using SARS-CoV2 primers designed in this study, using different dilutions of synthetic template

1. 4 Organization of COVID-19 sero-survey camp at CSIR-IIIM

Rekha Chouhan, Sajad Ahmed, Vijay Lakshmi Jamwal, Nitika Kapoor, Piyush Singh Jamwal, Sumit G. Gandhi* and Shantanu Sengupta*

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 two times (at Jammu) during the reporting period (11 September 2020 – 124 participants; 2nd February 2021 – 154 participants). This survey helped initially in identifying individuals who had already developed antibodies against SARS-CoV2, 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-COVID19 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 also helped the individuals in deciding when to get vaccinated.

1. 5 Development of Zinc gluconate-Vitamin C formulation for immunity improvement and management of Corona Virus Disease (COVID-19)

CSIR-IIIM Jammu has established fermentation based technology for production of various gluconate salts including Zinc gluconate, which has been reported to demonstrate higher bioavailability as compared to other zinc supplements. Zinc has been shown to contribute to a number of innate and adaptive immune signaling pathways. Ionic zinc possesses unique and distinct antiviral properties against a number of human viruses. High Zn^{2+} has been found to inhibit the replication of various RNA viruses, including influenza virus and other respiratory viruses. Vitamin C is also known as an essential antioxidant and enzymatic co-factor for many physiological reactions in the body, such as hormone production, collagen synthesis and immune potentiation. It is not only necessary for cell-mediated immune responses including leucocyte & macrophage functions, neutrophils motility and phagocytosis, but also for antimicrobial activity, interferon synthesis and antihistamine properties.

A combination of zinc gluconate and vitamin-C may support immune function for better potential for defense against viral infections. CSIR-IIIM has developed a formulation of natural vitamin C and Zinc gluconate with the aim to improve immunity for prevention and management of COVID-19.

The main constituents include *Malpighia emarginata* (Acerola cherry), a rich natural source of Vitamin C and Zinc gluconate, and an organic source of zinc. The formulation may be used as a promising immuno booster and modulator during the current COVID-19 pandemic.

Nutritional Information per Capsule (approx.)	
Energy	1.12 kcal
Protein	0.00g
Carbohydrate (Sugar as sucrose)	0.28g
Fat	0.00g

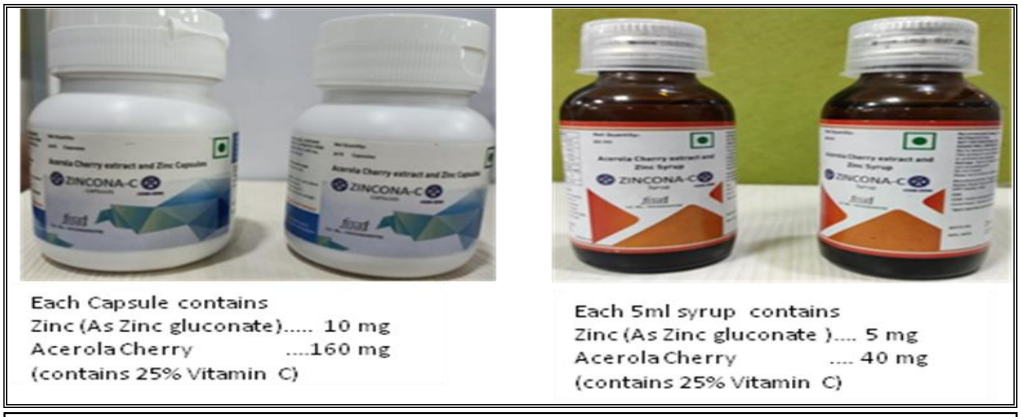


Figure 1.5.1: Zinc gluconate-Vitamin C Capsule formulation

1.6 Development of Processes for Active Pharmaceutical Ingredients towards COVID-19

The last financial year started with Lockdown and pandemic fear, however, the commitment of CSIR towards society has gathered all the labs across country and started a mission towards the development of COVID related APIs. In this direction, teams were build up in each lab, where CSIR-IIIM was led by Dr. P P Singh, Principal Scientist and taken the responsibility of development of four APIs namely Molnupiravir (EIDD-1931), Niclosamide, Nafamostat and Ribavirin and fragment of Remdesivir (Structure shown in Fig 1. 6.1). During this period, know-how was developed for all the five molecules and two non-infringing routes were developed for Molnupiravir and Nafamostat (One patent was filed and other is in process).

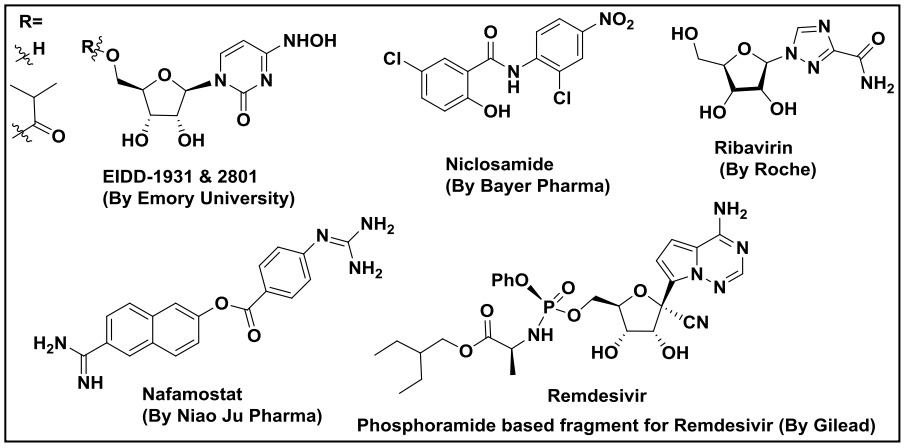


Figure 1. 6.1: Structure of Proposed API

Dr Parviner Pal Singh (Principal Scientist) and Dr Ravi Shankar (Senior Scientist) group worked towards the synthesis of Nafamostat and successfully developed know-how and non-infringing route (details given in Fig 1. 6.2).

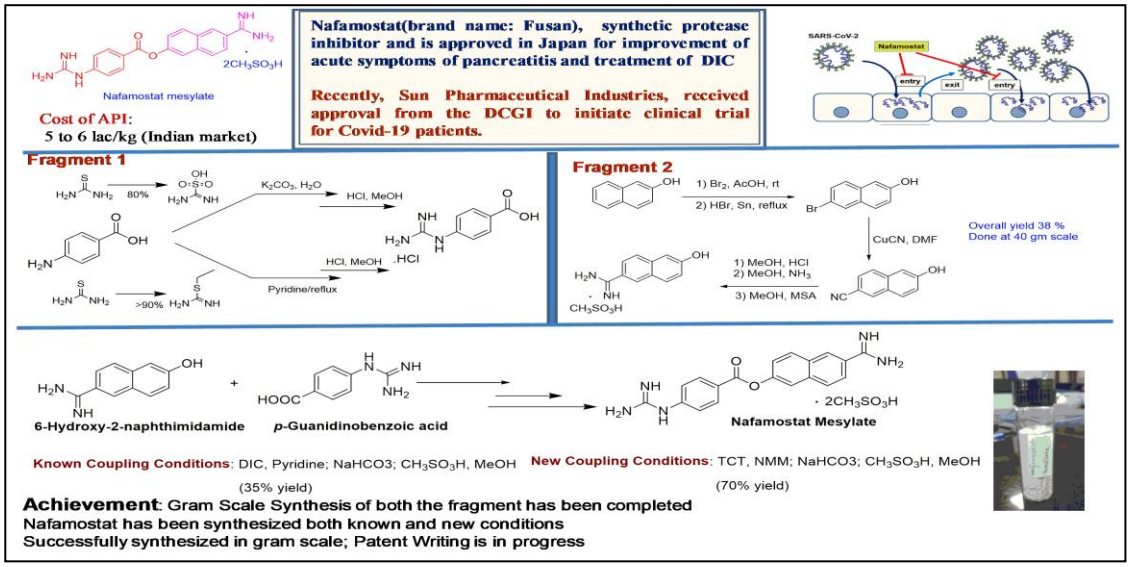


Figure 1. 6.2: Brief description regarding the synthesis of Nafamostat

Dr Parvinder Pal Singh group developmed a process for favipiravir. Favipiravir (RNA Polymerase inhibitor) originally developed by Toyama Chemical pharmaceutical company (subsidiary of the Fujifilm) known for treatment of influenza and viral strains which are untreatable, and been found as one of the most promising candidate working against the COVID-19 infections. The favipiravir has been recommended in China and Japan against COVID-19 infection. CSIR-IIIM in collaboration with M/s Anphar (a Jammu based API manufacturing company) has worked on its know-how process by following a multi-steps shown in Figure 1. 6.3. CSIR-IIIM has successfully optimized the conditions and transferred the process to M/s Anphar .

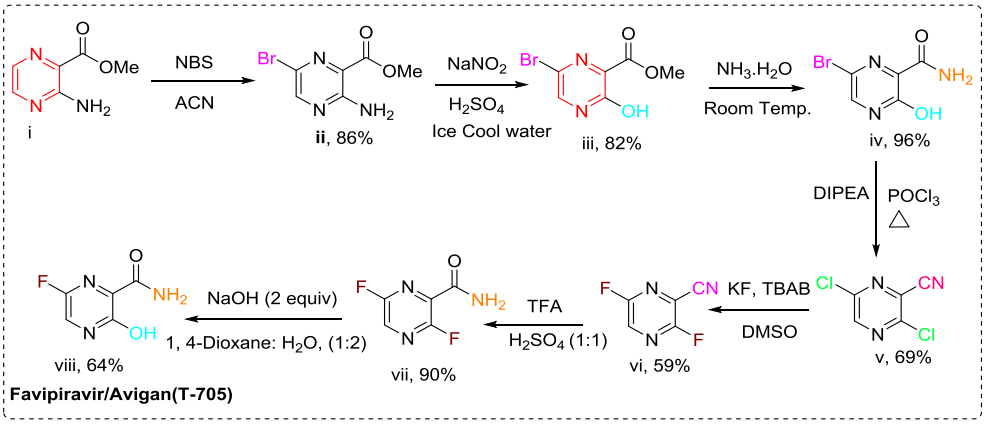
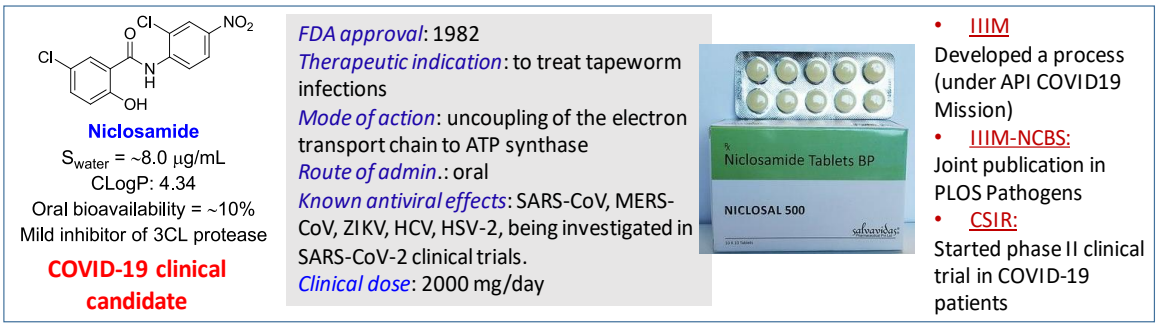


Figure 1. 6.3: Synthesis of Favipiravir.

Dr. Sandip Bharate group developed the process for synthesis of niclosamide. Niclosamide is currently being investigated in numerous clinical trials in COVID-19 patients. Thus, Bharate Lab developed a gram scale synthesis of niclosamide, and using this process and 50 g niclosamide was synthesized. The synthesized niclosamide was evaluated for anti-COVID-19 activity at Prof.Satyajit Mayor Lab at NCBS Bangalore. The niclosamide was identified as a promising inhibitor of the endocytosis step. The joint work has recently been published in "PLOS Pathogens".



Fluvoxamine Maleate was discovered in 1975 by Kali-Duphar, part of Solvay Pharmaceuticals, Belgium, now Abbott Laboratories), is an antidepressant of the selective serotonin reuptake inhibitor class and used for Treatment of obsessive–compulsive disorder. Major depressive disorder Anxiety disorders (panic disorder, post-traumatic stress). It is under clinical trials for Covid-19 treatment (5 No.). The investigational use of fluvoxamine for the treatment of COVID-19 is approved by the South Korean Ministry of Food and Drug Safety. Fluvoxamine is a selective serotonin reuptake inhibitor; fluvoxamine also activates sigma-1 receptors present intracellularly in the endoplasmic reticulum, thereby decreasing cytokine production. PP Singh group has developed the know-how for the synthesis of Fluvoxamine Maleate shown in Figure 1. 6.4 and transferred the technology to M/s Anphar.

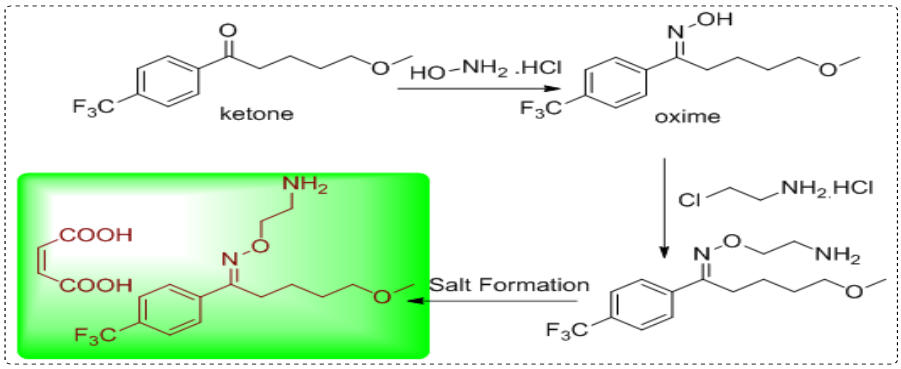


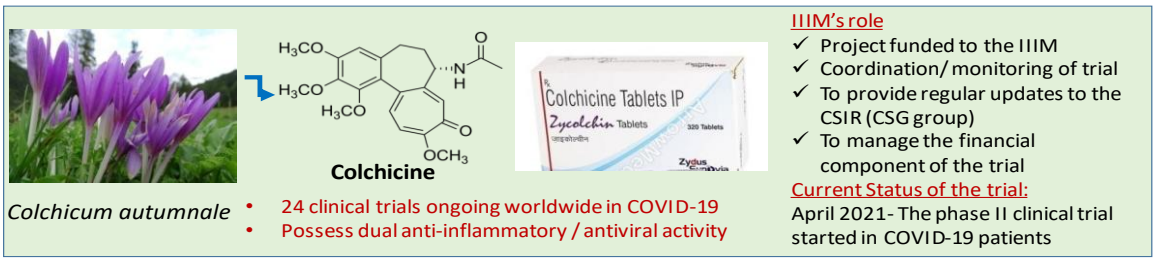
Figure 1. 6.4: Synthesis of Fluvoxamine Maleate.

1.7 Repurposing of colchicine for management of COVID-19 patients [MLP110002].

CSIR Labs Involved: CSIR-IIIM and CSIR-IICT; *Industry partner*: M/S Laxai Life Sciences, Telangana; *CRO*: M/S Insignia Clinical Services Pvt. Ltd

Clinical study title: A prospective, pilot, clinical trial to evaluate the efficacy and safety of Colchicine for improvement of clinical outcomes during Coronavirus (COVID-19) disease treatment in high-risk Indian patients (*CTRI/2021/04/032555*)

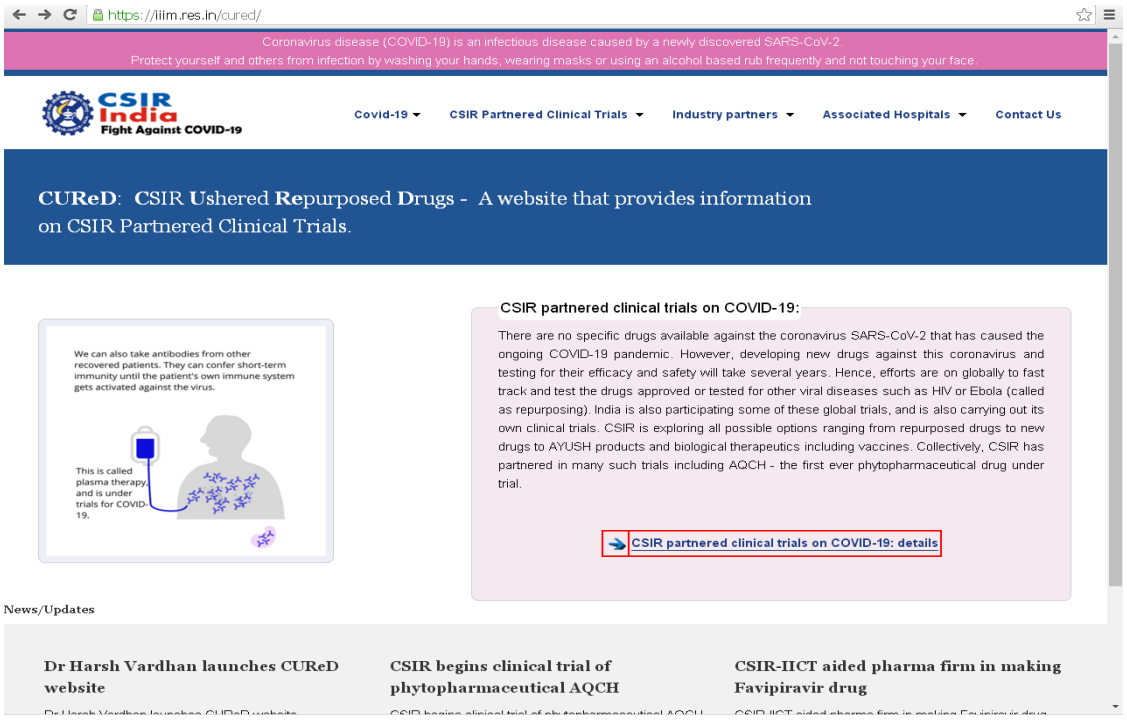
Brief Summary: One of the important host-specific events in COVID-19 patients in "cytokine storm". Several studies have shown that one of the primary reasons for mortality of COVID-19 infected patients is cytokine storm driven complications. Thus, the management of cytokine storm by potent anti-inflammatory drugs is also being investigated. One such potential FDA approved drug is "colchicine". Colchicine is a natural product isolated from meadow saffron (*Colchicum autumnale*); and is a FDA approved drug for treatment of inflammatory diseases 'gout' and 'Behçet's disease'. It exhibits anti-inflammatory effects via inhibiting the activation and migration of neutrophils to sites of inflammation. It also inhibits pro-inflammatory cytokines IL-6 and IL-1beta. Besides, it has also been reported to possess antiviral activity (in-vitro) against DENV, ZIKV [DENV: EC_{50} = 150 nM; ZIKV: 89% reduction at 5 µM). Worldwide, there are more than 24 clinical trials currently ongoing on colchicine in COVID-19 because of its potent anti-inflammatory properties. Two CSIR Laboratories namely, Indian Institute of Integrative Medicine Jammu and Indian Institute of Chemical Technology Hyderabad in collaboration with an industry partner M/S Laxai Life Sciences have started phase II clinical trial in COVID-19 patients.



1. 8 Computational Screening for Covid-19 targets

Dr. Amit Nargotra group has established the in-silico models for selected Covid targets viz., M^{PRO}, RdRP and Spike-ACE2 interface. The in-house compound library was screened on these targets, and 38 compounds were sent for in vitro evaluation at CDRI. Out of the 11 compounds that showed better affinity for M^{PRO}, 4 compounds showed IC_{50} in micromaolar range (11 to 60). Besides that at the initial stage we had carried out CMAP analysis of the 15 shortlisted antiviral drug molecules and identified 463 compounds having similar gene expression profiles, and this can be used further for drug repurposing. The identified compounds have been further classified based on their antiviral properties, and also based on the clinical trial stage of the compounds. Under the third vertical of network pharmacology, we have identified 9 plants for which we have collected data for 734 phytoconstituents and network construction on these was initiated. This would help us in identifying the gene-disease network, and exploring the possibility of combination drug.

1.9 Development of CUReD Web portal.: Developed a website CUReD, which contains the latest updates about Covid related CSIR partnered clinical trials in the area of i) Drugs/Vaccines/Therapeutics, ii) AYUSH Prophylactics / Therapeutics and iii) Diagnostics / Devices. The website was launched by the Hon'ble S&T minister Dr. Harsh Vardhan on 20th October 2020.



1.10 Clinical research studies on Ayurveda interventions as prophylaxis and as an add-on to standard care in the management of COVID 19.

- Under CSIR-AYUSH Joint initiative for the clinical studies on traditional Ayurveda formulations, CSIR-IIIM has undertaken following clinical studies in Sixteen reputed hospitals of the country.

(i) Ayurvedic formulation-1 for the Prophylaxis against SARS-COV-2 in subjects with increased risk during the COVID 19 Pandemic. A comparison with Hydroxychloroquine/SOC in the health care providers.

(ii) A Randomized, Open Label, Parallel Efficacy, Active Control, Multi-Centre Exploratory Drug Trial to Evaluate Efficacy and Safety of Ayurvedic formulation-2 as Adjunct Treatment to Standard of Care for the management of Mild to Moderate COVID-19 Patients.

(iii) A Randomized, Open Label, Parallel Efficacy, Active Control, Multi-Centre Exploratory Drug Trial to Evaluate Efficacy and Safety of an Ayurvedic Formulation-3 as an Adjunct Treatment to Standard of Care for the management of Mild to Moderate COVID-19 Patients.

- For the management of the disease in critically ill, hospitalized and high risk Patients, CSIR-IIIM Jammu has evaluated the safety and efficacy of *Mycobacterium* W in critically ill, hospitalized and high risk patients at the dedicated COVID-19 hospitals of the country in collaboration with M/s Cadila Pharmaceuticals Limited, Ahmedabad as an industry partner.

- Under Covid-19 management team of IIIM, Jammu around 1000 liters of WHO recommended Sanitizer was prepared for distribution among front line workers from hospitals and security forces located in Jammu.

The continuously increasing numbers of cancer patients and the increase in numbers of COVID-19 infections in cancer patients either undiagnosed, diagnosed, under treatment or under remission, have provided a sense of urgency to understand the interconnection and develop novel therapies to co-target viral infections and cancer. However, little is known about novel SARS-CoV-19 biology and very limited to no research has been done in the context of whether and how SARS-CoV-19 infection impacts cancer cells. Realizing the impact of spike protein in Covid infection, it is imminent to examine the role of spike protein of SARS-CoV-19 virus which binds to ACE2 in cancer emergence and treatment, and highlight the emerging need to study the role of COVID-19 infection in cancer progression and treatment.

1.11 Procedure for extraction of *Glycyrrhiza glabra* for Covid-19 national project

The well authenticated plant material was dried under shade and ground to coarse powder in cGMP plant. 20 kg of this powder was used for extraction with purified water and alcohol in 1:1 ratio (180 L). Extract was refluxed for 3 hrs the marc was again extracted twice sequentially for two hours. Total 8.3 Kg of extract was obtained after lyophilisation which was used for standardization and further processing.

The Standardization of *Glycyrrhiza glabra* Aqueous Extract Prepared at cGMP Plant, CSIR-IIIM, Jammu Using HPLC.

Standard	Retention time (min.)	Plant extract (%w/w)
Glycyrrhizic Acid	12.520	7.48
Liquiritin	10.558	0.53
Glabridin	14.272	0.16
Quercetin	11.697	0.06

Glycyrrhiza glabra | *Glycyrrhiza glabra* lyophilized extract

1.12 Rapid determination and optimisation of berberine from Himalayan *Berberis lycium* by soxhlet apparatus using CCD-RSM and its quality control as a potential candidate for COVID-19

SARS-CoV-2 (COVID-19) has become a global risk and scientists are attempting to investigate antiviral vaccine. Berberis is important plant due to the presence of bioactive phytochemicals, especially berberine from the protoberberine group of benzylisoquinoline and recent studies have shown its potential in treating COVID-19. *B. lycium* Royle growing in subtropical regions of Asia had wide applications in Indian system of medicine. Rapid determination and novel optimisation method for berberine extraction has been developed by Soxhlet extraction utilising central composite design-response surface methodology (CCD-RSM). Berberine was detected by high-performance liquid chromatography (HPLC), and the highest yield (13.39%) was obtained by maintaining optimal extraction conditions i.e., extraction time (7.28 h), ethyl alcohol (52.21%) and solvent to sample ratio (21.78 v/w). Investigation of two geographic regions (Ramnagar and Srinagar) showed high berberine content in lower altitude. This novel optimisation technique has placed berberine as a potential candidate for developing pharmaceutical products for human health care.

1.13 Preparation and Distribution of Hand Sanitizer and sanitization in CSIR-IIIM Campus and Residential Complex

The world is facing a medical crisis amid the COVID-19 pandemic and the role of adequate hygiene and hand sanitizers is inevitable in controlling the spread of infection in public places and healthcare institutions during first wave of COVID-19 infection in 2020. There has been a great surge in demand for hand sanitization products leading to shortages in their supply. As per the instructions from DG, CSIR, IIIM Jammu has prepared and still preparing Isopropyl alcohol based hand sanitizer according to WHO guidelines (WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge Clean Care Is Safer Care (Geneva: World Health Organization; 2009).

Almost 10,000 litters of Isopropyl alcohol based hand sanitizer was distributed to CSIR-IIIM employees and different organizations of Jammu like Govt. Medical and associated hospitals, Jammu and Kashmir police, CRPF hospital and Air Force hospital during the Covid-19 pandemic in 2020 and still distributing to CSIR-IIIM employees. Hand Sanitizer was prepared and distributed as well as sanitization drive was done in IIIM campus and residential colony.

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

Suruchi Gupta; Ravail Singh*; Prosenjit Paul

The spread of COVID-19 is a global concern that has taken a toll on entire human health. CSIR-IIIM Scientists performed the bioinformatics analysis to understand the genetic variability necessary to design effective drugs and vaccines. The study entails 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 1.14.1**). Based on the phylogenetic tree scientists grouped the 2019- nCoV genome sequences of Indian states into 13 major groups (**Figure 1.14.2**). These 13 representative groups (states) of India were then phylogenetically analyzed and SARS CoV-2 genomes (95 coronavirus sequences) from different countries worldwide. Scientists 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 region (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.

The 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. The 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.

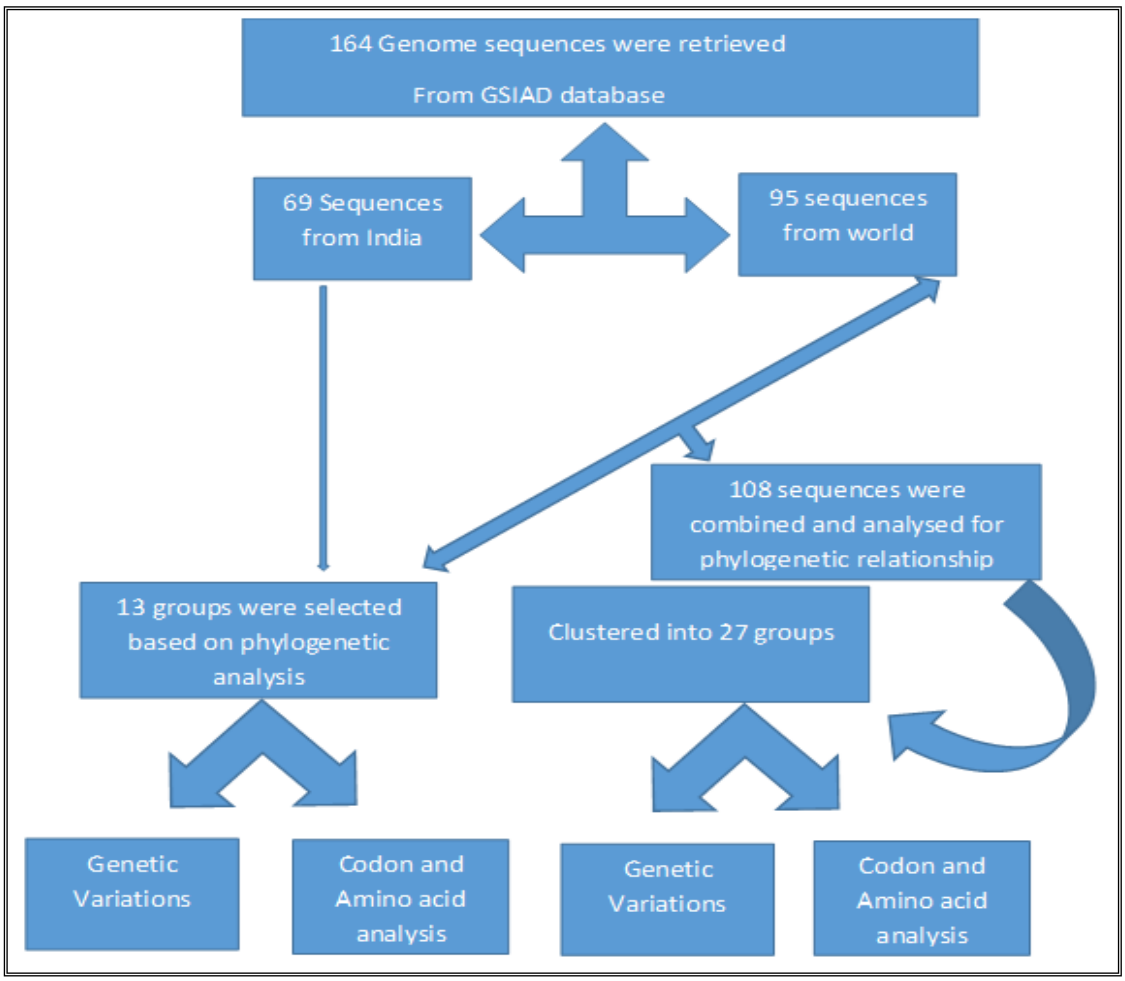


Fig.1.14.1: GSAID database was used to fetch 164 SARS CoV-2 genomic sequences, which comprised of 69 genomic sequences from India and 95 from other countries of the World

Fig.1.14.2 Multiple sequence alignment 65 world SARS CoV-2 genomes (including 5 Indian States) representing the hypervariable regions across the entire genome. (Mutations at 1068bp, 3046bp and 11092bp genomic positions are localized in gene orf1ab), (Mutations at 23412 bp and 25572bp are localized in spike gene), (Mutations at 28320 bp are localized in Nucleocapsid (N) gene)

2. SIGNIFICANT SCIENCE AND TECHNOLOGY ACTIVITIES

2.1 Serine-glycine-betaine, a novel dipeptide from an endophyte *Macrophomina phaseolina:* Isolation, bioactivity and biosynthesis

Endophytes are a rich source for structurally complex chemical scaffolds with interesting biological activities. Endophytes associated with *Brugmansia aurea* L. (family: Solanaceae), a medicinal plant, have not yet been explored for the bioactive metabolites. *M. phaseolina,* a fungal endophyte, was isolated from the roots of the plant. Its methanolic extract was found active against human cancer cell lines with IC_{50} <20 µg/mL. In the present study, the isolated fungal strain from the roots of *B. aurea* was identified as *M. phaseolina* based on the sequence of internal transcribed spacer regions, and it was deposited in GenBank with the accession number KX098325 (Fig. 1.2.1.1). A di-peptide compound, serine-glycine-betaine was isolated and characterized. Serine-glycine-betaine consists of a unit of an *N*-trimethyl glycine attached to serine. Compound **1** was isolated as a reddish-brown solid, which gave molecular ion peaks at m/z 206.3 [M + H] + in the positive ESIMS, corresponding to a molecular formula $C_8H_{17}N_2O_4$, and this was fully supported from its NMR data. Assignments of all the ^{13}C and ^{1}H NMR signals for two spin systems suggested that the molecule could be a conjugate of two compounds.

The compound exhibited potent activity against MIA PaCa-2 and HCT-116 cell lines with IC_{50} 8.9 and 15.16 µM, respectively. Further, it induced apoptosis in MIA PaCa-2 cells confirmed by microscopy. The apoptotic cell death in MIA PaCa-2 cells was evidenced biochemically with the generation of intracellular reactive oxygen species (ROS) level and leading to loss of mitochondrial membrane potential (MMP) due to activation of the intrinsic pathway. This study describes the plausible biosynthesis of serine-glycine-betaine based on genomics (genome sequencing, annotation and genes alignment). A novel di-peptide, serine glycine betaine isolated from *M. phaseolina* induced apoptosis in MIA-Pa-Ca-2 cells. This study confirms that dipeptides like serine-glycine-betaine and tyrosine-betaine might be specific to fungal genera, hence being used for diagnostic purposes.

Table 2.1.1 Cytotoxic activity of compounds (**1**) against human cancer cell lines IC_{50} (µM)

Molecule	MIA PaCa-2	HCT-116	MDA-MB-231	PC-3	FR2 (Normal)
Serine-glycine-betaine	8.9±0.05	15.16 ±0.15	34.6±0.03	22.4±0.16	>50
Paclitaxel	0.750	0.120	<0.01	0.065	-

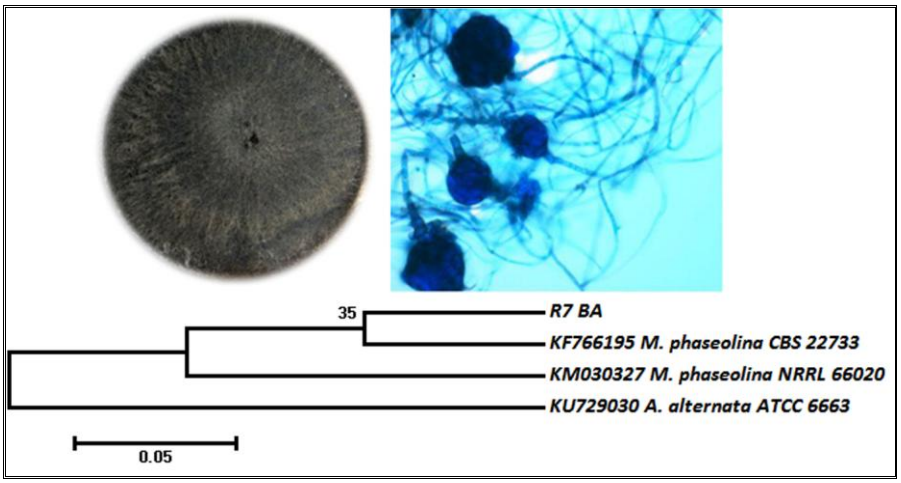


Figure 2.1.1: Morphology, microscopy (*sequence)* of *M. phaseolina* at *400x* and phylogenetic tree (*based on ITS-5.8S rDNA sequence)* of *M. phaseolina*.

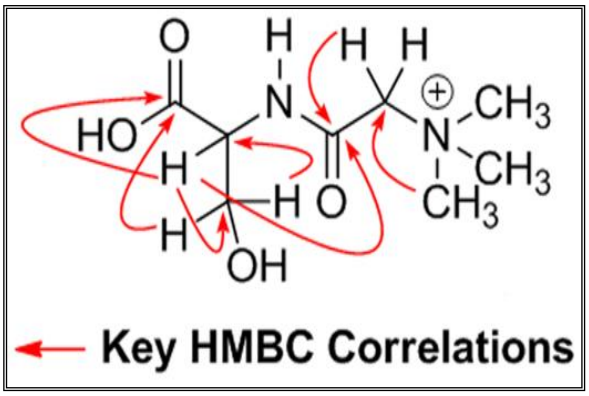


Figure 2.1.2: Selected 2D NMR (HMBC) correlations for compound (**1**)

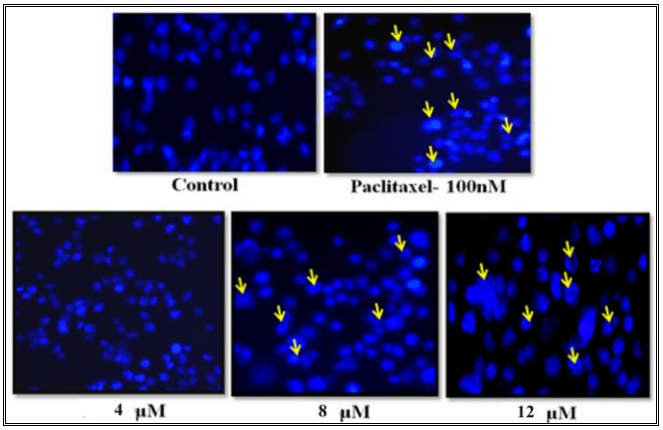


Figure 2.1.3: Change in nuclear morphology of MIA PaCa -2 using DAPI after treatment with different concentrations (4, 8, and 12) µM of compound Serine glycine betaine (**1**). Paclitaxel (1 µM) was used as positive control and untreated cells as a negative control. A significant increase in nuclear condensation and apoptotic bodies was observed with increase in compound (**1)** concentration.

2.2 Mutation, Chemo-profiling, Dereplication and Isolation of Natural products from *Penicillium oxalicum*

Diethyl sulphate (DES) based chemical mutagenesis were applied on different fungal strains with an aim to diversify the secondary metabolites. The mutant strain (VRE-MT1) of *Penicillium oxalicum* was subjected to the dereplication (LCMS based) and isolation of natural products, resulting to obtain ten molecules of bioactive potential. Metabolites viz tuckolide, methylpenicinoline, 2-acetyl-3,5-dihydroxy-4,6-dimethylbenzeneacetic acid, penicillixanthone A, brefeldin A 7-ketone, antibiotic FD 549 were observed for the first time from *Penicillium oxalicum*. The results of antimicrobial activity reveals that the compounds N-[2-(4-hydroxyphenyl) ethenyl] formamide, methylpenicinoline, penipanoid A have potent antibacterial activity against *Bacillus subtilis* (ATCC 6633) with MIC of 16 µM, 64 µM and 16 µM respectively and the compounds N-[2-(4hydroxyphenyl) ethenyl] formamide, methylpenicinoline, penipanoid A were found active against *Escherichia coli* (ATCC 25922), with MIC of 16 µM, 64 µM and 16 µM respectively. Also, the metabolites N-[2-(4-hydroxyphenyl) ethenyl] formamide, tuckolide showed effective antioxidant activity in DPPH and ABTS scavenging assays. The mutant VRE-MT1 was found to have 8.34 times higher quantity of N-[2-(4-hydroxyphenyl) ethenyl] formamide as compared to the mother strain. The DES based mutagenesis strategy has found to be the potent tool to diversify the secondary metabolites in fungi.

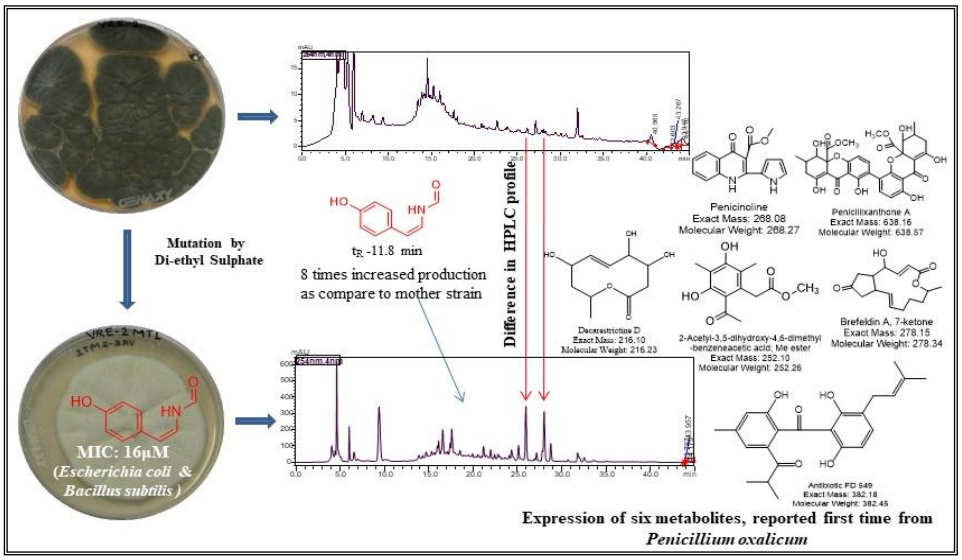


Figure 2.2.1: Schematic diagram showing isolation of Natural products from *Penicillium oxalicum*

2.3 Fermentative production of xylitol from aromatic spent lignocellulosic biomass:

Xylitol has attracted considerable attention in the food and pharmaceutical industries because it has useful characteristics, including its use for the prevention of dental caries, as a sugar substitute for insulin-independent diabetics, and as a natural food sweetener. Xylitol is currently produced on an industrial scale by a catalytic reduction (hydrogenation) of xylose obtained from wood sources such as white birches. However, alternative processes have been extensively explored because of the high production cost and environmental impact associated with the excessive utilization of natural wood sources. Microbial xylitol production from aromatic spent biomass wastes containing

hemicellulose could be a possible entrant. In microbial xylitol production from spent biomass (lemon grass) is first hydrolysed using dilute acid hydrolysis for extraction of xylose from hemicellulose further xylose rich hydrolysed used as the medium for xylitol production by xylose-utilizing yeasts. Therefore, to evaluate the feasibility of microbial xylitol production from spent biomass.

Research progress: This work deals with the development of an improved process for xylitol production from spent aromatic biomass hydrolysate by biotechnological routes. The bioconversion of xylose to xylitol is efficiently brought about by yeasts. Screening for xylitol producers was carried out by point inoculation of the yeast isolates on MGYP plate. These plates were incubated at 28 ± 1°C up to 24-36 h for obtaining yeast growth. The observations with respect to xylitol synthetic producing medium and further HPLC analysis. However, in order to select the most potent isolate, it was necessary to quantify the amount of xylitol being produced by each of these isolates. Therefore, quantitative estimation of xylitol production will be carried out for 15-35 yeast cultures. Preliminary qualitative analysis of yeast strains (Figure 1.2.3.1). On the basis of VK 035 was selected further study.

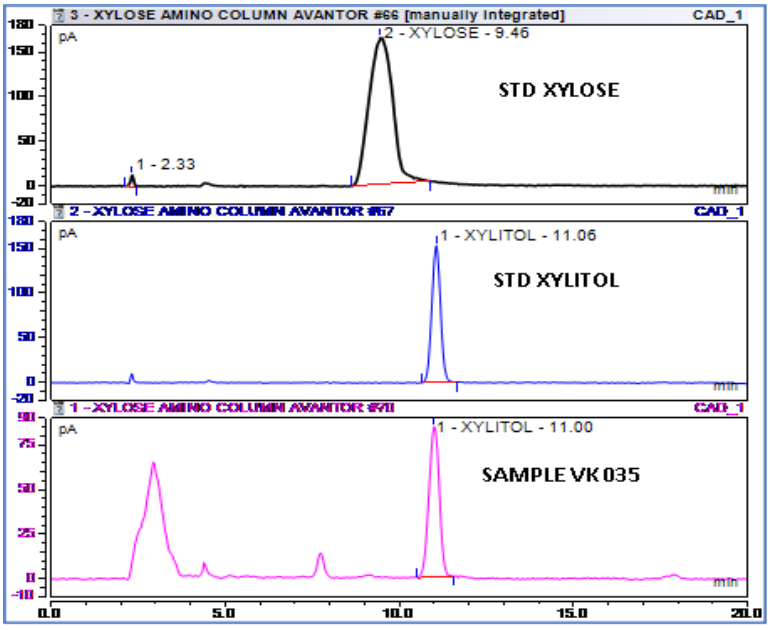


Figure 1.2.3.1: HPLC chromatogram of standards Xylose, Xylitol, and xylitol production

2.4 Purification and characterization of Serratiopeptidase from *Serratia marcescens* AD-W2

Serratiopeptidase is a proteolytic enzyme, extensively used as an anti-inflammatory and analgesic drug. Present work reports a thermoactive serratiopeptidase from *Serratia marcescens* AD-W2, a soil isolate from North-Western Himalayan region. The extracellular metalloprotease has been purified by a simple two-step procedure resulting in a specific activity of 20,492 Units/mg protein with 5.28 fold purification. The molecular mass of metalloprotease, as determined by SDS-PAGE, was ~51kDa.

The purified serratiopeptidase presented optimum activity at pH 9.0, temperature 50°C and with stability in wide pH and temperature range. Critical temperature of 50° Cconfirmed the thermoactivity of the purified serratiopeptidase. The kinetic studies of the purified

serratiopeptidase revealed V_{max} and K_m of 57,256 Units/mL and 1.57 mg/mL, respectively, for casein. The purified serratiopeptidase from *S. marcescens* AD-W2 was found to be 100% identical to serralysin from *Serratia marcescens* ATCC 21074/E-15. The catalytic domain comprising of Zn coordinated with three histidine residues (His192, His196, His202), along with glutamate (Glu193) and tyrosine (Tyr232) residues further confirmed that the purified protein identical to serralysin.

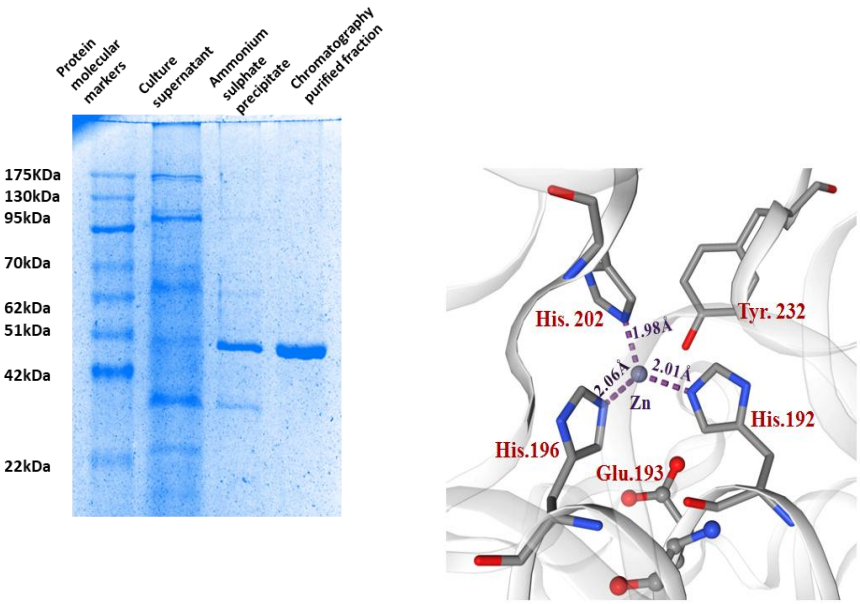


Figure 2.4.1: Purification of Serratiopeptidase from *Serratia marcescens*

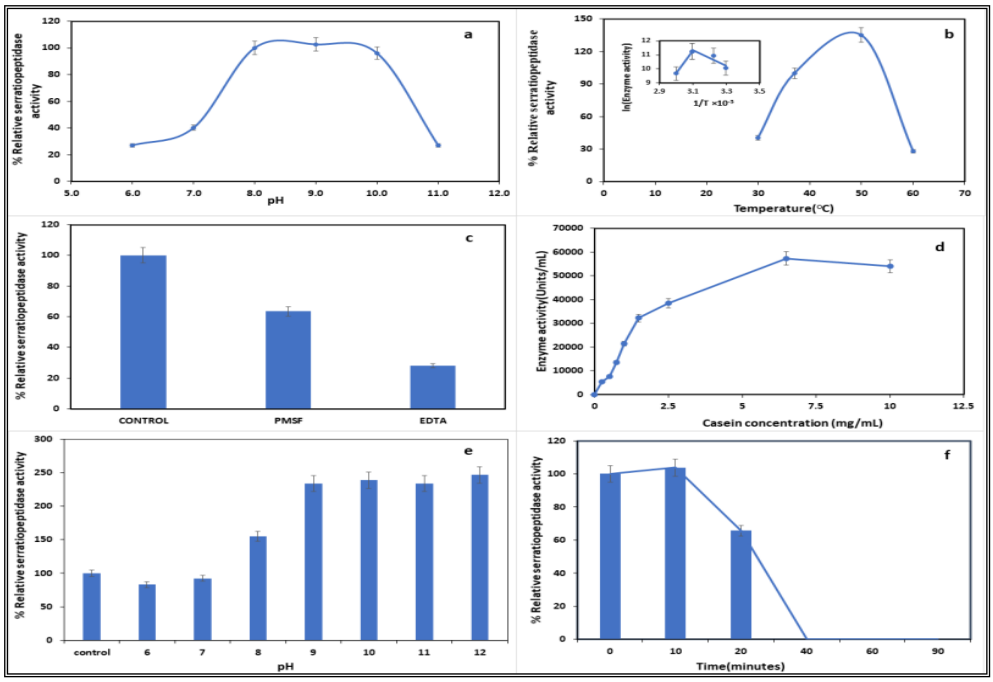
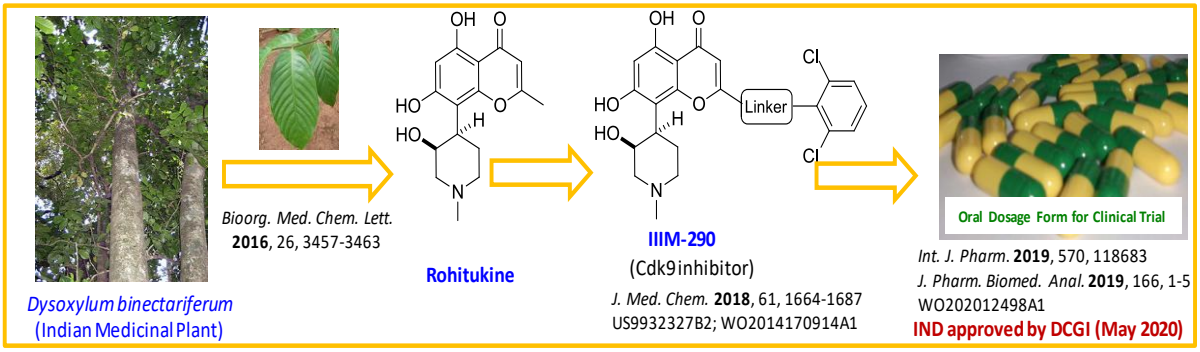


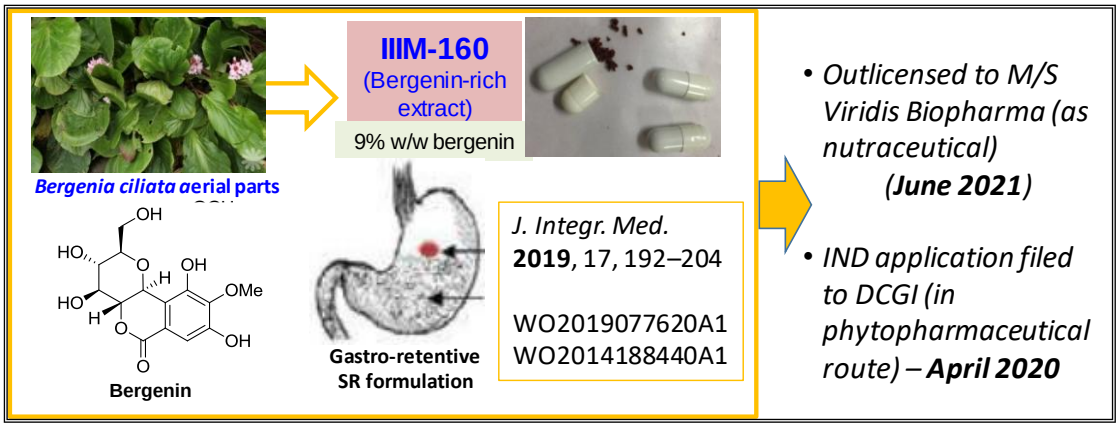
Figure 2.4.2: Characterization of Serratiopeptidase from *Serratia marcescens* AD-W2

2.5 Translational Research:

2.5.1. Grant of IND Application for NCE lead, IIIM-290: IIIM-290 is an orally bioavailable NCE lead based on a natural product rohitukine. It was discovered and developed at IIIM under 12th FYP BSC-205 and CSIR-FTT (MLP-5008) projects. It is a potent inhibitor of Cdk-1/A, Cdk-2/A, Cdk4/D3 Cdk5/p25, Cdk-6/D1 and Cdk-9/T1 with IC_{50} values in the range of 1.9 to 50 nM. It possesses promising in-vitro cytotoxicity in different types of cancer tissues, with most potent cytotoxicity in pancreatic and leukemia cells (IC_{50}< 1 µM). It displays an excellent in-vivo efficacy in human xenograft models of pancreatic cancer and leukemia. The regulatory pharmacology of the lead has been completed as a part of CSIR's FTT grant (MLP-5008), and the IND application was filed to DCGI in January 2020. The approval was received from DCGI on 28th May 2020, for this IND application, for conducting Phase I/ II clinical trial in locally advanced or metastatic pancreatic cancer patients.



2.5.2. IND application of IIIM-160 (*Bergenia ciliata* based phytopharmaceutical lead): Under the CSIR-phytopharmaceutical mission I (2017-2020), *Bergenia ciliata* based phytopharmaceutical lead IIIM-160 was developed. The preclinical pharmacology, regulatory Tox., and CMC documentation was completed. The lead is positioned for the management of pain in rheumatoid arthritis. The IND application has been filed to DCGI on 20th April 2020.



2.6 Basic research

2.6.1 Total Synthesis of Phospholipomannan of *Candida albicans*: PLM is composed of a mannose-inositolphosphoceramide lipid anchor (embedded in the cell wall) on which an unusual oligomeric (1 → 2)-β-mannan is linked through an anomeric phosphodiester linkage. Interestingly, the PLM anchor is quite distinct from the more widely occurring glycosylphosphatidylinositol (GPI) anchors in human biology in terms of the following: (a) (1 → 2)-β-mannan in place of the (1 → 2)-α-mannan motif of GPI anchors; (b) (1 → 2)-α-mannose linked to myo-D-inositol in place of the (1 → 6)-α-glucosamine-inositol motif, and (c) the presence of an unusual phytoceramide in place of the glycerolipid. More importantly, the PLM anchor is highly immunogenic due to its (1 → 2)-β-mannan structural motif, which is absent in human host and presented a good opportunity for the vaccine programme and moreover, its full synthesis is not reported till date, here, we have reported the first synthesis of the cell surface phospholipomannan anchor [β-Manp-(1 → 2)-β-Manp]n-(1 → 2)-β-Manp-(1 → 2)-α-Manp-1 → P-(O → 6)-α-Manp-(1 → 2)-Inositol-1-P-(O → 1)-phytoceramide of *Candida albicans* is reported. The target phospholipomannan (PLM) anchor poses synthetic challenges such as the unusual kinetically controlled (1 → 2)-β-oligomannan domain, anomeric phosphodiester, and unique phytoceramide lipid tail linked to the glycan through a phosphate group. The synthesis of PLM anchor was accomplished using a convergent block synthetic approach using three main appropriately protected building blocks: (1 → 2)-β-tetramannan repeats, pseudodisaccharide, and phytoceramide-1- H-phosphonate. The most challenging (1 → 2)-β-tetramannan domain was synthesized in one pot using the preactivation method.

The phytoceramide1-H-phosphonate was synthesized through an enantioselective A3 three component coupling reaction. Finally, the phytoceramide-1-H-phosphonate moiety was coupled with pseudodisaccharide followed by deacetylation to produce the acceptor, which on subsequent coupling with tetramannosyl-H-phosphonate provided the fully protected PLM anchor. Final deprotection was successfully achieved by Pearlman's hydrogenation. Synthesis of phospholipomannan of *candida albicans* shown in **Figure 2.6.1.1**

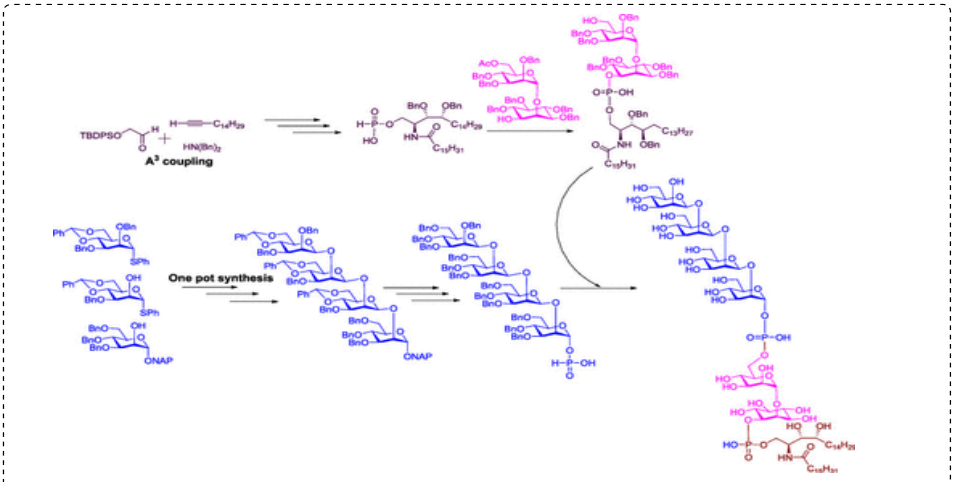


Figure 2.6.1.1: Synthesis of phospholipomannan of *candida albicans*.

2.6.2 Functionalization of Alkynes and Alkenes Using a Cascade Reaction Approach: Synthesis of β-Keto Sulfones under Metal-free Conditions: Here, we are reporting a multicomponent cascade reaction approach for the synthesis of β-keto sulfones by exploiting differential reactivity pattern of substrates under open-atmosphere and metal-free conditions. The coupling partners are aryldiazonium salts, unsaturated compounds, and DABSO. The optimized conditions worked well with both alkenes and alkynes. Moreover, the reaction also works with metabisulfite for the source of sulfone. The controlled liquid chromatography–mass spectrometry and 18O-labelled experiments suggested that air is a source of the incoming oxygen atom of the keto group of β-keto sulfones which is shown in **Figure 2.6.2.1.**

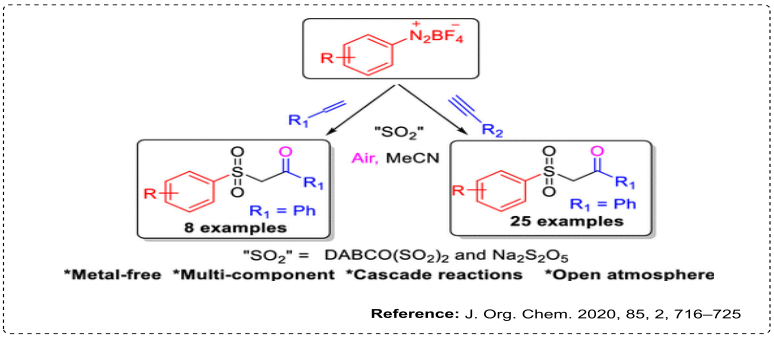
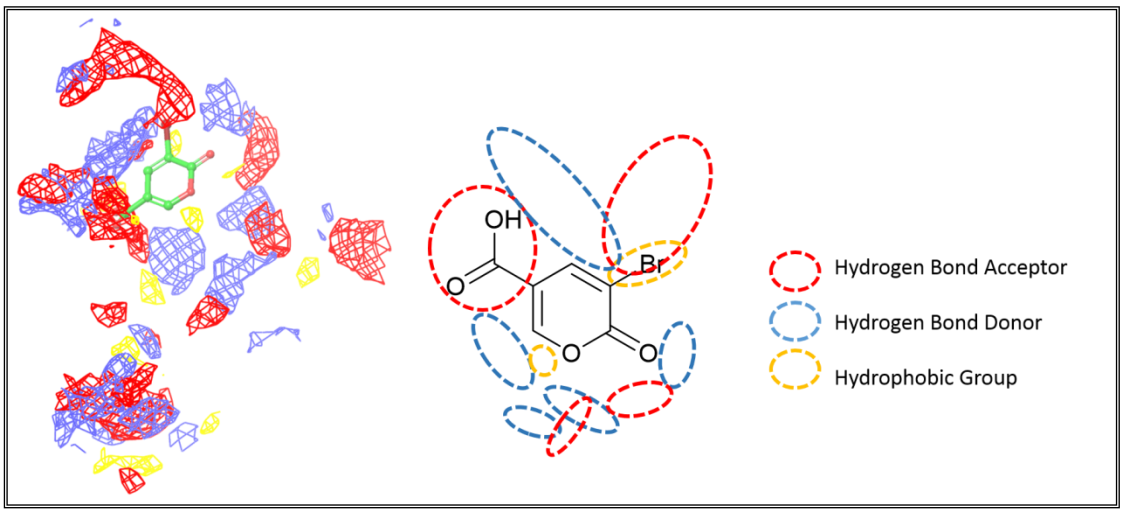
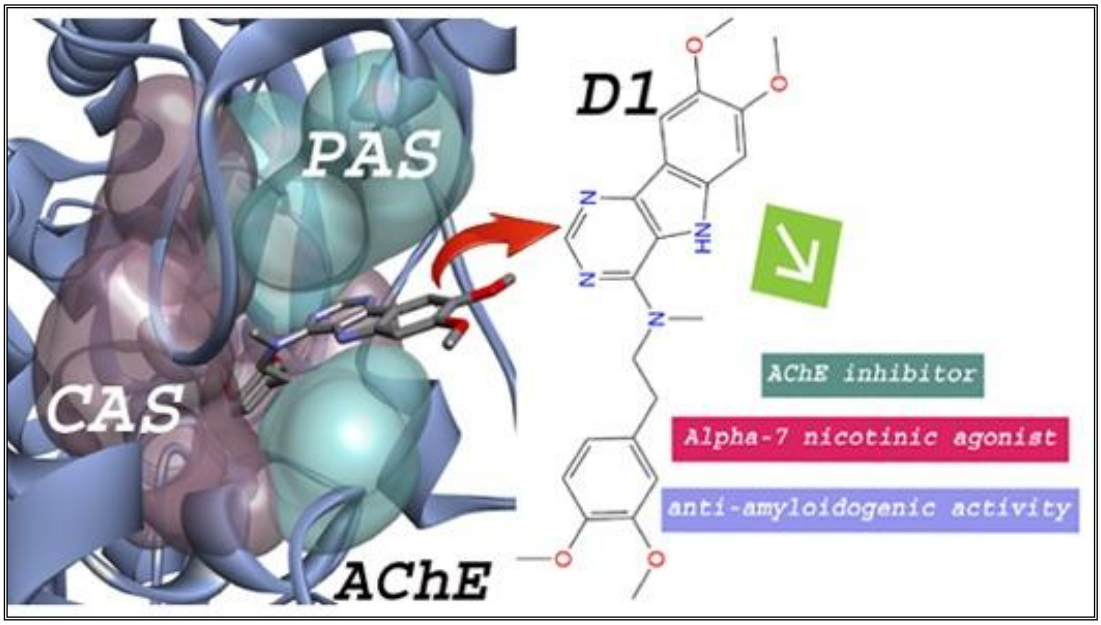


Figure 2.6.2.1: Synthesis of β-keto sulfones

2.6.3 Elucidation of mode of inhibition of E. Coli MurA inhibitors. UDP-N-acetylglucosamineenolpyruvyl transferase (MurA) is an important enzyme involved in the first cytosolic step of bacterial cell wall synthesis. MurA has no mammalian homolog; therefore, an emerging strategy for fighting bacterial diseases is to target the bacterial MurA enzyme. We employed a combination of ligand based and structure based in silico screening methods for screening 50,000 drug like (commercial source) and 2690 in-house compound library. Hits identified after in silico screening were validated by experimental validation under various incubation conditions using Malachite green phosphate assay. Thereafter, we identified two hits 3772-9534 and D396-0012 as MurA inhibitors. Among the hits identified, compound 3772-9534 showed significant changes in the value of IC50 across different assay conditions. The MD simulation study suggested a novel hit binding site (allosteric site) in MurA enzyme as a binding site for compound 3772-9534. It was also inferred from the MD studies that the binding of ligand induces conformational changes in enzyme, which leads to inhibition of enzymatic activity.



2.6.4 Discovery of a new donepezil-like acetylcholinesterase inhibitor for targeting Alzheimer's disease. Alzheimer's disorder is one of the most common world-wide health problems and its prevalence continues to increase thereby straining the healthcare budgets of both developed and developing countries. Using computational studies and biological validation, we identified a new donepezil-like natural compound derivative (D1) as a convincing AChE inhibitor. The in silico studies suggested that D1 exhibits a dual-binding mode of action and interacts with both the catalytic anionic site and PAS of human AChE. The biological studies confirm the dual binding site character of D1 and revealed that D1 not only enhances the acetylcholine levels but also reduces the accumulation of Aβ plaques in *C. elegans*. In fact, 5 µM of D1 was seen more potent in elevating the acetylcholine expression than 15 µM of donepezil. While most of the noncholinergic functions of donepezil associated with the PAS of AChE were gradually lost at higher concentrations, D1 was more functional at similar doses. Promisingly, D1 also exerted agonistic effect on the α7 nicotinic acetylcholine receptor.

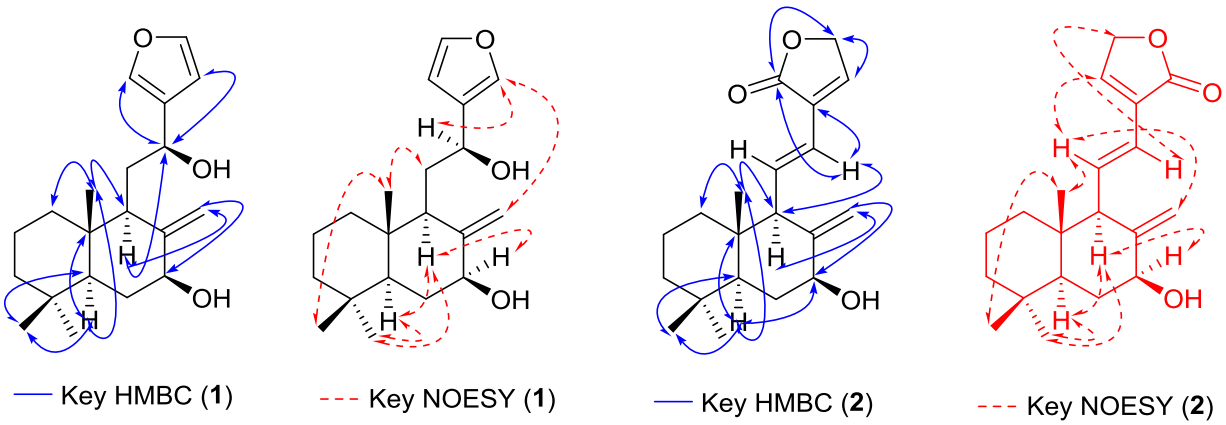


2.6.5 Coronarin K and L: Two Novel Labdane Diterpenes from *Roscoea purpurea:* An Ayurvedic Crude Drug

Roscoea purpurea commonly known as kakoli belongs to the family Zingiberaceae is abundantly available in alpine grassland, grassy hillsides and stony slopes of central to eastern Himalaya from Uttarakhand to North East states, up to an altitude of 3300m. It is an essential ingredient of an important Ayurvedic preparation known as *Astavarga*, which is a group of eight plants claimed to be useful in promoting seminal weakness, body overweight, curing fractures, high-fever, diabetic situation and as a heal for vata, pitta, raktadoshas. The groups of Astavarga plants are considered as a very excellent *Rasayana* with health-promoting and rejuvenating properties, and are recognized to support our immunity and have capacity of cell renewal. *Astavarga* plants are also known to restore human health and work as strong anti-oxidants in our body. Amongst eight Astavarga plants *Roscoea purpurea* is one of the essential ingredients of several herbal formulations like tonic and Chyawanprash. Traditionally it is used for the cure of diabeties, diarrhea, hypertension, fever, immunostimulant and inflammation etc. In Nepal, its tubers are boiled for edible purpose and also used in traditional veterinary medicine.In the view of its significance in Ayurvedic medicinal system, substantial pharmacological and phytochemical works have not been carried out. Previous phytochemical studies on *R. purpurea* have described the isolation of two principal groups of compounds, steroids and phenolic derivatives. To date, only few compounds have been identified and quantified through HPLC analysis from tubers of this plant by Singh and co workers, and they are presumed to be associated with its potent antioxidant activity.

Alcoholic extract of the plant have shown *in-vitro* anti-cancer, anti-oxidant and immunomodulatory activities. In our preliminary pharmacological study, cytotoxic activity was found for the methanol extract of *R. purpurea*a gainst lung cancer cell line at IC_{50} 25.71 (µg/ml).

On bioassay-guided fractionation, activity was localized in a chloroform-soluble fraction. Bioactivity guided purification of *n*-chloroform soluble fraction of *Roscoea purpurea* resulted in the identification 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 structural identification of new compounds (**1** and **2**) were determined by thorough analysis of 1D (^{1}H and ^{13}C) and 2D NMR (COSY, HSQC and HMBC) spectroscopic data. The relative configurations of 1 and 2 were determined with the help of NOESY correlations and comparison of optical rotations with known labdane diterpenes with established stereochemistry, while structure of known compounds were established 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 compounds (**1-5**) were screened for their cytototoxicity against all the cell lines by MTT assay. Coronarin K, **1** showed significant cytotoxic potential against lung cancer cell lines (A-549), with IC_{50} value of 13.49 μM, while other compounds did notshow activity below 22 μM.

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

Compound	IC_{50}, µM, in different human cancer cell lines			
	A-549	**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

2.6.6 Triazole based anticancer agents

A series of triaryl-1,2,3-triazoles, in order to check cytotoxicity on breast cancer cell lines have results indicated that most of the compounds possessed comparative anti-proliferative activities in both ER+*ve* (MCF-7) and ER−*ve*(MDA-MB-231) breast cancer cell lines been synthesized with pendent benzyl ring to mimic the phenolic **A** ring of Tamoxifene. Among synthesized derivatives, five compounds **8f**, **8i**, **8j**, **8n** and **8p** showed anti-proliferative activities at <5μM against MCF-7 cell line and three compounds **8e**, **8f** and **8j** show IC_{50} value greater than 30μM in FR-2 cells (normal cell). Moreover, to understand the mechanistic behavior of the selective compound **8f,** various studies performed viz. surface morphological changes by bright field microscopic examination, nuclear morphological alteration by DAPI staining, measurement of intracellular ROS level and determination of change in mitochondrial membrane potential. It was observed that, the selective compound **8f** associated with higher ROS generation along with decrease in mitochondrial membrane potential in addition to surface and nuclear morphological alterations such as reduction in number and shrinkage of cells coupled with nuclear blabbing indicating sign of apoptosis. Further, molecular docking study in comparison to tamoxifen was also carried out to investigate the interaction of **8f** with ER-α which favors its possible mode of anticancer action.

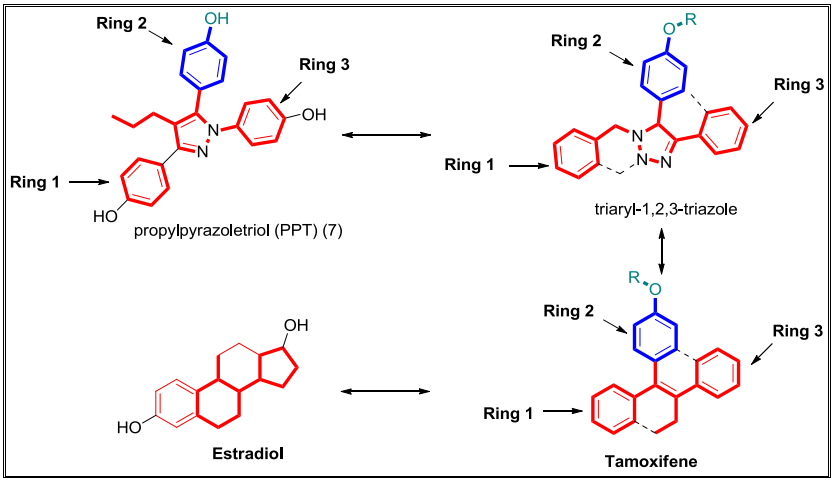


Figure 2.6.6.1: Structural resemblance of 1,2,3-triazole based molecule to tamoxifen, estradiol and propylpyrazoletriol(PPT)

In order to rationalize the activity profile, next we carried out the molecular docking study of computationally energy minimized conformation of active compound **8f** with structurally related drug moiety, 4-hydroxy tamoxifen (OHT) in ER α. Infact, compound **8f** displayed strong binding at the active site with the dock score of -9.97 while the co-crystallized ligand 4-hydroxytamoxifen has a dock score of -13.61. The overlay image of **8f** with 4-hydroxytamoxifen has indicated the perfect alignment of these two ligands with each other as shown in Figure 9. The N-benzyl and phenyl ring of **8f** were precisely superimposed over phenolic and phenyl ring of 4-hydroxytamoxifen, respectively and the triazole moiety of **8f** occupied the junction of three aryl rings containing C=C bond.

The key H-bonding interaction with Thr-347 of 4-hydroxytamoxifen was also observed in **8f**. The favorable interaction of **8f** with ER-α may be indicating that modulation of ER-α activity could be its possible mode of anticancer action.

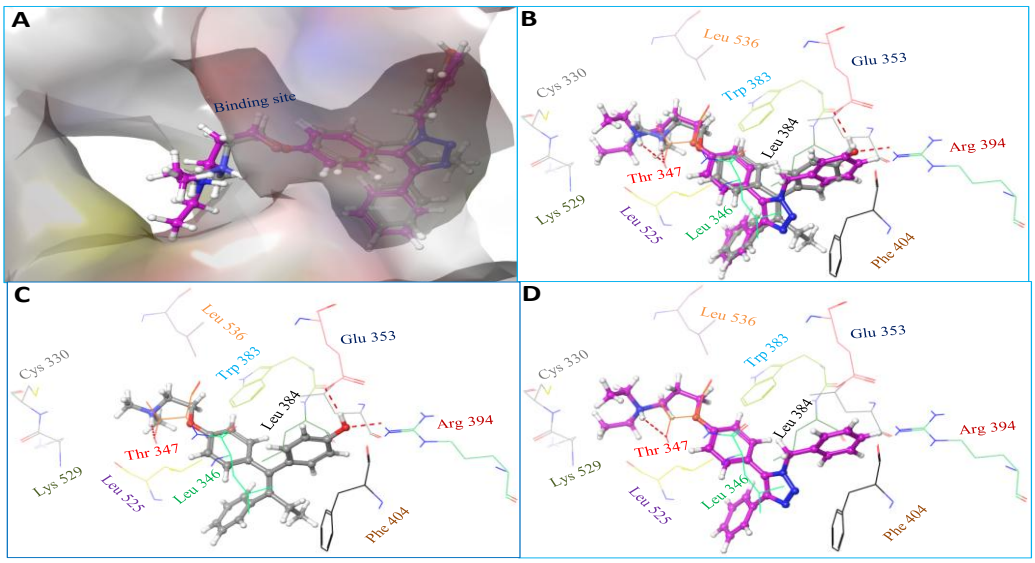


Figure 2.6.6.2: Interaction of 4-hydroxytamoxifen (grey) and **8f** (purple) with ER-α (PDB: 3ERT). (**A**) Surface view of ER-α protein showing the active site; (**B**) Overlay of 4-hydroxytamoxifen and **8f** in the active site of ER-α; (**C**) Interactions of 4-hydroxytamoxifen with ER-α active site; and (**D**) Interactions of **8f** with ER-α active site

The designed derivatives (**6a-6e**) and (**8a-8p**) were investigated for antitumoral activity and results indicated that most of the compounds possessed comparative anti-proliferative activities in MCF-7, MDA-MB-231 and HCT-116 cancer cells using SRB assay. Most synthesized compounds inhibited the growth of cancer cells at IC_{50} of less than 50 µM. Among synthesized derivatives, six compounds **8f (**3.5 µM), **8i (**4. 7 µM), **8j (**3.5 µM), **8n (**3.9 µM), **8p** (4.5 µM) and **8q** (3.3 µM) showed anti-proliferative activities at less than 5 µM against MCF-7 cell line and three compounds **8e (**30.8 µM), **8f (**34.8 µM) and **8j (**29.0 µM) showed IC_{50} value >30 µM in FR-2 cells. Five of these, **8e**, **8f**, **8g**, **8i** and **8j** inhibited the growth of both MCF-7 as well as MDA-MB-231 cell lines at IC_{50} below 20 µM (Table 1). Three of these, **8b**, **8m** and **8n** were active against MCF-7 cell line selectively. Dimethoxy derivative of compound **8q** was also synthesized and evaluated against MCF-7 cell line but no improvement was observed therefore, its activity against another cell line was not evaluated. N-debenzylated compound **8q** also showed decrease in activity which confirmed the importance of N-benzyl group in biological action. Activity of compound **8f** was evaluated towards MCF-7, MDA-MB-231 as well as HCT-116 tumor cells at different concentrations of 0.1, 1, 10, 50 and 100 µM. Selective destruction of tumor cells while guarding development of healthy cells plays a pivotal characteristic among cytoprotectives. Nine active derivatives were investigated against FR-2 (normal breast epithelial) cell line at density of 10,000 cell/well for possible cytotoxicity. As shown in Table 1, the IC_{50} values of compounds **8e**, **8f** and **8j** were found to be greater than 30 µM in FR-2 cell line which further showed remarkably higher activity as compared to MCF-7 (5.7, 3.5 and 3.5 µM), and MDA-MB-231 (15.28, 15.54 and 9.61 µM respectively), demonstrating that these molecules **8e**, **8f** and **8j** having reduced toxicity towards healthy human cells compared to tumor cells.

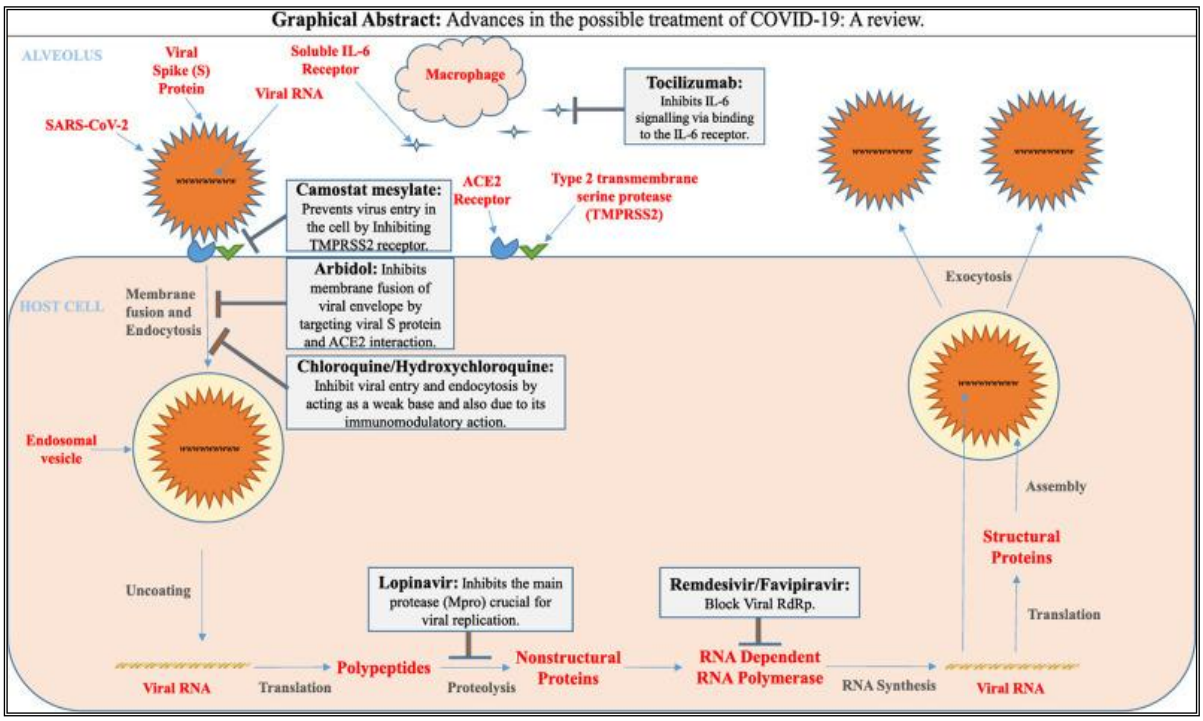
In this research work, we have synthesized triaryl-substituted 1, 2, 3-triazoles in

order to check cytotoxicity on breast and colon cancer cell lines. The biological results indicated that among all the compounds screened against different cell lines, compound **8f** induced apoptosis at IC_{50} dose chosen at 3.5 µM concentration in MCF-7 cells. Moreover, this diethyl amine substituted **8f** molecule inhibited cell proliferation effectively in both breast and colon cancer cell line variants. As per the screening of **8f** against normal breast epithelial cell line FR-2, the study observed the lack of cytotoxic effect at 3.5 µM concentration nearly indicating it to be 10-fold safer from their IC_{50} value against MCF-7 cells and far better than the tamoxifen. The mechanistic studies revealed that the compound **8f** triggered apoptosis in breast cancer cells which is a mechanism of autolysis of cells. Therefore, this work displays an important prospective towards futuristic approaches and possibilities for target molecule **8f** as a suitable chemotherapeutic agent. (For more information please visit Eur J Med Chem., 207, 2020, 112813; doi.org/10.1016/j.ejmech.2020.112813.)

2.7 **Advances in the possible treatment of COVID-19:** A Review (**European Journal of Pharmacology.** Elsevier. 883 (2020) 173372. DOI: 10.1016/j.ejphar.2020.173372)

Pankaj Chibber, Syed Assim Haq, Irfan Ahmed, Nusrit Iqbal Andrabi, Gurdarshan Singh.

The emergence of the global pandemic caused by novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has put a challenge to identify or derive the therapeutics for its prevention and treatment. Despite the unprecedented advances in the modern medicinal system, currently, there are no proven effective therapies. However, rapid research on SARS-CoV-2 epidemiology help unveiling some new targets for potential drug therapies. Many drugs have been screened, and even their clinical trials are going on at an exceptional pace. Amongst these RNA-dependent RNA polymerase inhibitors (favipiravir and remdesivir) and steroids especially dexamethasone showed promising effects. The biological agents like tocilizumab, interferons, and convalescent plasma prove to be beneficial in viral clearance. Moreover, many immunomodulatory and viral S protein targeting vaccines have their ongoing clinical trials. The establishment of various *in vitro* and *in vivo* models for preclinical studies can additionally help the current research. The volume and the pace of the clinical trials launched to evaluate the safety and efficacy of various agents against corona virus disease 2019 (COVID-19) reflect the need for high-quality evidence for various therapies to be practiced by clinicians. This study aims to sum up all the current advances in the global medicinal system against the COVID-19

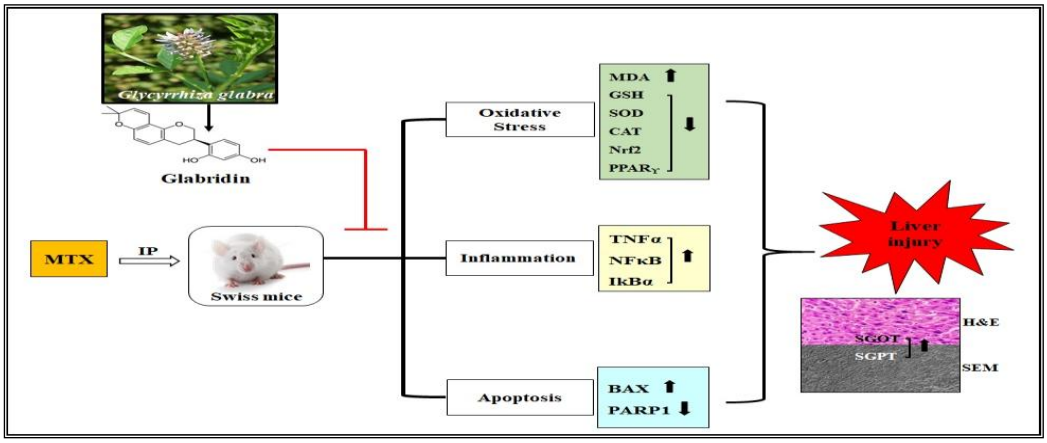


2.8 Glabridin ameliorates methotrexate-induced liver injury via attenuation of oxidative stress, inflammation, and apoptosis (Life Sciences, 2021, 278, 119583, 1-10)

Ashish Dogra, Divya Gupta, Swarnendu Bag, Irfan Ahmed, Shipra Bhatt, Ekta Nehra, Shakti Dhiman, Amit Kumar, Gurdarshan Singh, Sheikh Tasduq Abdullah, Payare Lal Sangwan, Utpal Nandi.

Despite unprecedented advances in modern medicine, no safe and effective drug is available till date for oral administration to combat drug-induced liver injury, which is a vital concern nowadays. The present study deals with the hepatoprotective effect of pure glabridin, a key phytoconstituent from *Glycyrrhiza glabra* with mechanistic investigations using an *in-vivo* methotrexate-induced liver injury model as there is no such precedent. The study was performed in the Swiss mice model where a single dose of methotrexate (40 mg/kg) was given on the 7^{th} day through an intraperitoneal route to induce hepatotoxicity, and glabridin as a test compound was administered orally for eleven consecutive days at 10 to 40 mg/kg of dose levels. Glabridin treatment significantly improved serum biochemical parameters (SGPT, & SGOT), pro-inflammatory cytokine (TNF-α) as compared to methotrexate alone. Oxidative stress markers (MDA, GSH, SOD, & CAT) were significantly ameliorated by glabridin as compared to methotrexate alone. Alterations in methotrexate-induced liver architecture were considerably prevented by glabridin treatment as suggested by liver histopathological examination (inflammatory infiltration, RBC congestion, nuclear necrosis, hepatocyte ballooning, sinusoidal dilation, and hepatocyte necrosis) and SEM investigation. As compared to the control group, MTX treatment caused significant down-regulation of Nrf2 protein expression, which was significantly up-regulated by glabridin treatment. We observed that glabridin treatment exhibits significant down-regulation of the NF-κB & IκBα which was markedly activated by MTX treatment. MTX treatment also induces apoptosis in the liver via escalating BAX. Glabridin significantly down-regulated the BAX expression which is near to the control level. In parallel, we also explored the full PARP1 expression which considerably declined

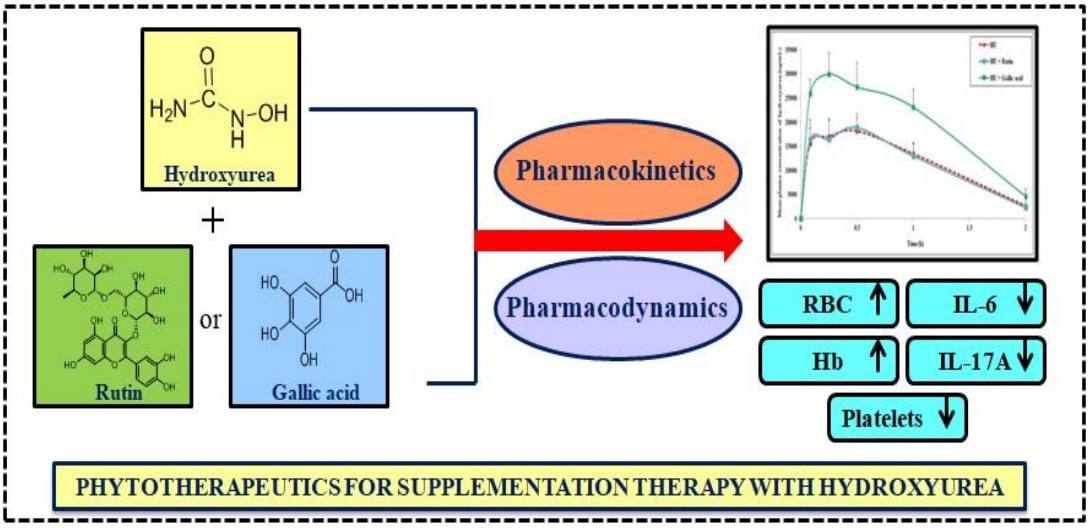
due to MTX treatment. Overall, glabridin is found to protect against MTX-induced liver injury by improving crucial factors for oxidative stress, inflammation, and apoptosis.



2.9 Integration of PK & PD approaches to assess the effect of rutin and gallic acid for concomitant therapy with hydroxyurea (ACS Omega, 2021, 6, 14542-14550)

Abhishek Gour, Ashish Dogra, Dilpreet Kour, Gurdarshan Singh, Ajay Kumar, Utpal Nandi

Hydroxyurea (HU) is the first ever approved drug by USFDA for sickle cell anemia (SCA). However, its treatment is associated with severe side effects like myelosuppression. Current research has been focussed on supplementation therapy for symptomatic management of SCA. The aim of present research work was to explore the individual effect of rutin and gallic acid for concomitant therapy with HU using PK & PD approaches as there is no such precedent till date. *In vivo* pharmacokinetic studies of HU in rats showed that rutin can be safely co-administered with HU but gallic acid significantly raised the overall oral exposure of HU by around 1.7 fold. HU is substrate of urease and horseradish peroxidase (HRP) enzyme. Rutin and gallic acid demonstrated an IC_{50} value of 780 µM and 635 µM, respectively, towards inhibition of urease activity. Rutin and gallic acid exhibited 40-64% and 53-70% inhibition of HRP at the concentration range of 250-1000 µM, respectively. Results displayed that there was no noteworthy effect (≤ 5%) of rutin or gallic acid to exhibit RBCs lysis up to the experimental concentration of 1 mg/ml. Gallic acid markedly enhanced the HU-induced decrease in lymphocytes proliferation. Both rutin and gallic acid exhibited a significant effect for the improvement in RBC as well as Hb level. Additionally, HU-mediated lessening of platelet count was got better due to the treatment with both rutin and gallic acid where the effect of rutin was statistically significant in comparison to HU. Serum level of both IL-6 and IL-17A was reduced by combined treatment of HU with rutin or gallic acid. Overall, both rutin and gallic acid are found to have phytotherapy potential along with HU and should be explored further to be phytotherapeutics for SCA.



2.10 Procedure for development of extract from *Cannabis sativa*:

An authenticated, dried and ground plant material was received from Chattha farm of IIIM, Jammu and used for extraction in Non-GMP pilot plant for R&D purpose. 25 kg of this plant material was used for extraction with 250 litres of solvent (ethanol: 95-99% pure). Overnight maceration was followed by transferring the liquid strain into the distillation tank after filtration. Concentrated portion was collected after distillation. Extraction process was repeated thrice and final distillate was dried in vacuum tray drier. Total 4.791 kg semi solid extract received from the plant material. The percentage of yield achieved was 19%.

Enrichment of Extract: First, collected and weighed all semi-concentrated material into stainless steel containers after vacuum tray drying. Silica (100-200 mesh size) was added into semi-solid extract in ratio of 1: 2.5. Solvent mixture of Hexane & Ethyl acetate (9:1) was added in mixture of semi-concentrated extract & silica in ratio of 6:1. Transferred it into Vacuum pan dryer and mixed properly. Filtered the soluble extract portion and collected the first filtrate. Repeated this process of fractionation three times with same solvents in same ratio into same extract residue to extract the maximum soluble fraction. Combined all four filtrate and concentrated on distillation vessel and transferred in Vacuum Tray dryer for drying. Thus enriched fraction was handed over for further processing and standadisation.

2.11 Procedure for extraction from *Bergenia ciliata*:

The well authenticated plant material was dried under shade and ground to coarse powder in cGMP plant. Sifted powder (25 kg) was used for extraction with purified water and alcohol in 1:1 ratio (250 L, 95-99% Purity). Left coarsely powdered crude material dipped into solvent over night at room temperature in the Extraction Vessel. Filtered the liquid extract through the filter cloth and transferred the extract into the Distillation Vessel. After distillation collected the distillate into S.S container and repeated the extraction thrice. Combine the collected three distillate of material and dried into spray drier. Total 8 kg dried extract powder received from two batches and samples submitted for CMC studies.

2.12 Procedure for Rhododendron extract:

Rhododendron liquid solution was loaded in SS trays and dried in Lyophilizer. After drying and grinded with the help of Heavy duty mixture grinder, the free flow poweder in aseptic condition was collected and samples of same were submitted CMC study for Quality Control Analysis.

	
Cannabis sativa	***Cannabis sativa* semisolid extract**
	
Bergenia ciliata	***Bergenia ciliata* lyophilized extract**
	
Rhododendron	***Rhododendron* lyophilized powder**

2.13 Anti-inflammatory activity of culinary herb: *Oreganum vulgare*

Dried leaves of *Oreganum vulgare*, the culinary herb, was subjected to ethanol extraction (OVEE). Rosmarinic acid (OVRA) has been isolated from the ethyl acetate fraction (OVEAF) of this extract. The extract, fraction and isolated compound were investigated for their anti-inflammatory activity in RAW 264.7 cells. All three of them showed inhibition of LPS induced nitric oxide, cytokines IL-6 and TNF-α in *in vitro* condition.

2.14 Anti-diabetic activity of fruits of *Ficus semicordata*

Three samples of *Ficus semicordata* – hydro-alcoholic extract, aqueous extract and an enriched fraction – were evaluated for their blood glucose lowering activity.

The investigations revealed a significant or promising blood glucose lowering activity of enriched fraction at 150 mg/Kg dose when administered as once daily dose for 14 days to streptozotocin induced diabetic rats.

2.14 Establishment of *in vitro* model of obesity using 3T3L-1 cells

Mouse embryonic fibroblast cells (3T3-L1 cell line) were cultured in DMEM medium supplemented with 10 % calf serum. After attaining full confluence, these cells were differentiated from preadipocytes to adipocytes using an adipogenic cocktail and specific treatment protocol for a period of 13 days. Lipid droplet accumulation was observed as identified by Oil red O staining followed by conventional microscopy. The ability of test extract/fraction/compound/standard to alter the lipid droplet accumulation could serve as an *in vitro* screening test for anti-adipogenic/obesity substances.

2.16 Establishment of progesterone induced obesity model in mice

Obesity being recognized as a disorder/disease by FDA has enormous influence on lifestyle of affected individuals along with changes in insulin sensitivity and elevating the propensity of cardiac diseases. In order to facilitate the evaluation of natural products/plant extracts for their utility in obesity conditions Scientists have developed short duration animal model of obesity. Subcutaneous administration of progesterone at 10 mg/kg dose to female Balb/c mice resulted in body weight gain and associated lipid profile disturbances. We used the well known lipid lowering drug orlistat as standard drug and evaluated the effect of a test extract. The body mass index (BMI), feed consumption and weight gain were monitored over a period of 28 days. Total cholesterol (TC) and triglyceride (TG) levels were also measured at the end of treatment period. Our investigations revealed that administration of progesterone resulted in increased body weight, BMI, serum TC and TG levels. Progesterone only treated group of animals showed increased feed consumption compared to any other group confirming the development of obesity. Administration of orlistat along with progesterone inhibited the weight gain, BMI, serum TC and TG levels. The test extract also showed encouraging results in line with orlistat and needs further investigations to confirm its beneficial effects.

2.17 Ethnopharmacological relevance of endangered medicinal herb Gentiana kurroo Royle.

The chemical evaluation of major bioactive compounds in diverse cytotypes from different plant parts along different altitudes presented an appreciable variability in sweroside, swertiamarin, and gentiopicroside contents. Additionally, the concentrations of these phytoconstituents varied for cytotoxicity potential among different screened cytotypes. This quantitative difference of active bio-constituents was in correspondence with the growth inhibition percentage of different tested cancer cell lines. Thus, the present investigation strongly alludes towards a prognostic approach for the identification of elite cytotypes/chemotypes with significant pharmacological potential.

2.18 Discovery of a Secalonic Acid Derivative from *Aspergillus aculeatus*, an Endophyte of *Rosa damascena* Mill., Triggers Apoptosis in MDA-MB-231 Triple Negative Breast Cancer Cells.

A new secalonic acid derivative(1) was isolated from the endophytic *Aspergillus aculeatus* associated with *Rosa damascena*. The planar structure of 1 was established on the basis of 1D and 2D NMR and ESI-TOF-MS spectra. The relative configuration of 1 was determined applying a combined quantum mechanical/NMR approach and, afterward, the comparison of calculated and experimental electronic circular dichroism spectra determined the assignment of its absolute configuration. The compound possesses strong cytotoxic activity against triple negative breast cancer (TNBC) cells. It was found to induce apoptosis, as evidenced by scanning electron microscopy and phase contrast microscopy. Furthermore, flow cytometry analyses demonstrated that 1 induced mitochondrial damage and reactive oxygen species mediated apoptosis, arresting the G1 phase of the cells in a dose-dependent manner. Also, the compound causes significant microtubule disruption in TNBC cells. Subsequently, 1 restricted the cell migration leading to the concomitant increase in expression of cleaved caspase and PARP.

2.19 Selective Spectrum Antibiotic Modulation of the Gut Microbiome in Type 2 Diabetes with Inflammatory Bowel Disease.

Currently, group of scientist are working on an objective to determine the role of gastrointestinal microbiome in Type 2 Diabetes Mellitus (T2DM) mice model with Inflammatory Bowel Disease (IBD). Our aim is to observe whether high fat diet induced T2DM, affects IBD pathogenesis. Further we are also exploring the role of gut microbiota as well as antibiotic treatment on T2DM and/or IBD. For the induction of T2DM, C57BL/6 mice were fed with high fat diet [HFD (60% fat)] up to 16 weeks. Controls were fed with standard rodent food [Normal food diet (NFD)] for the same duration as the respective to HFD group. At the end of 16 weeks blood glucose were measured from the tail vain for the confirmation of T2DM.

After 16 weeks group of mice were received DSS in sterilized tap water (3 % DSS *w*/*v*) for 5 days (Day1- Day 5) to induce the colitis. Mice were randomly assigned to 2 experimental groups: DSS treatment group (control group with normal diet), DSS treatment group (T2D mice with HFD) At day 5, the solution of DSS were replaced by normal water until evaluation. On the 7th day of the experiment mice were sacrificed. Colon tissue, blood and stool samples were collected for histopathological, biochemical and microbiome assessments.

2.20 Identification of a cross-talk between EGFR and Wnt/beta-catenin signalling pathways in HepG2 liver cancer cells

The epidermal growth factor receptor (EGFR) is a membrane-bound receptor tyrosine kinase (RTK) ubiquitously expressed on all cells. Among all RTKs, *EGFR* was the *first discovered*, the *first* one linked to cancer development, and the most intensively studied

RTK member. Upon ligand binding, EGFR gets dimerized which results in the autophosphorylation of its conserved tyrosine residues present at its C-terminal domain followed by the activation of downstream signaling pathway.Activation of the EGFR triggers downstream signal transduction cascades like RAS/MAPK and PI3/AKT signaling in order to promote cell proliferation and differentiation. Apart from regulating many physiological activities, EGFR is a driver of tumorigenesis in many cancers particularly in lung and breast cancer, and in glioblastoma. Gene amplification, activating point mutations, deletions of the extracellular domain, and transcriptional upregulation of EGFR resulting in unregulated cell proliferation has been reported in many cancers. This makes EGFR an attractive candidate for anti-cancer drug discovery. In this study, we generated GFP fusion constructs of EGFR and its mutants to analyze their subcellular localization in normal and cancer cells and impact of their sub-cellular location on its various activities using immunoblotting, confocal microscopy, reporter assays, loss-of-function EGFR mutants, and EGFR specific small molecule inhibitors. Interestingly, EGFR was seen to be exclusively present at the membrane of normal cells and many cancer cells, however, in HepG2 cells EGFR showed predominant nuclear localization. In HepG2 cells, the nuclear EGFR was shown to be involved in modulating TCF dependent β-catenin transcriptional activity in a similar fashion as IGF1R tyrosine kinase (as was reported earlier from our jam Jamwal etal 2018). More importantly, we show that cytoplasmic and nuclear functions are two independent activities of EGFR. Thus we showed the kinase independent functions are involved in regulating the nuclear activities of EGFR through its association with Wnt/beta-catenin signalling pathway - one of the most critical signalling pathways involved in regulating proliferation and differentiation of stem cells**.**

2.21 Evaluation of the immunomodulatory and anti-inflammatory activity of Bakuchiol using RAW 264.7 macrophage cell lines and in animal models stimulated by lipopolysaccharide (LPS)

Bakuchiol (BAK) has been reported to have a diverse pharmacological property as an antibiotic, anti-cancer, anti-hypolipidemic, anti-inflammatory and anti-convulsant agent. This study aimed to elucidate the immunomodulation and anti-inflammatory mechanism of bakuchiol using lipopolysaccharide stimulated RAW 264.7 macrophages and various animal models. The present study has shown that BAK significantly suppressed the pro-inflammatory cytokine expression in a dose-dependent manner and its oral administration significantly decreased delayed hypersensitivity responses as compared to control group. The assessment of immunomodulatory activity was carried out by the testing Hemagglutinating antibody (HA) titer, delayed type hypersensitivity (DTH) responses and phagocytic index by carbon clearance test. On the other hand, it showed significant decrease in circulating antibody titer and carbon clearance assay in a concentration-dependent manner. BAK has significantly potentiated the cellular immunity as well as humoral immunity by facilitating the footpad thickness responses in sheep RBCs in sensitized mice by significantly decreasing circulating antibody titer. Molecular studies revealed that BAK inhibited the activation of upstream mediator nuclear factor-κB by suppressing the phosphorylation of IκBα and p65. The responses were statistically significant as compared with the control (*$p < 0.05$, **$p < 0.01$).

2.22 Development of RT-PCR based genotyping of Sickle Cell Anemia Transgenic mice (Berkeley model) for future breeding and R & D activities at CSIR-IIIM

Transgenic mice model for sickle cell anemia (SCA) helps in understanding the pathophysiology of the disease and aids in the development of disease specific drug discovery. Hba^{tm1paz} Hbb^{tm1Tow} Tg (HBA-HBBs) 41Paz/J transgenic mice from the Jackson Laboratory (also known as Berkeley model) is the commonly used transgenic model to study sickle cell anemia disease. This mouse model is developed by knocking out the mouse α and β globin genes and incorporating human transgene which carries the mutation which causes sickling in humans. The mice homozygous for the α and β globin null allele (mutant) with sickle transgene are able to express human sickle hemoglobin and are called sickle cell anemia mice which not express the mouse Hba or Hbb. These mice mimic the major genetic, hematologic profile and histopathologic features which are observed in human SCA. The mice heterozygous for α and β globin null allele masks the expression of the transgene leading the production of non-sickling mice. The genotyping of all the three genes helps in identifying the sickling and non-sickling mice for the selection of animal for future breeding and research activities. The mice are genotyped by isolating the genomic DNA from tail and ear samples and analyzed using real time fluorescence probe based quantitative PCR (qPCR), fluorescence probe-based allele discrimination and high-resolution melting (HRM) analysis to find the hemizygous and homozygous transgene .

Using copy number variation (ΔCq) and homozygous and heterozygous alleles in mouse Hbb genes. The melt curve analysis differentiates the homozygous and heterozygous alleles in Hba genes.

2.23 Development of GLP (Good Laboratory Practices) Facility at CSIR-IIIM for Regulatory Toxicology studies as per National GLP Compliance Monitoring Authority (NGCMA)

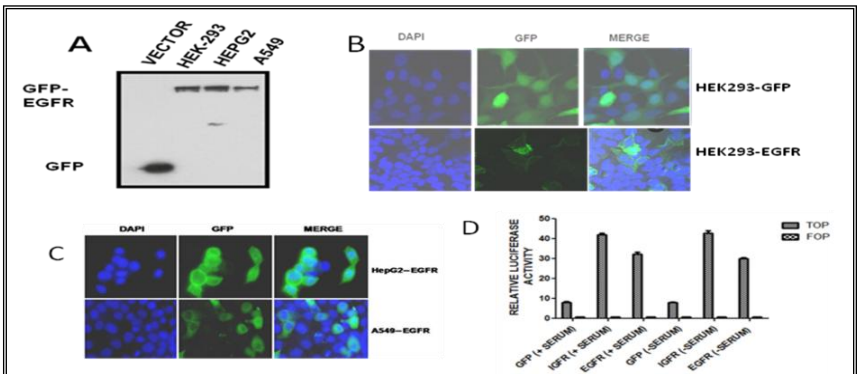
Good Laboratory Practice (GLP) is a quality system concerned with the organizational process and condition under which non-clinical health and environmental safety studies are planned, performed, monitored, recorded, archived and reported (OECD Doc. No. 1). Any chemicals, pharmaceuticals products and biomedical materials that are developed for the human health and environmental safety should not cause any hazard to human, animals and environment. The non-hazardous nature of the compounds are to be validated through various studies and data generated by the studies, which will be monitored by the regulatory authorities of the concerned nation through GLP system developed by Organization for Economic Co-operation and Development (OECD).

India is the member of OECD working group on GLP for Mutual Acceptance of Data (MAD) w.e.f. 3rd March 2011. The data generated on the non-clinical health and environmental safety studies in India are accepted by 36 OECD member countries and 6 non-member MAD adherent countries. With respect to GLP facility development at CSIR-IIIM, the organogram for the GLP facility has been established with test facility management. The Standard Operation Procedures (SOP) concern to Quality Assurance Unit (QAU), Animal House Facility (AHF) and Documentation Control (DC) in

conducting regulatory toxicity studies has been developed. The required SOP's and Formats related to Quality Assurance Unit and Animal House Facility has been established in the facility. Four on-line lecture programs i.e., Genesis/Principles of GLP, Quality Assurance (QA) in GLP (OECD GLP Document No.4), Role and Responsibilities of TICO (Test Item Control Office) and Roles and responsibilities of study director and study personnel in GLP studies has been delivered by renowned speakers in the field of GLP to the members. Few instruments for the GLP facility are procured and installed, the list of instruments with unique instrument code has been developed for the instruments procured and calibrations are documented as per GLP requirements. Molecular biology laboratory has been established in the Animal House Facility for undergoing routine genetic monitoring of different inbred (BALB/c, C57BL/6J, DBA2, 129J) and transgenic mice strains for proper reproducibility of research data and health monitoring of the laboratory animals using robust PCR and RT-PCR techniques.

2.24 Restoration of p53 functionality in wt and mutant p53 (R237H) cells by hybrid octapeptide P4.

P4 induced p53 expression in a dose and time dependent manner in colon cancer cells. Concomitantly up regulation of MDM2 is observed due to the negative feedback loop that exists between MDM2 and p53.While Nutlin-3a restores p53 function in p53 wild type contexts only, P4 works in both wt and mutated (R273H) contexts. Survival of APC knockout mice (inducible colon cancer model) is significantly enhanced upon P4 administration.



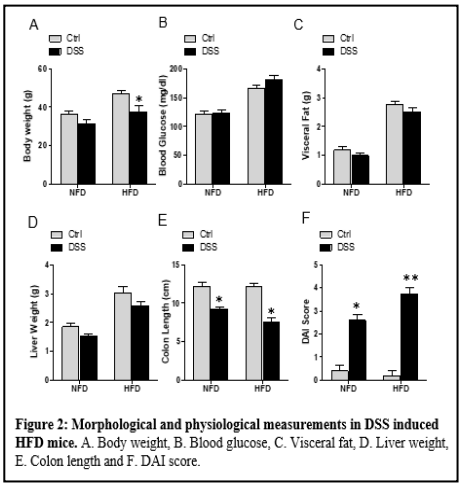


Figure 2: Morphological and physiological measurements in DSS induced HFD mice. A. Body weight, B. Blood glucose, C. Visceral fat, D. Liver weight, E. Colon length and F. DAI score.

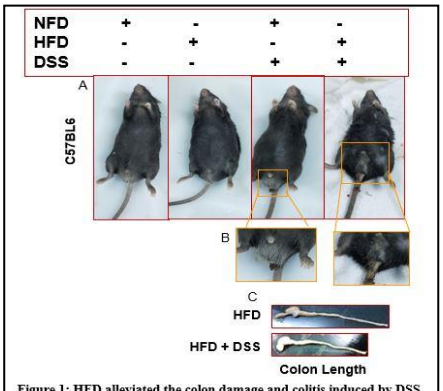
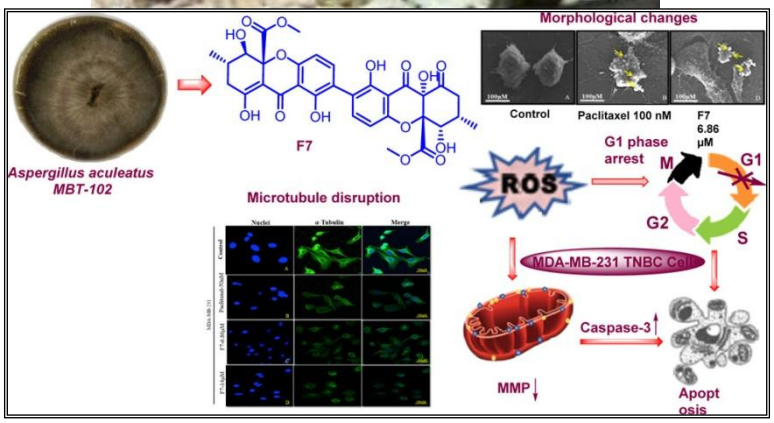
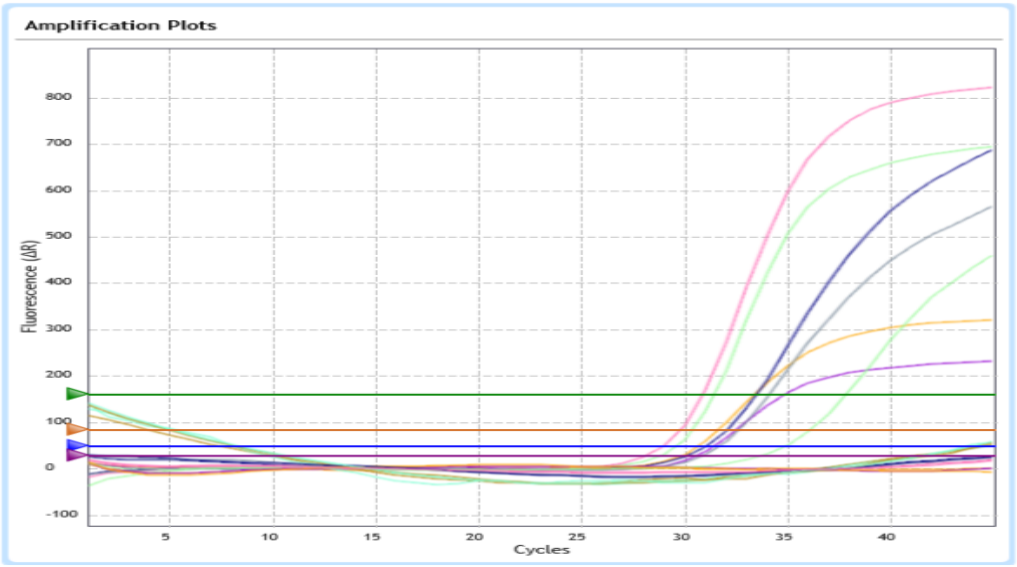
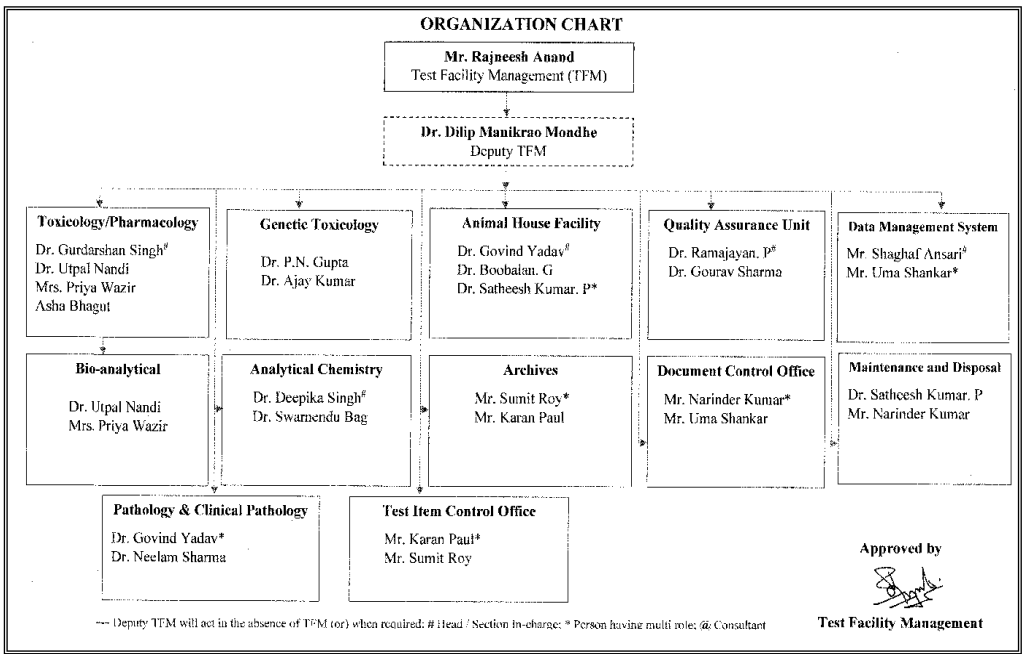


Figure 1: HFD alleviated the colon damage and colitis induced by DSS. A. Representative image of mice based on there diet (NFD or HFD) and DSS Induction. B. Picture represents that HFD mice showed higher level of anal bleeding after DSS induction compared to mice fed with NFD. C. Comparison of colon length shortening after DSS induction between HFD and NFD mice.



Graphical Displays





2.25 Area expansion under Lavender and Clarysage at Field Station Bonera.

An area of 25 acres was developed and brought under new plantation of lavender (*Lavendula angustifolia)* at field station. The new plantation will augment the generation of quality planting material of the crop required to be extended to the farmer fields under different extension and mission projects. The crop plantation will also generate Lavender oil.

An area of 2.5 acres of land was developed for the production of *Salvia sclarea* nursery at farm to be utilized under CSIR AROMA MISSION, CSIR Ladakh Initiative and other projects. *Salvia sclarea*, Rose Scented Geranium and *Mentha arvensis* were also introduced for crop production on an area of 05 acres at Farm.

2.26 Introduction of Saffron at Field Station Bonera.

Saffron (*Crocus sativus*) is a highly priced spice crop commercially grown under temperate conditions of Pampore in Kashmir Valley. Since last many decades the crop production and productivity has seen stagnation due to multiple factors predominantly biotic stress due to corm rots. Saffron was successfully introduced at F/S Bonera in August, 2020 to diversify the crop production at Farm owing to its high marketable value and to develop agrotechnological protocols for enhanced corm size and corm rot management.

2.27 Comprehensive identification and characterization of MATE gene family in *Nicotiana tabacum*

Umar Gani, Priyanka Sharma, Abhishekh Kumar Nautiyal, Maridul Kundan, Wajid, Harshita Tiwari, Amit Nargotra, Prashant Misra

The MATE family of transporters is involved in the transportation of diverse molecules, including metal ions and small organic molecules, and therefore, it plays an important role in plant biology. *Nicotiana tabacum* is an important plant species owing to its academic and applied value. However, comprehensive genome-wide identification and characterization of *MATE* genes have not been carried out in this plant species so far. In the present study, we, for the first time, have carried out genome-wide identification of *MATE* gene family members in *N. tabacum*.

We identified 138 MATE genes from *N. tabacum*, which were grouped into four major clades (Fig. 2.27.1). Based on the homology with the characterized MATE transporters, the functions of some of the *N. tabacum* MATE transporters have been predicted. A majority of the *NtMATE* transporters were predicted to be localized on the cell membrane. Based on the tissue-specific transcriptome data, the expression of *NtMATE* genes was reported to be differential in different tissues, with some genes showing highly tissue-specific expression (Fig. 2.27.2). The analysis of the upstream regions of the *NtMATE* genes predicted several *cis*-acting elements associated with hormonal, developmental, and stress responses. Some of the genes were found to show induced expression following methyl-jasmonate treatment (Fig. 2.27.3). The co-expression analysis suggested the involvement of MYB, HDG, WRKY, ERF, and NAC family transcription factors in the regulation of selected *NtMATE* genes. Some of the *MATE* genes (*NtMATE81*, *NtMATE82*, *NtMATE88*, and *NtMATE89*) were predicted to be targeted by microRNAs nta-miR167a, nta-miR167b, nta-miR167c, nta-miR167d and ntamiR167e). The homology modeling followed by molecular docking of the selected MATE transporters provided insights into key amino acid residues involved in the binding of the alkaloids (Fig. 4). The analysis also predicted that hyocyamine could be a preferred substrate for the selected set of transporters. Taken together, our study develops a solid foundation for further research work on MATE transporter genes in *N. tabacum*.

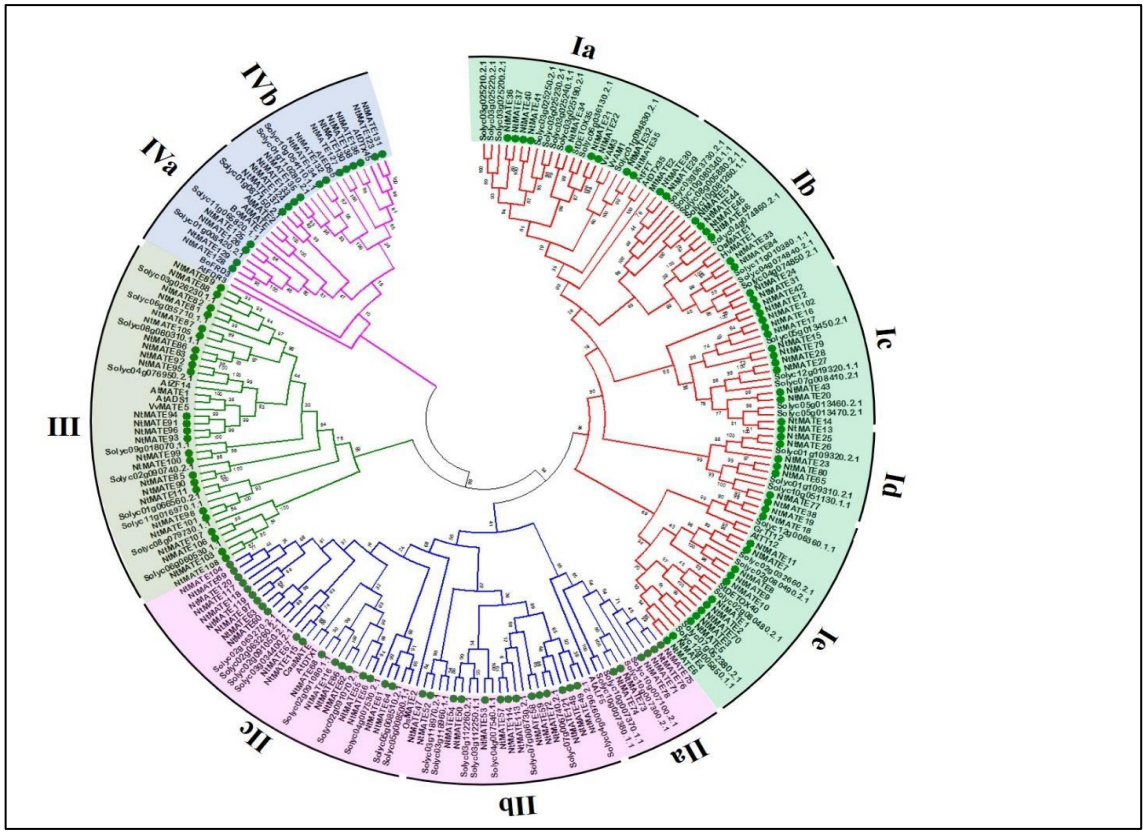


Fig. 2.27.1. Phylogenetic analysis of MATE proteins from *N. tabacum*. (Gani et al. 2021, Gene)

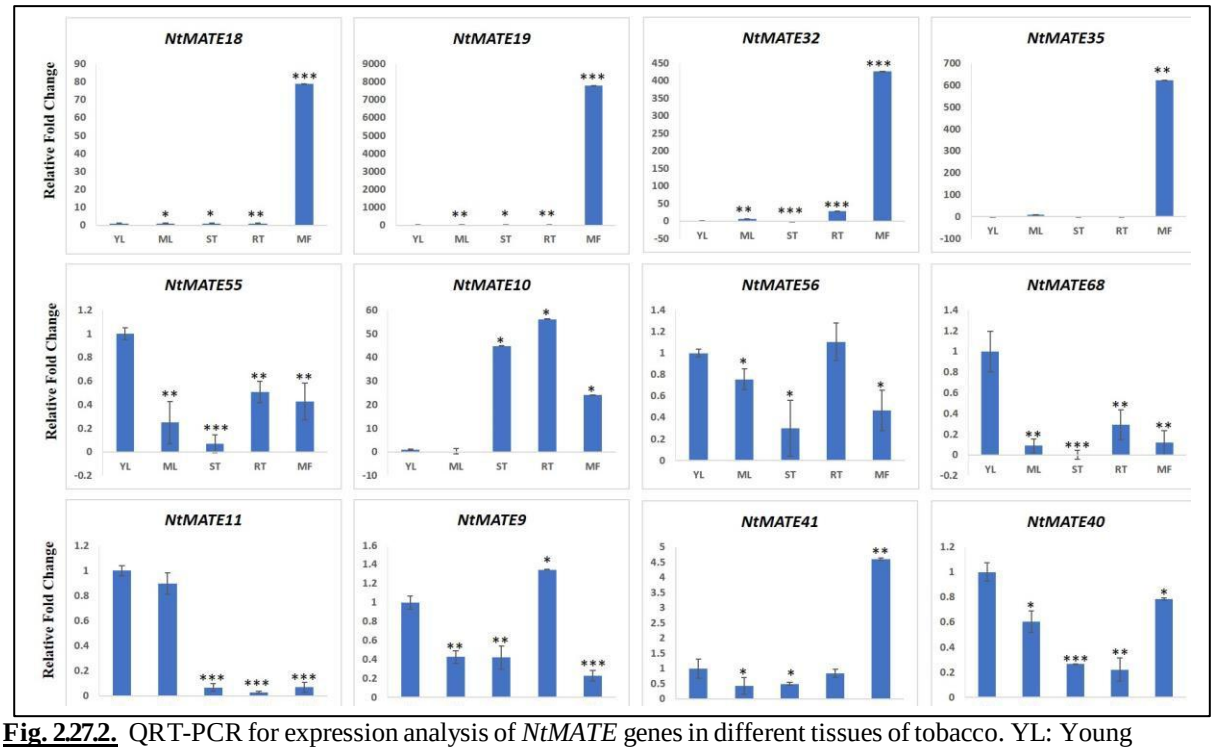


Fig. 2.27.2. QRT-PCR for expression analysis of *NtMATE* genes in different tissues of tobacco. YL: Young leaf, ML: Mature leaf, ST: Stem, RT: Root, MF: Mature Flower (Gani et al. 2021, Gene)

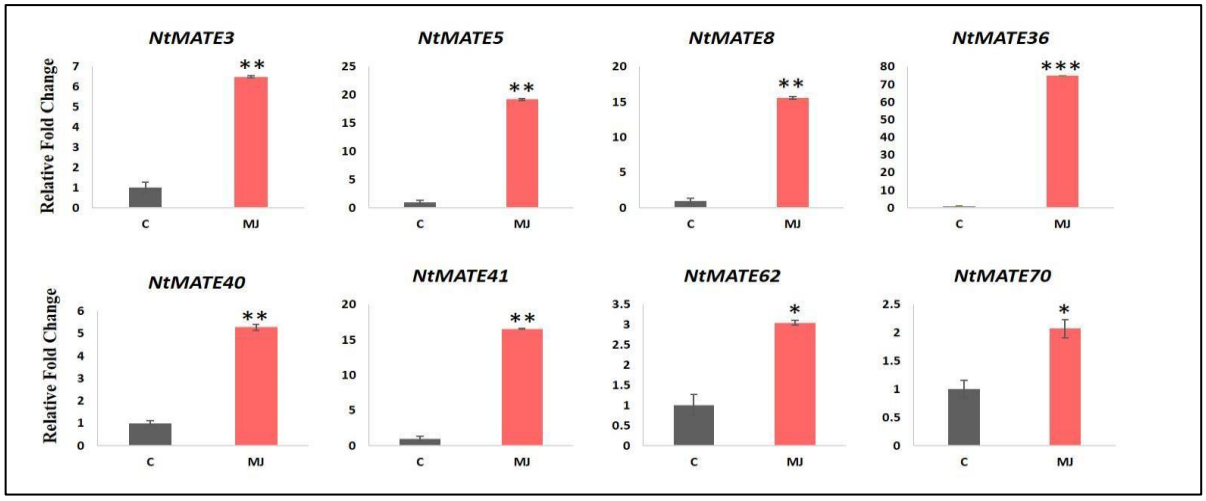


Fig. 2.27.3. The expression analysis of selected *NtMATE* genes in response to MeJA treatment. The relative expression of the eight *NtMATE* genes in response to MeJA (150 µM) was analyzed by qRT-PCR, using the expression of *NtUbiquitin* gene as the normalization control. C, control, MJ, methyl-jasmonate treated plant (Gani et al. 2021, Gene)

2.28 Flavonol specific R2R3 MYB family of transcription factor regulates expression of *MATE* transporter genes in *Nicotiana tabacum*

Umar Gani, Abhishekh Kumar Nautiyal, Prashant Misra

The promoter regions of the *NtMATE21* and *NtMATE22* genes were reported to display a putative binding site for P-type MYB transcription factors. The GUS staining in the leaves of transgenic *GUS* fusion lines with *NtMATE21* and *NtMATE22* was highly enhanced following constitutive transient expression of *Nicotiana tabacum* MYB12 gene (Fig. 2.28.1). These results demonstrated that NtMYB12 could directly regulate the expression of *NtMATE21* and *NtMATE22*.

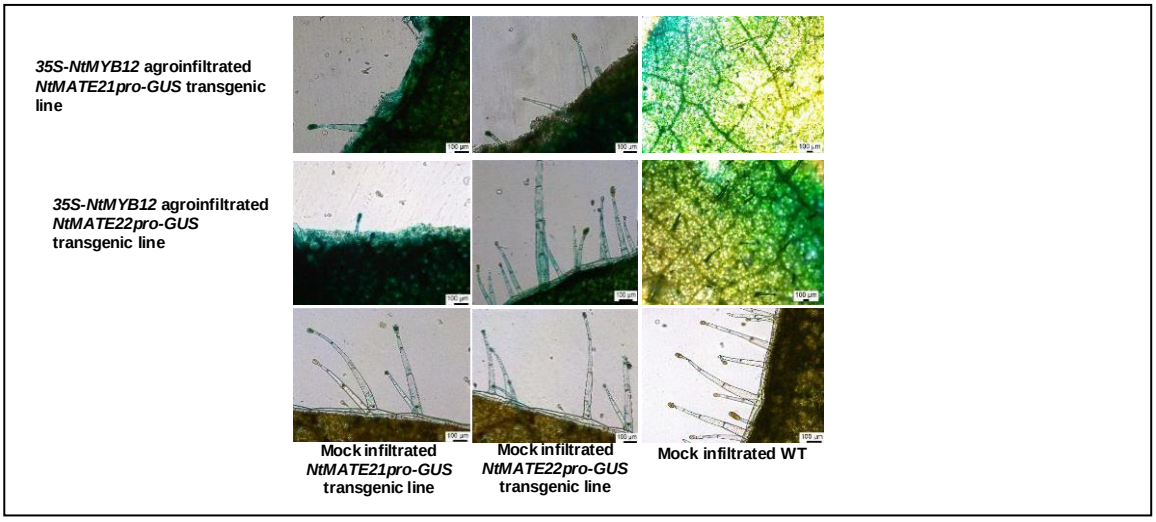


Fig.2.28.1 Transient constitutive expression of *NtMYB12* in *NtMATE21*-pro-GUS and *NtMATE22*- pro-*GUS* transgenic lines.

2.29 Characterization of *Cannabis sativa* MYB transcription factors

Maridul Kundan, V.P. Rahul, Sumeet Gairola and Prashant Misra

Two R2R3 MYB family transcription factor genes, namely *CsMYB33* and *CsMYB78* have been characterized in the context of their role in the regulation of the secondary

metabolism in *C. sativa*. The expression of these genes was up-regulated in the pigmented leaves as compared to the non-pigmented leaves, suggesting their involvement in the regulation of anthocyanin biosynthesis. Further, transient overexpression of *CsMYB33* in *Nicotiana benthamiana* leaves led to the activation of anthocyanin biosynthesis, testifying to the role of CsMYB33 as an activator of the anthocyanin biosynthesis (Fig. 2.29.1). Further studies through the development of stable transgenic lines of *N. tabacum* are underway.

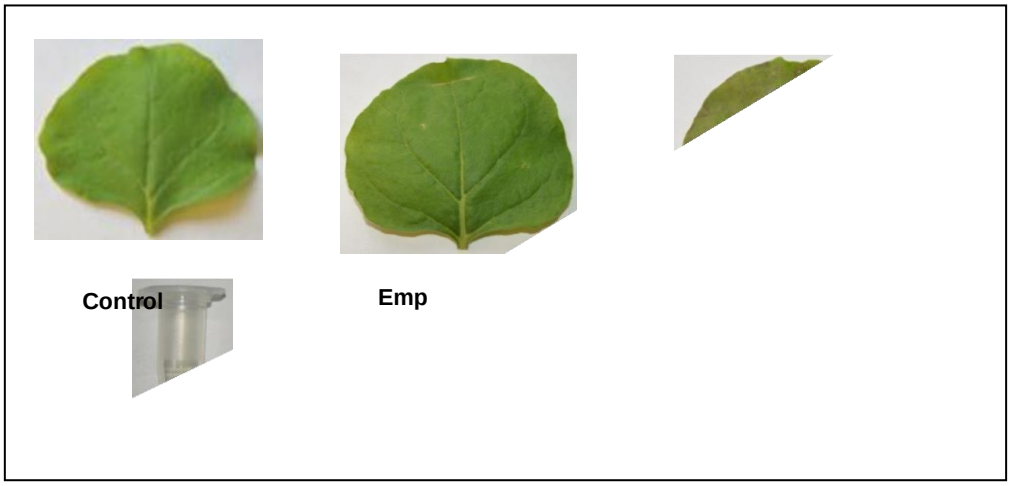


Fig. 2.29.1: Transient overexpression of *CsMYB33* in *Nicotiana benthamiana* leaf through agroinfiltration.

Agrobacterium tumefaciens harboring plant expression construct for the overexpression of *CsMYB33* was agroinfiltrated in *N. benthamiana* leaf. For control, empty vector agroinfiltrated and non-agroinfiltrated leaves were taken. The anthocyanin pigmentation in the leaves infiltrated with *CsMYB33* suggests the role of *CsMYB33* in the regulation of the anthocyanin pathway. In the last lane, the centrifuge tubes with the acidic methanolic extract of the corresponding leaves have been shown.

2.30 Paclobutrazol Induces Photochemical Efficiency in Mulberry (*Morus alba* L.) Under Water Stress and Affects Leaf Yield Without Influencing Biotic Interactions

Rajat Mohan, Tarandeep Kaur, Hilal A. Bhat, Manu Khajuria, Sikander Pal and Dhiraj Vyas*

Mulberry (*Morus* spp.) is an important plant used for rearing silkworms (*Bombyx mori* L.). Its fruit is also used for human consumption with several medicinal properties. Most of the mulberry cultivation in India is under the risk of either intermittent or terminal drought, as 50% of the Country's mulberry acreage falls under arid and semi-arid conditions. Triazole-induced abiotic stress tolerance has been used successfully in many horticultural crops, including planted trees. In order to understand the underlying mechanism, the effect of paclobutrazol (PBZ), a triazole, was studied on physiological tolerance in mulberry under water stress and rainfed conditions. During pot experiment, PBZ improved the photosynthetic accumulation of CO_2 under water stress conditions, thus improving survival percentage. Different concentrations of PBZ (5, 10, 25, 50, 100, and 500 mg L^{-1}) were applied in field during rainfed conditions. A lower concentration (10–25 mg L^{-1}) of PBZ significantly ($p \leq 0.05$) improved leaf biomass by increasing net photosynthetic rates. An increase in the photochemical efficiency of PSII and higher NPQ

mediated through the xanthophyll cycle was found to be the mechanism for these physiological effects. PBZ also reduced lipid peroxidation by inducing enzymatic antioxidants and redox metabolites. Bioassays do not suggest any negative interactions on silkworm or on downstream processing of silk.

This study, therefore, provides a mechanism of physiological tolerance and recommends the use of PBZ to mitigate stressful environments in planted trees under water stress and rainfed conditions. Results have been discussed in the context of improving commercial silk yield.

Table 1 Morphological and moisture characteristics in leaves of mulberry treated with various PBZ (0, 5, 10, 25, 50, 100, and 500 mg L^{-1}) concentrations

	Control	PBZ-5	PBZ-10	PBZ-25	PBZ-50	PBZ-100	PBZ-500
New shoots/tree	15.0 ± 2.0	15.3 ± 0.57	17.0 ± 2.0	17.3 ± 1.54	19.0 ± 2.0	16.3 ± 0.57	16.0 ± 1.0
Internodal distance (cm)	4.34 ± 0.19	3.61 ± 0.07*	2.99 ± 0.50*	3.19 ± 0.15*	3.54 ± 0.27*	3.57 ± 0.13*	3.29 ± 0.16*
100 leaf weight (g)	260 ± 5.60	330 ± 5.57*	372 ± 4.15*	307 ± 5.04*	327 ± 5.00*	327 ± 3.01*	243 ± 4.35*
Leaf yield (kg)	1.41 ± 0.07	1.40 ± 0.01*	1.60 ± 0.10*	1.73 ± 0.03*	1.93 ± 0.07*	1.46 ± 0.02	1.13 ± 0.02*
Moisture (%)	67.40 ± 0.21	68.43 ± 0.79	68.68 ± 1.78	68.62 ± 0.19	70.08 ± 0.12	70.04 ± 1.33	70.29 ± 0.61
MRC (%)	77.82 ± 4.61	83.87 ± 1.49	78.50 ± 2.74	79.50 ± 0.91	80.85 ± 2.29	81.50 ± 2.46	81.07 ± 2.20

Ten-year-old trees of variety S-146 were used in randomized block design and PBZ treatment was given as soil drench application. Each value is a mean of at least nine independent readings ($n \geq 9$). * represents statistically significant differences over control (0 PBZ) after one-way analysis of variance followed by a Tukey HSD post hoc test ($p \leq 0.05$)

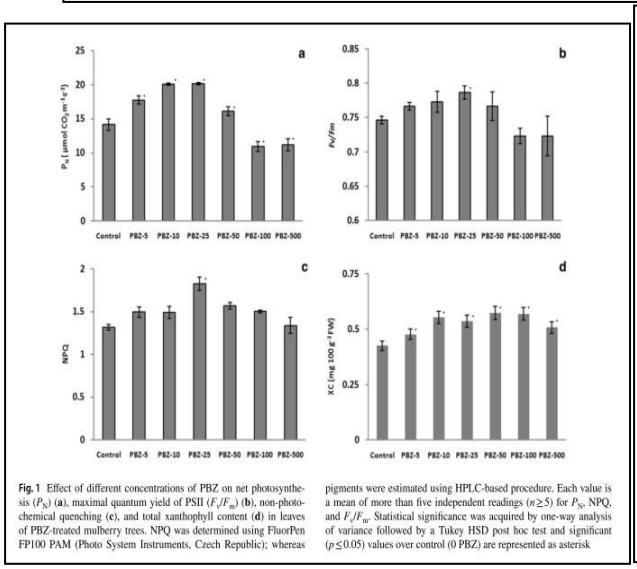


Fig. 1 Effect of different concentrations of PBZ on net photosynthesis (P_N) (**a**), maximal quantum yield of PSII (F_v/F_m) (**b**), non-photochemical quenching (**c**), and total xanthophyll content (**d**) in leaves of PBZ-treated mulberry trees. NPQ was determined using FluorPen FP100 PAM (Photo System Instruments, Czech Republic); whereas pigments were estimated using HPLC-based procedure. Each value is a mean of more than five independent readings ($n \geq 5$) for P_N, NPQ, and F_v/F_m. Statistical significance was acquired by one-way analysis of variance followed by a Tukey HSD post hoc test and significant ($p \leq 0.05$) values over control (0 PBZ) are represented as asterisk

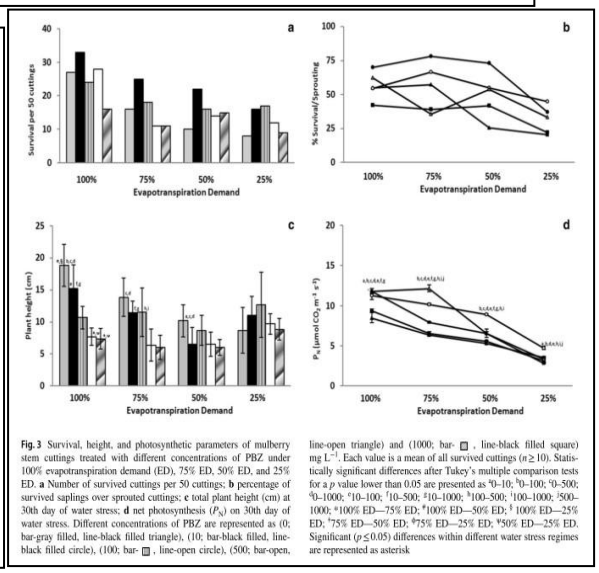


Fig. 3 Survival, height, and photosynthetic parameters of mulberry stem cuttings treated with different concentrations of PBZ under 100% evapotranspiration demand (ED), 75% ED, 50% ED, and 25% ED. **a** Number of survived cuttings per 50 cuttings; **b** percentage of survived saplings over sprouted cuttings; **c** total plant height (cm) at 30th day of water stress; **d** net photosynthesis (P_N) on 30th day of water stress. Different concentrations of PBZ are represented as (0; bar-gray filled, line-black filled triangle), (10; bar-black filled, line-black filled circle), (100; bar- ▨ , line-open circle), (500; bar-open, line-open triangle) and (1000; bar- ▨ , line-black filled square) mg L^{-1}. Each value is a mean of all survived cuttings ($n \geq 10$). Statistically significant differences after Tukey's multiple comparison tests for a p value lower than 0.05 are presented as [a]0–10; [b]0–100; [c]0–500; [d]0–1000; [e]10–100; [f]10–500; [g]10–1000; [h]100–500; [i]100–1000; [j]500–1000; [k]100% ED—75% ED; [l]100% ED—50% ED; [m]100% ED—25% ED; [n]75% ED—50% ED; [o]75% ED—25% ED; [p]50% ED—25% ED. Significant ($p \leq 0.05$) differences within different water stress regimes are represented as asterisk

(Rajat Mohan et al., (2020) *Journal of Plant Growth Regulation 39*: 205–215.)

2.31 Photochemical efficiency is negatively correlated with the Δ^9 tetrahydrocannabinol content in *Cannabis sativa* L.

Manu Khajuria, Vishav Prakash Rahul and Dhiraj Vyas*

Cannabis sativa L is an important plant source of durable fibers, nutritious seeds, and medicinally important phytocannabinoids, including Δ^9-tetrahydrocannabinol (THC) and cannabidiol (CBD). Light has been 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, immuno-detection of the photosynthetic machinery was analyzed on seven accessions from different environments, in conjunction with the cannabinoid content. All the accessions were clearly divided into three groups based on their relative content of CBD and THC. Group I with (CBD/THC > 1) had a clear advantage in terms of the damage to the D1, RbCL and Lhc1 protein holo-complex. Performance indicators of photochemistry based on the OJIP kinetics suggested a stoichiometrically negative correlation with the THC content. Zeaxanthin- dependent quenching is primarily responsible for lower NPQ in Group III with high THC content (THC > 6%). The THC treatment on *Arabidopsis thaliana* also suggested a dose-dependent decrease in the photochemical efficiency suggesting the exclusivity of THC in causing the response. This resulted in the damage of photosynthetic machinery and the generation of free radicals, thereby compromising the yield. The study opens a new screening method for *Cannabis*, based on cannabinoid content.

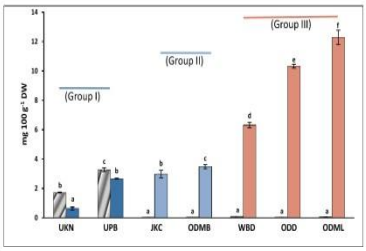


Fig. 1. Metabolic content of total CBD (gradient fill) and THC (solid fill) present in the main inflorescence of seven different accessions of *Cannabis* grown in controlled conditions. The concentration was expressed as mg 100 g^{-1} DW ± SD. Different alphabet represents statistically significant values at $p \leq 0.05$ as determined by one-way ANOVA with 'a' representing the minimum value. Based on the relative content of CDB and THC, the accessions were distinguished in three different groups as given in the text.

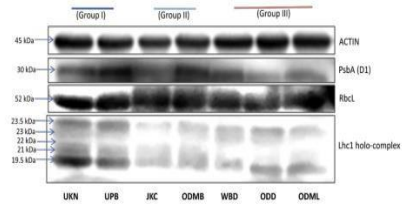


Fig. 3. Immunodetection of PsbA (30 kDa), RbcL (52 kDa) and Lhc1 (19–25 kDa) after SDS-PAGE separation of 20 µg protein from the leaves of seven different accessions of *Cannabis*. The antibody was diluted to a final concentration of 1:10000. Actin was used as a loading control. The western blot analysis was performed for two independent times with similar results.

A

	Control	THC		
		100 µM	500 µM	1000 µM
F_v/F_m	0.75±0.008^c	0.72±0.01^b	0.71±0.02^b	0.68±0.01^a

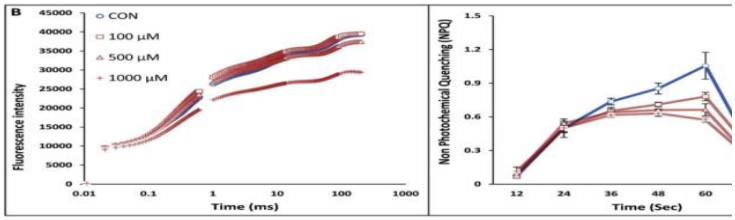


Fig. 9. F_v/F_m (A), OJIP kinetics (B) and NPQ (C) observed in *Arabidopsis thaliana* (Col 0) plants treated with different concer taken 24 h after the treatment. Different alphabet represents statistically significant values at $p \leq 0.05$ as determined by o minimum value. The measurements represent the more than 10 independent readings ± SD.

(Khajuria et al., (2020). *Plant Physiology and Biochemistry* 151: 589–600.)

2.32 Neural network model approach for automated benthic animal identification

Ravail Singh* and Varun Mumbarekar

Benthos consists of the organism which lives near the bottom of the aquatic ecosystem. Based on the size, they are divided into megabenthos, macrobenthos, and meiobenthos. Invertebrates/ benthic fauna are recognized worldwide as one of the essential sources of secondary metabolites with promising bioactivities. These organisms possessed numerous biological activities like antibacterial, antioxidant, anti- acetylcholinesterase. The most tedious and hectic job is to identify the tiny benthic animals by spending thousands of hours under the microscope. All the fauna need to be counted, sorted, picked and permanently mounted on glass slides for taxonomic identification. All faunal identifications need a lot of pre-processing and it consumes a lot of time to identify a single specimen. Therefore, to reduce the complexity of many such procedures, combined with the desire to identify larger datasets, we came up with new software based on artificial intelligence, automatically identifying the benthic fauna through microscopic images. In this paper, we propose a machine learning method for automatic visual identification through the images of the benthic fauna. To this end, we propose a neural network model, where we demonstrate that the proposed approach differentiates the fauna based on images. However, it works well with vast amounts of image data and significant computational resources.

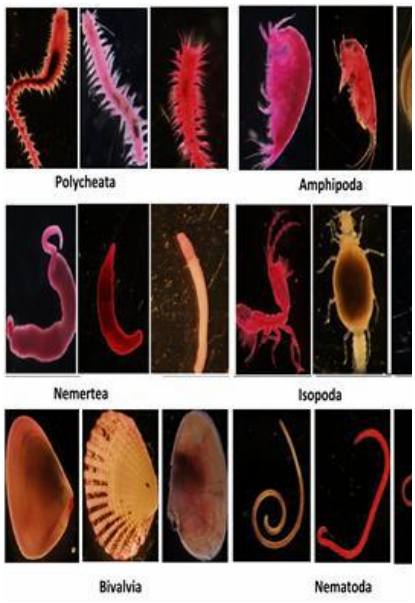


Fig 2.32.1: Sample images of each of the organisms for classifier and detector (ttps://doi.org/10.1016/j.icte.2021.03.003)

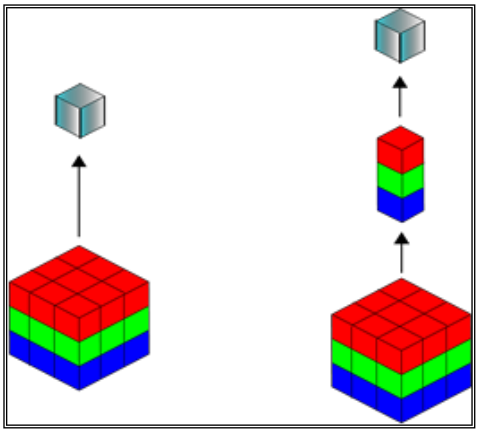
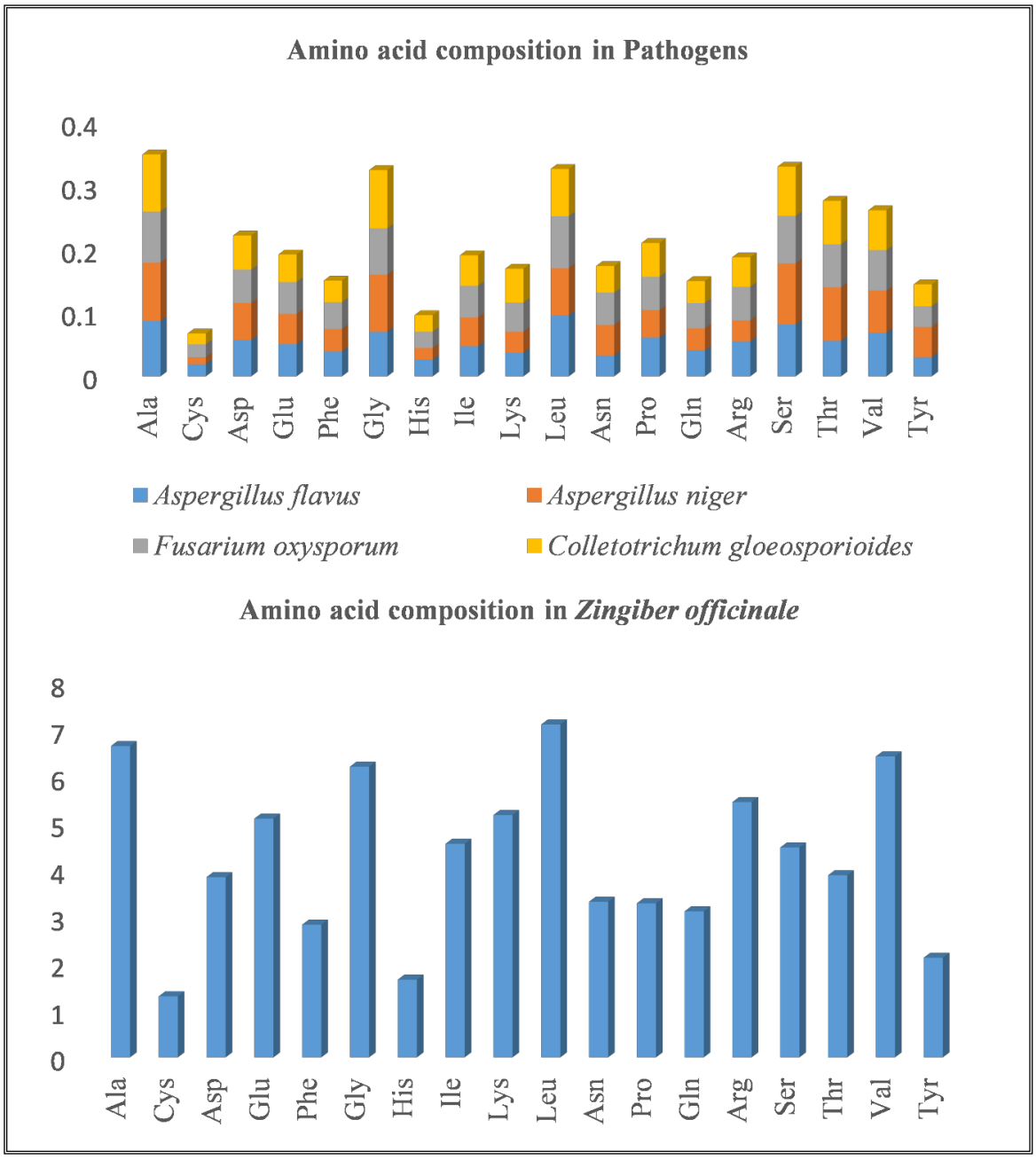


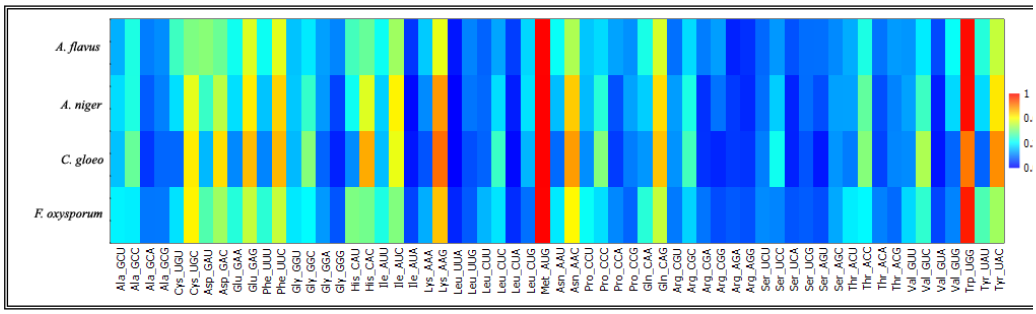
Fig. 2.32.2 : standard convolution and Depthwise Separable convolution (depthwise convolution followed by pointwise convolution)

2.33 Comparative study of codon usage profiles of *Zingiber officinale* and its associated fungal pathogens

Suruchi Gupta, Ravail Singh *

Codon usage bias influences the genetic features prevalent in the genomes of all the organisms. It also plays a crucial role in establishing the host-pathogen relationship. The present study elucidates the role of codon usage pattern regarding the predilection of fungal pathogens *Aspergillus flavus, Aspergillus niger, Fusarium oxysporum and Colletotrichum gloeosporioides* towards host plant *Zingiber officinale*. We found a similar trend of codon usage pattern operative in plant and fungal pathogens. This concurrence might be attributed to the colonization of fungal pathogens in *Z. officinale*. The transcriptome of both plant and pathogens showed bias towards GC-ending codons. Natural selection and mutational pressure seem to be accountable for shaping the codon usage pattern of host and pathogen. Based on different analyses like RSCU, preferred codon usage, amino acid composition, codon context, and correspondence analysis, we observed a similar pattern in all the selected pathogens and hosts' codon usage. This coincidence might be the reason for the successful colonization of these pathogens inside the *Z. officinale*. We also established that the coding sequences of *Z. officinale* and the pathogens have a bias towards GC-ending codons more profoundly to C- ending codons. The ENC and neutrality plot results revealed the influence of both the evolutionary forces *i.e,* mutational and translational selection on codon usage patterns. Some preferred codons unique to a particular genus like *A. flavus, F. oxysporum, Z. officinale* were also identified that could be considered as the signature codons for the identification of the respective genera. The information regarding preferred codons avoided codons, unique codons present in the host and pathogens would be helpful to manipulate the codons using targeted mutational studies to combat the pathogenesis. Moreover, this study would lay a foundation for future research on other pathogens associated with *Z. officinale* and plants belonging to *Zingiberaceae* family.



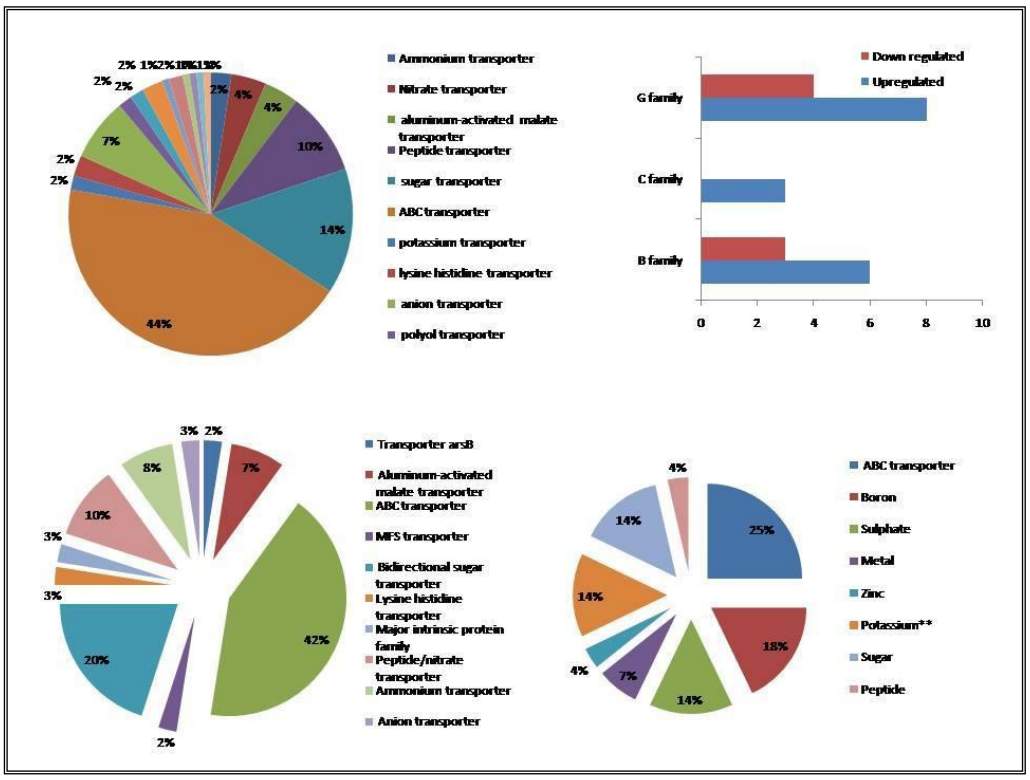


(10.1007/s00438-021-01808-8)

2.34 Transcriptome-wide mining of ABC gene family members and their role in secondary metabolism in *Glycyrrhiza glabra*.

Pooja Goyal, Ritu Devi, Suphla Gupta

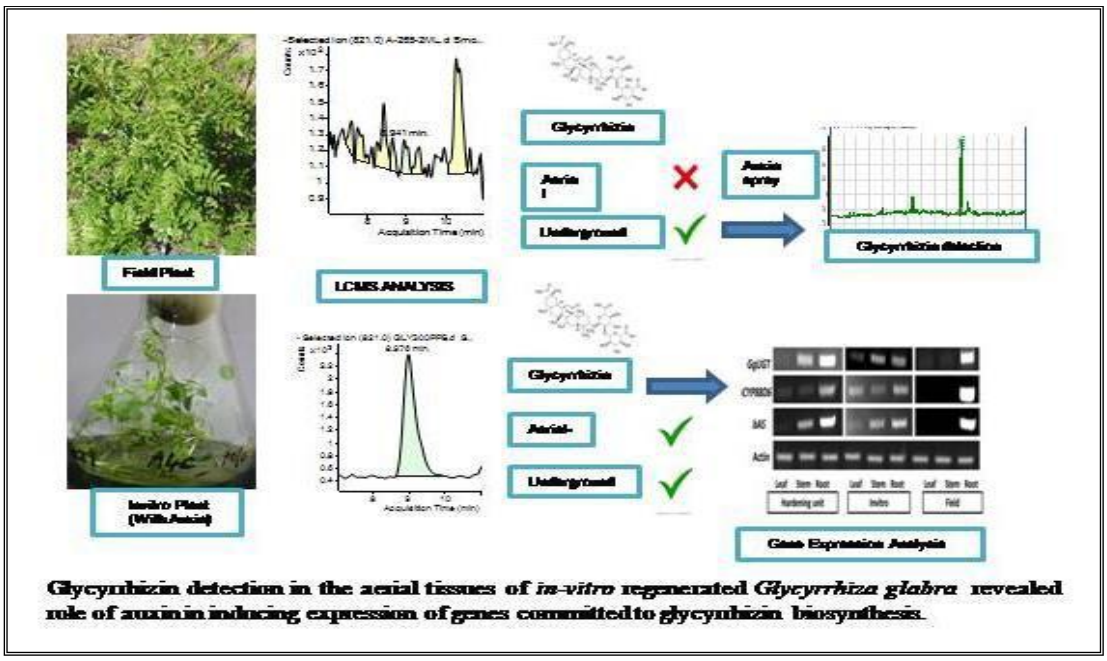
Transcript mining, identification and characterization of putative ABC gene family members from *G. glabra*. ABC gene family expression analysis based screening to identify the transporter gene sub-families involved in biotic and abiotic stress. Further, the functional characterization of selected transporters using knockdown mutants/over-expression in homologous and heterologous systems. The research will help identify transporter functions for understanding the biological processes at both the cellular and organizational levels, assigning a functional role to individual transporter proteins.



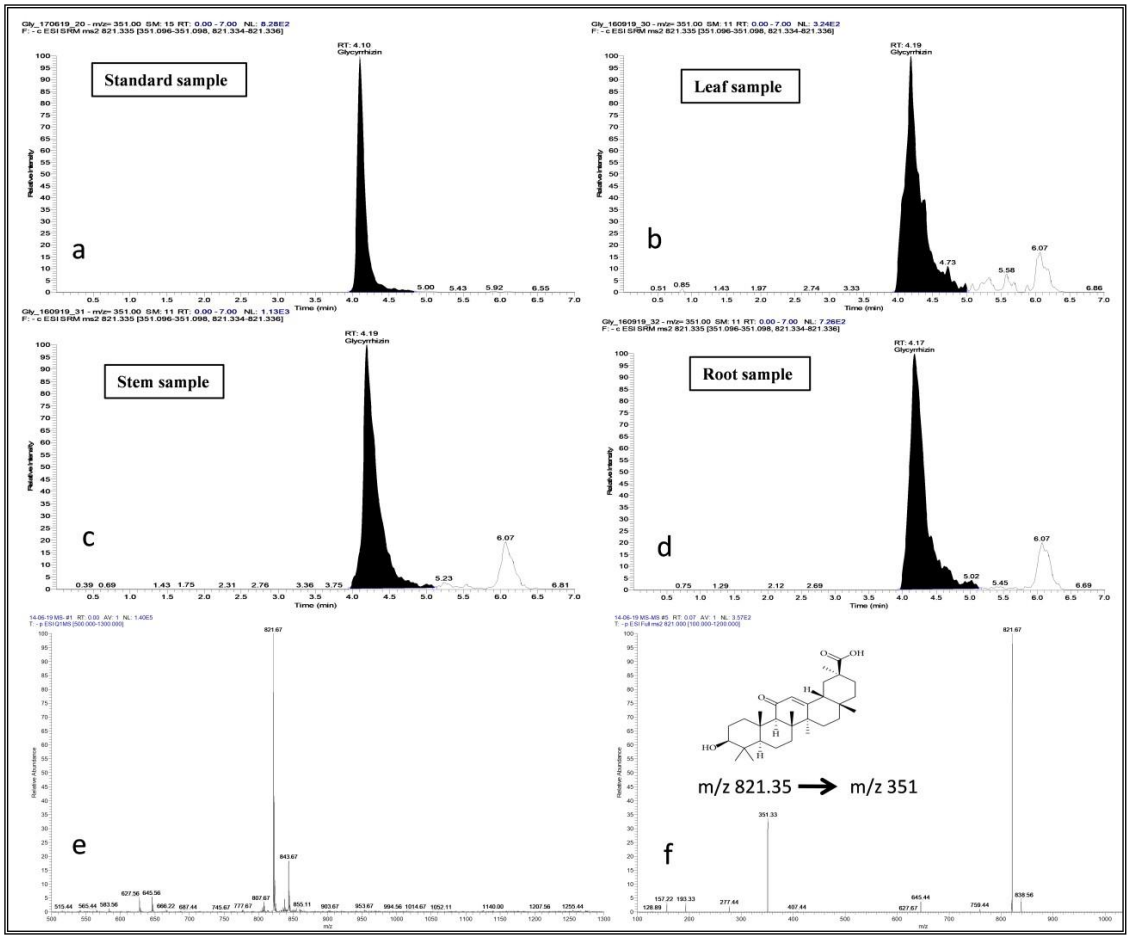
2.35 Functional and biochemical characterization of glycyrrhizin biosynthetic pathway in *Glycyrrhiza glabra L.*

Malik Muzaffar Manzoor, Pooja Goyal, Ajai P Gupta, Suphla Gupta

Establishment of tissue culture system for the genomic studies in *G. glabra* plant. The developed culture lines of different morphogenetic nature (root culture, stolons and *in vitro* raised plants) were utilized for the molecular cloning and expression analysis of key regulatory genes involved in the biosynthesis of glycyrrhizin. All the full-length genes of the glycyrrhizin biosynthesis pathway have been isolated and cloned from *Glycyrrhiza glabra*. Their *in-silico* characterization and promoter studies have been completed, which will be utilized for metabolic engineering experiments. The study reports a protocol for the regeneration of *Glycyrrhiza glabra* plantlet from the leaf explants, demonstrating the presence of glycyrrhizin in the underground (7.0–29.8 µg/g) & aerial (7.3–23.4 µg/g) tissues of the in vitro regenerated plants, which was otherwise not detected in the aerial tissues of the field plant. Further, spatio- temporal relative gene expression analysis of aerial tissues of in-vitro regenerated *G. glabra* showed expression of all the known genes committed to glycyrrhizin pathway. In the shoot system, maximum expression of squalene epoxidase (7.9 fold), β-amyrin synthase (21.8 folds), Licorice β-amyrin 11-oxidase (5.9 folds) and UDP-glucosyltransferase (1.7 folds) was observed in different months. However, no expression was detected in the aerial tissues of the field grown plant. Also, a correlation was found between the expression patterns of Licorice β- amyrin 11-oxidase with glycyrrhizin accumulation.



Glycyrrhizin detection in the aerial tissues of *in-vitro* regenerated *Glycyrrhiza glabra* revealed role of auxin in inducing expression of genes committed to glycyrrhizin biosynthesis.

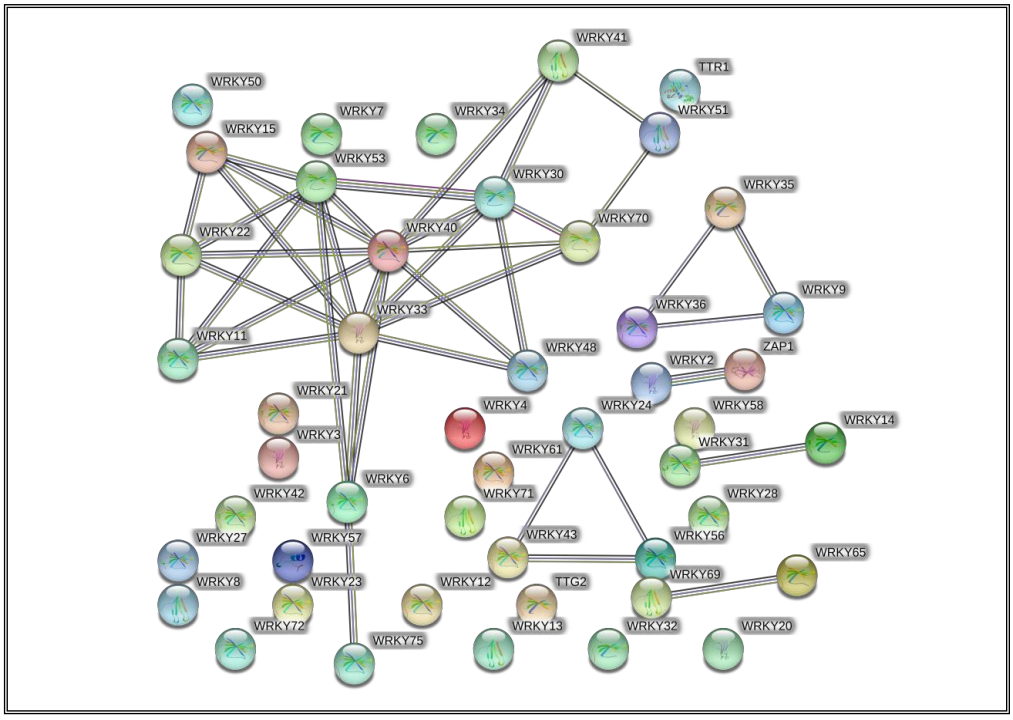


2.36 Transcriptome wide analysis of WRKY transcription factors in *Glycyrrhzia glabra* and elucidation of role of selected genes in abiotic stress.

Pooja Goyal, Ajai P Gupta, Suphla Gupta

This study identifies 147 full-length *WRKY* genes based on the transcriptome analysis of Glycyrrhiza genus (*G. glabra* and *G. uralensis*). Based on the number of WRKY domains, sequence alignment and phylogenesis, the study identified GuWRKY27 comprising of 3 WRKY domains in *G.uralensis* and a new subgroup-IIf (10 members), having novel zinc finger pattern (C-X4-C-X22-HXH) in *G.glabra*. Multiple WRKY binding domains (1–11) were identified in the promoter regions of the *GgWRKY*genes indicating strong interacting network between the WRKY proteins. Tissue-specific expression of 25 *GgWRKYs*, under normal and treated conditions, revealed 11 of the 18 induction factor-triggered responses corroborating to the response observed in *AtWRKYs*. The study identified auxin-responsive *GgWRKY* 55 & *GgWRKY*38; GA3 responsive *GgWRKYs*15&59 in roots and *GgWRKYs*8, 20, 38, 57 &58 in the shoots of the treated plant. *GgWRKYs* induced under various stresses included *GgWRKY*33 (cold), *GgWRKY*4 (senescence), *GgWRKYs*2, 28 & 33 (salinity), and *GgWRKY*40 (wounding).

Overall, 23 *GgWRKYs* responded to abiotic stress, and hormonal signals induced 17 WRKYs. Of them, 13 *WRKYs* responded to both, suggesting an inter-connection between hormone signaling and stress response. The present study will help understand the transcriptional reprogramming, protein-protein interaction and cross-regulation during stress and other physiological processes in the plant.



2.37 Screening of lemongrass genotypes for their essential oil and herb yield potential

VP Rahul Sougata Sarkar, Indrapal Verma, Jyoti, Shazia Paswal, Sheetal, Amit Kumar, Ayushman, Rishi Kesh Meena, Amit Kumar [1] , SR Meena, Chandra Pal Singh, Sumeet Gairola, Dhiraj Vyas, and DSR Readdy (Project- HCP 007)

A total of ten genotypes of lemongrass, including varieties, were screened for essential oil under field and screen house conditions at CSIR- IIIM experimental farm Chatha, Jammu. Among them, one selection LG 7 showed a positive response for their herb yield and essential oil. The remain two best C*ymbopogon* selections were identified for further essential oil studied and LG 7 were grown in yield trails for stability analysis.

Preliminary characteristics of the lemongrass selection 7

Plant height: - 170 - 190cm
Clump diameter: - 40 - 45cm
Slips count per clump: 80-90
Plant habit: - Erect, light green leaf sheath; stem colour purple to green, clumps tough, dense and leaves spreading.
Citral content: - 76.00% (approx).
Oil recovery:-1.2 to 1.3% in Clevenger type apparatus. ***Herb yield: - 65-70 tonnes/ ha/year***

Field view of LG 7

Picture: - LG 7 Plant picture

Picture: - clump of LG 7

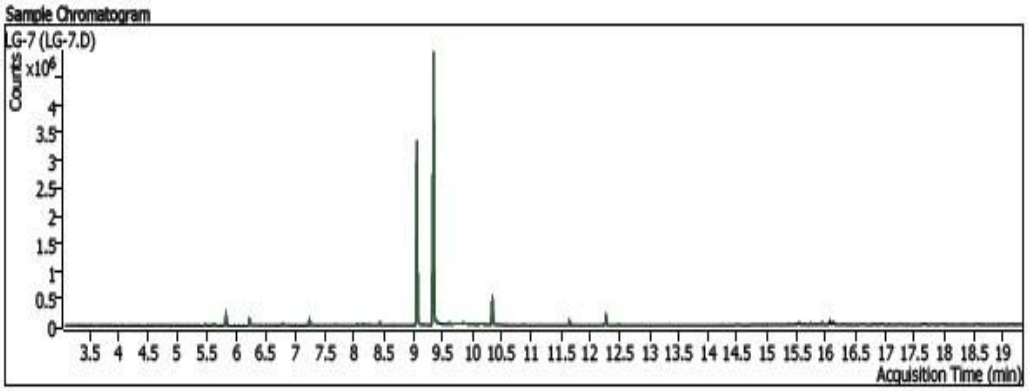
Picture: - LG 7 slips

Library Search Results - NonTarget Hits with Details

File Name	LG-7.D	Path Name	D:\MassHunter\Data
Instrument Name	GCMS-S80	Dil.	1

Component RT	Compound Name	CAS#	Formula	Component Area	Match Factor	Area %
5.4730	Tricyclo[2.2.1.0(2,6)]heptane, 1,7,7-trimethyl-	508-32-7	C10H16	29141.9	94.0	0.2197
5.6213	(1R)-2,6,6-Trimethylbicyclo[3.1.1]hept-2-ene	7785-70-8	C10H16	38345.8	94.9	0.2892
5.8231	Camphene	79-92-5	C10H16	243639.2	98.3	1.837
6.2208	5-Hepten-2-one, 6-methyl-	110-93-0	C8H14O	171283.2	97.4	1.292
6.7906	D-Limonene	5989-27-5	C10H16	39925.0	91.9	0.3011
7.2417	4-Nonanone	4485-09-0	C9H18O	144716.7	97.0	1.091
7.6868	3-Oxatricyclo[4.1.1.0(2,4)]octane, 2,7,7-trimethyl-	1686-14-2	C10H16O	20371.3	78.9	0.1536
8.0489	Cyclopropanemethanol, 2-methyl-2-(4-methyl-3-pentenyl)-	98678-70-7	C11H20O	29706.5	76.9	0.224
8.1616	2-Cyclohexene-1-carboxaldehyde, 2,6,6-trimethyl-	432-24-6	C10H16O	63196.4	86.5	0.4765
8.2507	Isoneral	1000414-18-0	C10H16O	22003.4	89.3	0.1659
8.4347	3,6-Octadienal, 3,7-dimethyl-	55722-59-3	C10H16O	67891.8	96.1	0.5119
9.0638	Neral	106-26-3	C10H16O	4004176.1	98.7	30.19
9.3428	2,6-Octadienal, 3,7-dimethyl-, (E)-	141-27-5	C10H16O	6170094.1	98.6	46.53
9.6158	Geranyl acetate	105-87-3	C12H20O2	21794.4	83.5	0.1643
9.8473	Epoxy-linalooloxide	1000007-96-5	C10H18O3	234465.4	80.2	1.768
10.1440	2,6-Octadienoic acid, 3,7-dimethyl-, (E)-	4698-08-2	C10H16O2	87010.0	83.4	0.6561
10.3399	Geranyl acetate	105-87-3	C12H20O2	668874.0	99.4	5.044
10.8741	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-,[1R-(1R*,4Z,9S*)]-	118-65-0	C15H24	17789.1	83.7	0.1341
11.6457	Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-, (1.alpha.,4a.beta.,8a.alpha.)-	39029-41-9	C15H24	97316.6	97.2	0.7338
12.2689	Caryophyllene oxide	1139-30-6	C15H24O	219975.1	97.5	1.659
12.4707	(1R,3E,7E,11R)-1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]dodeca-3,7-diene	19888-34-7	C15H24O	22251.7	76.5	0.1678
15.7410	Propanoic acid, 2-methyl-, 1-methyl-1-(4-methyl-3-cyclohexen-1-yl)ethyl ester	7774-65-4	C14H24O2	36252.6	75.6	0.2734
15.9369	Propanoic acid, 2-methyl-, 1-methyl-1-(4-methyl-3-cyclohexen-1-yl)ethyl ester	7774-65-4	C14H24O2	51121.9	77.5	0.3855

Sample Chromatogram



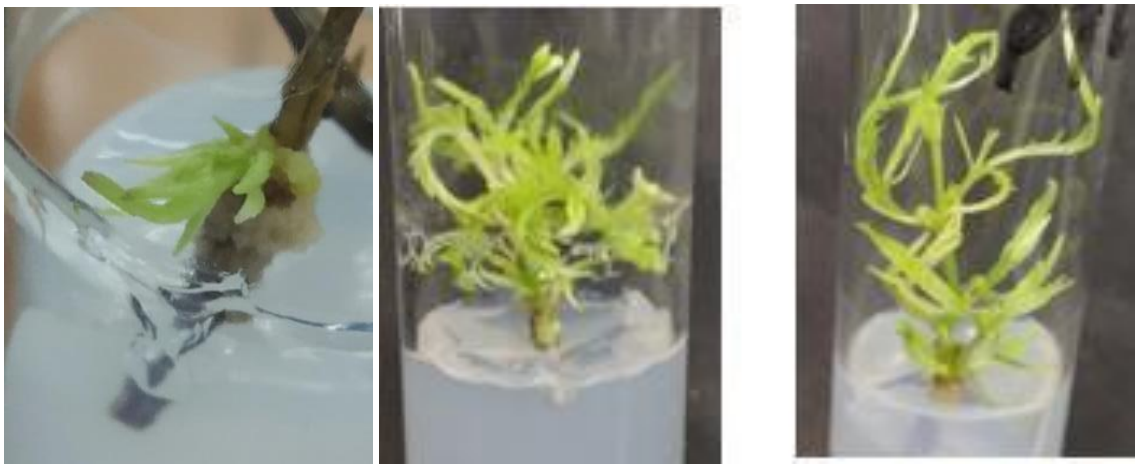
Picture: - GCMS report of LG7

Note: Citral content 76% (citral isomeric forms)

2.37 Micropropagation studies of *Cannabis sativa* L.

Srinivas Kota, Yadunandan Sen, Dhiraj Vyas and Prashant Misra

Hemp (*Cannabis sativa* L.) belongs to the Cannabaceae family, and the psychotomimetic activity of the plant has been known since antiquity. Cannabis is one of the oldest known medicinal plants in human history. Hemp is distinguished based on the concentration of ^9-tetrahydrocannabinol (pharmacological active ^9-THC, commonly referred to as THC) and in cannabidiol (CBD; inactive, but a good identification marker). Different growth regulators like BAP, KN, TDZ, GA3, Zeatin, IAA etc., were used to optimize regeneration using various explants like cotyledon, hypocotyl, leaf, flower buds, nodes and internodes in *Cannabis sativa*. However, nodal explants on TDZ and IAA combination initiated multiple shoot induction. Further, optimization by modification of media composition is under progress. The leaf explants displayed initiation of callus in the MS medium containing growth regulators. The callus has been multiplied and is currently being tested for shoot regeneration using a different combination of growth regulators.



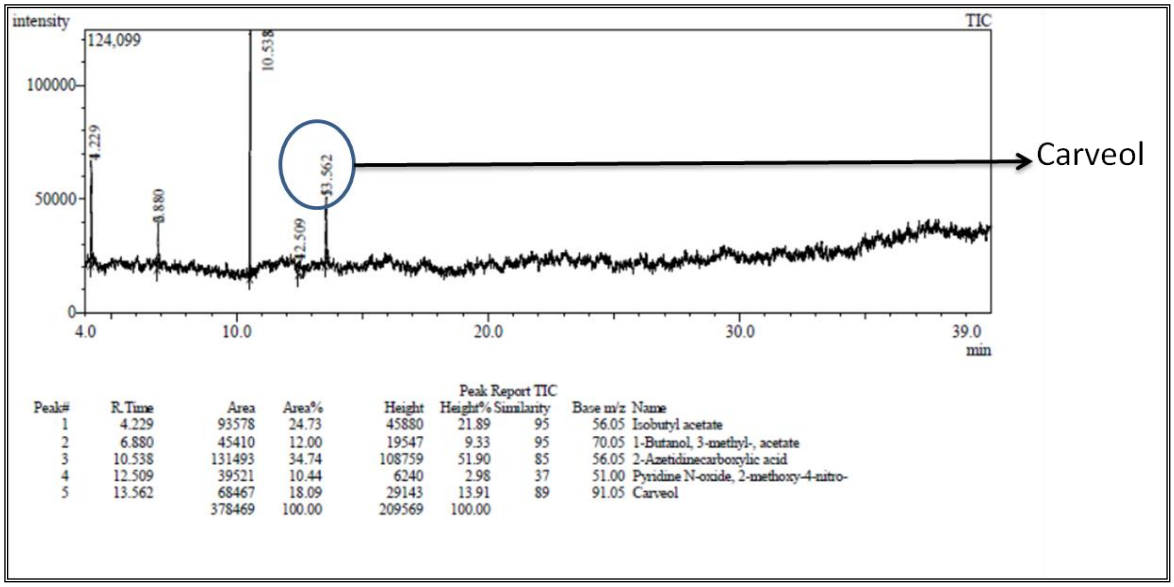
Multiple shoot induction through nodal explants

3. SIGNIFICANT SCIENCE AND TECHNOLOGY CONTRIBUTIONS

3.0 Title of Mission Projects: Theme ANB- CSIR-Aroma Mission (Phase-II)

3.1 Biotransformation of limonene to carveol:

Microorganisms and their enzymes have proven to be versatile biocatalysts for biotransformation of various terpenoids. The maximum microbial transformations of terpenoids have been performed on monoterpenes, which are the main constituents of many essential oils. Among various monoterpenes, limonene (C10H16) (4-isopropenyl-1-methyl cyclohexene) is a widely available monoterpenes hydrocarbon and a major component in oils from citrus peel. L-limonene is mainly found in a variety of trees and herbs such as Mentha spp., while D-limonene is the major component obtained from the peel of oranges and lemons, it is also found in adequate amount in essential oil of caraway. Natural functions are reported including prevention of dehydration, microbial inhibition especially fungal growth. Most of the reported studies dealing with microbial conversions of limonene, suggests low yields of products due to volatility of the substrate and the toxicity of limonene to most of the microorganisms. This study was aimed at the screening of microorganisms which yields carveol as bio transformed product. In the course of the survey a strain *Aspergillums* sp. (RSH) was shown to successfully biotransform limonene to Carveol.



Peak Report TIC

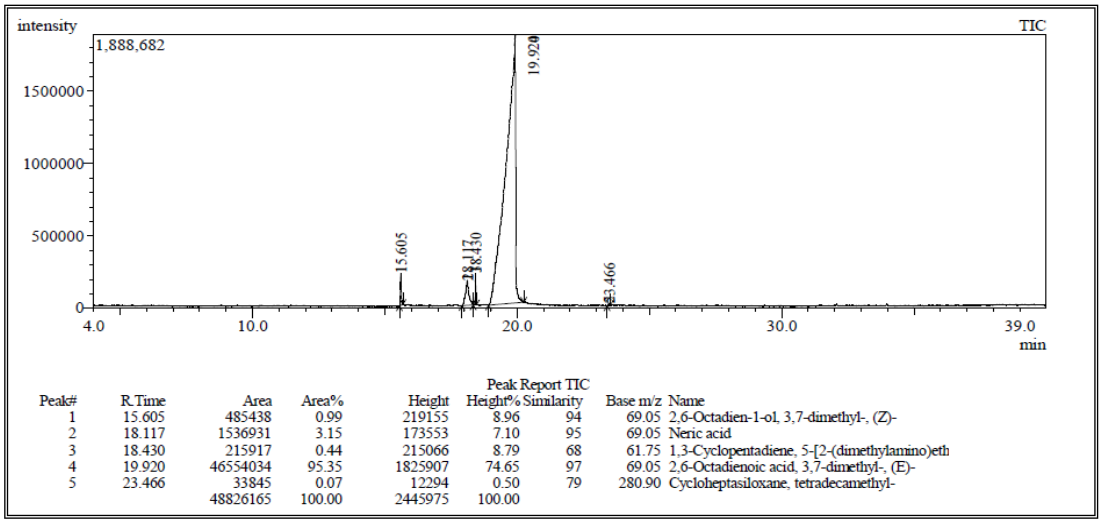
Peak#	R.Time	Area	Area%	Height	Height%	Similarity	Base m/z	Name
1	4.229	93578	24.73	45880	21.89	95	56.05	Isobutyl acetate
2	6.880	45410	12.00	19547	9.33	95	70.05	1-Butanol, 3-methyl-, acetate
3	10.538	131493	34.74	108759	51.90	85	56.05	2-Azetidinecarboxylic acid
4	12.509	39521	10.44	6240	2.98	37	51.00	Pyridine N-oxide, 2-methoxy-4-nitro-
5	13.562	68467	18.09	29143	13.91	89	91.05	Carveol
		378469	100.00	209569	100.00			

Figure 3.1.1: GC-MS analysis of carveol (biotransformed product)

3.2 Biotransformation of Geraniol to Geranic acid

Geraniol is a monoterpene that is found within many essential oils of aromatic plants like lemongrass, geranium, rose-grass, etc. It has pleasant rose like aroma and commercially used as fragrance in cosmetic products. However, it has number of biological activities such as anti-microbial activity, act as plant insect repellent, also has antioxidant and anti-inflammatory properties.

Biotransformation of geraniol to geranic acid by using microbes has gained importance because of its number of applications. It finds its application in perfume industries, act as a building block for the production of natural flavour esters, has strong antifungal properties and also as a de-pigmenting agent in melanocytes and has low cell toxicity. This study was aimed at the screening of microorganism which yields geranic acid as bio transformed product and *Mucor* sp. was found to biotransform geraniol to geranic acid effectively.



Peak Report TIC

Peak#	R.Time	Area	Area%	Height	Height%	Similarity	Base m/z	Name
1	15.605	485438	0.99	219155	8.96	94	69.05	2,6-Octadien-1-ol, 3,7-dimethyl-, (Z)-
2	18.117	1536931	3.15	173553	7.10	95	69.05	Neric acid
3	18.430	215917	0.44	215066	8.79	68	61.75	1,3-Cyclopentadiene, 5-[2-(dimethylamino)eth
4	19.920	46554034	95.35	1825907	74.65	97	69.05	2,6-Octadienoic acid, 3,7-dimethyl-, (E)-
5	23.466	33845	0.07	12294	0.50	79	280.90	Cycloheptasiloxane, tetradecamethyl-
		48826165	100.00	2445975	100.00			

Figure 3.1.2: GC-MS analysis of biotransformation reaction

3.3 Biotransformation of Citral to geraniol and nerol

Citronellol is a fragrance ingredient used in decorative cosmetics and fine fragrances. It has many applications in flavoring, extracts, and food and drug manufacturing. Its use worldwide is greater than 1,000 metric tons per annum. Attempts were made to biotransform the pure terpene aldehyde (citral) to more valuable products i.e. geraniol and nerol. Geraniol is known for its biological activities such as anti-microbial activity, as insect repellent, and antioxidant as well as anti-inflammatory properties. Thus biotransformed products of Citral (geraniol and nerol) have more commercial value and thus may be useful for making value added products.

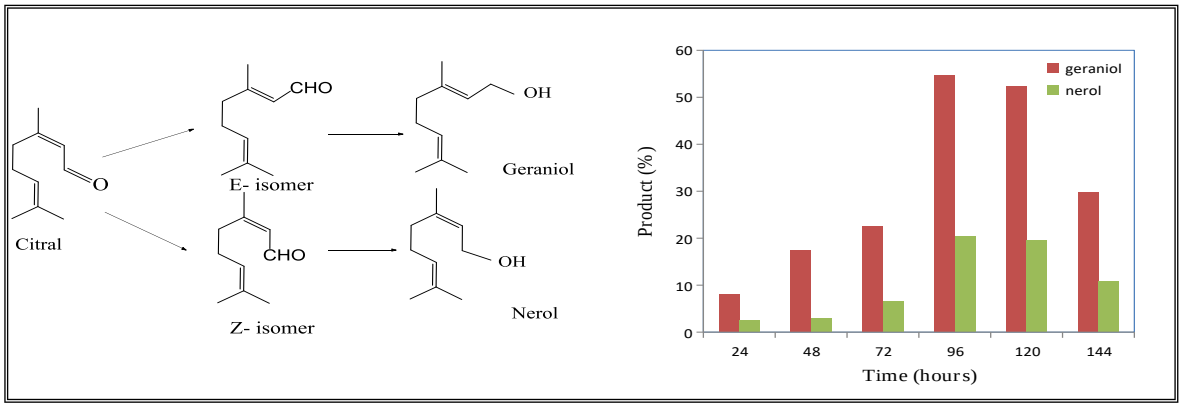


Figure 3.3.1: Biotransformation of citral to geraniol & nerol

3.4 An essential oil based formulation for postharvest storage of fruits

The diseased apples with the lesions were collected and pathogens were isolated on different media. The morphological identification of the pathogens was done. The dried aerial parts of *M. citriodora* (300 gm) were subjected to hydro-distillation for 4 hrs in Clevenger type apparatus. The distilled oil was dried over anhydrous Na_2SO_4. The oil sample was stored at 4°C until used for chemical analysis. GC and GC-MS analysis was performed by using Varian GC-4000 Gas Chromatograph, equipped with Flame Ionization Detector (FID). Identification of individual compounds was made by comparison of their mass spectra with those of the internal reference mass spectra library (Wiley/NIST) or with authentic compounds or with those of reported in literature database.

Monarda oil-based anti-pathogenic formulation is being developed for control of pathogenic fungi of *Brassica oleracea var. botrytis* (cauliflower) and *Brassica oleracea var. italica* (broccoli) and postharvest fungal pathogens of *Citrus Limon* (lemon). Fungal pathogens of *Citrus* Limon were isolated from infected samples. A total of 9 fungi was isolated, and their morphology studied.

Pathogenic fungi were also isolated from infected samples of *Brassica oleracea var. botrytis* (cauliflower) (13 fungi) and *Brassica oleracea var. italica* (broccoli) (14 fungi). Morphology was studied through Lactophenol Cotton Blue Staining. In-vitro screening for antifungal activity by various essential oils and individual essential oil components against the isolated pathogens was carried out

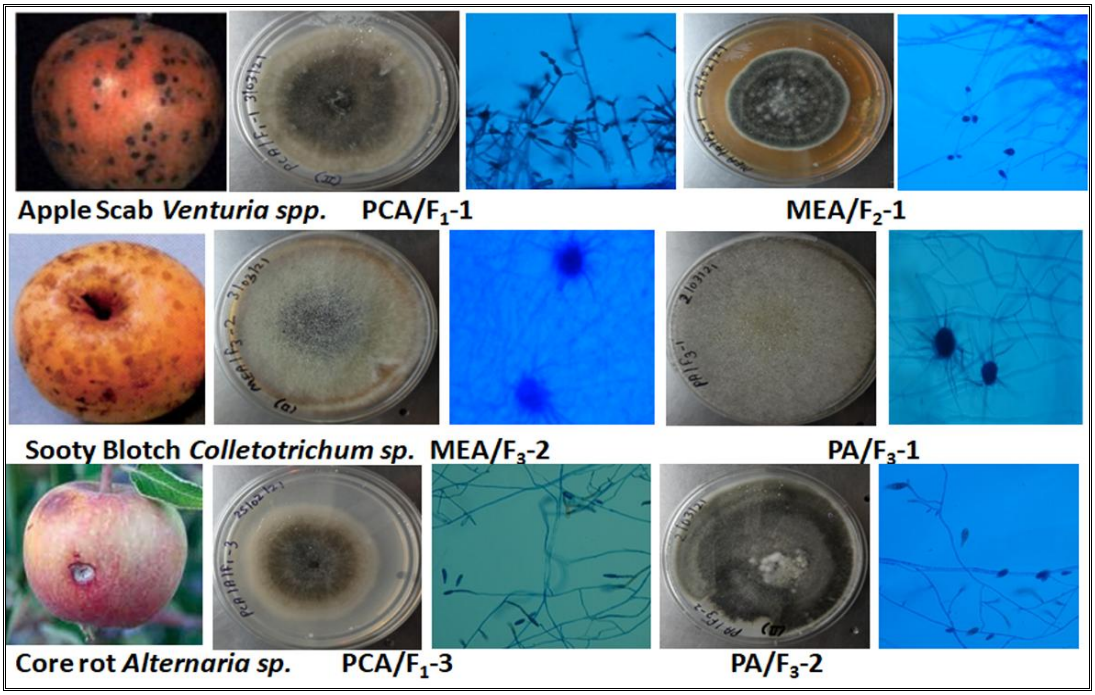


Figure 3.4.1 (A): Isolation of pathogenic fungi from apples and their morphological characterization

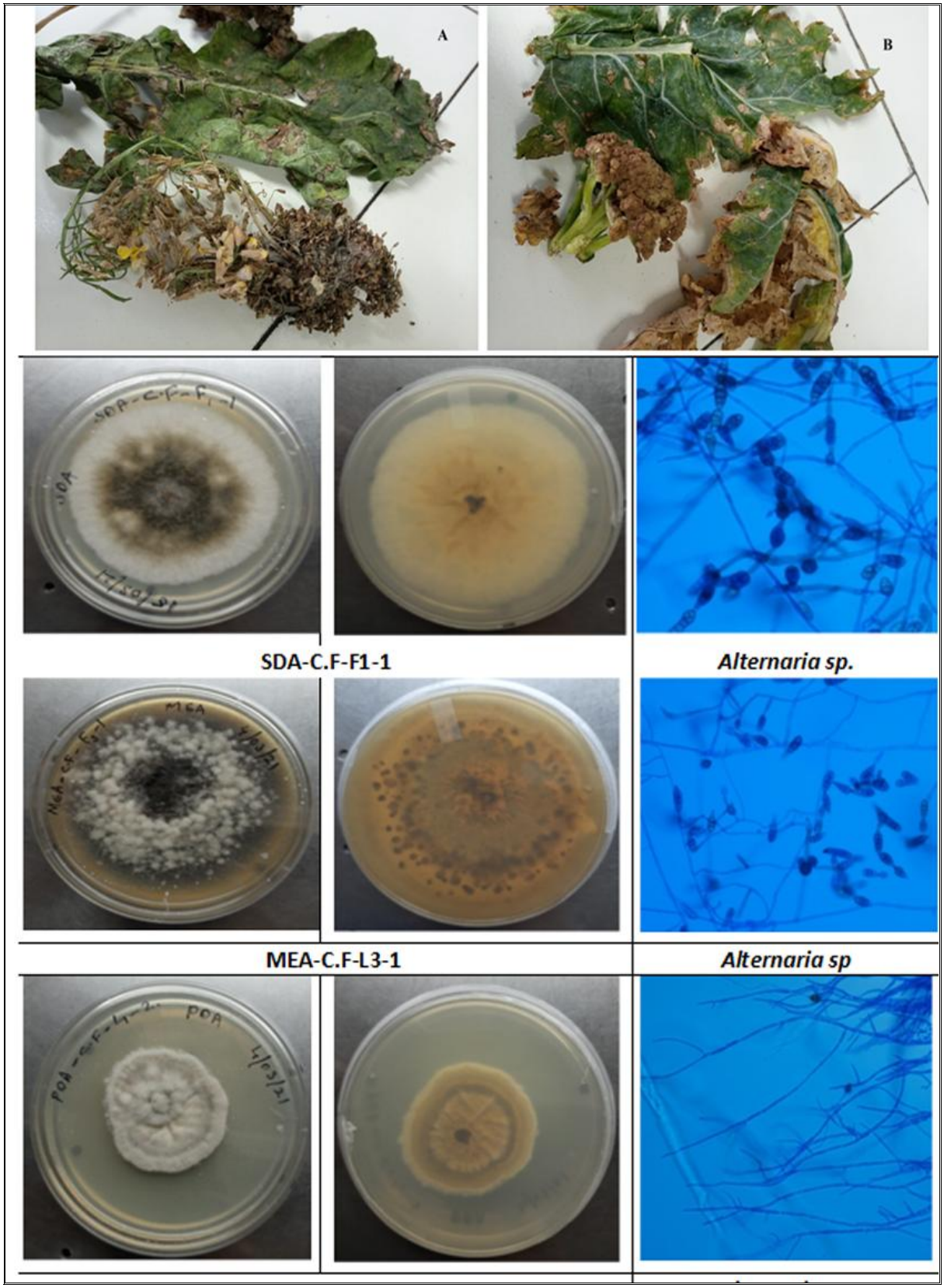


Figure 3.4.1(B): Infected leaves and flowers of *Brassica oleracea var. italica* (A) and *Brassica oleracea var. botrytis* (B) Isolated fungal pathogen

3.5 Evaluation of the immunomodulatory and anti-inflammatory activity of Bakuchiol using RAW 264.7 macrophage cell lines and in animal models stimulated by lipopolysaccharide (LPS)

Amit Kumar, Gifty Sawhney, Rakesh Kumar Nagar, Narendra Chauhan, Nidhi Gupta, Anpurna Kaul, Zabeer Ahmed, P.L. Sangwan *, P. Satheesh Kumar , Govind Yadav*

Bakuchiol (BAK) has been reported to have a diverse pharmacological property as an antibiotic, anti-cancer, anti-hypolipidemic, anti-inflammatory and anti-convulsant agent. This study aimed to elucidate the immunomodulation and anti-inflammatory mechanism of bakuchiol using lipopolysaccharide stimulated RAW 264.7 macrophages and various animal models. The present study has shown that BAK significantly suppressed the pro-inflammatory cytokine expression in a dose-dependent manner and its oral administration significantly decreased delayed hypersensitivity responses as compared to control group. The assessment of immunomodulatory activity was carried out by the testing Hemagglutinating antibody (HA) titer, delayed type hypersensitivity (DTH) responses and phagocytic index by carbon clearance test. On the other hand, it showed significant decrease in circulating antibody titer and carbon clearance assay in a concentration-dependent manner. BAK has significantly potentiated the cellular immunity as well as humoral immunity by facilitating the footpad thickness responses in sheep RBCs in sensitized mice by significantly decreasing circulating antibody titer. Molecular studies revealed that BAK inhibited the activation of upstream mediator nuclear factor-κB by suppressing the phosphorylation of IκBα and p65. The responses were statistically significant as compared with the control ($*p < 0.05$, $**p < 0.01$).

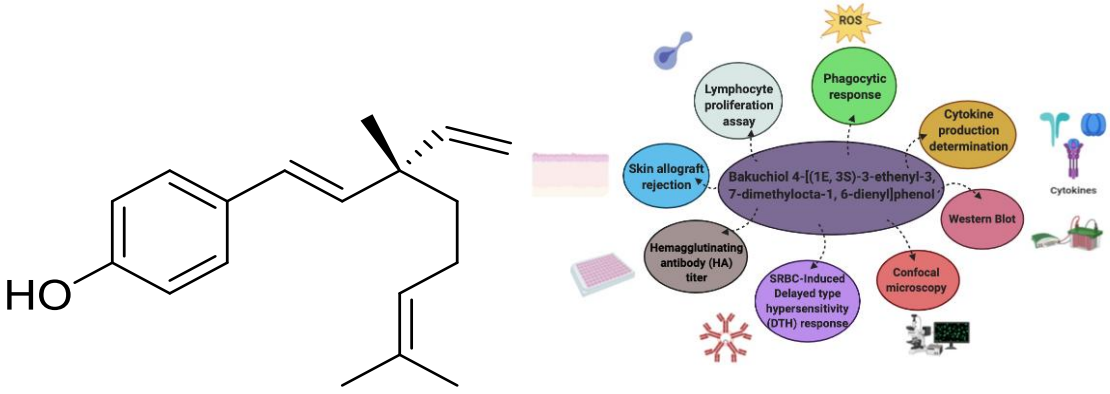


Figure 3.5.1. Bakuchiol

3.6 Contribution of IIIM rodent animals in Institute's Research and Development

S.No.	Area of studies	Contribution of iiim Rodents, Animal health and care during experiments	No. of Animals
1	Cancer	Balbc,DBA2,C57	
2	Pk,toxicity ,safety	Balb/c,Swiss,wistar Rat	
3	Neuroinflammation,	Balbc,C57	
4	IND enabling studies	Balb/c,Swiss,C57BL6,wistar Rat	
5	Anti-Diabetic studies	Wistar Rat	
6	Alzihmer study, neuronal-cell culture, Pain.	C57BL6	
7	Antiinflammatory for bovine mastitis	Bal/c,swiss,C57bl6,Wistar Rat,Rabbit	
8	Sickle cell anemia drug discovery,safety	Balb/c,	
9	Anti-inflammatory	Balb/c	
10	Cancer	Balb/c	
11	Aroma mission-skin melanogenesis, experimental photodamage	C57BL6	
12	MELANOMA-Cancer study	C57bl6	

3.6.1 Eleven clients were added from scientific institutions in respect to animal sale

Animal sale from CSIR-IIIM to other R&D institutions from April 2020 to 31March2021
Amount received from clients in FY 2020-2021: Rs 510400 (Five lakh, ten thousand and four hundred)

Date	Name of client	Institution	State	no. of animals	Total Amount received in IIIM Account Rs.
13.08.2020	Dr. HU Malik	SKUAST-K,srinagar	J&K	60	24000
21.09.2020	Dr. sameer Farhat	SKUAST-K,srinagar	J&K	70	28000
30.09.2020	store officer	CRI,Kasauli	Himachal Pradesh	100	100000
09.10.2020	Dr. Seema Akbar	RIIUM,SRINAGAR,	J&K	117	46800
15.12.2020	Dr. Seema Akbar	RIIUM,SRINAGAR	J&K	150	60000
30.12.2020	Dr. Yogendra Padwad	CSIR-IHBT,Palampur	Himachal Pradesh	83	24900
30.12.2020	Dr.Yogendra Padawad	CSIR-IHBT,Palampur	Himachal Pradesh	40	12000
07.12.2020	Dr. Sayed Zameer	SKUAST-K,srinagar	J&K	50	20000
07.12.2020	Dr. Showkeen Muzamil	SKUAST-K SRINAGAR	J&K	94	37500
00.01.2021	Dr Rajbir batti	GNDU Amritser	Panjab	82	24600
00.01.2021	Dr Rajbir batti	GNDU Amritser	Panjab	30	9000
12.02.2021	Dr Palwinder	GNDU Amritser	Panjab	36	10800
19.02.2021	Dr Seema Akbar Assistant Director I/C	RRIUM ,SRINAGAR	J&K	110	44000
09.03.2021	Dr. Sukhraj Kaur Associate prof	GNDU Amritser	Panjab	60	20400
22.03.2021	Dr Pawan verma	SKUAST-J	J&K	24	9600
17.03.2021	Dr Seema Akbar Assistant Director I/C	RRIUM ,SRINAGAR	J&K	97nos. booked	38800
				1203	510400

3.6.2 Overall distribution of client in five years

Distribution of Clients in States of India

1. Jammu and Kashmir
2. Haryana
3. Punjab
4. Himachal Pradesh(HP)
5. Rajasthan
6. Delhi
7. Madhya Pradesh(MP)

3.7 Procedure for development of extract from *Bergenia ciliata*:

The well authenticated plant material was dried under shade and ground to coarse powder in cGMP plant. Sifted powder (25 kg) was used for extraction with purified water and alcohol in 1:1 ratio (250 L, 95-99% Purity). Left coarsely powdered crude material dipped into solvent overnight at room temperature in the Extraction Vessel. Filtered the liquid extract through the filter cloth and transferred the extract into the Distillation Vessel. After distillation collected the distillate into S.S container. Repeated the extraction process thrice. The distillate was dried into spray drier. Total 8 kg dried extract powder received from two batches and samples submitted for CMC studies.

Bergenia ciliata

Bergenia ciliata lyophilized extract

3.8 Morpho-taxonomic and genetic characterization of wild *Cannabis* germplasm from Western Himalaya, India

Sumeet Gairola, Javaid Fayaz Lone, Kanwaljeet Singh, Pankaj Kumar, Prashant Misra, and Dhiraj Vyas (**Project No. MLP-1007)**

Cannabis, one of humanity's oldest crops, has been cultivated for millennia, gained global attention due to a large and broad spectrum of pharmacological activities. It is worth mentioning that this plant has been mostly absent from scientific research, especially in our country, due to some restrictions from the narcotics department. The plant is found in various habitats and altitudes and is the world's most distinct, notorious, and controversial plant. Genus *Cannabis* is exceptionally diverse and has generated great misunderstanding among taxonomists concerning its identification.

The Western Himalayan region of India possesses great altitudinal variation, diverse geological formation, and different climatic zones *viz*., subtropical to temperate to alpine, resulting in the immense diversity of its flora. The range of climatic conditions in this region is highly variable because of considerable variation in altitudes. Marked variations are noticeable both in the quality and quantity of flora with respect to the different latitudinal, altitudinal, and habitat conditions. This variation in Western Himalaya makes its environment highly suitable for the growth of *Cannabis*. Wider genetic adaptability, coupled with the wide range of environmental variation, has given rise to the large numbers of populations of *Cannabis* adapted to the particular microclimate in the Western Himalayan region. Due to this, an immense variation in the wild populations of *Cannabis* growing in the region is observed. For the first time in India, approval for legal captive cultivation of *Cannabis* was accorded to the CSIR-IIIM, Jammu, by the Government of Jammu and Kashmir. After getting approval for *Cannabis* cultivation for research purposes, the present study was initiated to assess morpho-taxonomic and genetic variation in wild *Cannabis* germplasm from Western Himalaya, India.This is the first study of its kind from India on this extremely important plant. For the present study, different geographically separated locations along an altitudinal gradient between 300 and 4000 m asl were visited in the Western Himalayan region viz., Union Territory of Jammu & Kashmir, Uttarakhand, and Himachal Pradesh. During the field visits, seeds of different wild *Cannabis* accessions along with morphological, ecological, and locational data were collected. During 2020-2021 the seeds of 95 *Cannabis* accessions were collected. The seed viability of the collected seeds was tested in the laboratory at CSIR-IIIM Jammu. These seeds with grown in the controlled conditions as per terms of the license received from the J&K Government. Grown plants were assessed for their morphological, phenological, genetic, and chemical characters. More than 400 herbarium specimens of *Cannabis* accessions collected from different locations of Western Himalaya were prepared and submitted to the internationally recognized Janaki Ammal Herbarium (RRLH) at IIIM, Jammu. Studies on morpho-taxonomic, genetic, and chemical variation in the grown accession are undergoing.

3.9 Botanical and molecular standardization of High-Value Raw Plant Drugs used in Indian Systems of Medicine

Pankaj Kumar and Sumeet Gairola (Project No. MLP-1007)

Plants are used for medicinal purposes in traditional medicine systems, ethnic preparations, and pharmaceutical and herbal industries to prepare various herbal preparations. Approximately 80% population of the world is dependent on herbal medicinal products. Herbal drugs may be supplied as intact or in dried form, broken or powder form. Herbal drugs are plants or plant parts, which are procured from wild or cultivated sources. After collection, the herbal samples are generally subjected to different processing stages, including washing, drying, and storage. Identification and authentication of herbal drugs become difficult in crude raw form and broken or fragmented or powdered form. The use of herbal drugs is often reported with misidentification and adulteration problems in various collection, transportation, and

processing stages. Adulteration of herbal drugs can be intentional or unintentional and can result in serious health hazards. Proper identification and authentication of plant species is the initial step in herbal preparations and form the most important step for herbal medicine safety and efficacy. Botanical standardization is known to provide a simple, fast, time, and cost- effective identification method. Different plant parts vary in their anatomical features, and the different plant parts need to be characterized and standardized for the unique botanical features. There is a requirement to develop proper macroscopic and macroscopic standards for plant species with descriptions of taxonomically significant characters. A complete botanical standard with detailed morphological, anatomical, and powder characterization with quantitative and photographic data is developed for different plant parts. The study comprised detailed botanical standards for 140 plant specimens belonging to 108 plant species representing 13 different plant parts (Figure 3.9.1 to Figure 3.9.2). DNA barcode sequences were developed using nuclear (ITS) and cytoplasmic (matK, rbcL, and psbA-trnH) DNA barcode markers.

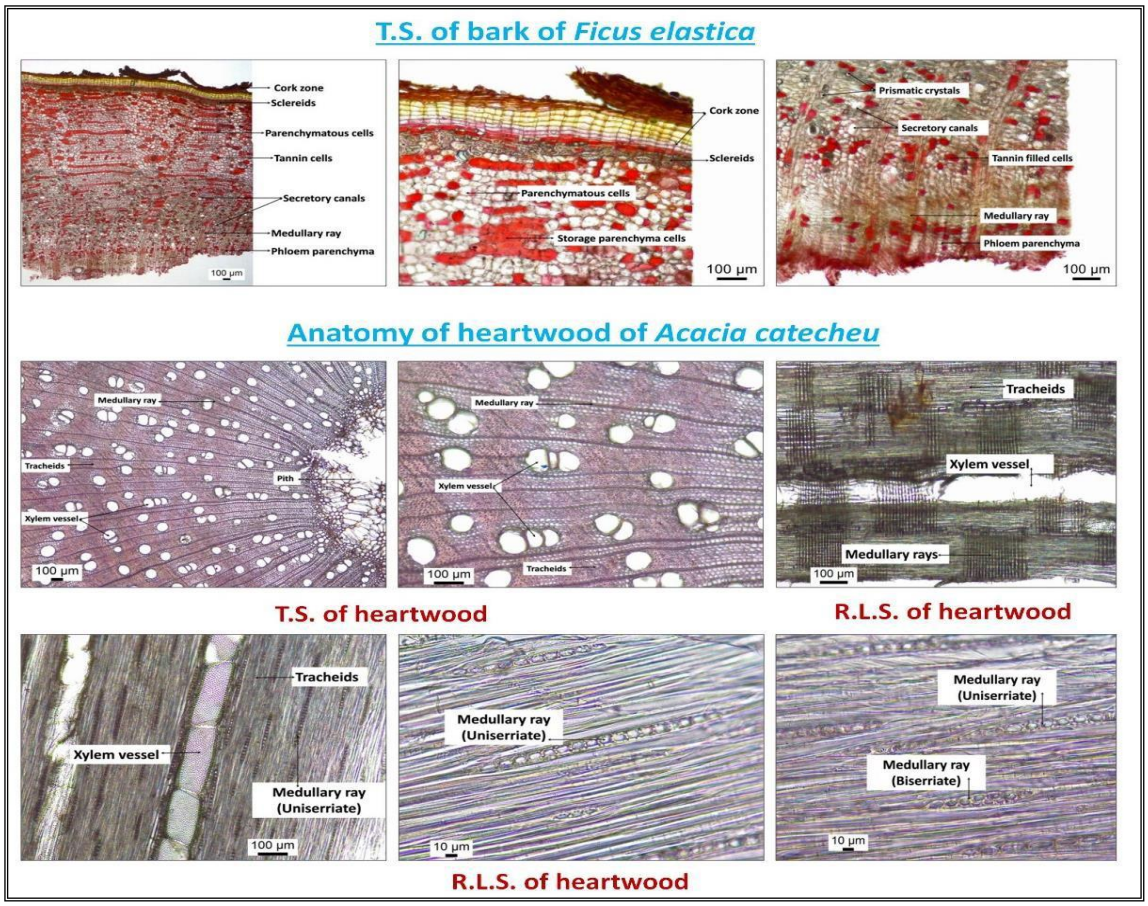


Figure 3.9.1: Cross-sections of some of the studied raw plant drugs.

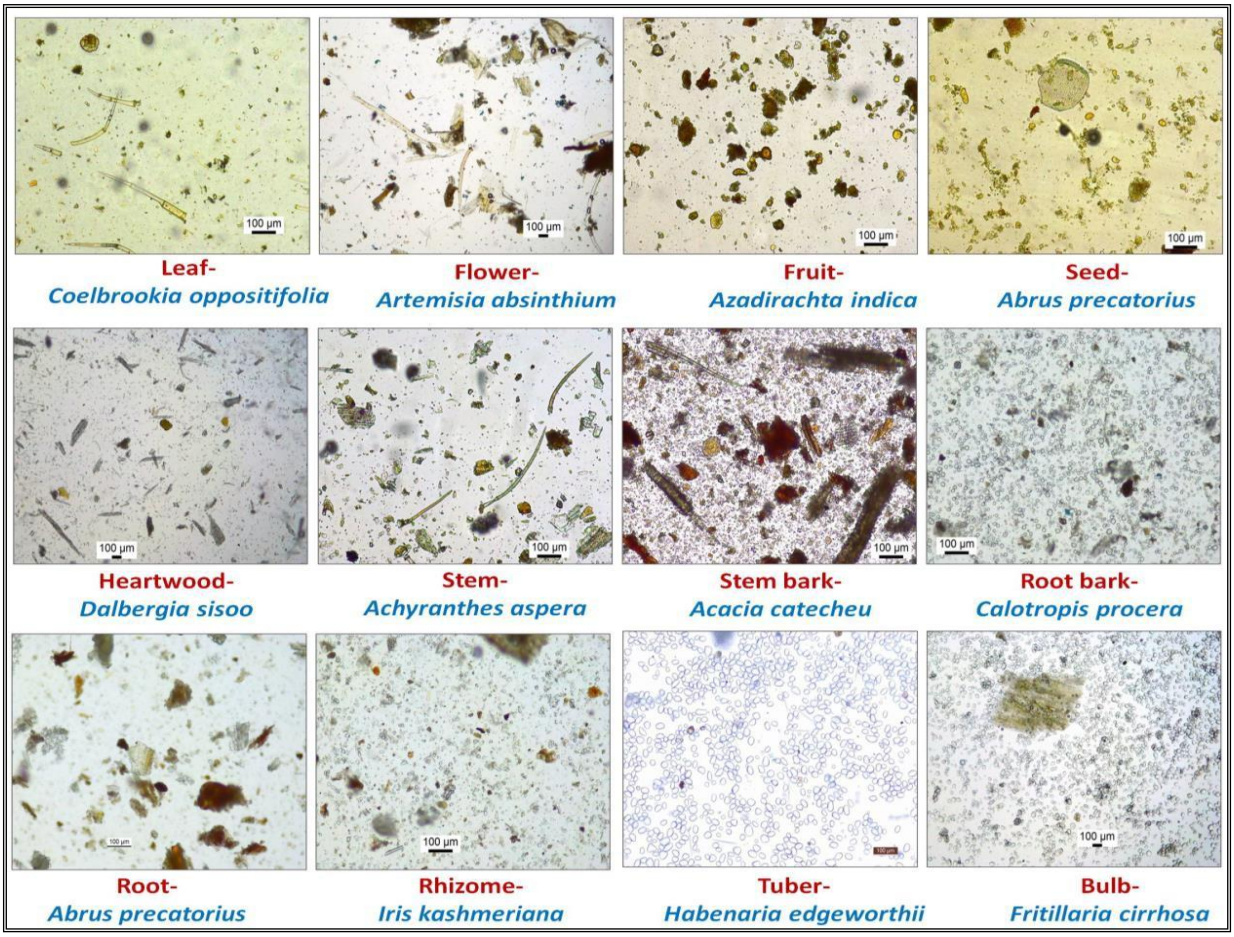


Figure 3.9.2: **Common microscopic structure in powder study of different plant parts.**

3.10 Upgradation, management, and enrichment of Janaki Ammal Herbarium (RRLH) and Crude Drug Repository (CDR) at CSIR-IIIM, Jammu

Sumeet Gairola, Madan, Pankaj Kumar, Kanwaljeet Singh, Javaid Fayaz Lone, Bushan Kumar, Zohra Batool (**Project No. MLP-1007)**

The Janaki Ammal Herbarium at CSIR-IIIM, Jammu, is an internationally recognized national referral facility. The acronym RRLH has been assigned to it, which is registered in Index Herbariorum at New York, U.S.A. Various maintenance and management activities were undertaken in the RRLH during 2020-21 *viz*., taxonomic up-gradation as per latest classification, fumigation, change of genus and family covers, etc. Services of identification of herbarium specimens were provided to the industry, academia, and other Government departments. Overall, > 600 Herbarium specimens were accessioned to RRLH during 2020-21. More than 800 herbarium specimens were collected from different ecological niches and localities of J&K, Ladakh, Uttarakhand, and Himachal Pradesh. All the collected plant specimens were processed as per the standard procedure. In addition to that, more than 1500 digital photographs of plants were taken for preparing the digital database.

A Crude Drug Repository (CDR) at CSIR – IIIM, Jammu, is a national referral facility catering to the needs of industry, academia, and scientists in the form of identification of crude drugs (Figure 3.10.1). This referral facility is accessible to the pharmaceutical industry, traders, medicinal practitioners, natural products chemists, botanists, students, and academicians. The authentication service of crude drug specimens received from throughout India is provided through this facility. Authenticated plant material and certification of drug specimens are also provided using this facility. Permanent crude drug accession numbers are given to each specimen. Besides that, passport data about plant part, plant part code, botanical name, family, Ayurvedic/ vernacular name, received from, and project from which it is received are also kept for each specimen. Presently a total of 4200 authenticated crude drug specimens of various parts of the plants, belonging to 1152 taxa (168 families, 749 genera, 1139 species, three subspecies, and four varieties) used as medicine in various indigenous systems of medicine have been housed at Crude Drug Repository (CDR) of CSIR-IIIM, Jammu.

Figure 3.10.1: **Crude Drug Repository (CDR) at CSIR-IIIM, Jammu**

Various maintenance activities were undertaken in the CDR *viz*., fumigation with pesticides, application of naphthalene balls, etc. All the specimens available at CDR were checked, and labels were updated. Valid botanical names with author citations of all the plant species were verified from www.theplantlist.org, Version 1.1 (2013). Studies were conducted to ascertain the identity and botanically standardize the selected high-value raw medicinal plants. Detailed botanical and pharmacognostic monographs were developed for some important raw plant drugs for various industry and mission projects. A total of 55 authentic raw plant drug specimens and all the passport data were accessioned to the CDR at CSIR-IIIM, Jammu.

3.11 CSIR-Mission Phase 2: Catalysing Rural Empowerment through Cultivation, Processing, Value Addition and Marketing of Aromatic Plants (Project No. HCP-0007).

The prime focus of the mega CSIR Network project- Aroma mission aims at Catalysing Rural Empowerment through Cultivation, Processing, Value Addition and Marketing of Aromatic Plant for realizing the dream of Honourable Prime Minister of doubling the income of farmers by adopting improved released varieties of aromatic crops having high demand in International & National aroma market. Here, Dr. Suphla Gupta, Principal Scientist and team from the Plant Sciences Division was involved in improving the eugenol content in *Ocimum gratissimum*. Dr. Supha Gupta was able to select 12 lines having eugenol content of more than 91%. Studies on understanding the role of endophytes in secondary metabolism of *Glycyrrhiza glabra* L involves, identification of the genes in glycyrrhizin biosynthesis and unraveling the influence of endophytes on its biosynthesis and accumulation *in-planta*. Agricultural Nutritional Biotechnology (ANB) approved CSIR Network Project: Deciphering the mechanism(s) of host-endophytes co-evolution enhanced secondary metabolite production and crop productivity having CSIR-IIIM component for Understanding the role of endophytes in secondary metabolism of *Glycyrrhiza glabra* L.

3.12 Demonstration and Transplanting of Aromatic Crops in Chhattisgarh

Rajendra Bhanwaria, Rajendra Gochar, Sabha Jeet, V.P. Rahul, S.R. Meena and Sumit Gairola

In accordance with this activity, CSIR-IIIM Jammu has undertaken approximately 150 acres of land in four districts (Gariyaband, Jagdalpur, Kondagaon and Mhasamund) of Chhattisgarh state of India. The variety CKP-25 developed by IIIM (*Cymbopogon khasianus*× *Cymbopogon pendulus)* known as lemongrass hybrid, belongs to the family Poaceae. It is an interspecific hybrid, and the oil contents are 0.6 to 0.8 %. This crop has valuable chemical compounds such as citral (80-85%), which has high demand in perfumery, flavor, and pharmaceutical industries to develop aroma-based products. Further demonstration and distribution of planting material CKP-25 slip approximately 32.0 lac to various farmer clusters in Chhattisgarh. This variety shows superior performance and handing additional income to farmers than traditional crop cultivated in this region.

3.13 Extension of Medicinal and Aromatic plants (Cash crop) and their Captive cultivation in drought prone area of Bundelkhand region U.P. and M.P. for socio-economic upliftment.

Sabha Jeet, Chandra Pal Singh, Indrapal Verma, Kaushal Kumar, Shyam P. Singh, Chahat Chhopra, Shweta Pandey, Amit Kumar Singh, S.R. Meena, Rajendra Gochar, Nupun Kumar Pandey, Anil Katare Prem Narayan, Ramakant, V.P Rahul, Rajendra Bhawanria, Sumeet Gairola, Sumit G. Gandhi, Ram Ji, Dhiraj Vyas and Ravindra Verma

CSIR- Indian Institute of Integrative Medicine (IIIM) Jammu demonstrated/ captive cultivation of Medicinal and aromatic plants of CSIR-Agro technology under the DBT sponsored project entitled "Demonstration of Cultivation, processing and value addition of selected aromatic crops in Bundelkhand region and under CSIR-Aroma Mission. The quality planting material was procured by the IIIM beneficiaries/ farmers and distributed to farmers in free of cost. CSIR developed varieties such as Lemongrass (CKP-25) and Rosagrass (IIIM (J) CK-10) varieties were key crops were demonstrated. Farmers took keen interest in adopting the cultivation of medicinal and aromatic plants and > 45,00,000 slips/plant procured and distributed to more than 150 farmers of district Lalitpur (U.P.), Mahoba (U.P.), Jalaun (U.P.), Jhansi (U.P.), Tikamgarh (M.P.), Sagar (M.P.) and Datia (M.P.) were benefitted and cultivated for an area of 219 acres in the financial yearr 2020-2021, and their trial demonstrations were performed at the field. Since the Bundelkhand region facing livelihood challenges due to continuous drought in the past few years. The routine agricultural crops *viz.*, cereals, pulses, etc., cannot produce yield due to water scarcity. The cultivation of drought-resistant, nongrazing aromatic crops shall be a boon to the farmers of this region. The value addition in terms of quality assurance shall enhance the sale ability of aromatic plant produce and farmers' income sustainability.

Field view of Extension activities in Bundlekhand region U.P.& M.P.

किसानों को निशुल्क वितरित किए गए लेमन ग्रास एवं रोजा ग्रास के पौधे

कोरोना काल में भी आईआईएम परियोजना से लाभान्वित हो रहे महोबा के किसान

स्वतंत्र प्रभात (अनूप सिंह)

महोबा । भारतीय समवेत औषध संस्थान जम्मू (आईआईएम) एवं जैव प्रौद्योगिकी विभाग भारत सरकार द्वारा प्रायोजित बुंदेलखंड परियोजना के तहत परियोजना प्रमुख डॉ सभाजीत कृषि वैज्ञानिक के मार्गदर्शन में परियोजना सहायक महोबा निपुण कुमार पांडे द्वारा जनपद महोबा के किसानों को रोपण हेतु लेमनग्रास एवं रोजा ग्रास की पौध वितरित किये गए जिसमें महोबा जिले के भाड़रा, मझलवारा, मिरतला, मामना, बिलवई एवं जुझार आदि के किसानों ने शुरुआत की है परियोजना सहायक निपुण कुमार पांडे ने बताया कि लेमनग्रास व अन्य सुरक्षित फसलों की खेती से किसानों को आय बढ़ाना एवं अन्ना प्रथा से फसलों को बचाना है तथा किसानों के जीवन स्तर बढ़ाने और आर्थिक स्थिति मजबूत करने के लिए जैव प्रौद्योगिकी मंत्रालय, भारत सरकार एवं सीएसआईआर

भारतीय समवेत औसत संस्थान जम्मू का संयुक्त प्रयास है एक बार रोकने के बाद प्रतिवर्ष चार से पांच बार पत्तियों की कटाई एवं लगाता 5 वर्ष तक की जा सकती है इस तरह किसानों का 5 वर्षों का जुताई एवं बुवाई का खर्च बच जाता है पत्तियों की कटाई के 24 घंटे बाद आसवन इकाई में तेल निकाला जाता है हमारे संस्थान द्वारा इस परियोजना अंतर्गत किसानों की सुविधा के लिए निशुल्क आसवन इकाई भी उपलब्ध कराई जाएगी ताकि किसानों को परेशानी का सामना ना करना पड़े इसके तेल का उपयोग सौंदर्य प्रसाधन इत्र और दवा बनाने के लिए किया जाता है तेल की विदेशों में अच्छी मांग है तेल का वर्तमान में भाव 1200 से लेकर 1800 रुपए प्रति लीटर है एक एकड़ में वर्ष भर में सिंचित भूमियों में लगभग एक लाख एवं असिंचित भूमियों में 50 हजार रुपये से 60 हजार रुपये का लाभ प्राप्त होता है।

महोबा के किसान चंद्र भूषण सिंह राजपूत जुझार के किसानों में गुलाब सिंह ,संदीप तिवारी ,रूप सिंह ,जयपाल सिंह एवं कपिल बिलवई के किसान जागेश्वर एवं प्रदीप सिंह मामना के किसान अभिषेक सिंह मिरतला के किसान शत्रुघ्न एवं धर्मपाल मझलवारा के किसान चंद्रशेखर एवं मानिक भाड़रा के किसान आलोक कुमार तिवारी, कौशल किशोर तिवारी, हरगोविंद ,अमरेश ,आस्तिक ,सुखदेव राजकुमार ,रोहित तिवारी को ग्रास के पौधे वितरित किए गए।

Dainik Jagran dated 04 Nov. 2020

महोबा

आज का दिन 1655 में इंग्लैंड और फ्रांस के बीच नौसेना और आर्थिक समझौतों पर हस्ताक्षर

जैविक खेती की ओर बढ़ रहा जिले में किसानों का रुझान, परंपरागत खेती से हो रहा किसानों का मोहभंग

जैविक खेती में भविष्य तलाश रहे अन्नदाता

राहत

लेमनग्रास में आ रही कम लागत

एक बार फसल बोने से पांच वर्ष तक कटाई

अन्ना पशु,जो वर्षे समस्या से मिल रहा छुटकारा

Hindustan dated 03 Nov. 2020

अच्छी पहल कोरोनाकाल में भी आईआईएम द्वारा लाभान्वित हो रहे किसान, पौधे पाकर किसानों में दिखी उत्सुकता

किसानों को निःशुल्क वितरित किए गए लेमनग्रास और रोजा ग्रास के पौधे

Dainik Bhaskar dated 04 Nov. 2020

आइआइएम द्वारा चलायी जा रही परियोजना का जिले में हुआ श्रीगणेश

किसानों में वितरित किये लेमनग्रास एवं रोजा ग्रास के पौधे

परियोजना प्रमुख व सहायक ने दी महत्वपूर्ण जानकारियां

Swatantra Bharat dated 04 Nov. 2020

3.14 Mint Cultivation in Punjab as an industrial crop for farmers under Aroma Mission phase-2 (Project - HCP 007)

VP Rahul, Chandra Pal Singh, Indrapal Verma, Jyoti, Shazia Paswal, Sheetal, Ayushman, Rajendra Gochar, SR Meena, Rajendra Bhanwaria, Sabhajeet, Srinivasa Kota, Sumeet Gairola, Dhiraj Vyas, and DS Readdy (Project- HCP 007)

Mint is an aromatic perennial herb popularly known as 'Pudina' in India and scientifically known as *Mentha* belongs to the family Lamiaceae and genus *Mentha*. Planting of mint is suitable from 1st week of February to 2nd week of March. The planting method for mint cultivation cut the sucker into 10 to 14cm length before sowing in the soil. About 450 to 500kg of suckers are required per hectare of land. Suckers should be set in furrows. Plant the suckers end to end with a spacing of 40cm apart in rows 60 cm apart. In mint cultivation, four weeks to 14 weeks period after planting is a crucial phase for controlling the weeds. To effectively control weeds combine mechanical, manual, and chemical methods. Apply the weedicides first followed by mechanical or manual methods after 8 to 10 weeks when mulching should also be applied. About 25 tones of well rotten farmyard manure (FYM) should be applied at the time of planting. Apply 150kg of nitrogen, 60kg of phosphorus, and 40kg potassium for two harvestings and for one harvesting 80:40:40(NPK) is essential. Irrigated land is suitable for its cultivation. Mint should be harvested first cut after 90 days. Harvesting of the plant should be done from the base.The team of Scientists CSIR-IIIM Jammu organizes the nine Awareness programs on the cultivation of aroma-bearing crops at Nawan Pind Donewal, Sardar Wala, Lohian khas, Meda Shakot, Bara Budh Singh, Badshah pur of District Jalandhar Punjab in village levels. And after a successful land survey, it was found that this area was suitable for mint cultivation. Approx 370 farmers have been registered, and they have a keen interest in growing mint crop. Team Aroma Mission distributed (one lakh) 100,000 kg quality planting material of *Mentha pipereta* to the registered beneficiaries under the Mission project. The total area of mint is cultivated in 500-acre area which produces 15000-16000 kg mint essential oil, exhibiting significant role for farmer's income and rural employment also. The present price of *Mentha pipereta* is Rs.2000-2100 per kg.

Field level demonstration of Mentha crop farmers


Field ready to transplant of Mentha crop


Distribution of QPM

Door to door delivery of QPM to beneficiaries

Overwhelming response of farmers for mint cultivation

3.15 Promotion and Demonstration of Lemongrass in eastern U.P. and Bihar under CSIR Aroma mission Phase-II.

Sabha Jeet, Chandra Pal Singh, Indrapal Verma, Kaushal Kumar, Shyam P. Singh, Chahat Chhopra, S.R. Meena, Rajendra Gochar, Nupun Kumar Pandey, Anil Katare Prem Narayan, Ramakant, V.P Rahul, Rajendra Bhawanria, Sumeet Gairola, Sumit G. Gandhi, Ram Ji, Dhiraj Vyas and Ravindra Verma

Uttar Pradesh and Bihar are the most populous state in India, and agriculture is the backbone of UP and Bihar economies, very fourth farmers in the Country comes from these states. Hence, one cannot expect the farmers' welfare in India without considering the farmers of UP and Bihar. About 85% population of this region lives in rural areas. They still provide employment to nearly 75% of the workforce and generating nearly 25% of the State Domestic Product. Farm income is the chief source of earning for agricultural households. The area under cultivation is shrinking day by day; there is a lot of scope for income generation. The agriculture production can only be increased to some extent through increasing cropping intensity, change in cropping pattern, providing quality and disease-resistant seeds of high yielding varieties to the farmers, imparting technological knowhow of cultivation practices and with the availability of better post harvest technology etc. Growing of medicinal and aromatic plants is the most profitable way. These productivities are the least effect by adverse climatic conditions, like drought, floods, insect and pest; do play a role in decreasing products. Medicinal and Aromatic plants cultivation and management therefore, could become highly remunerative both in financial and economic terms for the small-scale growers. The plants are increasing demand by major herbal drug industries, pharmaceuticals and cosmetics as an essential raw material of their drugs, MAPs-based industries expand jobs, and enhancing traditional uses through value-added processing can increase cash earnings to the local people. CSIR-IIIM, Jammu, provides an opportunity to the farmers of region U.P and Bihar for the promotion and growing of aromatic crops. The CKP-25 is an inter-specific hybrid variety (Cymbopogon khasianus × Cymbopogon pendulus) known as Lemongrass hybrid, belong to the family Poaceae developed by CSIR-IIIM Jammu. It is *citrol* rich novel variety and its oil contents are 0.5% and its main constituents are citral (80-85%). These varieties were mostly recommended in the rainfed as well as irrigated conditions. This variety is moisture stress tolerance. Moisture content is one of the factors responsible for the accumulation of secondary metabolites in the plant. Based on the recovery percentage 80-85 kg essential oil was obtained in one acre of land in the first year. The sale value of essential oil is approx. Rs 1000-1500 / kg. CK-10 (*Cymbopogon khasianus*) was developed by IIIM, known as Himrosa belongs to the family Poaceae. This crop having various valuable chemical compounds such as geraniol (80- 85%) and geranyl acetate (10-15%). This species is known for acclimatization to high drought and salt tolerance ability; therefore, well-drained sandy loam soils are most suited for its cultivation. This variety is hardy in nature, has a high drought tolerance capacity, and is easily cultivated in tropical and subtropical environments.

The oil is extensively used as perfumery, raw material in soaps, oral rose-like perfumes, cosmetics preparations and in the manufacture of mosquito repellent products. The prevailing price of essential oil of this crop in the I n d i a n market is 1700-2000 per kg, and this crop will give an approximately net profit of Rs 1.25 lakh per annum in the first year and subsequently in the next year onwards. Both CKP-25 and CK-10 have high demand in the flavor and fragrance industry to develop aroma-based products. Various advancement programs were organized in districts of U.P (Ayodhya, Lalitpur, Jhansi, Sultanpur), Bihar (Haspura, Aurangabad, Muzaffarpur, Motihari), and M.P (Katni, Sagar). A total of 33 lacs of CKP-25 and 8,75,000 CK-10 slips were distributed/cultivated among the farmers with coverage of about 250 acres. This will be a boon to farmers of this region to obtain good income and become an alternate cash crop.

Captive Cultivation

दैनिक जागरण 5

www.jagran.com लखनऊ, 15 मार्च, 2021

विभिन्न औषधीय पौधों का हब बनेगा जिला

संसू, सुलतानपुर : भारत सरकार के आईआईआईएम (भारतीय संवेत औषधि संस्थान) जम्मू की ओर से रविवार को कूरेभार के बाबूगंज में औषधीय खेती के लिए प्रशिक्षण कार्यक्रम आयोजित किया गया।

इसके जरिए किसानों को लेमन, रोजा ग्रास, रोज सेंटेड जेरेनियम, मेंथा, तुलसी आदि की खेती के लिए प्रेरित किया गया। संस्थान के वैज्ञानिक डा. सभाजीत ने किसानों को बताया कि एक एकड़ लेमन और रोजाग्रास की खेती करके 70 से 80 हजार रुपये प्रतिवर्ष मुनाफा कमाया जा सकत है। उन्होंने बताया कि बीज संस्थान की ओर से उपलब्ध कराया जाता है।

4. RURAL SECTOR AND SUSTAINABLE DEVELOPMENT

4.1 Boost up CSIR- Agro-technology through awareness cum training Programme

Under the societal empowerment and skill development programs as CSIR-Indian Institute of Integrative Medicine (IIIM), Jammu organized more than 20 skill development and training programs in Uttar Pradesh and Madhya states Pradesh to explore the CSIR Agro-technology of targeted commercial Medicinal and aromatic plants and their package and practices, suitable for rainfed areas among the farmers of these regions.

राष्ट्रीय हिन्दी दैनिक

स्वतंत्र प्रभात

www.swatantraprabhat.com

जो लिखेगा, वही दिखेगा

इंदौर-भोपाल में 1307 कोरोना संक्रमित मिले: पेज -12 || कृषि मंत्री ने कार्य परियोजनाओं का किया लोकार्पण: पेज -03

किसानों की स्थिति सुधारने के लिए बरदान साबित होगी लेमनग्रास

-एक एकड़ में किसान को 70 से 80 हजार रुपये प्रति वर्ष होगा मुनाफा

स्वतंत्र प्रभात

कबरई,महोबा – भारत सरकार सीएसआईआर भारतीय समवेत औषध संस्थान (आईआईआईएम) जम्मू द्वारा आज ग्राम सूरा चौकी ब्लाक कबरई जिला महोबा में औषधीय एवं सुगंधित पौधों की खेती प्रसंस्करण एवं मूल्य संवर्धन और विपणन के माध्यम से ग्रामीण सशक्तिकरण पर एक दिवसीय जागरूकता प्रशिक्षण कार्यक्रम का आयोजन किया गया। यह आयोजन सीएसआइआर एरोमा मिशन परियोजना के तहत डॉ निवासा रेड्डी निदेशक के नेतृत्व में हुआ। कार्यक्रम का शुभारंभ विशिष्ट अतिथि श्याम सिंह जिला उद्यान अधिकारी महोबा ने किया। इस परियोजना का उद्देश्य आईआईएम जम्मू द्वारा विकसित औषधि एवं सुगंधित फसलों की खेती जैसे लेमनग्रास, रोजा ग्रास, मिंट, जिरेनियम एवं उपयोगी पौधों को किसानों के प्रक्षेत्र तक पहुंचा कर उनकी आर्थिक स्थिति को मजबूत करना है। इस कार्यक्रम के अध्यक्ष एवं परियोजना प्रमुख डॉक्टर सभाजीत ,वैज्ञानिक (आईआईआईएम, जम्मू) औषधि एवं सुगंधित फसलों की खेती करने के तौर-तरीकों एवं उनकी उपयोगिता के बारे में विस्तृत जानकारी दी। उन्होंने बताया एक एकड़ में लेमनग्रास और रोजा ग्रास की खेती करके यहाँ का किसान 70 हजार रुपये से 80 हजार रुपये प्रति वर्ष मुनाफा कमा सकता है। उन्होंने यह भी बताया सीएसआइआर अरोमा मिशन के तहत किसानों को तकनीकी जानकारी के साथ-साथ गुणवत्ता युक्त रोपण सामग्री पौध एवं बीज एक एकड़ के लिए संस्थान के द्वारा मुफ्त में दिया जाएगा तेल निकालने के लिए आसवन इकाई की भी सुविधा प्रति क्लस्टर मुफ्त में की जाएगी।

कार्यक्रम का संचालन परियोजना सहायक निपुण कुमार पांडे के द्वारा किया गया एवं किसानों को अधिक से अधिक संस्थान के साथ जुड़ने एवं लाभ प्राप्त करने के लिए प्रोत्साहित किया गया कार्यक्रम में महेंद्र वर्मा, गुलाब सिंह, चंद्रभूषण राजपूत ,आदित्य श्रीवास्तव, शत्रुघ्न एवं आधा सैकड़ा किसान उपस्थित रहे।

4.2 Catalyzing Rural Empowerment through Cultivation, Processing, Value Addition and Marketing of Aromatic Plants: CSIR-Aroma Mission Phase-2 interventions of CSIR- IIIM, Jammu

Sumeet Gairola, Qazi Parvaiz Hassan, VP Rahul, Sabha Jeet, Rajendra Bhanwaria, SR Meena, Shahid Rasool, Padma Lay, Phalisteen Sultan, Chandra Pal Singh, Rajinder Gochar, Habibullah, Niteen Ashok Narkhede, Vikrant Awasthi, Prashant Misra, Sumit G. Gandhi, Dhiraj Vyas, Abdul Rahim, Rajneesh Anand, D.S. Reddy (Project No. HCP-007)

To bring a decisive and transformative change in the rural economy, market dynamics, and growth opportunity, Aroma Mission was conceptualized to provide end-to-end technology and value-addition solutions across the country at a sizable scale. The first phase of the CSIR- Aroma Mission was completed on 31st March 2020. After completing the first phase of the CSIR-Aroma Mission, the second phase of the mission was initiated in April 2020. The total area of more than 1374.42 ha benefiting more than 1000 farmers has been bought under captive cultivation of selected aromatic crops at various locations throughout the country in the first year of CSIR-Aroma Mission Phase-2, by CSIR-IIIM Jammu (Figures 4.2.1 to 4.2.6).

Figure 4.2.1: Lemongrass (CKP 25) and Rosagrass (CK 10) distribution and plantation at Sultanpur and Jhansi, Uttar Pradesh

Figure 4.2.2: Lemongrass/ Rosagrass distribution and plantation at Aurangabad, Motihari, and Muzaffarpur, Bihar

Figure 4.2.3: Rosagrass distribution and plantation at Gujarat

Figure 4.2.4: Lavender plantation at Kulgam and Pulwama in Kashmir, J&K.

Figure 4.2.5: Jammu Monarda nursery at Gujarat

Figure 4.2.6: Lavender nursery at Bhaderwah, Doda district, J&K

Essential oils are the main economic ingredient of aromatic plants, which are extracted by employing distillation units. To enable farmers to distill the oil from aromatic plants, distillation units were installed in the clusters of villages. Installation of the distillation unit was a very vital component of the CSIR-Aroma Mission. The availability of such distillation facilities instills a sense of confidence in farmers about ensured returns from the cultivation of aromatic plants. In the first year of CSIR-Aroma Mission Phase-2, CSIR-IIIM, Jammu purchased Ten S.S. distillation units of 500 Kg capacity which have reached the locations and are under process of installation (Table 4.2.1). Ten other distillation units purchased earlier in the first phase of CSIR-Aroma Mission were also installed during this period. Four distillation units purchased earlier in the first phase of the CSIR-Aroma Mission were inaugurated (Figure 4.2.7).

Figure 4.2.7: Inauguration of three Distillation units at Bhaderwah, Doda District, J&K

Table 4.2.1: Locations where distillation units under CSIR-Aroma Mission Phase-2 are being installed by CSIR-IIIM, Jammu.

S.N	Selected site/Place/Full Address	State
1	Village Bhairopur, PO. Rupinpur/ Jaisinghpur, Distt. Sultanpur	Uttar Pradesh
2	Village Sindhaura, Haringtonganj, Distt. Ayodhya	Uttar Pradesh
3	Village Bharthipur, P.O. Guptarganj, Sultanpur	Uttar Pradesh
4	K.V.K. East Champaran (Piparakothi), Motihari	Bihar
5	Devoli Gram Panchayat, Junpani Road, Gujar, Nagpur	Maharashtra
6	Village Sudheen, Panchayat Kothian, Tehsil Pouni, Reasi	Jammu & Kashmir
7	Gram Panchayat Karyan Neota, Sei Senaye Village, Bhaderwah, Doda District	Jammu & Kashmir
8	Khelani Top,Bhaderwah, District Doda	Jammu & Kashmir
9	Village Devidhura, Tehsil Pati, District Champawat	Uttarakhand
10	Village Bahtara, Tharali, Chamoli district	Uttarakhand

During the first year of CSIR-Aroma Mission Phase-2, 46 awareness-cum-training programs were conducted for the growers and other stakeholders, particularly in the regions where farmers are adversely hit by the deficient/excessive rainfalls (Table 4.2.2). Experts from industries and financial institutions were also involved in training growers of various schemes for obtaining financial help (Figure 4.2.8 to Figure 4.2.11). Selected progressive farmers/ young entrepreneurs were also trained in distillation, fractionation/derivatization, extraction, quality control, product development, etc. Videos on the successful introduction and cultivation of aromatic plants and activities of CSIR-Aroma Mission were developed and released.

Table 4.2.2: Details of awareness-cum-training program conducted under CSIR-Aroma Mission Phase-2 by CSIR-IIIM, Jammu.

Sr. No.	Program Date	Program Location
1	12-06-2020	Garautha village, Jhansi, Uttar Pradesh
2	17-06-2020	Bhadra village, Mahoba, Uttar Pradesh
3	22-06-2020	Kharagapur village, Tikamgarh, Madhya Pradesh
4	07-07-2020	Budera village, Tikamgarh, Madhya Pradesh
5	18-08-2020	Kati village, Tikamgarh, Madhya Pradesh
6	29-08-2020	Vichpuri village, Sagar, Madhya Pradesh
7	31-08-2020	Madanpur village, Sagar, Madhya Pradesh
8	26-11-2020	Sudheen, Pouni, Reasi, Jammu and Kashmir
9	28-11-2020	Kothian, Pouni, Reasi, Jammu and Kashmir
10	09-02-2021	CSIR-IIIM, Canal Road, Jammu, Jammu and Kashmir
11	09-02-2021	IIIM Jammu, Jammu, Jammu and Kashmir
12	09-03-2021	Khelani top, Doda, Jammu and Kashmir
13	10-03-2021	Kathwada, Ahmedabad, Gujarat
14	10-03-2021	Community Hall Bhaderwah, Doda, Jammu and Kashmir
15	11-03-2021	Kakosi (Sidhpur), Patan, Gujarat
16	11-03-2021	Guttasa Village, Doda, Jammu and Kashmir
17	12-03-2021	Naritara, Gariyaband, Chhattisgarh

Sr. No.	Program Date	Program Location
18	12-03-2021	Agarwa (Thasara), Kheda, Gujarat
19	12-03-2021	Bhandarkoot, Kishtwar, Jammu and Kashmir
20	12-03-2021	Baraunsha, Sultanpur, Uttar Pradesh
21	13-03-2021	Khemara, Mhasamund, Chhattisgarh
22	14-03-2021	Kada, Lakhtar, Gujarat
23	14-03-2021	Mahuli, Nagpur, Maharashtra
24	14-03-2021	Babuganj, Sultanpur, Uttar Pradesh
25	15-03-2021	Rajpura, Kondagaon, Chattisgarh
26	15-03-2021	Rebarika, Amreli, Gujarat
27	15-03-2021	Deoli, Nagpur, Maharastra
28	16-03-2021	Kumharawand, Jagdalpur, Chhattisgarh
29	18-03-2021	Bandipora, Bandipora, Jammu and Kashmir
30	18-03-2021	KVK, Tikamgarh, Tikamgarh, Uttar Pradesh
31	18-03-2021	Panchmukhi Dharmshala, Tanakpur, Champawat, Uttarakhand
32	19-03-2021	Soora Chauki, Mahoba, Uttar Pradesh
33	20-03-2021	Bamour, Jhansi, Uttar Pradesh
34	20-03-2021	Pati, Champawat, Uttarakhand
35	21-03-2021	Lali, Udhampur, Jammu and Kashmir
36	21-03-2021	Aghoda Gram Panchayat, Okhalkanda, Nainital, Uttarakhand
37	22-03-2021	Nawan Pind Donewal, Jalandhar, Punjab
38	23-03-2021	Sardar Wala, Jalandhar, Punjab
39	23-03-2021	Lohian Khas, Jalandhar, Punjab
40	24-03-2021	Meda, Shakot, Jalandhar, Punjab
41	24-03-2021	Bara Budh Singh, Jalandhar, Punjab
42	25-03-2021	Turna, Jalandhar, Punjab
43	26-03-2021	Pippli, Punian, Poonian, Jalandhar, Punjab
44	26-03-2021	Badshahpur, Shahkot, Jalandhar, Punjab
45	27-03-2021	MIANI, SHAHKOT, Jalandhar, Punjab
46	30-03-2021	IIIM Farm, Bonera, Pulwama, Jammu and Kashmir

Figure 4.2.8: Training-cum-awareness program organized at Tanakpur, Champawat, Uttarakhand

Figure 4.2.9: Aroma Mission Phase-2 Launch program at CSIR-IIIM Jammu on 09-02-2021

Figure 4.2.10: Training-cum-awareness programme organized at Bhaderwah, Doda district, J&K

Figure 4.2.10: Training-cum-awareness programme organized at Bhaderwah, Doda district, J&K

Figure 4.2.11: Training-cum-awareness program organized at Bhandarkut, Kishtwar district, Jammu

.

4.3 Purple Revolution in Jammu division of UT of J&K, India

Sumeet Gairola, Qazi Parvaiz Hassan, Phalisteen Sultan, Rajendra Bhanwaria, VP Rahul, SR Meena, and Rajinder Gochar, Dhiraj Vyas, DS Reddy

(Project No. HCP-007)

Lavandula angustifolia Mill. (Syn. *L. officinalis* Chaix) or "True Lavender" is a small, non- hardy perennial evergreen subshrub belonging to the family Lamiaceae. The genus *Lavandula* comprises many important species geographically distributed in Mediterranean countries, Canary Islands and India. It is commercially cultivated in many parts of the world, mainly for its essential oil, obtained by the hydro-distillation of its attractive flowering spikes. Lavender starts commercial production from the third year onwards up to 15 years. Most of the Lavender oil in India is imported from Europe. There is a good market demand for essential oil of Lavender in the fragrance, aromatherapy, and cosmetics industry. Lavender oil produced in J&K has a market price of around Rs 10,000/- per kg in the Indian market. Dry Lavender flowers fetch a price between Rs. 1000/- to Rs 1500/- in the Indian market. In addition, by- products such as Lavender Hydrosol and distillation waste produced during the Lavender oil distillation process also have good market demand. Lavender was introduced in India in the 1940s in Kashmir by CSIR- Indian Institute of Integrative Medicine (CSIR-IIIM), J&K (then Drug Research Laboratory). It was popularised in Kashmir valley by CSIR. Lavender was introduced to the Bhaderwah region of District Doda, J&K, in 2010 on a trial basis. After successful field trials, CSIR-IIIM Jammu popularised its cultivation in the Jammu region under CSIR-Aroma Mission from 2016 onwards. Free Quality planting material (13 lakh lavender plants) of Lavender was provided to the small and marginal farmers under CSIR-Aroma Mission along with end-to-end technology transfer on cultivation, processing, harvesting, value addition, and marketing of the Lavender. CSIR-IIIM Jammu has installed six essential oil distillation units at various locations across the Doda district to support the Lavender farmers. CSIR-IIIM Jammu under CSIR- Aroma Mission is routinely conducting skill development programs on Lavender nursery development, value addition, and marketing for training progressive farmers and unemployed youth in remote places of J&K. Currently, more than 1000 farmers are growing Lavender at various locations of Jammu with major cultivation in the Bhaderwah region of Doda district, Jammu division, J&K. Districts of Jammu division

where farmers are growing Lavender are Doda, Udhampur, Kishtwar, Kathua, and Ramban. Lavender is mainly adopted by the farmers who used to grow Maize. They used to get a net income of around Rs. 2,500/- per Kanal per year (one hectare= 20 Kanal). Lavender oil production in the area varies between 40-60 liters per hectare per year, with an average of around 50 liters per hectare per year. The net income of these farmers has increased many folds from around Rs. 40,000/- to Rs. 60,000/- per hectare per year to between Rs. 3,50,000/- to Rs. 5,50,000 per hectare per year. Lavender has now become very popular in the Jammu Division. CSIR-IIIM, Jammu routinely receives requests from hundreds of farmers across J&K and nearby Uttarakhand and Himachal Pradesh states for scientific support and quality planting material of Lavender. Many farmers from other districts of Jammu and nearby Himalayan states of Uttarakhand and Himachal Pradesh are now routinely visiting Jammu to learn about Lavender cultivation.

Figure 4.3.1: Lavender distribution and plantation at different locations of the Doda district, J&K.

Due to the high market demand for quality planting material of Lavender, many farmers across Bhaderwah have generated nurseries of Lavender plants. They are earning reasonable amounts by selling plants to other farmers and government

departments between Rs. 5/- to Rs. 7/- per plant. CSIR-IIIM Jammu under CSIR Aroma Mission aims to expand its cultivation in J&K to 1500 ha in the next three years. Farmers of Doda produced 300, 500, and 800 Litres of Lavender oil in 2019, 2020, and 2021, respectively. The current production of Lavender oil in the region is at the inception stage as oil production from most of the plantations will start coming from 2022 onwards. The production of Lavender oil is expected to increase manifold in the coming years. Besides, farmers have earned a good amount of money by selling dry Lavender flowers and planting material to other farmers.

This activity of CSIR-IIIM, Jammu under CSIR-Aroma Mission has been widely covered by print and electronic media. The media has recognized this initiative of CSIR-IIIM, Jammu, with the title of "*Purple Revolution in Jammu*."

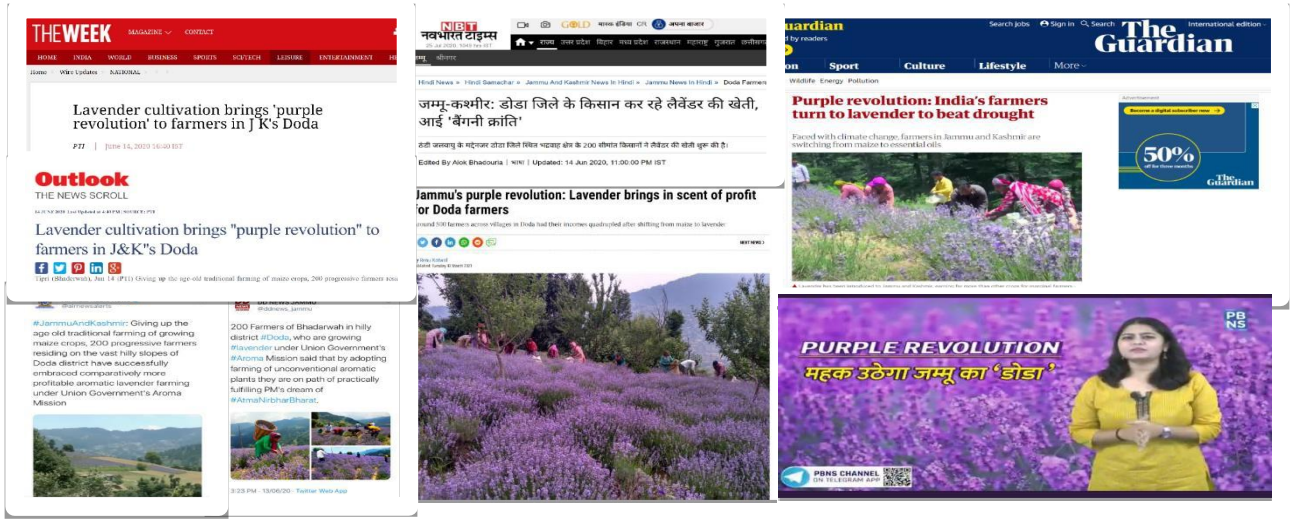


Figure 4.3.2: Media coverage of Purple Revolution in Jammu.

4.4 Rural Prosperity through Promotion of Aromatic Crops in Chhattisgarh

Rajendra Bhanwaria, Rajendra Gochar, Sabha Jeet, V.P. Rahul, S.R. Meena and Sumit Gairola

Chhattisgarh state of east-central India lies at an elevation that ranges from 800 to 950 feet (250 to 300 meters) about sea level. Chhattisgarh is home to several tribal castes, about 7.5% of India's tribal population, and tribal people form about 30% of the state's population. Chhattisgarh's population is about 25.54 million, and of that, Bastar's population is about 1.4 million comprising a large adivasi population. The major tribes of Bastar are muria, bhattra, halba, gadba, darta & dhurwa. About some three fourth of Chhattisgarh's population is rural and major occupation is predominantly agricultural. Nearly half of Chhattisgarh's land is farmland while most of the remainder is either under forest cover or is otherwise unsuitable for cultivation.

CSIR-IIIM is working on upgrading society under rural welfare through an extension project of aromatic crops. Diverse expertise development programs were organized under the aroma mission phase II project in four districts of Chhattisgarh such as Gariyaband, Jagdalpur, Kondagaon and Mhasamund in Central India. These programs were focused on themes such as rural employment through cultivation, processing, marketing and product development of aromatic (lemongrass) crops. A large number of farmers from four districts of Chhattisgarh (Jagdalpur, Gariyaband, Kondagaon and Mhasamund) were benefitted. A training programme was jointly organized with State forest research and Training Institute Raipur of Chhattisgarh state, and several farmers were benefitted.

5. GOVERNMENT OF INDIA MISSIONS

5.1 Mission: Atmanirbhar

5.1.1 Saffron cultivation and production under the Mission Atmanirbhar

Saffron (Crocus sativus L.) a perennial herb belongs to Iris family Iridaceae and is the most expensive spice in the world known for its aroma and colour and used for flavouring and colouring and in medicinal, pharmaceutical industries. The colour, flavour and aroma of saffron are mainly due to crocin, picrocrocin and safranal, respectively. Due to very high crocin content and rich aroma, the Kashmir saffron is famous worldwide and commands a premium price over the saffron available from Spain or Iran. Saffron is a legendary crop of Jammu and Kashmir produced on well drained karewa soils of Kashmir and Kishtwar where ideal climatic conditions are available for good growth and flower production. It grows at an elevation of 1500-2000 m amsl. Photoperiod and temperature exerts a profound influence on the flowering of saffron. Total world production of saffron is around 300 tons per year. Iran, India, Spain and Greece are the major saffron producing countries with Iran occupying the maximum area and contributing about 88% of world's saffron production. Though, India occupies the 2nd largest area but produces approximately 7 per cent of the total world production. Jammu and Kashmir is the only state in India where saffron is produced. Spain with 600 ha of land is the 3rd largest producer with an average productivity of 8.33 kg/ha which is highest in the world. The leading saffron growing countries like Iran, Spain and Greece with intensive production technologies are able to achieve higher production and productivity than our productivity and posing great threat to our saffron industry as imports are increasing every year. Thus, there is a need to increase production by bringing more area under cultivation and double the average productivity by adopting intensive production system, efficient processing and marketing to make it globally competitive and remunerative to growers. The total area under saffron cultivation in J&K is 3715 ha with production and productivity of 16 MT and 3.0 - 4.0 kg/ha, respectively. Saffron in J&K is primarily cultivated in four districts (Pulwama, Budgam, Srinagar, Kishtwar) with 86% saffron farming system in heritage site of Pampore over 3200 hectares. Pampore being peri-urban is under threat of commercialization /colonization therefore extending saffron cultivation in new potential and non traditional areas of J&K will provide more sustainability to the saffron cropping system. This will help to further improve overall saffron production of J&K keeping in view National demand of 100 M.T besides providing livelihood security to the marginally poor farmers of J&K. Owing to the importance of the crop for its national market demand and export potential the crop was successfully introduced and grown at the Field Station, Bonera of CSIR-IIIM in August, 2020. Under the Mission Atmanirbhar India the Institute envisages to further extend the crop on commercial scale in different non-traditional areas of the Valley.

5.1.2 Boost up CSIR- Agro-technology through awareness cum training Programme

Sabha Jeet, Chandra Pal Singh, Indrapal Verma, Kaushal Kumar, Shyam P. Singh, Chahat Chhopra, S.R. Meena, Rajendra Gochar, Nupun Kumar Pandey, Anil Katare Prem Narayan, Ramakant, V.P Rahul, Rajendra Bhawanria, Sumeet Gairola, Sumit G. Gandhi, Ram Ji, Dhiraj Vyas and Ravindra Verma

Under the societal empowerment and skill development programs as CSIR-Indian Institute of Integrative Medicine (IIIM), Jammu organized more than 20 skill development and training programs in Uttar Pradesh and Madhya states Pradesh. The overall objectives of the different programs is to explore the CSIR Agro-technology of targeted commercial Medicinal and aromatic plants and their package and practices, suitable for rainfed areas among the farmers of these regions. A one-day training program was conducted in districts of U.P (Sultanpur, Jhansi, Mahoba), M.P (Tikamgarh, Sagar) in which a total of 1,393 participants participated, among them, 210 were women participants. CSIR developed varieties such as Lemongrass, Rosagrass, and Jammu monarda varieties were the key crops discussed at the event.

राष्ट्रीय हिन्दी दैनिक

www.swatantraprabhat.com

स्वतंत्र प्रभात

किसानों की स्थिति सुधारने के लिए बरदान साबित होगी लेमनग्रास

-एक एकड़ में किसान को 70 से 80 हजार रुपये प्रति वर्ष होगा मुनाफा

स्वतंत्र प्रभात

कबरई,महोबा - भारत सरकार सीएसआईआर भारतीय समवेत औषध संस्थान (आईआईआईएम) जम्मू द्वारा आज ग्राम सूरा चौकी ब्लाक कबरई जिला महोबा में औषधीय एवं सुगंधित पौधों की खेती प्रसंस्करण एवं मूल्य संवर्धन और विपणन के माध्यम से ग्रामीण सशक्तिकरण पर एक दिवसीय जागरूकता प्रशिक्षण कार्यक्रम का आयोजन किया गया। यह आयोजन सीएसआइआर एरोमा मिशन परियोजना के तहत डॉ निवासा रेड्डी निदेशक के नेतृत्व में हुआ। कार्यक्रम का शुभारंभ विशिष्ट अतिथि श्याम सिंह जिला उद्यान अधिकारी महोबा ने किया। इस परियोजना का उद्देश्य आईआईएम जम्मू द्वारा विकसित औषधि एवं सुगंधित फसलों की खेती जैसे लेमनग्रास, रोजा ग्रास, मिंट, जिरेनियम एवं उपयोगी पौधों को किसानों के प्रक्षेत्र तक पहुंचा कर उनकी आर्थिक स्थिति को मजबूत करना है। इस कार्यक्रम के अध्यक्ष एवं परियोजना प्रमुख डॉक्टर सभाजीत ,वैज्ञानिक (आईआईआईएम, जम्मू) औषधि एवं सुगंधित फसलों की खेती करने के तौर-तरीकों एवं उनकी उपयोगिता के बारे में विस्तृत जानकारी दी। उन्होंने बताया एक एकड़ में लेमनग्रास और रोजा ग्रास की खेती करके यहाँ का किसान 70 हजार रुपये से 80 हजार रुपये प्रति वर्ष मुनाफा कमा सकता है। उन्होंने यह भी बताया सीएसआइआर अरोमा मिशन के तहत किसानों को तकनीकी जानकारी के साथ-साथ गुणवत्ता युक्त रोपण सामग्री पौध एवं बीज एक एकड़ के लिए संस्थान के द्वारा मुफ्त में दिया जाएगा तेल निकालने के लिए आसवन इकाई की भी सुविधा प्रति क्लस्टर मुफ्त में की जाएगी ।

कार्यक्रम का संचालन परियोजना सहायक निपुण कुमार पांडे के द्वारा किया गया एवं किसानों को अधिक से अधिक संस्थान के साथ जुड़ने एवं लाभ प्राप्त करने के लिए प्रोत्साहित किया गया कार्यक्रम में महेंद्र वर्मा, गुलाब सिंह, चंद्रभूषण राजपूत ,आदित्य श्रीवास्तव, शत्रुघ्न एवं आधा सैकड़ा किसान उपस्थित रहे।

Media coverage

Training and Awareness programme in different districts of Uttar Pradesh and Madhya Pradesh

S.No	State	District	Village Name/ Location	Date	Total Participants	Women Participants
1	U.P.	Sultanpur	Baraunsha	12.3.2021	55	15
2	U.P.	Sultanpur	Babuganj	14.3.2021	560	50
3	M.P.	Tikamgarh	KVK, Tikamgarh	18.3.2021	210	65
4	U.P.	Mahoba	Soora Chauki	19.3.2021	65	10
5	U.P.	Jhansi	Bamour	20.3.2021	75	20
6	U.P.	Jhansi	Vill. Garatha	12-Jun-20	20	5
7	U.P.	Mahoba	Vill. Bhadra	17-Jun-20	25	7
8	M.P.	Tikamgarm	Vill. Kharagapur	22-Jun-20	23	3
9	M.P.	Tikamgarh	Vill. Budera	07-Jul-20	34	6
10	M.P.	Tikamgarh	Vill. Kati	18-Aug-20	26	0
11	M.P.	Sagar	Vill. Vichpuri	29-Aug-20	20	5
12	M.P.	Sagar	Vill. Madanpur	31-Aug-20	20	9
13	U.P.	Mahoba	Village Mamna	08-10-2020	15	4
14	U.P.	Mahoba	Mirtala	09-10-2020	26	5
15	U.P.	Mahoba	Soora Chauki	19-03-2021	55	0
16	U.P.	Mahoba	Village Bhadra	10-07-2020	26	0
17	U.P.	Mahoba	Village Mamna, Mirtala	28-12-2020	40	4
18	U.P.	Mahoba	Village Jujhar, Bilbai	21-12-2020	22	0
19	U.P.	Mahoba	Bilbai	10-09-2020	42	2
20	U.P.	Mahoba	Jujhar	12-09-2020	34	0
	Total				**1393**	**210**

Glympses of Awareness cum training program



5.1.3 CSIR Summer Research Training Programme (CSIR-SRTP-2020) Online

भारतीय समवेत औषध संस्थान
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)
Indian Institute of Integrative Medicine
(Council of Scientific & Industrial Research)
Canal Road, Jammu Tawi - 180 001 (INDIA)

September 07, 2020

Abdul Rahim
Sr. Principal Scientist,
Head PME, BD & IT Division,
CSIR-IIIM, Jammu.

TO WHOM IT MAY CONCERN

This is to certify that **Ms. Archana Sahu**, student of B.Tech. (Biotechnology) from **Department of Biotechnology, Institute of Engineering and Technology, Bundelkhand University, Jhansi, Uttar Pradesh, India** has successfully completed her online training programme with CSIR- Indian Institute of Integrative Medicine under CSIR-Summer Research Training Programme (SRTP-2020) on *"Molecular Docking Studies on Multi Drug Resistant Bacteria (MDR) producing New Delhi Metallo-beta lactamase-1 (NDM-1) against carbapenems"* under the guidance of Dr. Asha Chaubey of this institute from 25-06-2020 to 31-08-2020.

She is sincere and a hard worker. I wish her all the success in her life.

(Abdul Rahim)

As directed by CSIR (HQ) to provide Summer Research Training Programme (CSIR-SRTP) 2020 Online programme was conducted to the students of Bachelors / Master Degrees in the areas of Chemical and Biological Science for the current year during June-August 2020 on online mode due to the unprecedented COVID-19 lockdown. CSIR-NEIST, Jorhat coordinated this CSIR-SRTP Training Programme 2020 and our laboratory received 100 + online applications, Research Management, Business Development & Information Science and Technology Division screened in 86 applications to undergo this training programme. Mentors/ scientists were alloted from the institute to each selected candidates to start the programme. Mentors online lecture schedules were circulated to the selected candidates for a two months programme. Project submission proforma were circulated to the trainees. The candidates submitted the dissertation work on the particular topics routed through their allotted supervisor/ mentor upon which the certificates were issued through email to each of the participated candidates.

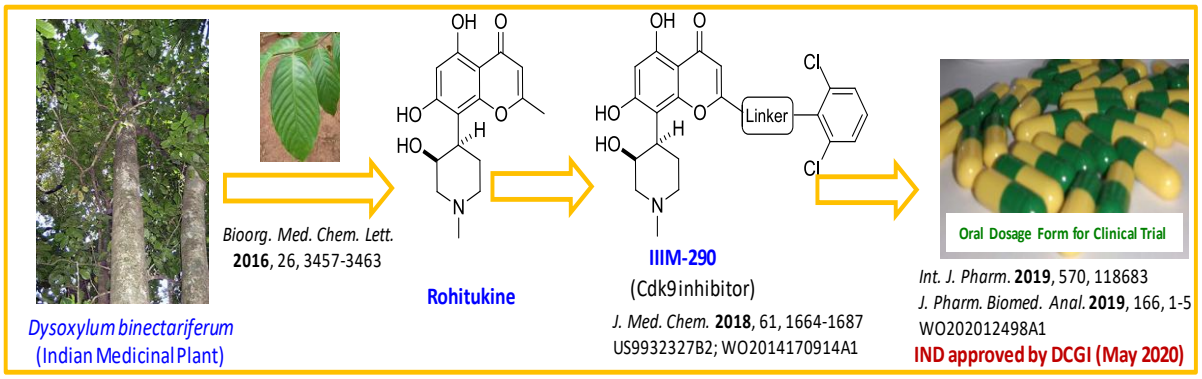
5.1.4 Under Skill India Mission: Training and workshop on Entrepreneurship Opportunities in Cultivation, Processing, Post-Harvest Management and Marketing of High Value Aromatic Cash Crops

One-day workshop on entrepreneurship opportunities in cultivation, processing, post-harvest management and marketing of High Value Aromatic Cash Crops Skill development programme was organised for the rural farmers /entreprenurs in the field station Bonera at Pulwama on 16th, 18th and 20th March 2021in which a total of 90 trainees participated. The salient features of this training programme were:

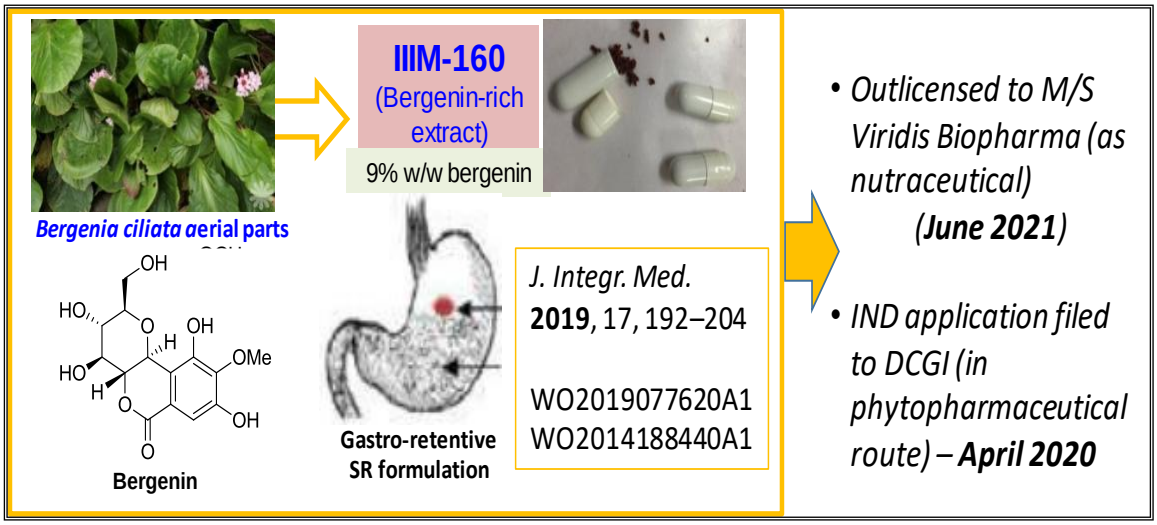
- Nursery management of MAPs
- Extraction techniques for distillation of essential oils
- Storage and marketing
- To promote Growers, Entrepreneurs and Youth through advanced training for aromatic crop cultivation and their future prospective.

5.2 Mission: Swasth bharat

5.2.1 Grant of IND Application for NCE lead, IIIM-290: IIIM-290 is an orally bioavailable NCE lead based on a natural product rohitukine. It was discovered and developed at IIIM under 12th FYP BSC-205 and CSIR-FTT (MLP-5008) projects. It possesses promising in-vitro cytotoxicity in different types of cancer tissues, with most potent cytotoxicity in pancreatic and leukemia cells. DGCI has approved for conducting Phase I/ II clinical trial in locally advanced or metastatic pancreatic cancer patients.



5.2.2 *Bergenia ciliata* based phytopharmaceutical lead IIIM-160 was developed the preclinical pharmacology, regulatory Tox., and CMC documentation was completed. The lead is positioned for the management of pain in rheumatoid arthritis. The IND application has been filed to DCGI on 20th April 2020.



5.2.3 Development of Clinical therapeutics under Ayush mode: CSIR-IIIM Jammu conducted the Phase I Clinical trial titled "A Phase- I, Dose-escalation study to evaluate the safety, tolerability and Pharmacokinetic of ICB014-A002, Herbal Capsule in healthy adult volunteers" in collaboration with one of the Indian CRO company at Apollo Hospitals, Ahmadabad, Gujarat.As per the current status of the study, it is informed that a complete Phase-I Clinical trial study was completed.

5.2.4 Hands-on Training and workshop on PCR and Real Time PCR (RT-PCR)

Research Management, Business Development & Information Science and Technology Division successfully cordinated hands-on training and workshop on PCR and Real Time PCR (RT-PCR) which was conducted from 1st March 2020 – 05th March 2020, which was organised at CSIR-IIIM, Jammu in which 40 partipants were trained both onsite and online. This training programme was conducted for Post Graduate / Graduate students, Research Scholars and Virtual Attendees of Biological and Chemical Sciences. The salient features and aim behind this training programme were:

- Introduction to the general principles on PCR and Real time PCR(RT-PCR)
- Hands-on training for DNA and RNA extraction
- Set-up of PCR and RT-PCR reactions
- Agarose gel electrophoresis demonstration
- Gene expression analysis of RT-PCR results
- Technical specifications and troubleshooting

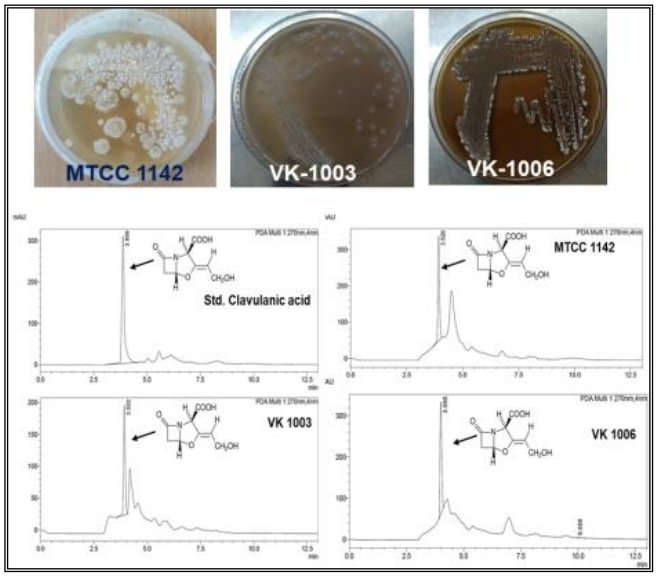
5.3 Mission: Make in India

5.3.1 Fermentation strategies for the production of clavulanic acid and downstream processing for its isolation and purification for healthcare applications

Current scenario of dreadful infections has raised the burden of respiratory diseases among the human kind globally. In one of the recent studies, it was found that if the resistance of antimicrobial-based drugs would keep on burgeoning, then eventually, approx. 10 million people might die by the end of 2050, resulting 3.5% reduction in GDP at the cost of 100 trillion USD. However, the use of enormous antimicrobials is one of the major concerns. Though medical achievements have observed the efficacious role of these antimicrobials, *viz.* penicillin, cephalosporins and tetracyclines, concurrently, their excess and uncontrolled usage has resulted into development of resistance in bacteria. The resistance of β-lactam antibiotics is a global concern. The most important resistance mechanisms involve β-lactamases, the enzymes produced by vivid Gram-positive and Gram-negative bacteria that inhibit these antibiotics by burning their beta-lactam ring. However, the cost of CA containing drugs is still roaring and usually, medical-based insurance companies do not cover it particularly for low-income and lower-middle-income countries. Thereby, large number of people does not get covered owing to their poor living conditions and consequently fall in prey to infectious diseases. It is obvious that there is need to develop new fermentation strategies for clavulanic acid production with cost attractiveness. Accordingly, this research activites aims to develop an efficient bioprocess for the production of CA employing batch or fed-batch operations by a strain of Streptomyces sp. Solid-state fermentation (SSF) and submerged fermentation (SmF) both will be evaluated and compared. In order to reduce the cost of production, several low-cost carbon sources such as oil cakes and agricultural residues rich in starch will be used. Media and process engineering tools will be used to attain enhanced productivities.

Research progress:

Clavulanic acid is a β-lactam drug combine with β-lactam antibiotics to healing of wide spectrum of communicable diseases. CA is a innate secondary metabolite of Streptomyces clavuligerus. The aim of this project is to isolate newer CA producers from indigenous microflora, its characterization, process optimization and subsequent standardization of scale up and downstream processing, We have already established a proof of concept for aforesaid project up to 1L production size in our laboratory. An indigenously



isolated strain of *Streptomyces* sp. VK-1006 was found to produce significant 0.5 g/l of clavulanic acid under unoptimized conditions after 96 h of incubation. Further, to make this process commercially viable, more work need to be carried out on process optimization, upscaling, characterization, purification and needed more extensive research on in-vitro study, these results would prove to be beneficial to develop a cost-effective process for CA production. Here, in this proposed project we are providing a solution for the production of clavulanic acid in a commercially viable manner with high quality and a way to reduce dependence on imports from on China and boost domestic manufacturing.

5.4 Mission: Startup India

5.4.1 IIIM-TBI (Indian Institute of Integrative Medicine- Technology Business Incubator) a company of CSIR-IIIM, Jammu is devoted to R&D activities, technology support and academic including: Skill Training/HR) for the benefit of industrial biotechnology in the country; IIIM-TBI invites applications for "Manpower Training programme in Fermentation Technology" at CSIR-IIIM, Jammu.

6. TECHNOLOGY LICENSED/ COMMERCIALISED

6.1 Under Good Health and Wellbeing:

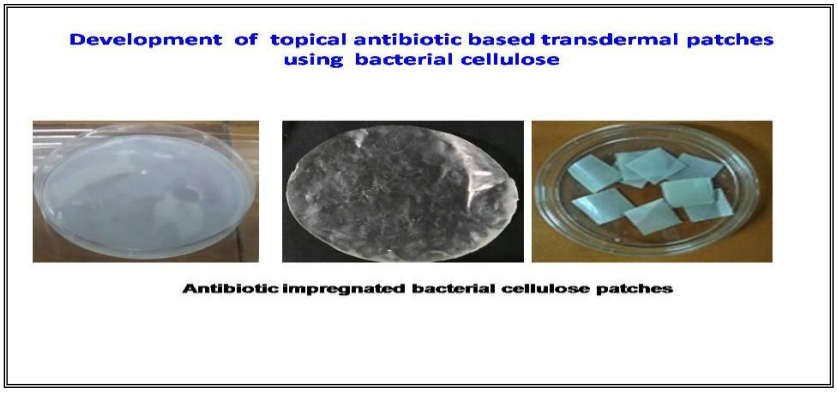
6.1.1 Process Development of Favipiravir to M/s Anphar Pharma Pvt. Ltd., Jammu.

CSIR- Indian Institute of Integrative Medicines (IIIM), Jammu and Anphar Laboratories Pvt. Ltd., a Jammu based Pharma Company have jointly developed synthetic lab process of Favipiravir, which has been found as a potential treatment for Coronavirus. Giving the detail of the work carried out by Dr Ram Vishwakarma, Director, CSIR-IIIM, Jammu and Anil Gupta, Managing Director, Anphar Laboratories in a joint press statement issued which stated that this project was undertaken jointly by IIIM and M/s Anphar Laboratories Pvt. Ltd. immediately after the first lockdown was announced.

Considering the emergent situation of Covid-19, they decided to devise some mechanism to immediately develop the lab process of Favipiravir at CSIR-IIIM and simultaneously scale up the process at the manufacturing at company site in Gangyal Industrial Area.

Accordingly a joint team was constituted with Dr Parvinder Singh, Principal Scientist, Dr Bhawal Ali Shah, Sr Scientist, Dr Mukesh Kumar (SRF), Rohit Singh (SRF), Maninder Singh (Project fellow) from IIIM, side and Ankit Gupta, Technical Director and Dr Rajesh Thaper, Director Racemix Molecules Pvt Ltd from Anphar Laboratories Pvt Ltd side to jointly work to identify the route of synthesis on one side and scaling up the production on the other side. It was further stated that the objective of this work was to synthesize the Favipiravir from indigenously produced chemicals to make it cost effective to make the treatment affordable to the people of India. The most important achievement of the process is that not even a single chemical/raw material is imported thus objective of Aatamnirbharta is accomplished in this case. Technology transfer of lab-scale symthesis of Favipiravir drug molecule to M/s Anphar Laboratories, Gangyal, Jammu, J&K.

6.1.2 Development of Trans-dermal patches using bacterial cellulose: Technology has been transferred to the Delhi Based Company. The technology transfer agreement has been signed with M/S Hemp Street Medicare Private Limited, Delhi on 16th Day of November 2020 for the transfer of technology on the "Production of bacterial cellulose membranes to develop Trans dermal patches for pain management". Transfer Agreement with M/s Hemp Street Medicare Pvt Ltd,.



7. AcSIR Activities

Details of AcSIR Ph.D Students

Biological Sciences

Enrollment No.	Name of the Student	Faculty of Study	Date of Joining CSIR-Lab	Guide
10BB20A37001	ANANTA GANJOO	Biological Science	27-08-2020	DR. VIKASH BABU
10BB20A37002	NEHA SHARMA	Biological Science	27-08-2020	DR. ASHA CHAUBEY
10BB20A37003	AATIF RASHID	Biological Science	27-08-2020	DR. DHIRAJ VYAS
10BB20A37004	AWZIA AMIN	Biological Science	27-08-2020	DR. ZABBER AHMED / Dr. Phalisteen sultan
10BB20A37010	MAHIR BHARDWAJ	Biological Science	27-08-2020	DR. UTPAL NANDI
10BB20A37011	NITIKA BHASIN	Biological Science	28-08-2020	DR. SUNDEEP JAGLAN
10BB20A37012	SAJIDA BANOO	Biological Science	27-08-2020	Dr. Padma Lay
10BB20A37015	SAHIL BHARTI	Biological Science	27-08-2020	DR. ANINDYA GOSWAMI
10BB20A37017	MANZOOR AHMED	Biological Science	28-08-2020	Dr. Zabeer Ahmed
10BB20A37018	SOBIA ANJUM	Biological Science	28-08-2020	DR. ZABEER AHMED
10BB20A37019	MUSTAQ AHMAD NAJAR	Biological Science	27-08-2020	DR PRASOON GUPTA
10BB20A37021	AALIM MAQSOOD	Biological Science	28-08-2020	Dr. Tasduq Abdullah
10BB20A37022	RUPALI CHOUDHARY	Biological Science	28-08-2020	Dr. Zabeer ahmed
10BB20A37023	HARJOT KAUR	Biological Science	27-08-2020	DR. AMIT NARGOTRA
10BB20A37024	PARNA SAHA	Biological Science	27-08-2020	DR. ASHA CHAUBEY
10BB20A37025	SUMMAYA PERVEEN	Biological Science	28-08-2020	Dr. Rashmi sharma
10BB20A37026	ARJAN SINGH	Biological Science	27-08-2020	DR. MEENU KATOCH
10BB20A37028	SAFIYA MEHRAJ	Biological Science	28-08-2020	DR . ZAHOOR A PARRY
10BB20A37034	DIKSHA KUMARI	Biological Science	27-08-2020	Dr. Kuljit Singh
10BB20A37035	KANEEZ FATIMA	Biological Science	28-08-2020	DR. FAYAZ MALIK

10BB20A37038	BHAWNA VERMA	Biological Science	27-08-2020	DR SUPHLA GUPTA
10BB21J37005	POONAM CHOUDHARY	Biological Science	21-01-2021	DR. SUNDEEP JAGLAN
10BB21J37015	SHAFALI BHASIN	Biological Science	22-01-2021	DR. DHIRAJ VYAS
10BB21J37006	SHAMSUN NISA	Biological Science	21-01-2021	DR. RAVAIL SINGH
10BB21J37021	DIKSHA KOUL	Biological Science	22-01-2021	DR. ASHA CHAUBEY
10BB21J37013	GURSIMAR KAUR	Biological Science	21-01-2021	DR. ANINDYA GOSWAMI
10BB21J37020	ISHFAQ AHMAD BABA	Biological Science	21-01-2021	DR. ZAHOOR AHMED PARRAY
10BB21J37007	ASHIYA JAMWAL	Biological Science	22-01-2021	DR. UTPAL NANDI

Chemical Sciences

10CC20A37005	PRATIKSHA KHAJURIA	Chemical Sciences	27-08-2020	DR. S. D. SAWANT
10CC20A37005	PRATIKSHA KHAJURIA	Chemical Sciences	27-08-2020	DR. S. D. SAWANT
10CC20A37006	MUNEER UL SHAFI BHAT	Chemical Sciences	28-08-2020	DR. BHAHWAL ALI SHAH
10CC20A37007	RADHIKA ANAND	Chemical Sciences	28-08-2020	DR. PARVINDER PAL SINGH
10CC20A37008	SHAGHAF MOBIN ANSARI	Chemical Sciences	27-08-2020	DR. BHAHWAL ALI SHAH
10CC20A37009	ABDUL NAVEED	Chemical Sciences	28-08-2020	DR. S. D. SAWANT
10CC20A37013	SAJJAD AHMED	Chemical Sciences	27-08-2020	DR. QAZI NAVEED
10CC20A37014	BHUPESH KUMAR SHARMA	Chemical Sciences	27-08-2020	Dr. Ravi Shankar
10CC21J37005	NOREIN SAKANDER	Chemical Sciences	21-01-2021	DR. DEBARAJ MUKHERJEE
10CC21J37008	DURGA PRASAD MINDALA	Chemical Sciences	21-01-2021	DR. PARVINDER PAL SINGH
10CC21J37002	BASHIR AHMAD LONE	Chemical Sciences	21-01-2021	DR. PRASOON GUPTA
10CC21J37003	YASH MANKAD	Chemical Sciences	21-01-2021	DR. SRINIVASA REDDY
10CC21J37004	AMIT KUMAR	Chemical Sciences	21-01-2021	DR. RAVI SHANKAR
10CC21J37001	DANDAWATE MONICA RAJENDRA	Chemical Sciences	22-01-2021	DR. SRINIVASA REDDY

8. List of Publications (2020)

List of CSIR-IIIM Publications (Calendar Year: 2020)
(AIF= 3.24)

Accessed from Scifinder + Web of Science Database

S.No.	Title	Author	Impact Factor
1	Recent Advances in Strategies for Extracellular Matrix Degradation and Synthesis Inhibition for Improved Therapy of Solid Tumors. *Current Pharmaceutical Design* **(2020),** 26(42), 5456-5467. Language: English, Database: CAPLUS, DOI:10.2174/1381612826666200728141601	Sandha, Kamalpreet Kaur; Shukla, Monu Kumar; Gupta, Prem N.	2.208
2	Carbon stocks and anthropogenic disturbances in temperate coniferous forests of Jammu Region in Western Himalaya, India. *Research and Reviews in Biotechnology and Biosciences* **(2020),** 7(2), 1-19. Language: English, Database: CAPLUS	Gairola, Sumeet; Sharma, Jyotsana; Vyas, Dhiraj	--
3	Medicinal chemistry of natural products to discover kinase inhibitors for cancer: Discovery and preclinical development of IIIM-290 for pancreatic cancer. Abstracts of Papers, 260th ACS National Meeting & Exposition, San Francisco, CA, United States, August 23-27, 2020 (2020), MEDI-0041. Language: English, Database: CAPLUS	Bharate, Sandip Bibishan	---
4	Anagallis arvensis Induces Apoptosis in HL-60 Cells Through ROS-Mediated Mitochondrial Pathway. *Nutrition and Cancer* **(2020),** Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1080/01635581.2020.1856893	Agrawal, Satyam Kumar; Agrawal, Madhunika; Sharma, Parduman Raj; Ahmad, Khursheed; Shawl, Abdul Sami; Arora, Saroj; Saxena, Ajit Kumar	2.363
5	Effect of temperature and insect herbivory on the regulation of glucosinolate-myrosinase system in Lepidium latifolium. *Physiologia Plantarum* **(2020),** Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1111/ppl.13289	Bhat, Rohini; Faiz, Sheenam; Ali, Villayat; Khajuria, Manu; Mukherjee, Debaraj; Vyas, Dhiraj	4.148
6	Palladium-Catalyzed Barluenga-Valdes Type Cross-Coupling Reaction: Alkenylation of 7-Azaindoles. *Asian Journal of Organic Chemistry* (2020), Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1002/ajoc.202000516	Raina, Gaurav; Kannaboina, Prakash; Ahmed, Qazi Naveed; Mondal, Krishanu; Das, Parthasarathi	3.13
7	Meet our editorial board member. Current Medicinal Chemistry (2020), 27(25), 4153-4154. Language: English, Database: CAPLUS	Bharate, Sandip B	--

S.No.	Title	Author	Impact Factor
8	Novel amidase catalysed process for the synthesis of vorinostat drug. *Journal of Applied Microbiology* **(2020),** 129(6), 1589-1597. Language: English, Database: CAPLUS, DOI:10.1111/jam.14753	Singh, R. V.; Sharma, H.; Ganjoo, A.; Kumar, A.; Babu, V.	3.066
9	Potential Inhibitors Against NDM-1 Type Metallo-β-Lactamases: An Overview. Microbial Drug Resistance (New Rochelle, NY, United States) (2020), 26(12), 1568-1588. Language: English, Database: CAPLUS, DOI:10.1089/mdr.2019.0315	Sharma, Smriti; Sharma, Sumit; Singh, Parvinder Pal; Khan, Inshad Ali	2.519
10	Conceptualization and Synthesis of the First Inosito-Inositol (Decahydroxydecalin, DHD): In silico Binding to β-Amyloid Protein. *Chemistry - A European Journal* **(2020)**, 26(71), 17005-17010. Language: English, Database: CAPLUS, DOI:10.1002/chem.202003367	Rashid, Showkat; Bhat, Bilal A.; Mehta, Goverdhan	4.857
11	Antimicrobial activities and mechanism of action of Cymbopogon khasianus (Munro ex Hackel) Bor essential oil. *BMC Complementary Medicine and Therapies* (2020), 20(1), 331. Language: English, Database: CAPLUS, DOI:10.1186/s12906-020-03112-1	Singh, Gurpreet; Katoch, Meenu	2.833
12	Triethylamine-methanol mediated selective removal of oxophenylacetyl ester in saccharides. Organic & Biomolecular Chemistry (2020), Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1039/d0ob02192j	Rasool, Javeed Ur; Kumar, Atul; Ali, Asif; Ahmed, Qazi Naveed	3.412
13	2-Isoxazolines: A Synthetic and Medicinal Overview. ChemMedChem (2020), Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1002/cmdc.202000575	Kumar, Gulshan; Shankar, Ravi	3.124
14	Isolation and Characterization of Serratiopeptidase Producing Bacteria from Mulberry Phyllosphere. Current Microbiology (2020), Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1007/s00284-020-02280-0	Koul, Diksha; Chander, Devtulya; Manhas, Ravi S.; Chaubey, Asha	1.746
15	Heteroarene-tethered Functionalized Alkyne Metamorphosis. *Chemistry - A European Journal (2020)*, Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1002/chem.202002154	Bag, Debojyoti; Sawant, Sanghapal D.	4.857
16	Antioxidant analysis in seeds of four different accessions of Cannabis sativa L. from Jammu. *Research and Reviews in Biotechnology and Biosciences* **(2020),** 7(1), 1-10. Language: English, Database: CAPLUS, DOI:10.5281/zenodo.3727367	Rashid, Aatif; Ali, Villayat; Khajuria, Manu; Faiz, Sheenam; Jamwal, Sumit; Lone, Javaid Fayaz; Gairola, Sumeet; Vyas, Dhiraj	--

S.No.	Title	Author	Impact Factor
17	Characterization and overexpression of sterol δ22-desaturase, a key enzyme modulates the biosyntheses of stigmasterol and withanolides in Withania somnifera (L.) Dunal. *Plant Science* (Shannon, Ireland) (2020), 301, 110642. Language: English, Database: CAPLUS, DOI:10.1016/j.plantsci.2020.110642	Sharma, Arti; Rana, Satiander; Rather, Gulzar A.; Misra, Prashant; Dhar, Manoj K.; Lattoo, Surrinder K.	3.591
18	Progress in the Total Synthesis of Natural Products Embodying Diverse Furofuranone Motifs: A New Millennium Update. *Asian Journal of Organic Chemistry* (2020), 9(11), 1726-1753. Language: English, Database: CAPLUS, DOI:10.1002/ajoc.202000401	Bhat, Bilal A.; Rashid, Showkat; Mehta, Goverdhan	3.13
19	Recent Advances in Metal-Catalyzed Carbonylation Reactions by Using Formic Acid as CO Surrogate. *ChemistrySelect* (2020), 5(36), 11272-11290. Language: English, Database: CAPLUS, DOI:10.1002/slct.202003395	Hussain, Nazar; Chhalodia, Anuj Kumar; Ahmed, Ajaz; Mukherjee, Debaraj	1.811
20	Design, synthesis and comparative analysis of triphenyl-1,2,3-triazoles as anti-proliferative agents. European Journal of Medicinal Chemistry (2020), 207, 112813. Language: English, Database: CAPLUS, DOI:10.1016/j.ejmech.2020.112813	Dheer, Divya; Behera, Chittaranjan; Singh, Davinder; Abdullaha, Mohd; Chashoo, Gousia; Bharate, Sandip B.; Gupta, Prem N.; Shankar, Ravi	5.572
21	Discovery of methoxy-naphthyl linked N-(1-benzylpiperidine) benzamide as a blood-brain permeable dual inhibitor of acetylcholinesterase and butyrylcholinesterase. *European Journal of Medicinal Chemistry* (2020), 207, 112761. Language: English, Database: CAPLUS, DOI:10.1016/j.ejmech.2020.112761	Abdullaha, Mohd; Nuthakki, Vijay K.; Bharate, Sandip B.	5.572
22	Discovery of a New Donepezil-like Acetylcholinesterase Inhibitor for Targeting Alzheimer's Disease: Computational Studies with Biological Validation. *Journal of Chemical Information and Modeling* (2020), 60(10), 4717-4729. Language: English, Database: CAPLUS, DOI:10.1021/acs.jcim.0c00496	Akhoon, Bashir Akhlaq; Choudhary, Sushil; Tiwari, Harshita; Kumar, Ajay; Barik, Manas Ranjan; Rathor, Laxmi; Pandey, Rakesh; Nargotra, Amit	4.549
23	Membrane transporters: the key drivers of transport of secondary metabolites in plants. *Plant Cell Reports* (2020), Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1007/s00299-020-02599-9	Gani, Umar; Vishwakarma, Ram A.; Misra, Prashant	3.825

S.No.	Title	Author	Impact Factor
24	Discovery of a Secalonic Acid Derivative from Aspergillus aculeatus, an Endophyte of Rosa damascena Mill., Triggers Apoptosis in MDA-MB-231 Triple Negative Breast Cancer Cells. *ACS Omega* (2020), 5(38), 24296-24310. Language: English, Database: CAPLUS, DOI:10.1021/acsomega.0c02505	Farooq, Sadaqat; Qayum, Arem; Nalli, Yedukondalu; Lauro, Gianluigi; Chini, Maria Giovanna; Bifulco, Giuseppe; Chaubey, Asha; Singh, Shashank K.; Riyaz-Ul-Hassan, Syed; Ali, Asif	2.87
25	Effect of rutin on pharmacokinetic modulation of diclofenac in rats. *Xenobiotica* (2020), 50(11), 1332-1340. Language: English, Database: CAPLUS, DOI:10.1080/00498254.2020.1773008	Dogra, Ashish; Gour, Abhishek; Bhatt, Shipra; Sharma, Priyanka; Sharma, Anjna; Kotwal, Pankul; Wazir, Priya; Mishra, Prashant; Singh, Gurdarshan; Nandi, Utpal	1.902
26	Chiral Transient Directing Group Strategies in Asymmetric Synthesis. Chemistry - An Asian Journal (2020), 15(20), 3225-3238. Language: English, Database: CAPLUS, DOI:10.1002/asia.202000657	Bag, Debojyoti; Verma, Praveen Kumar; Sawant, Sanghapal D.	4.056
27	Photo-induced 1,2-carbohalofunctionalization of C-C multiple bonds via ATRA pathway. *Organic & Biomolecular Chemistry* (2020), 18(41), 8278-8293. Language: English, Database: CAPLUS, DOI:10.1039/d0ob01454k	Bag, Debojyoti; Kour, Harpreet; Sawant, Sanghapal D.	3.412
28	Self-Assembly in Peptides Containing β-and γ-amino Acids. *Current Protein and Peptide Science* (2020), 21(6), 584-597. Language: English, Database: CAPLUS, DOI:10.2174/1389203721666200127112244	Shankar, Sudha; Rahim, Junaid Ur; Rai, Rajkishor	2.52
29	Modulation of Kinases by Small Molecules for Therapeutic Management of Various Diseases" - Part II. *Current Topics in Medicinal Chemistry* (Sharjah, United Arab Emirates) (2020), 20(17), 1521. Language: English, Database: CAPLUS, DOI:10.2174/1568026620172006241146 31	Bharate, Sandip B.	3.218
30	A highly sensitive UPLC-MS/MS method for hydroxyurea to assess pharmacokinetic intervention by phytotherapeutics in rats. *Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences* (2020), 1154, 122283. Language: English, Database: CAPLUS, DOI:10.1016/j.jchromb.2020.122283	Gour, Abhishek; Dogra, Ashish; Wazir, Priya; Singh, Gurdarshan; Nandi, Utpal	3.004
31	Transition-Metal-Catalyzed Carbohalogenative 1,2-Difunctionalization of C-C Multiple Bonds. Advanced Synthesis & Catalysis (2020), 362(19), 3948-3970. Language: English, Database: CAPLUS, DOI:10.1002/adsc.202000630	Bag, Debojyoti; Mahajan, Shivangani; Sawant, Sanghapal D.	5.851

S.No.	Title	Author	Impact Factor
32	14-Residue peptaibol velutibol A from Trichoderma velutinum: its structural and cytotoxic evaluation. *RSC Advances* (2020), 10(52), 31233-31242. Language: English, Database: CAPLUS, DOI:10.1039/d0ra05780k	Singh, Varun Pratap; Pathania, Anup Singh; Kushwaha, Manoj; Singh, Samsher; Sharma, Vandana; Malik, Fayaz A.; Khan, Inshad A.; Kumar, Anil; Singh, Deepika; Vishwakarma, Ram A.	3.119
33	Rapid determination and optimisation of berberine from Himalayan Berberis lycium by Soxhlet apparatus using CCD-RSM and its quality control as a potential candidate for COVID-19. *Natural Product Research* (2020), Ahead of Print. Language: English, Database: CAPLUS, DOI:10.1080/14786419.2020.1806274	Katare, Anil Kumar; Singh, Bikarma; Shukla, Pooja; Gupta, Sandeep; Singh, Bishander; Yalamanchili, Kavya; Kulshrestha, Nitin; Bhanwaria, Rajendra; Sharma, Ashok Kumar; Sharma, Sarita; et al	2.158
34	High-throughput screening of compounds library to identify novel inhibitors against latent Mycobacterium tuberculosis using streptomycin-dependent Mycobacterium tuberculosis 18b strain as a model. *Tuberculosis* (Oxford, United Kingdom) (2020), 124, 101958. Language: English, Database: CAPLUS, DOI:10.1016/j.tube.2020.101958	Sharma, Smriti; Bhat, Rahul; Singh, Rohit; Sharma, Sumit; wazir, Priya; Singh, Parvinder Pal; Vishwakarma, Ram A.; Khan, Inshad Ali	2.576
35	Analysis of single nucleotide polymorphisms between 2019-nCoV genomes and its impact on codon usage. *bioRxiv* (2020), 1-14. Language: English, Database: CAPLUS, DOI:10.1101/2020.08.05.237404	Gupta, Suruchi; Singh, Ravail; Paul, Prosenjit	---
36	Synthesis and Conformational Analysis of 2-O-Silyl Protected Nucleosides from Unprotected Nucleobases and Sugar Epoxides. *European Journal of Organic Chemistry* (2020), 2020(28), 4408-4416. Language: English, Database: CAPLUS, DOI:10.1002/ejoc.202000650	Ahmed, Ajaz; Rasool, Faheem; Singh, Gurpreet; Katoch, Meenu; Mukherjee, Debaraj	2.889
37	Photoredox-Mediated Synthesis of Functionalized Sulfoxides from Terminal Alkynes. *Organic Letters* (2020), 22(14), 5661-5665. Language: English, Database: CAPLUS, DOI:10.1021/acs.orglett.0c02055	Kumar, Jaswant; Ahmad, Ajaz; Rizvi, Masood Ahmad; Ganie, Majid Ahmed; Khajuria, Chhavi; Shah, Bhahwal Ali	6.091
38	Preclinical and Clinical Studies on Bryostatins, A Class of Marine-Derived Protein Kinase C Modulators: A Mini-Review. *Current Topics in Medicinal Chemistry* (Sharjah, United Arab Emirates) (2020), 20(12), 1124-1135. Language: English, Database: CAPLUS, DOI:10.2174/1568026620666200325110444	Raghuvanshi, Rinky; Bharate, Sandip B.	3.218

S.No.	Title	Author	Impact Factor
39	Modulation of Kinases by Small Molecules for Therapeutic Management of Various Diseases - Part I. *Current Topics in Medicinal Chemistry* (Sharjah, United Arab Emirates) (2020), 20(12), 1057-1058. Language: English, Database: CAPLUS, DOI:10.2174/1568026620122005040905 32	Bharate, Sandip B.	3.218
40	2-Halo Glycals as "Synthon" for 2-C-Branched Sugar: Recent Advances and Applications in Organic Synthesis. *Asian Journal of Organic Chemistry* (2020), 9(6), 882-897. Language: English, Database: CAPLUS, DOI:10.1002/ajoc.202000195	Hussain, Nazar; Ahmed, Ajaz; Mukherjee, Debaraj	3.13
41	Par-4 mediated Smad4 induction in PDAC cells restores canonical TGF-β/ Smad4 axis driving the cells towards lethal EMT. *European Journal of Cell Biology* (2020), 99(4), 151076. Language: English, Database: CAPLUS, DOI:10.1016/j.ejcb.2020.151076	Mohd Faheem, Mir; Rasool, Reyaz ur; Ahmad, Syed Mudabir; Jamwal, Vijay Lakshmi; Chakraborty, Souneek; Katoch, Archana; Gandhi, Sumit G.; Bhagat, Madhulika; Goswami, Anindya	3.025
42	Total Synthesis of Phospholipomannan of Candida albicans. *Journal of Organic Chemistry* (2020), 85(12), 7757-7771. Language: English, Database: CAPLUS, DOI:10.1021/acs.joc.0c00402	Gannedi, Veeranjaneyulu; Ali, Asif; Singh, Parvinder Pal; Vishwakarma, Ram A.	4.335
43	A concise and sequential synthesis of the nitroimidazooxazole based drug, Delamanid and related compounds. RSC Advances (2020), 10(29), 17085-17093. Language: English, Database: CAPLUS, DOI:10.1039/d0ra01662d	Sharma, Sumit; Anand, Radhika; Cham, Pankaj Singh; Raina, Sushil; Vishwakarma, Ram. A.; Singh, Parvinder Pal	3.119
44	Recent Advances in Photoredox Methods for Ketone Synthesis. *Asian Journal of Organic Chemistry* (2020), 9(6), 863-881. Language: English, Database: CAPLUS, DOI:10.1002/ajoc.202000112	Chalotra, Neha; Sultan, Shaista; Shah, Bhahwal Ali	3.13
45	Photochemical efficiency is negatively correlated with the Δ9- tetrahydrocannabinol content in Cannabis sativa L. *Plant Physiology and Biochemistry* (Issy-les-Moulineaux, France) (2020), 151, 589-600. Language: English, Database: CAPLUS, DOI:10.1016/j.plaphy.2020.04.003	Khajuria, Manu; Rahul, Vishav Prakash; Vyas, Dhiraj	3.72
46	Description of Druglike Properties of Safranal and Its Chemistry behind Low Oral Exposure. *ACS Omega* (2020), 5(17), 9885-9891. Language: English, Database: CAPLUS, DOI:10.1021/acsomega.0c00160	Dogra, Ashish; Kotwal, Pankul; Gour, Abhishek; Bhatt, Shipra; Singh, Gurdarshan; Mukherjee, Debaraj; Nandi, Utpal	2.87

S.No.	Title	Author	Impact Factor
47	Synthesis of aryl ethers of carbohydrates via reaction with arynes: selective O-arylation of trans-vicinal dihydroxyl groups in carbohydrates. *Organic & Biomolecular Chemistry (*2020), 18(22), 4174-4177. Language: English, Database: CAPLUS, DOI:10.1039/d0ob00540a	Bhardwaj, Monika; Hussain, Nazar; Zargar, Irshad Ahmad; Dash, Ashutosh K.; Mukherjee, Debaraj	3.412
48	Antibacterial potential of Juglomycin A isolated from Streptomyces achromogenes, an endophyte of Crocus sativus Linn. *Journal of Applied Microbiology* (2020), 128(5), 1366-1377. Language: English, Database: CAPLUS, DOI:10.1111/jam.14568	Ahmad, T.; Arora, P.; Nalli, Y.; Ali, A.; Riyaz-Ul-Hassan, S.	3.066
49	Neurodegenerative diseases and Withania somnifera (L.): An update. *Journal of Ethnopharmacology* (2020), 256, 112769. Language: English, Database: CAPLUS, DOI:10.1016/j.jep.2020.112769	Dar, Nawab John; MuzamilAhmad	3.69
50	Evaluation of rohitukine-enriched fraction of Dysoxylum binectariferum Hook.f. (leaves) as anti-arthritic phytopharmaceutical candidate: Chemical standardization, in-vivo validation, formulation development and oral pharmacokinetics. *Journal of Ethnopharmacology* (2020), 254, 112758. Language: English, Database: CAPLUS, DOI:10.1016/j.jep.2020.112758	Kumar, Vikas; Bharate, Sonali S.; Bhurta, Deendyal; Gupta, Mehak; Gandhi, Sumit G.; Singh, Deepika; Jaglan, Sundeep; Kumar, Ajay; Vishwakarma, Ram A.; Bharate, Sandip B.	3.69
51	Selenium dioxide promoted dinitrogen extrusion/direct selenation of arylhydrazines and anilines. *Tetrahedron* (2020), 76(16), 131105. Language: English, Database: CAPLUS, DOI:10.1016/j.tet.2020.131105	Yaqoob Bhat, Mohammad; Kumar, Atul; Naveed Ahmed, Qazi	2.233
52	Morphological characterization of wild Rosa L. germplasm from the Western Himalaya, India. *Euphytica* (2020), 216(3), 41. Language: English, Database: CAPLUS, DOI:10.1007/s10681-020-2567-2	Singh, Kanwaljeet; Sharma, Yash Pal; Gairola, Sumeet	1.614
53	Investigation of α/γ hybrid peptide self-assembled structures with antimicrobial and antibiofilm properties. *Journal of Peptide Science* (2020), 26(4-5), e3243. Language: English, Database: CAPLUS, DOI:10.1002/psc.3243	Shankar, Sudha; Singh, Gurpreet; Rahim, Junaid Ur; Qayum, Arem; Sharma, Parduman R.; Katoch, Meenu; Rai, Rajkishor	1.877
54	Oxone-DMSO Triggered Methylene Insertion and C(sp2)-C(sp3)-H-C(sp2) Bond Formation to Access Functional Bis-Heterocycles. *Journal of Organic Chemistry* (2020), 85(7), 4951-4962. Language: English, Database: CAPLUS, DOI:10.1021/acs.joc.9b03477	Kour, Jaspreet; Venkateswarlu, Vunnam; Verma, Praveen K.; Hussain, Yaseen; Dubey, Gurudutt; Bharatam, Prasad V.; Sahoo, Subash C.; Sawant, Sanghapal D.	4.335

S.No.	Title	Author	Impact Factor
55	A Comprehensive Transcriptome-Wide Identification and Screening of WRKY Gene Family Engaged in Abiotic Stress in Glycyrrhiza glabra. *Scientific Reports* (2020), 10(1), 373. Language: English, Database: CAPLUS, DOI:10.1038/s41598-019-57232-x	Goyal, Pooja; Manzoor, Malik Muzafar; Vishwakarma, Ram A.; Sharma, Deepak; Dhar, Manoj K.; Gupta, Suphla	3.998
56	Recent Advances in Total Synthesis of Bioactive Furo[3,2-b]furanone Natural Products. *Asian Journal of Organic Chemistry* (2020), 9(4), 449-479. Language: English, Database: CAPLUS, DOI:10.1002/ajoc.201900714	Bhat, Bilal A.; Rashid, Showkat; Sengupta, Saumitra; Mehta, Goverdhan	3.13
57	Comprehensive transcriptome analysis provides insights into metabolic and gene regulatory networks in trichomes of Nicotiana tabacum. Plant Molecular Biology (2020), 102(6), 625-644. Language: English, Database: CAPLUS, DOI:10.1007/s11103-020-00968-2	Nautiyal, Abhishek Kumar; Gani, Umar; Sharma, Priyanka; Kundan, Maridul; Fayaz, Mohd.; Lattoo, Surrinder K.; Misra, Prashant	3.302
58	Chemical analysis of saffron by HPLC based crocetin estimation. *Journal of Pharmaceutical and Biomedical Analysis* (2020), 181, 113094. Language: English, Database: CAPLUS, DOI:10.1016/j.jpba.2020.113094	Reddy, Chilakala Nagarjuna; Bharate, Sandip B.; Vishwakarma, Ram A.; Bharate, Sonali S.	3.209
59	Effect of Natural Phenolics on Pharmacokinetic Modulation of Bedaquiline in Rat to Assess the Likelihood of Potential Food-Drug Interaction. *Journal of Agricultural and Food Chemistry* (2020), 68(5), 1257-1265. Language: English, Database: CAPLUS, DOI:10.1021/acs.jafc.9b06529	Kotwal, Pankul; Dogra, Ashish; Sharma, Ankita; Bhatt, Shipra; Gour, Abhishek; Sharma, Sumit; Wazir, Priya; Singh, Parvinder Pal; Kumar, Ajay; Nandi, Utpal	4.192
60	Discovery of Helminthosporin, an Anthraquinone Isolated from Rumex abyssinicus Jacq as a Dual Cholinesterase Inhibitor. ACS Omega (2020), 5(3), 1616-1624. Language: English, Database: CAPLUS, DOI:10.1021/acsomega.9b03693	Augustin, Ntemafack; Nuthakki, Vijay K.; Abdullaha, Mohd.; Hassan, Qazi Parvaiz; Gandhi, Sumit G.; Bharate, Sandip B.	2.87
61	Andrographolide: Chemical modification and its effect on biological activities. *Bioorganic Chemistry* (2020), 95, 103511. Language: English, Database: CAPLUS, DOI:10.1016/j.bioorg.2019.103511	Kumar, Gulshan; Singh, Davinder; Tali, Javeed Ahmad; Dheer, Divya; Shankar, Ravi	4.831
62	Discovery of benzo[cd]indol-2-one and benzylidene-thiazolidine-2,4-dione as new classes of NLRP3 inflammasome inhibitors via ER-β structure based virtual screening. *Bioorganic Chemistry* (2020), 95, 103500. Language: English, Database: CAPLUS, DOI:10.1016/j.bioorg.2019.103500	Abdullaha, Mohd; Ali, Mehboob; Kour, Dilpreet; Kumar, Ajay; Bharate, Sandip B.	4.831

S.No.	Title	Author	Impact Factor
63	Catalytic advances in direct functionalizations using arylated hydrazines as the building blocks. *Catalysis Reviews: Science and Engineering* (2020), 62(3), 406-479. Language: English, Database: CAPLUS, DOI:10.1080/01614940.2019.1702191	Balgotra, Shilpi; Verma, Praveen Kumar; Vishwakarma, Ram A.; Sawant, Sanghapal D	11.389
64	A Modified, Efficient and Sensitive pH Indicator Dye Method for the Screening of Acid-Producing Acetobacter Strains Having Potential Application in Bio-Cellulose Production. *Applied Biochemistry and Biotechnology* (2020), 191(2), 631-636. Language: English, Database: CAPLUS, DOI:10.1007/s12010-019-03211-x	Kumar, Manoj; Tanoj, Nipunta; Saran, Saurabh	2.277
65	Trigonelline, a naturally occurring alkaloidal agent protects ultraviolet-B (UV-B) irradiation induced apoptotic cell death in human skin fibroblasts via attenuation of oxidative stress, restoration of cellular calcium homeostasis and prevention of endoplasmic reticulum (ER) stress. Journal of Photochemistry and Photobiology, B: Biology (2020), 202, 111720. Language: English, Database: CAPLUS, DOI:10.1016/j.jphotobiol.2019.111720	Lone A., Nazir; Malik A., Tanveer; Naikoo H., Shahid; Raghu R., Sharma; Tasduq, Sheikh A.	4.383
66	Functionalization of Alkynes and Alkenes Using a Cascade Reaction Approach: Synthesis of β-Keto Sulfones under Metal-free Conditions. *Journal of Organic Chemistry* (2020), 85(2), 716-725. Language: English, Database: CAPLUS, DOI:10.1021/acs.joc.9b02779	Kumar, Mukesh; Ahmed, Riyaz; Singh, Maninder; Sharma, Shweta; Thatikonda, Thanusha; Singh, Parvinder Pal	4.335
67	Chromatography: An important tool for drug discovery. *Journal of Separation Science* (2020), 43(1), 105-119. Language: English, Database: CAPLUS, DOI:10.1002/jssc.201900656	Ahmad Dar, Alamgir; Sangwan, P. L.; Kumar, Anil	2.878
68	Differentiation of human neuroblastoma cell line IMR-32 by sildenafil and its newly discovered analogue IS00384. *Cellular Signalling* (2020), 65, 109425. Language: English, Database: CAPLUS, DOI:10.1016/j.cellsig.2019.109425	Dar, Mohd. I.; Jan, Suraya; Reddy, G. Lakshma; Wani, Rubiada; Syed, Mudassir; Dar, Mohd. J.; Sawant, Sanghapal D.; Vishwakarma, Ram A.; Syed, Sajad H.	3.968
69	LC-MS/MS profile of an active pharmaceutical ingredient and its impurities in commercial preparation. *Journal of Liquid Chromatography & Related Technologies* (2020), 43(3-4), 131-137. Language: English, Database: CAPLUS, DOI:10.1080/10826076.2019.1680561	Kushwaha, Manoj; Goel, Bharat; Jaglan, Sundeep; Jain, Shreyans K.	0.992

S.No.	Title	Author	Impact Factor
70	Combining ligand- and structure-based in silico methods for the identification of natural product-based inhibitors of Akt1. *Molecular Diversity* (2020), 24(1), 45-60. Language: English, Database: CAPLUS, DOI:10.1007/s11030-019-09924-9	Mahajan, Priya; Wadhwa, Bhumika; Barik, Manas Ranjan; Malik, Fayaz; Nargotra, Amit	2.013
71	Identification of aplysinopsin as a blood-brain barrier permeable scaffold for anti-cholinesterase and anti-BACE-1 activity. *Bioorganic chemistry* (2020), 107104568, Language: English, Database: MEDLINE	Nuthakki Vijay K; Yadav Bheemanaboina Rammohan R; Bharate Sandip B	4.831
72	Recent developments on solid-state fermentation for production of microbial secondary metabolites: Challenges and solutions. *Bioresource technology* (2020), 124566, Language: English, Database: MEDLINE	Kumar Vinod; Saran Saurabh; Ahluwalia Vivek; Kumar Jitendra; Patel Anil Kumar; Singhania Reeta Rani	7.539
73	Targeting EHMT2/ G9a for cancer therapy: Progress and perspective. *European journal of pharmacology* (2020), 893173827, Language: English, Database: MEDLINE	Jan Suraya; Dar Mohd Ishaq; Wani Rubiada; Sandey Jagjeet; Mushtaq Iqra; Lateef Sammar; Syed Sajad Hussain	3.263
74	Inhibition of Ultraviolet-B Radiation Induced Photodamage by Trigonelline Through Modulation of Mitogen Activating Protein Kinases and Nuclear Factor-κB Signaling Axis in Skin. Photochemistry and photobiology (2020), , Language: English, Database: MEDLINE	Lone Nazir A; Malik Tanveer A; Sheikh Umar A; Love Sharma; Gupta Divya; Tasduq Sheikh A; Lone Nazir A; Malik Tanveer A; Sheikh Umar A; Love Sharma; et al	2.721
75	Evaluation of the immunomodulatory and anti-inflammatory activity of Bakuchiol using RAW 264.7 macrophage cell lines and in animal models stimulated by lipopolysaccharide (LPS). *International immunopharmacology* (2020), 91107264, Language: English, Database: MEDLINE	Kumar Amit; Kumar Nagar Rakesh; Chauhan Narendra; Sawhney Gifty; Ahmed Zabeer; Gupta Nidhi; Kaul Anpurna; Sangwan P L; Satheesh Kumar P; Yadav Govind	3.943
76	Identification of a cross-talk between EGFR and Wnt/beta-catenin signaling pathways in HepG2 liver cancer cells. *Cellular signalling* (2020), 79109885, Language: English, Database: MEDLINE	Singh Gurjinder; Hossain Md Mehedi; Bhat Aadil Qadir; Ayaz Mir Owais; Bano Nasima; Eachkoti Rafiqa; Dar Mohd Jamal	3.968
77	AKT isoforms have discrete expression in triple negative breast cancers and roles in cisplatin sensitivity. *Oncotarget* (2020), 11(45), 4178-4194, Language: English, Database: MEDLINE	Wadhwa Bhumika; Paddar Masroor; Khan Sameer; Mir Sameer; Malik Fayaz; Wadhwa Bhumika; Paddar Masroor; Khan Sameer; Mir Sameer; Malik Fayaz; et al	---

S.No.	Title	Author	Impact Factor
78	Characterization and overexpression of sterol Δ(22)-desaturase, a key enzyme modulates the biosyntheses of stigmasterol and withanolides in Withania somnifera (L.) Dunal. *Plant science : an international journal of experimental plant biology* (2020), 301110642, Language: English, Database: MEDLINE	Sharma Arti; Rana Satiander; Rather Gulzar A; Misra Prashant; Lattoo Surrinder K; Dhar Manoj K	3.591
79	Expansion of the CRISPR/Cas Genome-Sculpting Toolbox: Innovations, Applications and Challenges. *Molecular diagnosis & therapy* (2020), , Language: English, Database: MEDLINE	Batool Asiya; Malik Fayaz; Batool Asiya; Andrabi Khurshid Iqbal	3.38
80	Investigating 11 Withanosides and Withanolides by UHPLC-PDA and Mass Fragmentation Studies from Ashwagandha (Withania somnifera). *ACS omega* (2020), 5(43), 27933-27943, Language: English, Database: MEDLINE	Girme Aboli; Saste Ganesh; Pawar Sandeep; Balasubramaniam Arun Kumar; Musande Kalpesh; Singh Ruchi; Hingorani Lal; Darji Bhaumik; Satti Naresh Kumar; Verma Mahendra Kumar; et al	2.87
81	Natural Products in Mitigation of SARS CoV Infections. *Current medicinal chemistry* (2020), , Language: English, Database: MEDLINE	Sharma Venu; Sharma Ankita; Bharate Sandip B	4.184
82	New approaches for antituberculosis leads from Actinobacteria. *Drug discovery today* (2020), 25(12), 2335-2342, Language: English, Database: MEDLINE	Hussain Aehtesham; Hassan Qazi Parvaiz; Shouche Yogesh S	7.321
83	Datura stramonium essential oil composition and it's immunostimulatory potential against colon cancer cells. 3 Biotech (2020), 10(10), 451, Language: English, Database: MEDLINE	Chandan Gourav; Saini Reena V; Kumar Chetan; Verma M K; Satti N K; Saini Adesh K; Saini Reena V	1.798
84	Novel Vitamin E TPGS based docetaxel nanovesicle formulation for its safe and effective parenteral delivery: Toxicological, pharmacokinetic and pharmacodynamic evaluation. *Journal of liposome research* (2020), 1-16, Language: English, Database: MEDLINE	Singh Amrinder; Thakur Shubham; Singh Harmanpreet; Singh Harjeet; Jain Subheet Kumar; Kaur Sandeep; Kaur Satwinderjeet; Dudi Rajesh; Mondhe Dilip Manikrao	2.455
85	Par-4 activation restrains EMT-induced chemoresistance in PDAC by attenuating MDM-2. *Pancreatology : official journal of the International Association of Pancreatology* (IAP) ... [et al.] (2020), 20(8), 1698-1710, Language: English, Database: MEDLINE	Ahmad Syed Mudabir; Mir Khalid Bashir; Nawaz Shah; Nayak Debasis; Faheem Mir Mohd; Yadav Govind; Goswami Anindya	3.629
86	Dimethoate Induces DNA Damage and Mitochondrial Dysfunction Triggering Apoptosis in Rat Bone-Marrow and Peripheral Blood Cells. *Toxics* (2020), 8(4), , Language: English, Database: MEDLINE	Nazam Nazia; Lone Mohammad Iqbal; Hamid Abid; Qadah Talal; Banjar Alaa; Alam Qamre; Alam Qamre; Saeed Mohd; Ahmad Waseem	3.271

S.No.	Title	Author	Impact Factor
87	Oreganum Vulgare: In-vitro assessment of cytotoxicity, Molecular docking studies, Antioxidant, and evaluation of anti-inflammatory activity in LPS stimulated RAW 264.7 cells. *Medicinal chemistry* (Shariqah (United Arab Emirates)) (2020)	Mir Reyaz Hassan; Sawhney Gifty; Kumar Parveen; Bhagat Asha; Madishetti Sreedhar; Ahmed Zabeer; Masoodi Mubashir Hussain; Verma Rohini; Ranjana Soni; Jachak Sanjay M; et al	2.577
88	Analyzing structural differences between insulin receptor (IR) and IGF1R for designing small molecule allosteric inhibitors of IGF1R as novel anti-cancer agents. Growth hormone & IGF research : official journal of the Growth Hormone Research Society and the International IGF Research Society (2020), 55101343, Language: English, Database: MEDLINE	Bano Nasima; Hossain Md Mehedi; Bhat Aadil Qadir; Ayaz Mir Owais; Kumari Monika; Sandhu Padmani; Akhter Yusuf; Dar Mohd Jamal	1.618
89	A report on DNA sequence determinants in gene expression. *Bioinformation* (2020), 16(5), 422-431, Language: English, Database: MEDLINE	Singh Ravail; Sophiarani Yengkhom	---
90	Recent advances in tumor microenvironment associated therapeutic strategies and evaluation models. *Materials science & engineering. C, Materials for biological applications* (2020), 116111229, Language: English, Database: MEDLINE	Haider Tanweer; Sandha Kamalpreet Kaur; Soni Vandana; Gupta Prem N	5.88
91	Oncogenic BRAF, endoplasmic reticulum stress, and autophagy: Crosstalk and therapeutic targets in cutaneous melanoma. *Mutation research* (2020), 785108321, Language: English, Database: MEDLINE	Rather Rafiq A; Bhagat Madhulika; Singh Shashank K	5.803
92	Aucklandia costus (Syn. Saussurea costus): Ethnopharmacology of an endangered medicinal plant of the himalayan region. *Journal of ethnopharmacology* (2020), 263113199, Language: English, Database: MEDLINE	Nadda Rohit Kumar; Khosla Prem Kumar; Ali Aaliya; Goyal Renu Chib; Goyal Rohit	3.69
93	Role of environmental pollutants in Alzheimer's disease: a review. *Environmental science and pollution research international* (2020), 27(36), 44724-44742, Language: English, Database: MEDLINE	Mir Reyaz Hassan; Masoodi Mubashir Hussain; Sawhney Gifty; Madishetti Sreedhar; Ahmed Zabeer; Pottoo Faheem Hyder; Mohi-Ud-Din Roohi; Jachak Sanjay M	3.056
94	Drug resistance in cancer: mechanisms and tackling strategies. *Pharmacological reports : PR* (2020), 72(5), 1125-1151, Language: English, Database: MEDLINE	Haider Tanweer; Pandey Vikas; Banjare Nagma; Soni Vandana; Banjare Nagma; Gupta Prem N	2.754
95	Advances in the possible treatment of COVID-19: A review. *European journal of pharmacology* (2020), 883173372, Language: English, Database: MEDLINE	Chibber Pankaj; Singh Gurdarshan; Haq Syed Assim; Ahmed Irfan; Andrabi Nusrit Iqbal	3.263

S.No.	Title	Author	Impact Factor
96	In-vitro antitumor activity of compounds from Glycyrrhiza glabra against C6 glioma cancer cells: identification of natural lead for further evaluation. *Natural product research* (2020), 1-4, Language: English, Database: MEDLINE	Goel Bharat; Tripathi Nancy; Bhardwaj Nivedita; Sahu Bharat; Jain Shreyans K; Sharma Anuradha; Kaur Gurcharan; Singh Bikarma	2.158
97	Convergence of therapy-induced senescence (TIS) and EMT in multistep carcinogenesis: current opinions and emerging perspectives. *Cell death discovery* (2020), 651, Language: English, Database: MEDLINE	Faheem Mir Mohd; Ahmad Syed Mudabir; Goswami Anindya; Faheem Mir Mohd; Bhagat Madhulika; Seligson Nathan D; Seligson Nathan D; Ahmad Syed Mudabir; Goswami Anindya; Rasool Reyaz Ur; et al	4.114
98	Immunomodulation-mediated anticancer activity of a novel compound from Brugmansia suaveolens leaves. *Bioorganic & medicinal chemistry* (2020), 28(12), 115552, Language: English, Database: MEDLINE	Kumar Sunil; Dhar Kanaya Lal; Gupta Aditi; Saini Reena Vohra; Kumar Amit; Mahindroo Neeraj	3.073
99	Three months of COVID-19: A systematic review and meta-analysis. *Reviews in medical virology* (2020), 30(4), e2113, Language: English, Database: MEDLINE	Rafiq Danish; Bazaz M A; Batool Asiya	4.221
100	Anti-inflammatory and analgesic potential of OA-DHZ; a novel semisynthetic derivative of dehydrozingerone. *International immunopharmacology* (2020), 83106469, Language: English, Database: MEDLINE	Chibber Pankaj; Singh Gurdarshan; Kumar Chetan; Singh Amarinder; Assim Haq Syed; Ahmed Irfan; Singh Surjeet; Vishwakarma Ram; Kumar Anil	3.943
101	Invivo hepatoprotective potential of extracts obtained from floral spikes of Prunella vulgaris L. *Journal of Ayurveda and integrative medicine* (2020), 11(4), 502-507, Language: English, Database: MEDLINE	Ahmad Gazanfar; Masoodi Mubashir H; Tabassum Nahida; Mir Sameer Ahmad; Iqbal Mir Javaid	---
102	Design, characterization, and evaluation of antibacterial gels, Boc-D-Phe-γ(4)-L-Phe-PEA/chitosan and Boc-L-Phe-γ(4)-L-Phe-PEA/chitosan, for biomaterial-related infections. *Materials science & engineering. C, Materials for biological applications* (2020), 110110648, Language: English, Database: MEDLINE	Malhotra Kamal; Chauhan Neelam; Shankar Sudha; Rai Rajkishor; Singh Yashveer	5.88
103	A nonpeptidyl molecule modulates apoptosis-like cell death by inhibiting P. falciparum metacaspase-2. *The Biochemical journal* (2020), 477(7), 1323-1344, Language: English, Database: MEDLINE	Vandana; Prasad Kona Madhavinadha; Pandey Kailash C; Shankar Sudha; Rai Rajkishor; Kashif Mohammad; Kalia Inderjeet; Singh Agam P	4.097

S.No.	Title	Author	Impact Factor
104	Dipsacus inermis Wall. modulates inflammation by inhibiting NF-κB pathway: An in vitro and in vivo study. *Journal of ethnopharmacology* (2020), 254112710, Language: English, Database: MEDLINE	Hassan Sumaya; Sajjad Nasreena; Bhat Muzaffar Ahmad; Ali Rohaya; Khan Sameer Ullah; Gupta Shilpa; Ahmad Zabeer; Ganie Showkat Ahmad; Hamid Rabia	3.69
105	Probiotic properties of a phytase producing Pediococcus acidilactici strain SMVDUDB2 isolated from traditional fermented cheese product, Kalarei. *Scientific reports* (2020), 10(1), 1926, Language: English, Database: MEDLINE	Bhagat Deepali; Raina Neelu; Slathia Parvez Singh; Sharma Preeti; Kumar Amit; Katoch Meenu; Khajuria Yugal	3.998
106	Integration of EMT and cellular survival instincts in reprogramming of programmed cell death to anastasis. *Cancer metastasis reviews* (2020), 39(2), 553-566, Language: English, Database: MEDLINE	Chakraborty Souneek; Mir Khalid Bashir; Goswami Anindya; Chakraborty Souneek; Mir Khalid Bashir; Goswami Anindya; Seligson Nathan D; Seligson Nathan D; Nayak Debasis; Kumar Rakesh	6.4
107	Physiological, Biochemical and Reproductive Studies on Valeriana wallichii, a Critically Endangered Medicinal Plant of the Himalayan Region Grown under In-Situ and Ex-Situ Conditions. *Plants* (Basel, Switzerland) (2020), 9(2), , Language: English, Database: MEDLINE	Asgher Mohd; Rashid Shaista; Verma Susheel; Kumari Priyanka; Khan Sajid; Khan Nafees A; Vyas Dhiraj; Qadir Shaista; Ali Mohammad Ajmal; Ahmad Parvaiz; et al	2.762
108	Peripheral Merozoite Surface Proteins Are Targets of Naturally Acquired Immunity against Malaria in both India and Ghana. *Infection and immunity* (2020), 88(4), , Language: English, Database: MEDLINE	Asier Garcia-Senosiain , Ikhlaq Hussain Kana , Susheel Kumar Singh, Bishwanath Kumar Chourasia, Manoj Kumar Das , Daniel Dodoo, Subhash Singh , Bright Adu , Michael Theisen	3.159
109	Expanding the chemical diversity through microorganisms co-culture: Current status and outlook. *Biotechnology advances (Review)*(2020), 40107521, Language: English, Database: MEDLINE	Arora Divya; Gupta Prasoon; Jaglan Sundeep; Roullier Catherine; Grovel Olivier; Bertrand Samuel	10.744
110	Seed Priming with Jasmonic Acid Counteracts Root Knot Nematode Infection in Tomato by Modulating the Activity and Expression of Antioxidative Enzymes. *Biomolecules* (2020), 10(1), , Language: English, Database: MEDLINE	Bali Shagun; Kaur Parminder; Bhardwaj Renu; Jamwal Vijay Lakshmi; Gandhi Sumit G; Sharma Anket; Ohri Puja; Ali Mohammad Ajmal; Ahmad Parvaiz; Ahmad Parvaiz	4.082

S.No.	Title	Author	Impact Factor
111	Antiproliferative activity of diarylnaphthylpyrrolidine derivative via dual target inhibition. *European journal of medicinal chemistry* (2020), 188111986, Language: English, Database: MEDLINE	Verma Amit Kumar; Iqbal Hina; Fatima Kaneez; Kumar Yogesh; Luqman Suaib; Chanda Debabrata; Khan Feroz; Shanker Karuna; Dudi Rajesh Kumar; Tabassum Misbah;Mondhe, DM et al	5.572
112	Adenylate cyclase activator forskolin alleviates intracerebroventricular propionic acid-induced mitochondrial dysfunction of autistic rats. *Neural regeneration research* (2020), 15(6), 1140-1149, Language: English, Database: MEDLINE	Mehan Sidharth; Rahi Saloni; Tiwari Aarti; Kapoor Tarun; Rajdev Kajal; Sharma Ramit; Khera Himanshi; Kosey Sourabh; Kukkar Umesh; Dudi Rajesh	3.171
113	In vitro bactericidal activity of 3-cinnamoyl-4-hydroxy-6-methyl-2-pyrone (CHP) against drug-susceptible, drug-resistant and drug-tolerant isolates of Mycobacterium tuberculosis. *Journal of global antimicrobial resistance* (2020), 2257-62, Language: English, Database: MEDLINE	Bhat Zubair Shanib; Rather Muzafar Ahmad; Maqbool Mubashir; Ul Lah Hafiz; Yousuf Syed Khalid; Hussain Aehtesham; Jabeen Zuhra; Wani Mushtaq Ahmad; Ahmad Zahoor	2.706
114	Molecular characterization and overexpression analyses of secologanin synthase to understand the regulation of camptothecin biosynthesis in Nothapodytes nimmoniana (Graham.) Mabb. *Protoplasma* (2020), 257(2), 391-405, Language: English, Database: MEDLINE	Rather Gulzar A; Sharma Arti; Misra Prashant; Lattoo Surrinder K; Kumar Amit; Kaul Veenu	2.751
115	Screening of Antitubercular Compound Library Identifies Inhibitors of Mur Enzymes in Mycobacterium tuberculosis. *SLAS discovery : advancing life sciences R & D* (2020), 25(1), 70-78, Language: English, Database: MEDLINE	Eniyan Kandasamy; Rani Jyoti; Bajpai Urmi; Rani Jyoti; Ramachandran Srinivasan; Bhat Rahul; Khan Inshad Ali	---
116	Cyclodextrin nanosponges based site-retentive controlled release system for treatment of rheumatic arthritis. JOURNAL OF DRUG DELIVERY SCIENCE AND TECHNOLOGY (2020), 60.	Banjare, N; Gautam, L; Behera, C; Gupta, PN; Vyas, S; Vyas, SP	3.981
117	Spectrin conjugated PLGA nanoparticles for potential membrane phospholipid interactions: Development, optimization and in vitro studies. JOURNAL OF DRUG DELIVERY SCIENCE AND TECHNOLOGY (2020), 60.	Haider, T; Pandey, V; Behera, C; Kumar, P; Gupta, PN; Soni, V	3.981
118	Dihydropyrimidinones: efficient one-pot green synthesis using Montmorillonite-KSF and evaluation of their cytotoxic activity. RSC ADVANCES (2020), 10(69), 42221- 42234	Farooq, S; Alharthi, FA; Alsalme, A; Hussain, A; Dar, BA; Hamid, A; Koul, S	3.119
119	Total synthesis and absolute configuration determination of Ktedonoketone, a benzenoid metabolite from Thermophilic bacterium. TETRAHEDRON LETTERS (2020), 61 (47),	Dandawate, M; Choudhury, R; Krishna, GR; Reddy, DS	2.415

S.No.	Title	Author	Impact Factor
120	Nanohydroxyapatite-, Gelatin-, and Acrylic Acid-Based Novel Dental Restorative Material. ACS OMEGA (2020), 05(43), 27886- 27895	Sharma, K; Sharma, S; Thapa, S; Bhagat, M; Kumar, V; Sharma, V	2.87
121	Development and Validation of Novel and Highly Sensitive Stability-Indicating Reverse Phase Ultra Performance Liquid Chromatography Method for Quantification of Ibrutinib and its ten Degradation Products. INDIAN JOURNAL OF PHARMACEUTICAL SCIENCES (2020), 82(6), 958-966.	Mehta, L; Naved, T; Grover, P; Bhardwaj, M; Mukherjee, D	0.97
122	Evaluation of novel indigenous fungal consortium for enhanced bioremediation of heavy metals from contaminated sites. ENVIRONMENTAL TECHNOLOGY & INNOVATION (2020), 20.	Talukdar, D; Jasrotia, T; Sharma, R; Jaglan, S; Kumar, R; Vats, R; Kumar, R; Mahnashi, MH; Umar, A	5.263
123	Synergistic antioxidant and antimicrobial activities of essential oils of some selected medicinal plants in combination and with synthetic compounds. INDUSTRIAL CROPS AND PRODUCTS (2020), 154.	Sharma, K; Guleria, S; Razdan, VK; Babu, V	5.645
124	Recent advances in the global ring functionalization of 7-azaindoles. CHEMICAL COMMUNICATIONS (2020), 56(79), 11749-11762.	Kannaboina, P; Mondal, K; Laha, JK; Das, P	6.222
125	Integrating DNA damage response and autophagy signalling axis in ultraviolet-B induced skin photo-damage: a positive association in protecting cells against genotoxic stress. RSC ADVANCES (2020), 10(60), 36317- 36336	Umar, SA; Tasduq, SA	3.119
126	Neoconopodium paddarensis, a new species of Apiaceae from Jammu and Kashmir, Western Himalaya, India. PHYTOTAXA (2020), 459(4), 285-290.	Thakur, S; Singh, B; Tashi, N; Dutt, HC	---
127	Toward a Single-Dose Cure for Buruli Ulcer. ANTIMICROBIAL AGENTS AND CHEMOTHERAPY (2020), 64(9).	Thomas, SS; Kalia, NP; Ruf, MT; Pluschke, G; Pethe, K	---
128	Exploring Plant-Based Ethnomedicine and Quantitative Ethnopharmacology: Medicinal Plants Utilized by the Population of Jasrota Hill in Western Himalaya. SUSTAINABILITY (2020), 12(18).	Singh, B; Singh, B; Kishor, A; Singh, S; Bhat, MN; Surmal, O; Musarella, CM	3.251
129	Thermosensitive injectable hydrogel containing carboplatin loaded nanoparticles: A dual approach for sustained and localized delivery with improved safety and therapeutic . JOURNAL OF DRUG DELIVERY SCIENCE AND TECHNOLOGY (2020), 58.	Thakur, S; Singh, H; Singh, A; Kaur, S; Sharma, A; Singh, SK; Kaur, S; Kaur, G; Jain, SK	3.981

S.No.	Title	Author	Impact Factor
130	Synthesis, COX-2 inhibition and metabolic stability studies of 6-(4-fluorophenyl)-pyrimidine-5-carbonitrile derivatives as anticancer and anti-inflammatory agents. JOURNAL OF FLUORINE CHEMISTRY (2020), 236.	Akhtar, W; Nainwal, LM; Khan, MF; Verma, G; Chashoo, G; Bakht, A; Iqbal, M; Akhtar, M; Shaquiquzzaman, M; Alam, MM	2.05
131	Structural diversity, natural sources, and pharmacological potential of plant-based saponins with special focus on anticancer activity: a review. MEDICINAL CHEMISTRY RESEARCH (2020), 29(10), 1707- 1722.	Rehan, M; Shafiullah; Mir, SA	1.965
132	Anticholinesterase Activity and Mass Spectral Analysis of Olea dioica Roxb., An in vitro Study. INDIAN JOURNAL OF PHARMACEUTICAL SCIENCES (2020), 82(4), 601-611.	Pratap, GK; Rather, SA; Shantaram, M	0.97
133	Sub -cellular localization and quantitative estimation of heavy metals in lemongrass plants grown in multi -metal contaminated tannery sludge. SOUTH AFRICAN JOURNAL OF BOTANY (2020), 131, 74-83.	Pandey, J; Sarkar, S; Verma, RK; Singh, S	2.315
134	Pollen morphology and variability of theRosaL. species of Western Himalaya in India. GENETIC RESOURCES AND CROP EVOLUTION (2020), 67(8), 2129-2148.	Singh, K; Sharma, YP; Sharma, PR; Gairola, S	1.524
135	Chemical and real-time based analysis revealed active gene machinery of glycyrrhizin biosynthesis and its accumulation in the aerial tissues of in-vitro regenerated Glycyrrhiza glabra L. PLANT GROWTH REGULATION (2020), 92(2), 263-271.	Manzoor, MM; Goyal, P; Gupta, AP; Khan, S; Jaswal, P; Misra, P; Pandotra, P; Ahuja, A; Vishwakarma, RA; Gupta, S	3.412
136	Bioremediation potential of novel fungal species isolated from wastewater for the removal of lead from liquid medium. ENVIRONMENTAL TECHNOLOGY & INNOVATION (2020), 18.	Sharma, R; Talukdar, D; Bhardwaj, S; Jaglan, S; Kumar, R; Kumar, R; Akhtar, MS; Beniwal, V; Umar, A	5.263
137	Malononitrile-activated synthesis and anti-cholinesterase activity of styrylquinoxalin-2(1H)-ones. RSC ADVANCES (2020), 10(27), 15966-15975	Mahajan, S; Slathia, N; Nuthakki, VK; Bharate, SB; Kapoor, KK	3.119
138	Molecular docking analysis of selected natural products from plants for inhibition of SARS-CoV-2 main protease. CURRENT SCIENCE (2020), 118(7), 1087-1092	Sampangi-Ramaiah, MH; Vishwakarma, R; Shaanker, RU	1.102
139	Ethnobotanical plants used for gastrointestinal ailments by the inhabitants of Kishtwar plateau in Northwestern Himalaya, India. INDIAN JOURNAL OF TRADITIONAL KNOWLEDGE (2020), 19(2), 288-298.	Thakur, S; Tashi, N; Singh, B; Dutt, HC; Singh, B	0.757

S.No.	Title	Author	Impact Factor
140	Design and synthesis of sulphonyl acetamide analogues of quinazoline as anticancer agents. MEDICINAL CHEMISTRY RESEARCH (2020), 29(5), 916-925	Khazir, J; Mir, BA; Pandita, M; Pilcher, L; Riley, D; Chashoo, G	1.965
141	Paclobutrazol Induces Photochemical Efficiency in Mulberry (Morus alba L.) Under Water Stress and Affects Leaf Yield Without Influencing Biotic Interactions. JOURNAL OF PLANT GROWTH REGULATION (2020), 39(1), 205-2015	Mohan, R; Kaur, T; Bhat, HA; Khajuria, M; Pal, S; Vyas, D	4.169
142	Synthesis of 1,2,4-oxadiazole derivatives: anticancer and 3D QSAR studies. MONATSHEFTE FUR CHEMIE (2020), 151(3), 385-395	Vaidya, A; Jain, S; Kumar, BP; Singh, SK; Kashaw, SK; Agrawal, RK	1.451
143	Identification and characterization of cadmium resistant fungus isolated from contaminated site and its potential for bioremediation. ENVIRONMENTAL TECHNOLOGY & INNOVATION (2020), 17	Talukdar, D; Sharma, R; Jaglan, S; Vats, R; Kumar, R; Mahnashi, MH; Umar, A	5.263
144	Silk as a leading-edge biological macromolecule for improved drug delivery. JOURNAL OF DRUG DELIVERY SCIENCE AND TECHNOLOGY (2020), 55	Pandey, V; Haider, T; Jain, P; Gupta, PN; Soni, V	3.981
145	Design, synthesis, and anticancer evaluation of acetamide and hydrazine analogues of pyrimidine. JOURNAL OF HETEROCYCLIC CHEMISTRY (2020), 57(3), 1306-1318	Khazir, J; Mir, BA; Chashoo, G; Maqbool, T; Riley, D; Pilcher, L	2.193
146	Conversion of amino acids to aryl/heteroaryl ethanol metabolites using human CYP2D6-expressing live baker's yeast. RSC MEDICINAL CHEMISTRY (2020), 11(1), 142-147	Bhardwaj, M; Chib, S; Kaur, L; Kumar, A; Chaudhuri, B; Malik, F; Vishwakarma, RA; Saran, S; Mukherjee, D	---
147	O,O '-Dimethyl diphenyldithiophosphates of titanium(IV): synthesis, spectroscopic, DFT and biological studies. MOLECULAR PHYSICS (2020), 118(13)	Kour, M; Kumar, S; Andotra, S; Lata, S; Kaur, R; Singh, G; Vikas; Katoch, M; Pandey, SK	1.962
148	Synthesis and anticancer activity of N-9- and N-7- substituted 1,2,3 triazole analogues of 2,6-di-substituted purine. MEDICINAL CHEMISTRY RESEARCH (2020), 29(1), 33-45	Khazir, J; Mir, BA; Chashoo, G; Pilcher, L; Riley, D	1.965
149	Vitamin E TPGS based palatable, oxidatively and physically stable emulsion of microalgae DHA oil for infants, children and food fortification. JOURNAL OF DISPERSION SCIENCE AND TECHNOLOGY (2020), 41(11), 1674-1689	Singh, H; Singh, J; Singh, SK; Singh, N; Paul, S; Sohal, HS; Gupta, U; Jain, SK	2.262

9. List of Patents
(2020-2021)

CSIR-IIIM Patents Filed and Granted (2020-2021)

A.) Filed in India (2020- 2021)

NIL

B.) Filed in Abroad (2020- 2021)

Sno	Country	Lab	Title	Inventors	Filing Date	Application No.
1	US	IIIM	Sustained Release Formulations of Crocus Sativus	Bharate Sonali Sandip, Kumar Vikas, Singh Rohit, Rani Sarita, Gupta Mehak, Kumar Ajay, Bharate Sandip Bibishan, Vishwakarma Ram	06-04-2020	16/753969
2	US	IIIM	Gastroretentive Sustained Release Formulations Of Bergenia Ciliata	Bharate Sonali Sandip, Singh Rohit, Gupta Mehak, Singh Bikarma, Katare Anil Kumar, Kumar Ajay, Bharate Sandip Bibishan, Vishwakarma Ram	14-04-2020	16/755919
3	EP	IIIM	Sustained Release Formulations of Crocus Sativus	Bharate Sonali Sandip, Kumar Vikas, Singh Rohit, Rani Sarita, Gupta Mehak, Kumar Ajay, Bharate Sandip Bibishan, Vishwakarma Ram	15-04-2020	18796784.9
4	EP	IIIM	Gastroretentive Sustained Release Formulations Of Bergenia Ciliata	Bharate Sonali Sandip, Singh Rohit, Gupta Mehak, Singh Bikarma, Katare Anil Kumar, Kumar Ajay, Bharate Sandip Bibishan, Vishwakarma Ram	16-04-2020	18783141.7
5	EP	IIIM	A Process For Thr Preparation Of Natural Crystallized Thymol From Monarda Citriodora (Jammu Monarda) Oil	Shankar Ravi, Chandra Suresh, Meena Siya Ram, Verma Mahendra Kumar, Bindu Kushal, Vij Bhavna, Dheer Divya, Jyoti, Vishwakarma Ram Asrey	30-06-2020	19704054.6
6	US	IIIM	A Process For Thr Preparation Of Natural Crystallized Thymol From Monarda Citriodora	Shankar Ravi, Chandra Suresh, Meena Siya Ram, Verma Mahendra	01-07-2020	16/959615

			(Jammu Monarda) Oil	Kumar, Bindu Kushal, Vij Bhavna, Dheer Divya, Jyoti, Vishwakarma Ram Asrey		
7	CA	IIIM	A Process For Thr Preparation Of Natural Crystallized Thymol From Monarda Citriodora (Jammu Monarda) Oil	Shankar Ravi, Chandra Suresh, Meena Siya Ram, Verma Mahendra Kumar, Bindu Kushal, Vij Bhavna, Dheer Divya, Jyoti, Vishwakarma Ram Asrey	03-07-2020	3087654
8	US	IIIM	Sustained Release Formulations Of Dysoxylum Binectariferum	Bharate Sonali Sandip, Kumar Vikas, Gupta Mehak, Gandhi Sumit, Kumar Ajay, Bharate Sandip Bibishan, Vishwakarma Ram	08-10-2020	17/046007
9	CA	IIIM	Sustained Release Formulations Of Dysoxylum Binectariferum	Bharate Sonali Sandip, Kumar Vikas, Gupta Mehak, Gandhi Sumit, Kumar Ajay, Bharate Sandip Bibishan, Vishwakarma Ram	16-10-2020	3097503
10	EP	IIIM	Sustained Release Formulations Of Dysoxylum Binectariferum	Bharate Sonali Sandip, Kumar Vikas, Gupta Mehak, Gandhi Sumit, Kumar Ajay, Bharate Sandip Bibishan, Vishwakarma Ram	19-10-2020	19723887.6
11	CA	IIIM	Solid Dispersion Comprising An Anticancer Compound With Improved Solubility And Efficacy	Bharate Sonali Sandip, Kumar Vikas, Mintoo Mubashir Javed, Mondhe Dilip Manikrao, Bharate Sandip Bibishan, Vishwakarma Ram	09-11-2020	3099901

12	EP	IIIM	Solid Dispersion Comprising An Anticancer Compound With Improved Solubility And Efficacy	Bharate Sonali Sandip, Kumar Vikas, Mintoo Mubashir Javed, Mondhe Dilip Manikrao, Bharate Sandip Bibishan, Vishwakarma Ram	10-11-2020	19833947.5
13	US	IIIM	Solid Dispersion Comprising An Anticancer Compound With Improved Solubility And Efficacy	Bharate Sonali Sandip, Kumar Vikas, Mintoo Mubashir Javed, Mondhe Dilip Manikrao, Bharate Sandip Bibishan, Vishwakarma Ram	17-12-2020	17/253193
14	WO	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	11-03-2021	PCT/IN2021/ 050242

C.) Granted in India (2020-2021)

Sno	Country	Lab	Title	Inventors	Grant Date	Patent No.
1	IN	IIIM	N-Substituted Beta-Carbolinium Compounds As Potent P-Glycoprotein Inducers	Bharate Sandip, Kumar Ajay, Manda Sudhakar, Joshi Prashant, Bharate Sonali, Vishwakarma Ram	20/Jul/2020	341979
2	IN	IIIM	Design, Synthesis And Biological Evaluation Of Isoform Selective Analogs Of Liphagane Scaffold As Anticancer Agents: P13k-Alpha/Beta Inhibitors	Ram A Vishwakarma, Sanghapal Damodhar Sawant, Parvinder Pal Singh, Abid Hamid Dar, Parduman Raj Sharma, Ajit Kumar Saxena, Amit Nargotra, Kolluru Anjaneya Aravind Kumar, Mudududdla Ramesh, Asif Khurshid Qazi, Aashiq Hussain, Nayan Chanauria	22/Jan/2021	356467

Sno	Country	Lab	Title	Inventors	Grant Date	Patent No.
3	IN	IIIM	Fused Pyrimidines As Isoform Selective Phosphoinositide-3-Kinase-Alpha Inhibitors And Process For Preparation Thereof	Bharate Sandip Bibishan, Bhushan Shashi, Mohammed Shabber, Guru Santosh Kumar, Bharate Sonali Sandip, Kumar Vikas, Mahajan Girish, Mintoo Mubashir Javed, Mondhe Dilip Manikrao, Vishwakarma Ram	01/Mar/2021	359878
4	IN	IIIM	Polyalkylated Acyl And Benzoyl-Phloroglucinols As Potent P-Glycoprotein Inducers	Bharate Sandip, Kumar Ajay, Bharate Jaideep, Joshi Prashant, Wani Abubakar, Mudududdla Ramesh, Sharma Rohit, Vishwakarma Ram	18/Mar/2021	361941

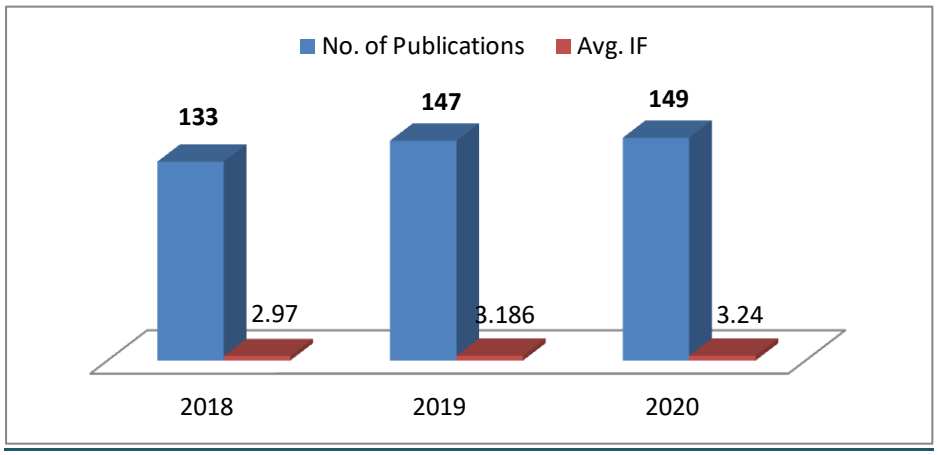
D.) Granted Abroad (2020- 2021)

Sno	Country	Lab	Title	Inventors	Grant Date	Patent No.
1	CA	IIIM	Design, Synthesis And Biological Evaluation Of Isoform Selective Analogs Of Liphagane Scaffold As Anticancer Agents: P13k-Alpha/Beta Inhibitors	Ram A Vishwakarma, Sanghapal Damodhar Sawant, Parvinder Pal Singh, Abid Hamid Dar, Parduman Raj Sharma, Ajit Kumar Saxena, Amit Nargotra, Kolluru Anjaneya Aravind Kumar, Mudududdla Ramesh, Asif Khurshid Qazi, Aashiq Hussain, Nayan Chanauria	14/Apr/2020	2867452
2	GB;EP	IIIM	Polyalkylated Acyl And Benzoyl-Phloroglucinols As Potent P-Glycoprotein Inducers	Bharate Sandip, Kumar Ajay, Bharate Jaideep, Joshi Prashant, Wani Abubakar, Mudududdla Ramesh, Sharma Rohit, Vishwakarma Ram	22/Apr/2020	3209638
2	US	IIIM	Fused Pyrimidines As Isoform Selective Phosphoinositide-3-Kinase-Alpha Inhibitors And Process For Preparation Thereof	Bharate Sandip Bibishan, Bhushan Shashi, Mohammed Shabber, Guru Santosh Kumar, Bharate Sonali Sandip, Kumar Vikas, Mahajan Girish, Mintoo Mubashir Javed, Mondhe Dilip Manikrao, Vishwakarma Ram	30/Jun/2020	10696688
3	CA	IIIM	A Pharmaceutical Composition For The Treatment Of Multi-Drug Resistant Infections	Vishwakarma Ram, Kumar Ajay, Khan Inshad Ali, Bharate Sandip Bibishan, Joshi Prashant, Singh Samsher, Satti Naresh	25/Aug/2020	2960455

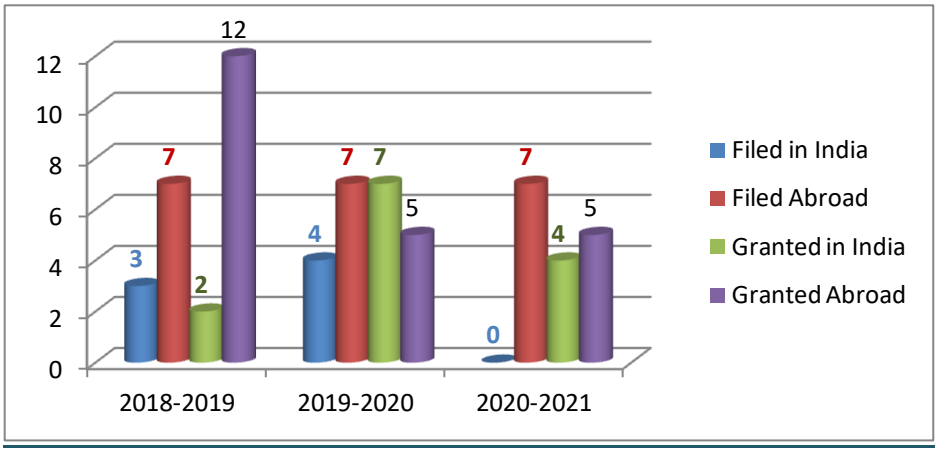
Sno	Country	Lab	Title	Inventors	Grant Date	Patent No.
4	EP;GB	IIIM	Fused Pyrimidines As Isoform Selective Phosphoinositide-3-Kinase-Alpha Inhibitors And Process For Preparation Thereof	Bharate Sandip Bibishan, Bhushan Shashi, Mohammed Shabber, Guru Santosh Kumar, Bharate Sonali Sandip, Kumar Vikas, Mahajan Girish, Mintoo Mubashir Javed, Mondhe Dilip Manikrao, Vishwakarma Ram	30/Sep/2020	3380476
5	US	IIIM	A Process For Thr Preparation Of Natural Crystallized Thymol From Monarda Citriodora (Jammu Monarda) Oil	Shankar Ravi, Chandra Suresh, Meena Siya Ram, Verma Mahendra Kumar, Bindu Kushal, Vij Bhavna, Dheer Divya, Jyoti, Vishwakarma Ram Asrey	09-03-2021	10941096

10. Performance Indicator

INSTITUTIONAL PUBLICATIONS



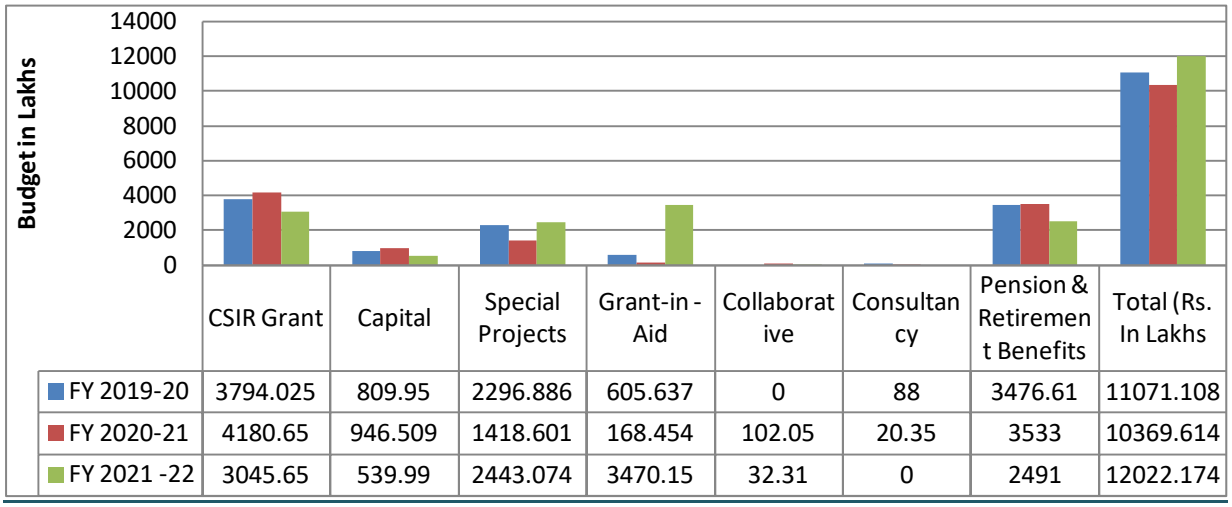
INSTITUTIONAL PATENTS APPLICATIONS



TECHNOLOGY TRANSFERRED (2020-2021)

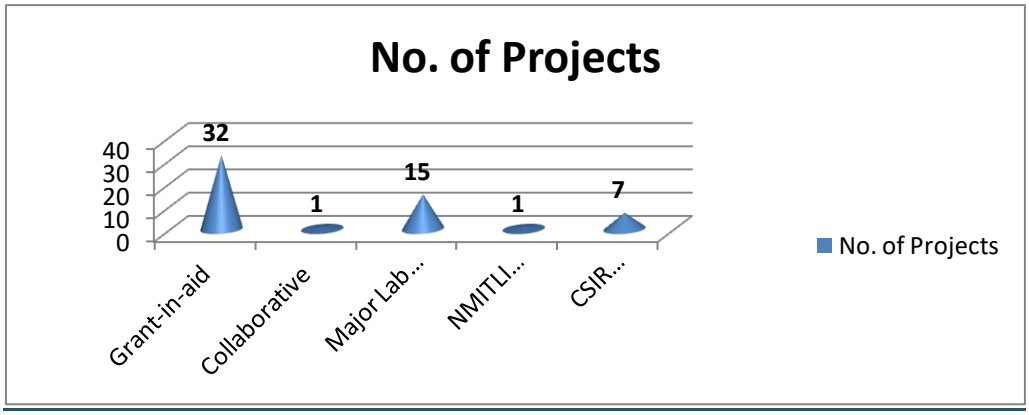
- Process Development of Favipiravir to M/s Anphar Pharma Pvt. Ltd., Jammu.
- Cellulose patches technology to M/s Hemp Street Medicare Pvt. Ltd., Delhi.

BUDGET

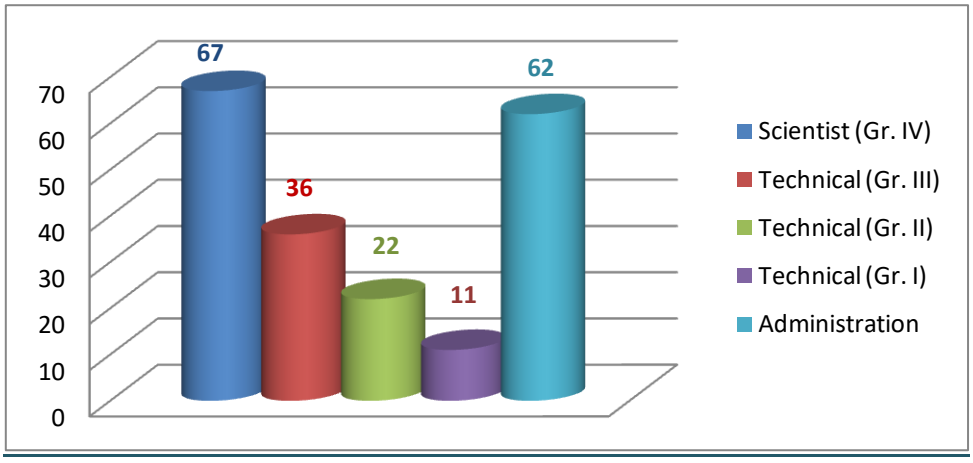


	CSIR Grant	Capital	Special Projects	Grant-in-Aid	Collaborative	Consultancy	Pension & Retirement Benefits	Total (Rs. In Lakhs
FY 2019-20	3794.025	809.95	2296.886	605.637	0	88	3476.61	11071.108
FY 2020-21	4180.65	946.509	1418.601	168.454	102.05	20.35	3533	10369.614
FY 2021 -22	3045.65	539.99	2443.074	3470.15	32.31	0	2491	12022.174

PROJECTS



HUMAN RESOURCE



11. KEY ACTIVITIES DURING THE FINANCIAL YEAR

11.1 CSIR-Indian Institute of Integrative Medicine launches Aroma Mission Phase-II

CSIR-Indian Institute of Integrative Medicine, Jammu has launched CSIR-Aroma Mission Phase-II on 9th February 2021. Scientists-farmers interaction programme was organised in the auditorium of IIIM, Jammu which was attended in person by large number of farmers from all over JK UT and others virtually from Punjab, Rajasthan, Gujarat, Assam, Uttarakhand, and Madhya Pradesh. Dr. J.P.Sharma, Vice Chancellor, SKAUST, Jammu was the chief guest on the occasion and Padma Shri Prof. Sudhir Sopori, Ex-Vice Chancellor, JNU, Dr. D. Srinivasa Reddy, Director, CSIR-IIIM, Jammu, Dr. Prabodh K. Tripathi, Director, CSIR-CIMAP, Lucknow, and Ramakant Harlalka, M.D. Nishant Aroma, Mumbai were the other dignitaries attended the programme. On this occasion, besides technical session, a documentary on CSIR-Aroma Mission was released and scientists-farmers interaction was also held.

11.2 CSIR-IIIM & National Institute of Sowa Rigpa (NISR), Leh Sign MoU for Research Collaboration

CSIR-Indian Institute of Integrative Medicine, Jammu has entered into an agreement with National Institute of Sowa Rigpa, Leh, an autonomous organization under the Ministry of AYUSH, Govt of India on 29th January 2021. The MoU is aimed for conservation and cultivation of selected medicinal plants of Trans-Himalayas, isolation and characterization of the novel compounds from the medicinal plants used in Sowa Rigpa System of Medicine, CMC of identified single plant herbal formulation of the Sowa Rigpa System and conceiving joint R&D projects based on mutual interest of both the Institutes.

11.3 Agreement Signed Between CSIR-IIIM and NDTL for Research Collaboration

Agreement was signed by Dr. D. Srinivasa Reddy, Director, CSIR-Indian Institute of Integrative Medicine (IIIM), Canal Road, Jammu and Dr. P.L. Sahu, Scientific Director, National Dope Testing Laboratory (NDTL), Ministry of Youth Affairs & Sports, Government of India on 11th January 2021 for research collaboration by combining their respective research capabilities in the areas of synthesis of reference standards and *in-vitro* and *in-vivo* studies (PK studies) on the metabolites with main emphasis on the national goals in area of Dope testing and Global positioning. In future both the Institutes will also explore the role of phyto-chemicals in particular phyto-steroids in dope testing.

11.4 Com/Secy Sampheal called on by team of CSIR to discuss agro potential in Ladakh

With the aim to explore potential in medicinal and aromatic plants in Ladakh, a team of Council of Scientific & Industrial Research (CSIR) called upon Commissioner/Secretary Agriculture UT Ladakh Rigzin Sampheal. The team of CSIR headed by Director Indian Institute of Integrative Medicine (IIIM) Jammu Dr. D. Srinivasa Reddy is on a three-day visit to Ladakh in connection with the different initiatives CSIR aspires to initiate in various areas of agriculture, horticulture, medicine and other related fields. Com/Secy Sampheal welcomed the concept of the team and talked about diverse medicinal and aromatic possibilities hidden in the wilderness of Ladakh. He informed the team of researchers to deliberate on the areas that would help in generating income to the grass-root farmers. He also added that despite the short summer season with harsh cold winters, nature has gifted Ladakh with some rare plants that can be useful in many fields. Careful and detailed research would help in yielding desired results.

Director CSIR-IIIM Called on Hon'ble Lt. Governor of J&K

12. Conferences / Webinars / Seminars / Symposium / Books / Book Chapters / Invited Talks / Workshops etc.

12.1 Conferences / Webinars

- **Dr. Shahid Rasool,** Senior Scientist, organized webinar titled "Discover Lavender: Empowering Hill and Mountain Farmers through sustainable production of Lavender in J&K"under the auspices of India International Science Festival 2020 on **12.12.2020.**
- **Dr. Sumit G. Gandhi,** Principal Scientist presented a aticle in the webinar "Emerging and Re-emerging Infectious Diseases" organised by NV Patel College of Pure and Applied Sciences, Sardar Patel University, VV Nagar, Anand, Gujarat.
- **Dr. Sumit G. Gandhi,** Principal Scientist presented a aticle in the webinar "Unravelling the Plant Metabolic Pathways Using Multiomics" organised by TransDisciplinary University (TDU), Bengaluru.
- Pankaj Kumar, **Sumeet Gairola**, 2021. Macroscopic and Microscopic Standardization of Root Drugs of 14 Medicinally Important Species of Family Apocynaceae. Presented at

  Two Day National e-Conference on "Plant Science Research: Relevance, Funding, Challenges, and Opportunities" (16th January- 17th January 2021) organized by Department of Botany, Hansraj College in collaboration with Mahatma Hansraj Faculty Development Centre Hansraj College, University of Delhi.

- Kanwaljeet Singh, Deepika Singh, Javaid Fayaz Lone, Yash Pal Sharma, **Sumeet Gairola**. 2021. Nutraceutical profile of rose hips of three underutilized wild rose species from Western Himalaya, India. Presented at XLIII All India Botanical Conference of the Indian Botanical Society on Sustainable Development of Plants Resources and Conservation of Threatened Plants in Botanic Gardens organized by CSIR-National Botanical Research Institute (NBRI) from 19^{th} to 21^{st} March 2021.

- IIIM-Technology Business Incubator in collaboration with Bhaskaracharya College of Applied Sciences (affiliated with University of Delhi) organized a Webinar Series 2020 titled "Covid 19 Pandemic: The Road Map to Recovery" on 25th June 2020. **Dr Saurabh Saran** discussed Biosafety and Biosecurity regulations in the COVID-19 period. Over 65 students from University of Delhi attended the webinar.

12.2 Book Chapter

- Vijay Lakshmi Jamwal, Irshad Ahmad Rather, Nitika Kapoor and **Sumit G. Gandhi***. "Induction, Metabolite Analysis, and Transgenesis of Hairy Roots from Coleus forskohlii." Edited by Srivastava V., Mehrotra S., Mishra S. Hairy Root Cultures Based Applications. Springer Nature, Singapore, 2020.
- Rekha Chouhan, Natish Kumar, Amit Kumar, Sajad Ahmed, Yadunandan Sen and **Sumit G. Gandhi*. "**Establishment of Hairy Roots of Endangered Himalayan Plant *Swertia chirata*: A Sustainable Alternative to Extraction from Nature**."** Edited by Srivastava V., Mehrotra S., Mishra S. Hairy Root Cultures Based Applications. Springer Nature, Singapore, 2020.
- Durga Sajad Ahmed, Rekha Chouhan and **Sumit G. Gandhi*. "**Ethnobotanical and

Pharmacological Potential of Yams Used for Phytopharmaceutical and Nutraceutical Development." Edited by Bikarma Singh and Yash Pal Sharma. Human-Plant Relations and Future Drug Discovery. New India Publishing Agency, New Delhi, 2020.

- Rekha Chouhan, Sajad Ahmed, and **Sumit G. Gandhi*. "**Plant Volatile Organic Compounds and Neuroregenerative Health**."** Edited by Bikarma Singh. Botanical Leads for Drug Discovery. Springer Nature, Singapore, 2020.
- Gifty Sawhney, Satinder Kaur, Asha Bhagat and **Zabeer Ahmed**. "Medicinal Plants and their Role in Inflammation: A Close Look on Future Drug Discovery Activities" Botanical Leads for Drug Discovery, Springer Nature, 2020.
- Mir Mohd Faheem, Archana Katoch and **Anindya Goswami**. Role of Par-4 in EMT. Springer. 2021.
- Banjare N, Bhale B, Gupta PN. Cabbabinoids as promising anti-inflammatory agent, In: Botanical Leads for Drug Discovery, Bikarma Singh (Ed.), Springer, 2020.
- S. Bhatt, A. Gour, **G. Singh**, U. Nandi. Tuberculosis. Chronic Lung Diseases, Sheikh Rayees, Inshah Din, **Gurdarshan Singh**, Fayaz A. Malik (Eds.). Chapter 5, Page no: 87-127. Springer, 2020.
- B. Gorain, S. Dutta, U. Nandi, P. Sengupta, H. Choudhury. Frontiers in Pharmacology of Neurotransmitters. Chronic Lung Diseases. Singapore. Springer Nature. 2020, Chapter 4, Page no: 107-1142.
- Sheikh Rayees, Inshah Din, **Gurdarshan Singh**, Fayaz A. Malik (Eds.). Chronic Lung Diseases: Pathophysiology and Therapeutics, pages: 1-157, ISBN: 978-981-15-3733-2, Springer, 2020

12.3 Invited Talks

- **Dr. Shahid Rasool**, Senior Scientist gave an invited lecture on "Commercial production, processing and marketing of medicinal and aromatic crops" at Faculty of Forestry, SKUAST-K on 26.03.2021
- **Dr. Shahid Rasool,** Senior Scientist delivered an invited lecture in the webinar "Lavender Dreams: Raising J&K profile in Global Market" organized by Ziraat Times on 25.07.2021.
- **Dr. Asha Chaubey**, Principal Scientist delivered an invited talk on "Role of electronic documentation for the prevention and cure of pandemics" was delivered in a webinar organized by Regional Research Institute of Unani Medicine (RRIUM), Bhadrak, Odisha, CCRUM, M/o AYUSH, Govt of India on 29.06.2020
- **Dr. Asha Chaubey,** Principal Scientist gave a lecture on "Production and downstream processing of enzymes" was delivered in 5 days Hands-on workshop on "Basic Techniques In Industrial Microbiology" 15th-19th MARCH, 2021
- **Dr. Vinod Kumar**, Scientist, delivered an invited talk on "Valorisation of agricultural residue as a substrate for production of sugar alcohol: Opportunities and challenges" 5th International E-Conference on "Bioenergy, Environment and Sustainable Technologies (BEST 2021)" and International E-Conference on Bioprospecting (ICONBIO) during 29-30 January 2021 organized by Arunai Engineering College, Tiruvannamalai.

- **Dr. Asha Chaubey**, Principal Scientist delivered Invited talk on 'Women in Science' during an online workshop organized by Central University of Jammu on 10.2.21 on the theme Women Empowerment through Science and Technology, sponsored by J&K DST
- **Dr. Kuljit Singh**, Scientist delivered oral presentation in India International Science Festival (IISF-2020) held from December 22-25, 2020, in the category of Young Scientists Conference (YSC) under the theme pandemic crisis and challenges.
- **Dr. Sandip Bharate,** Principal Scientist delivered an invited talk on **"**Medicinal chemistry of natural products to discover kinase inhibitors for cancer: Discovery and preclinical development of IIIM-290 for pancreatic cancer (MEDI 41) (Abstract ID: 3402460)**"** in ACS Fall 2020 National Meeting & Exposition in San Francisco, CA, USA (virtual meeting) on 18th August 2020 and orgnised by American Chemical Society.
- **Dr. Sandip Bharate,** Principal Scientist delivered an invited talk on **"**Potential of Indian Medicinal Plants to Provide Drugs for Modern Medicine: A case study of Indian White Cedar**"** in one-month faculty induction program (March 2021) on 09th March 2021 and orgnised by Jammu University, Jammu.
- **Dr. Sandip Bharate,** Principal Scientist delivered an invited talk on **"**Importance of intellectual rights in drug discovery**"** in Four-week online faculty induction programme (28.1.2021 to 24.2.2021) on 20th February 2021 and orgnised by UGC-Human Resource Development Centre (HRDC), Guru Nanak Dev University, Amritsar.
- **Dr. Sandip Bharate,** Principal Scientist delivered an invited talk on **"**Unravelling the potential of Indian white cedar for discovery of modern drugs for unmet medical needs**"** in one-month faculty induction program (8.9.2020 to 5.10.2020) on 19th September 2020 and orgnised by UGC-Human Resource Development Centre (HRDC), Guru Nanak Dev University, Amritsar.
- **Dr. Sandip Bharate,** Principal Scientist delivered an invited talk on **"**Importance of protecting intellectual property rights in translational research**"** in One-Week Online Short-Term Course on "Intellectual Property Rights & Ethics" (28.7.2020-3.8.2020) on 31st July 2020 and orgnised by UGC-Human Resource Development Centre (HRDC), Guru Nanak Dev University, Amritsar.
- **Dr. Parvinder Pal Singh,** Principal Scientist delivered a talk on "Anti-TB Drug Discovery: Overview, Challenges and IIIM Initiatives" in UGC-Sponsored Refresher Course in Chemistry organised by University of Jammu on 12th March 2021and organised by Jammu University, Jammu.
- **Dr. Shashank Singh**, Principal Scientist delivered an invited talk on "Frontiers in Pharmaceutical Education and Research: Emerging Trends in Phytopharmaceuticals" in the XXXV-QIP on held during 09th-16th October, 2020.
- **Dr. Shashank Singh,** Principal Scientist delivered an invited talk on "Trends and techniques in cancer drug discovery from natural products" on 03rd August 2020 organized by KCT, Coimbatore, TN.

- **Dr. Shashank Singh,** Principal Scientist delivered an invited talk on "Role of traditional knowledge-based lifestyle interventions and cancer Incidences: An Indian prospective" on 01st

December 2020 organized by Bharati Vidyapeeth University's Poona College of Pharmacy, Pune.

12.4 Workshops / Training Programmes

- **Dr. Shahid Rasool,** Senior Scientist organized three "One Day Workshop on Entrepreneurship opportunities in cultivation, processing, post harvest management and marketing of high value aromatic cash crops" on 16.03.2021, 18.03.2021 and 20.03.201.
- **Dr. Shahid Rasool,** Senior Scientist, organized "One day awareness programme on cultivation, processing and marketing of high value aromatic plants in J&K"on 30.03.2021
- **Dr. Asha Chaubey,** Principal Scientist gave a 05 Days Hands-on workshop on Basic Techniques in Industrial Microbiology organized under Skill Development Program during 15-19 March 2021
- **Dr. Asha Chaubey,** Principal Scientist attented an online event which was organized on National Science Day under JIGYASA on 28 February 2021.
- Dr. Vinod Kumar, Scientist has participated in the TEQIP III sponsored E-Training Program/Short -term course on Systems Analysis for Biofuels and Bioproducts in the Department of Biosciences and Biomedical Engineering from 07-12 December 2020 at IIT Indore.
- **Dr. Vinod Kumar,** Scientist has participated 37th Induction Programme for Newly Recruited Scientists organized by CSIR, HRDG, GHAZIABAD, dated: 15th - 24th Feb, 2021.
- Under CSIR-Skill development Programme, Infectious diseases division organised Hands-on training and workshop on PCR and Real Time PCR (RT-PCR) from March 1-5, 2021, at CSIR-IIIM, Jammu.
- Infectious diseases division delivered a training sessions for FELUDA kits useful in detecting COVID-19 viral infection was organized by the department. These kits were received from TATA Medical and Diagnostics Ltd, Bangalore.
- Infectious diseases division delivered training to students in Covid19 RT PCR testing: Ten Lab. Technicians from GMC, eight students (deputed in Leh & Ladakh Laboratory), and Six Project Assistants from CSIR-IIIM were trained as per BSL-3 norms. They got expertise in handling and pooling of human clinical samples, RNA extraction and RT-PCR setup.
- City Camp – Jammu was conducted in colaboaration with Venture Centre Pune where 50 students/ entreprenurs participated. The theme of the City camp was 'Éssentials of Scientific Entrepreurship'. Day 1 of the workshop was conducted at Govt College for Women, Gandhi Nagar, Jammu where as Day 2 was conducted at Atal Auditorium of CSIR-IIIM, Jammu.

13. MoUs / Agreements

LIST OF AGREEMENTS AND MOU'S/CDA'S SIGNED BY CSIR-IIIM
April 2020 to March 2021.

1.	NDA and CDA Between CSIR-IIIM and Strand Life Sciences Pvt. Ltd., Bangalore-560 024, India.	The purpose as provided under this agreement and shall not retain the date for any other use.	07 May, 2020
2.	Seed Development Agreement Between CSIR-IIIM and Induscann Research Pvt. Ltd., reg. Office at C-1503, Viento, Lakeshore Green, Palava city, Kalyan, Thane-421202, Maharashtra.	Parties agree to use all reasonable efforts to safeguard the information against unauthorised disclosure to and use by others.	08th May, 2020
3	Agreement Between CSIR-IIIM and Tirupati Life Sciences, office at Surajpur, Nahan Road, Paonta Sahib, Distt. Sirmour, H.P. (India)	The parties use the confidential information for the purpose as provided under this agreement and shall not retain the data for any other use.	02nd July, 2020
4.	CDA Between CSIR-IIIM, Jammu and Clearsynth Labs., Ltd., Mumbai office at 17, Lotus Business Park, New Link Road, Andheri (West), Mumbai-400053.	Both parties agree to develop collaborative projects of mutual interest	5th of August, 2020.
5.	CDA Between CSIR-IIIM, Jammu and IOSYNTH Labs. Pvt. Ltd., office at WFF-11, BBC, Biotech Park, Electronic City Phase-1, Bangalore-560100, Karnataka, India.	Proprietary catalysts and technologies for the production of chemical intermediates and APIs and utilisation of IIIM Jammu.	17th of August, 2020
6.	Agreement between CSIR-IIIM and CSIR-IICT and Laxai Life Sciences Pvt. Ltd., office at Block-A, Phoenix Primea near ICICI Bank, Financial Distt. Gochibowli, Hyderabad, India	Agreed to participate together in clinical trial program to identify best treatment regime and protocol and have agreed to fund the programme on the terms and conditions.	21st August, 2020
7.	MOU Between CSIR-IIIM and Ministry of AYUSH, Govt. of India cooperation in the field of Research and drug development and procurement of Ayurveda, Unani and Homeopathy drugs.	Each party will endeavour to take necessary steps to encourage and promote co-operation in joint research projects for quality standards of Ayurvedic, Unani and Homeopathic medicines.	26th August, 2020
8.	CDA Between CSIR-IIIM and Ikanik Farms, Toranto, Canada	The sole purpose of determining whether there is a basis for entering into a business relationship between Discloser and Recipient.	2nd September, 2020

9.	Tripartite Non closure agreement for the technology-Microbial Fermentation process for manufacture of DHA Algae oil between National Research Development Corp.20-22, Zamroodpur, Kailash Colony Extn. New Delhi-110048 and M/s Bills Biotech Pvt. Ltd., Ahmadabad-380059, Gujarat	To work with Indian and global pharmaceutical industry to out-license new products and technologies.	09th September, 2020
10.	CDA Between CSIR-IIIM and Organic Naturalas India Pvt. Ltd., office at 172/4, Murugu Nagar, Fifth street, Velacherry Chennai, Tamilnadhu-600042	Confidential information for the purpose as provided under this agreement and shall not retain the data for any other use.	26th September, 2020
11.	CDA Between CSIR-IIIM and Boyce Biosynthetic office at Villa Hermuzd, 8A, Carmichael Road, Mumbai-400026.	Mutually disclosed and provided under this agreement and shall not retain the data for any other use.	28th September, 2020
12.	Agreement Between CSIR-IIIM and Hemp Street Medicare Pvt. Ltd., office at 90, New Mangla Puri, Sultanpur, MG Road, New Delhi-110030	Hempstreet to agrees to enter in to agreement for transfer of cellulose technology of CSIR-IIIM on non-exclusive basis.	16th November, 2020
13.	Agreement Between CSIR-IIIM and National Institute of Mental Health and Neuro Sciences (NIMHANS), Bangalore-560 029	The rational Drug Discovery collaboration Agreement. Consideration received from any project IP shall be equally distributed by both the parties.	7th December, 2020
14.	Agreement Between CSIR-IIIM and M/s Terraphilic Innoventures New Delhi-110019	In order to determine whether relation is of mutual interest both parties need to discuss, receive and evaluate confidential information from each other.	9th December, 2020
15.	CDA Between CSIR-IIIM, Canal Road, Jammu and M/s Habitat Genome Improvement, Primary Producer Co. Ltd., Hisar-125001, Haryana.	The parties use the confidential information for the purpose as provided under this agreement and shall not retain the data for any other use.	15th December, 2020
16.	Collaborative Research Agreement (CRA) Between IIIM-Jammu and All India Institute of Medical Sciences (AIIMS), Ansari Nagar, New Delhi-29	The parties desire to establish common framework to facilitate in terms of exchange of information, material to carry out research, seek funding and to execute such other agreements as may be	22nd December, 2020

		necessary for the project.	
17.	Agreement between CSIR-IIIM, Jammu and The National Dope Testing Laboratory (NDTL) office at East Gate No. 10, Jawaharlal Nehru stadium complex, Lodhi Road, New Delhi-110003.	Synthesis of reference standards and in-vitro and in-vivo studies (PK studies) on the metabolites and long term metabolites.	11th Jan. 2021
18.	MOU Between CSIR-IIIM, Jammu and M/s Hindustan Aeronautics (HAL) Ltd., office at 15/1, Cubbon Road, Bangalore-560 001, India.	Parties have deliberated between them and concluded that CSIR-IIIM will augment facility in Ladakh with the fund made by HAL under its CSR obligations.	20th Jan. 2021
19.	MOU Between CSIR-IIIM, Jammu and National Institute of SOWA Rigpa, Leh having its office at Skalzangling Leh., UT, Ladakh, India.	Development of agro-technologies and commercial cultivation of high value medicinal and aromatic plants from western Himalayas.	29th Jan. 2021

14. HONOURS / AWARDS

14.1 Honours / Awards

- **Dr. Shahid Rasool,** Senior Scientist received certificate of appreciation for actively contributing as speaker in the theme "Agri-tech" in India International Science Festival, 2020 conducted from 22.12.2020 to 25. 12. 2020.

- **Dr Rashmi Sharma,** Scientist received First Prize in Women Scientists and Entrepreneurs Conclave conducted by International Science Festival (IISF) 2020.
- **Dr. Debaraj Mukherjee,** Principal Scientist received "Resource Person Award" at Natural Products in Holistic Healthcare- Recent Trends & Future Prospects (NPH2) organized by Department of Pharmaceutical Engineering & Technology, IIT (BHU), Varanasi, and December 2020.
- **Dr. Debaraj Mukherjee,** Principal Scientist received "2020 Professor D.K. Banerjee Memorial Lecture Award" at Pfizer Symposium on Organic Chemistry organized by Department of Organic Chemistry, Indian Institute of Science, Banglore, and February 2020.
- **Dr. Debaraj Mukherjee's** student Received "Professor P. Sengupta Memorial Award" for the presentation in the 57th Annual Convention of Chemists, 2020 & International Conference on "Recent Trends in Chemical Sciences (RTCS-2020)"organized by the Indian Chemical Society, Kolkata during December 26 – 29,2020.
- **Dr. Debaraj Mukherjee,** Principal Scientist received reviewer of reputed scientific Journals likes J. Am. Chem. Soc., J. Org. Chem., Bio-organic and Medicinal Chemistry, Bio-organic and Medicinal Chemistry Letters, European Journal of Medicinal Chemistry, etc.
- **Dr. Sandip Bharate,** Principal Scientist is awarded with MEDI Young Investigator Award by American Chemical Society USA in 2020.
- **Dr. Sandip Bharate,** Principal Scientist is awarded with World's top 2% scientists' in the field of Medicinal &Biomolecular Chemistry based on a study by Scientists from Stanford University USA American Chemical Society USA in 2020.

15. Hindi Cell Activities

राजभाषा हिन्दी अनुभाग

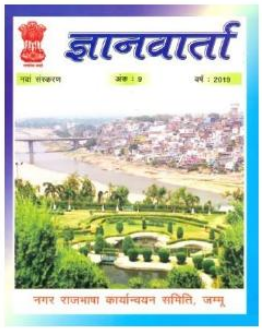
सीएसआईआर-भारतीय समवेत औषध संस्थान, जम्मू राजभाषा के कार्यान्वयन के लिए सदा ही तत्पर रहता है। हिन्दी अनुभाग द्वारा राजभाषा विभाग, भारत सरकार के दिशा-निर्देशों व हिन्दी के वार्षिक कार्यक्रमों का उचित पालन करते हुए स्थानीय स्तर पर उचित कार्यवाही सुनिश्चित की जाती है। इसके साथ-साथ संस्थान में राजभाषा से संबंधित सरकारी/विभागीय दैनिक कार्य भी किया जाता है।

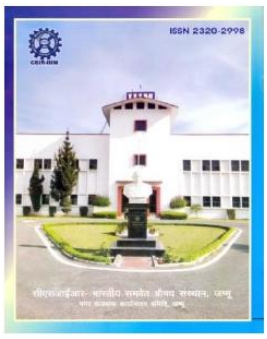
वार्षिक कार्यक्रमों में हिन्दी सप्ताह/पखवाड़ा मनाया जाना - जिसमें विभिन्न प्रतियोगिताएं आयोजित करवाना, समय-समय पर हिन्दी/राजभाषा से संबंधित कार्यशालाओं का आयोजन, हिन्दी में हो रहे कार्य का मूल्यांकन इत्यादि रहता है। संस्थान में राजभाषा/हिन्दी के उपयोग को बढ़ावा देने के लिए अधिकारियों/ कर्मचारियों को उचित प्रोत्साहन/पुरस्कार राशि की भी व्यवस्था की गई है। समय-समय पर योग्य अधिकारियों/ कर्मचारियों को उचित प्रशिक्षण के लिए भी नामित किया जाता है ।

नगर राजभाषा कार्यान्वयन समिति (नरकास), जम्मू मे योगदान:

सीएसआईआर-भारतीय समवेत औषध संस्थान, नराकास, जम्मू का एक अहम सदस्य है। आई.आई.आई.एम. के निदेशक, नराकास, जम्मू के अध्यक्ष हैं। नराकास जम्मू के अधीन अभी करीब 80 केन्द्रीय कार्यालय आते है जिनकी साल में दो अर्धवार्षिक बैठकें आयोजित की जाती हैं।

संस्थान द्वारा नराकास, जम्मू की राजभाषा गृह पत्रिका "ज्ञानवार्ता" का समय-समय पर प्रकाशन किया जाता है। पत्रिका मे नराकास सदस्य कार्यालयों के अधिकारियों, कर्मचारियों व् शोध छात्रों द्वारा लिखे गये साहित्यिक लेख, वैज्ञानिक शोध पत्र, नाटक एवं उत्कृष्ट कहानी, रचनाएं प्रकाशित की जाती है तथा यह विश्वविद्यालयों के प्राध्यापकों/शोध छात्र/छात्राओ के लिए भी उपयोगी है । इस गृह पत्रिका की पंजियन संख्या **ISSN 2320-2998** है ।





कोविड-19 को ध्यान में रखते हुए वर्तमान में सभी प्रकार की बैठकें ऑनलाइन आयोजित की जा रही है।

वित्त वर्ष 2020-21 में हिन्दी अनुभाग की गतिविधियों का ब्यौरा नीचे दिया गया है :

क्रमांक	गतिविधियों का विवरण	तिथि
1.	**राजभाषा कार्यान्वयन समिति की बैठकें**	
	पहली बैठक (अप्रैल से जून)	24.06.2020
	दूसरी बैठक (जुलाई से सितम्बर)	30.09.2020
	तीसरी बैठक (अक्टूबर से दिसम्बर)	29.12.2020
	चौथी बैठक (जनवरी से मार्च)	31.03.2021
2.	**नगर राजभाषा कार्यान्वयन समिति की बैठकें**	
	पहली छमाही बैठक	24.06.2020
	दूसरी छमाही बैठक	24.11.2020
3.	**हिन्दी कार्यशाला का आयोजन**	**मुख्य-वक्ता**
	विषय: "हिन्दी की जीवन यात्रा और प्रगति" दिनाक: 14.09.2020	श्री अशोक कुमार दीक्षित, पूर्व प्राध्यापक, खादी ग्रामोद्योग, जम्मू
	विषय: "राजभाषा की उपयोगिता - हिन्दी या अंग्रेजी" दिनाक: 30.12.2020	श्री सुकृति कुमार शर्मा, सहायक निदेशक, दूरदर्शन केन्द्र, जानीपुर, जम्मू
	विषय "कार्यालय में हिन्दी में कार्य करने हेतु यूनिकोड का प्रयोग" दिनाक: 25.03.2021	श्री सन्तोष कुमार, सहायक निदेशक, हिन्दी शिक्षण योजना, राजभाषा विभाग, गंग्याल, जम्मू
4.	हिन्दी सप्ताह-2020 दिनाक: 07.09.2020 से 14.09.2020 तक	निबंध लेखन, सूक्ति लेखन, राजभाषा हिन्दी के मूल कार्य का मूल्यांकन आदि
5.	प्रशिक्षण कार्यक्रम सत्र : 01 जनवरी-मई, 2021	इस अवधि के दौरान 13 योग्य अधिकारियों/कर्मचारियों को हिन्दी प्रबोध, प्रवीण, प्राज्ञ व पारंगत कक्षाओं का ऑनलाइन (ONLINE) प्रशिक्षण के लिए नामित किया गया है।

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 APPOINTMENT MADE DURING THE PRECEDING CALENDER YEAR 2020

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (DSIR) O/o INDIAN INSTITUTE OF INTEGRATIVE MEDICINE, JAMMU.

	Representation of SCs/STs/OBCs(As on 01.01.2021)				Number of appointments made during the calendar year 2020.									
					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	84	11	06	13	12	01	03	05	-	-	-	-	-	-
Group B	64	13	03	11	-	-	-	-	-	-	-	-	-	-
Group C	67	27	-	10	**04	03	-	-	-	-	-	-	-	-
Group D(Excluding Sweepers)	*													
Group D(Sweepers)	*													
TOTAL	215	51	09	34	16	04	03	05	-	-	-	-	-	-

*shown in Group C column.

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 APPOINTMENT MADE IN THE SERVICE IN VARIOUS GRADES IN THE CALENDER YEAR 2020

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (DSIR) O/o INDIAN INSTITUTE OF INTEGRATIVE MEDICINE, JAMMU.

	Representation of SCs/STs/OBCs(As on 01.01.2021)				Number of appointments made during the calendar year 2020.									
					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	05	01	-	02	-	-	-	-			-	-	-	-
PB-3 Rs.6600	23	02	04	08	11	01	03	05	-	-	-	-	-	-
PB-3 Rs 7600	17	05	-	-	01	-	-	-	-	-	-	-	-	-
PB-4 Rs 8700	34	02	-	03	-	-	-	-	-	-	-	-	-	-
PB-4 Rs 8900	03	01	01	-	-	-	-	-	-	-	-	-	-	-
PB-4 Rs 10,000	03	-	01	-	-	-	-	-	-	-	-	-	-	-
HAG+Above	01	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	86	11	06	13	12	01	03	05	-	-	-	-	-	-

D Report – I

ANNUAL STATEMENT SHOWING THE REPRESENTATION OF THE PERSONS WITH DISABILITIES IN SERVICES
(AS ON 1ST JANUARY, 2021)

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (DSIR)
O/o CSIR-INDIAN INSTITUTE OF INTEGRATIVE MEDICINE, JAMMU.

Group	Total	In Identified posts	Number of Employees		
			VH	HH	OH
1	2	3	4	5	6
Group A	84				03
Group B	64				01
Group C	67				01
Group D					
TOTAL	215				05

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 APPOINTMENT MADE DURING THE PRECEDING CALENDER YEAR 2020

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (DSIR) O/o INDIAN INSTITUTE OF INTEGRATIVE MEDICINE, JAMMU.

	Representation of SCs/STs/OBCs(As on 01.01.2021)				Number of appointments made during the calendar year 2020.									
					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	84	11	06	13	12	01	03	05	-	-	-	-	-	-
Group B	64	13	03	11	-	-	-	-	-	-	-	-	-	-
Group C	67	27	-	10	**04	03	-	-	-	-	-	-	-	-
Group D(Excluding Sweepers)	*													
Group D(Sweepers)	*													
TOTAL	215	51	09	34	16	04	03	05	-	-	-	-	-	-

*shown in Group C column.

**appointed on compassionate ground

17. HUMAN RESOURCE

HUMAN RESOURCE

Director
Dr.D. Srinivasa Reddy

Chief Scientist
Er. Rajneesh Anand
Dr. D.M. Mondhe
Er. Abdul Rahim

Sr. Principal Scientist
Dr. Gurdarshan Singh
Dr. Zabeer Ahmed
Dr. Anindya Goswami

Principal Scientist
Dr. Muzamil Ahmad
Dr. Shashank Kr. Singh
Dr. Fayaz Ahmed Malik
Dr. Sandip B. Bharate
Dr. (Ms.) Asha Chaubey
Dr. Sanghapal D. Sawant
Dr. Sheikh Tasduq Abdullah
Dr. Dhiraj Kr. Vyas
Dr. Prem N. Gupta
Dr. Sumit Gandhi
Dr. Zahoor Ahmad Parry
Dr. Qazi Parvaiz Hassan
Dr. Syed Riyaz-Ul Hassan
Dr. (Mrs.) Suphla Bajpai Gupta
Dr. Debaraj Mukherjee
Dr. Amit Nargotra
Dr. Pyare Lal Sangwan
Dr. Qazi Naveed Ahmad
Dr. Mohd Jamal Dar
Dr. Khursheed A. Bhat
Dr. Prasoon Kumar Gupta
Dr. (Mrs.) Deepika Singh
Dr. Parvinder Pal Singh
Dr. Syed Sajad Hussain
Dr. Saurabh Saran
Sh. Anil Kumar Katare
Dr. Govind Yadav
Dr. Bhahwal Ali Shah
Dr. Sundeep Jaglan

Sr. Scientist
Dr. Rajkishore Rai
Dr. (Mrs.) Meenu Katoch
Dr. Bilal Ahmad Bhat
Dr. (Mrs.) Nasheeman Ashraf
Dr. Sumeet Gairola
Dr. Prashant Misra
Er. Shaghaf Mobin Ansari
Dr. Vikash Babu
Dr. Ravi Shankar
Dr. Utpal Nandi
Dr. Shahid Rasool

Scientist
Dr. Sreedhar Madishetti
Dr. Rajendra Bhanwaria
Dr. Vishav Prakash Rahul
Dr. Sabha Jeet
Dr. Nazia Abbas
Dr. Firdoous Ahmad Mir
Dr. Ravail Singh
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.

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 Sultlan
Dr. Siya Ram Meena
Sh. Sanjay Sharma

Superintending Engineer (Civil)
*Sh. G.P. Singh

Superintending Engineer (Elect.)
Sh. Ashwani Chopra

Sr. Technical Officer (1)
Sh. Ajit Prabhakaran
Dr. M.K. Verma

Assistant Executive Engineer (Civil)
*Sh. S.N. Bharti

Technical Officer
Mrs. Bhavana 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
Sh. Ashok Kumar Bhargava
Mrs. Priya Wazir
Sh. Sumit Roy
Sh. Habibullah
Sh.Yadunandan Sen

Junior Engineer (Electrical)
Sh. Bikram Singh

Junior Engineer (Mechanical)
Sh. Narinder Kumar

Sr. Technician (3)
Sh. Vikram Bhradwaj

Sh. Ajeet Singh
Sh. Kuldeep Singh
Mrs. Shabnam Khan
Mrs. Sunita Devi

Sr. Technician(2)
Mrs. Neelam Sharma
Mrs. Raj Kumari
Sh. Vikram Abrol
Sh. Madan Lal
Sh. P.R. Mehta
Dr. Anil Prabhakar
Sh. Ashwani Sharma
Sh. Partap Chand
Mrs. Kiran Koul
Sh. Satya Bhushan
Sh. Rajinder Kumar
Sh. Vijay Kumar
Sh. Ashok Kumar
Sh. Kasturi Lal
Ms. Anjum Vashist

Sr.Technician (1)
Sh. Rajesh KumarSahdev

Technician (2)

Technician (1)
Sh. Asad Ullah
Sh. Rahul Kalgotra
Sh. Karan Pal
Sh. Kirshan Kumar

Lab Assist.
Sh. Bishan Kumar
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. (2)
Sh. Ashok Kumar
Sh. Nagar Lal
Sh. Kuldeep Kumar

Sr. Controller of Administration
Sh. Pankaj Bahadur

Store & Purchase Officer
Sh. Praphul Kumar

Finance & Accounts Officer
Sh. Zahoor Ahmad Wani

Section Officer (G)
Sh. Rajesh Kumar Gupta

Section Officer (F&A)
*Sh. Anil Gupta

Section Officer (S&P)
Sh. Satish Sambyal

Private Secretary
-

Assistant Section Officer (G)
Sh. Romesh Kumar Mottan
Sh. U.S. Thappa
Sh. Ranjeet Kr. Gupta
Sh. Manoj Kumar
Ms. Nisha Vij
Sh. Rajinder Singh
Sh. Ashok Kumar
Mrs. Rekha Gupta
Sh. Mohd. Ayub Bhat

Asstt. Section Officer (S&P)
Mrs. Rajni Kumari

Assistant Section Officer (F&A)
Sh. Vikas Patiaya
Sh. Vinod Kumar Meena
Mrs. Lovely Ganjoo

Receptionist
Mrs. Jyoti Prabha

Security Assistant
Sh. Bhupinder Singh
Sh. Balkrishan
Sh. Subash Chander

Sr. Secretariat Assistant (F&A)
Sh. Sanchit Kumar Sharma
Sh. Roshan Lal

Sr. Secretariat Assistant (S&P)
Sh. Bua Ditta
Sh. Angrez Chand
Sh. Rakesh Chowdhary

Sr. Secretariat Assistant (G)
Sh. Tarsem Kumar
Sh. Kartik Kapoor
Sh. Rankush Pandita
Sh. Ishan Dogra

Jr. Secretariat Assistant (G)
Sh. Krishan Mamwal

Halwai
Sh. Janak Raj

Junior Stenographer
Sh. Abshishek Gupta
Sh. Rishu Sharma
Sh. Satish Kumar
Sh. Sahil Salotra
Ms. Jyoti Devi

Driver
Sh. Mohit Kumar
Sh. Tarun Kashyap

MTS Staff
Sh. Mohd. Farooq Bhat
Sh. Ram Lal
Sh. Chaman Lal
Sh. Ashok Kumar Balgotra
Sh. Parshotam Lal
Sh. Romesh Kumar
Sh. Pawan Kumar
Sh. Rajesh Kr. Tandon
Sh. Moses Tegi
Sh. Subash Chander
Sh. Sodagar Mal
Sh. Mangal Dass
Sh. Suram Chand
Sh. Girdhari Lal
(S/o Sh. Singara Ram)
Sh. Girdhari Lal
(S/o Sh. Daya Ram)
Sh. Sukhdev Raj
Sh. Sat Pal
Sh. Bua Ditta
Sh. Ashok Kumar
(S/o Sh. Charantu Ram)

Sh. Ashok Kumar
(S/o Sh. Gharoo Ram)
Sh. Dev Raj
Sh. Sham Lal
Sh. Kali Das
Smt. Satya Sharma
Sh. Seva Ram
Sh. Sodagar Lal
Sh. Ashok Kumar
Sh. Karnail Chand
Sh. Surinder Kumar
Sh. Munna
Sh. Sodagar Lal
(S/o Sh. Babu Ram)
Sh. Bachan Lal
Sh. Daleep Raj
Sh. Roshan Lal
Smt. Kirti
Sh. Ashwani Kumar