

# 2019

## PROCEEDINGS



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**DIVISION OF BIOCHEMISTRY  
IARI NEW DELHI**

**Society for Plant Biochemistry  
and Biotechnology (SPBB)**

# National Workshop

**Proteomics and Metabolomics: Application in Agriculture  
for Enhancing Grains Productivity and Processability**

# PROCEEDINGS



## Proteomics and Metabolomics: Application in Agriculture for Enhancing Grains Productivity and Processability

**SOCIETY FOR PLANT BIOCHEMISTRY  
AND BIOTECHNOLOGY  
NEW DELHI**



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## PREFACE

The workshop/ panel discussion on “Proteomics and Metabolomics – Application in Agriculture for Enhancing grains productivity and processability” was planned to highlight the importance of advanced omics tools used in Biochemistry having potential to influence different dimensions of research. Most of the research work in present scenarios is dominated with Molecular Biology and Genetic Engineering tools and biochemical tools have been observed to be on the verge of extinct. This workshop was planned in order to discuss the importance of evolving Omics tools and their use in the area of Biochemistry and Molecular Biology and at the same time listing the gaps and providing the possible solutions to popularize the tools among the young researchers and scientists.

Division of Biochemistry, IARI has long legacy of utilizing various tools of proteomics and metabolomics in different areas of research for getting significant research outcome as evident from the publications. Division is also involved in human resource development by providing hands-on-experience to scientists/ researchers in different tools of proteomics and metabolomics under the aegis of different training programs.

In current workshop, different sessions were planned in order to have through discussions on different aspects of proteomics and metabolomics and to address some of the issues like -

- Importance and future of proteomics and metabolomics in Agriculture.
- Different proteomics and metabolomics tools for characterizing the Defence Network and nutritional quality of grains.
- Different bioinformatics tools used in proteomics and metabolomics.

The first session highlighted the importance of gel-based and gel-free proteomics tools as well as importance and utility of techniques like NMR, UPLC, ICP-MS, etc. in metabolome profiling. The focus was more towards the utility of these techniques for enhancing grain productivity and quality under present threat of global climate change. The discussion was well received at both the front and numerous questions were raised and probable solutions were provided. We are highly thankful to Society for Plant Biochemistry and Biotechnology (SPBB), New Delhi for supporting us in organizing this National Workshop on such an important topic and to all the participants for making it a grand success.

# PROCEEDING NATIONAL WORKSHOP

## Proteomics and Metabolomics: Application in Agriculture for Enhancing Grains Productivity and Processability

A National workshop on “Proteomics and Metabolomics: Application in Agriculture for Enhancing Grains Productivity and Processability” was organized on 19<sup>th</sup> August, 2019 under the aegis of Society of Plant Biochemistry and Biotechnology (SPBB), New Delhi for highlighted the importance, uses, and gaps in Proteomics and Metabolomics – the two most important tools of OMICS. The objective of the workshop was to discuss the evolution of different dimensions of proteomics and metabolomics, there uses in the field of Agriculture for enhancing the quantity and quality of grains, limitations and future line of action. In order to address the objectives mentioned above, a session was convened under the chairmanship of Dr. Viswanathan C. (Coordinator, School of Basic Sciences, ICAR-Indian Agricultural Research Institute) with Prof. Rajat Sandhir (Prof. & Pri. Sci., Punjab University, Chandigarh) as Co-chair and Dr. Suneha Goswami (Scientist-SS) as rapporteur. The lead talks were delivered by Prof. Rajat Sandhir (Prof. & Pri. Sci., Punjab University, Chandigarh), Dr. Rajeev K. Naik (Head, Division of Biochemistry, MPKV, Rahuri, Maharashtra), Dr. Rakesh Pandey (Head, Microbial Technology & Nematology Department, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow), Dr. Ranjeet R. Kumar (Senior Scientist, Division of Biochemistry, ICAR-Indian Agricultural Research Institute, New Delhi) and Mr. Sandeep Kumar (PhD student, Division of Biochemistry, ICAR-Indian Agricultural Research Institute, New Delhi) in diverse areas of proteomics and metabolomics.

This proceeding of National Workshop summarizes the viewpoint of renowned speakers from diverse areas and regions of India and need not be considered as the sole opinion of Society for Plant Biochemistry and Biotechnology, New Delhi. The key points shared by the speakers has been summarized below –

**Prof. Rajat Sandhir** delivered talk on “**Applications of NMR-based metabolomics**” and highlighted the following points –

- He highlighted the importance of NMR in analysing low molecular weight (< 2000 Da) organic molecules in a sample such as a single cell, leaf, fruit, and seedling.
- Discussed the importance of metabolome as it gives functional end-point of physiology and pathophysiology study, provides reasonable scale of the analytical challenge and direct mirror of environmental influences especially in (Mal-) nutrition, Exercise, Medication, etc.
- Explained the targeted and untargeted metabolomics and highlighted the importance and use of both the approaches.
- Targeted metabolomics is highly accurate though the scope is limited as compared to un-targeted approach.
- Addressed the question “Why Metabolomics is Difficult” and concluded that chemical diversity ( $10^5$ ) is the main reason behind the limited use of the technique and its complexity.
- Even the concentrations of cellular metabolites vary over several orders of magnitude (mM to pM) and differences in molecular weight (20-2000 Da) are also reason behind the complexity of metabolomics.
- Highlighted the importance of HPLC and LC-MS and shared the detection limit of both the technique in the order of 100 nM, allowing detection of large number of metabolites.
- Explained the importance of NMR spectroscopy as it provides structural information about organic compounds and biomolecules. NMR involves an interaction between electromagnetic radiation and the nucleus of an atom.
- NMR can be used in non-invasive manner, making it possible to metabolically profile intact tissue or whole organ and uses isotopes possessing property of

magnetic spin-  $^1\text{H}$ ,  $^{13}\text{C}$  and  $^{31}\text{P}$ . Like LC-MS, virtually any sample type (including intact tissue) can be assayed - LC-MS (nM) vs. NMR ( $\mu\text{M}$ ).

- NMR is preferred over other technique because of Rapid metabolite identification and quantifications and Monitoring flux/kinetics in real time.
- Discussed the steps involved in NMR like prepare the cells, harvest the metabolome, collect the NMR data analyse the NMR data, analyse the metabolic changes.
- NMR can be used Metabolomics can be used in functional genomics and to differentiate plants from different origin, or after different treatments. It can also be used to identify secondary plant compounds involved in host plant resistance.

**Dr. Rajeev K. Naik**  
Lead Speaker

Head & Pri. Sci., MPKV, Rahuri

**Dr. Rajeev K. Naik** delivered talk on “**Metabolomics for improvement of complex metabolic traits in crop plants**” and discuss the following key points –

- Highlighted the importance of Metabolomics like - Metabolomics reflects integration of gene expression, protein interaction and other regulatory processes and provides precision and speed for improving targeted traits in developing climate smart and nutrition sensitive agriculture.
- Conveyed that Metabolomics along with NGS has come a long way in trait discovery, trait mapping, markers, elite line development, etc.
- Highlighted the importance of Metabolomics in dissecting the abiotic stress tolerance mechanism in plants.
- Metabolomics can be used for the annotation of gene function and is the most reliable and authentic.
- Discuss the importance of metabolome in dissecting the genotype–phenotype associations in rice grains.
- Share the use of metabolome in characterizing the pathways related to rice grain chalkiness.

- Highlighted the importance of Enzyme-driven metabolomics screening with examples like identification of host compounds targeted by pathogen enzymes and to make them insensitive to pathogen enzymes [Tomato : Tomatine degradation by Tomatinase, Wheat – MBOA (6-methoxy-benzoxazolin-one) degradation by Fdb1, etc.

**Dr. Rakesh Pandey**      Head & Pri. Sci., CIMAP, Lucknow  
**Lead Speaker**

**Dr. Rakesh Pandey** delivered his talk on "**Plant Metabolites Vs Cognitive diseases in *Caenorhabditis elegans***". Some of the key points of the talk are –

- Discussed the significant role of model organisms in biomedical, environmental and plant sciences for easing research and development activities globally.
- He cited the example of Father of Genetics, “Gregor John Mendal”, who played with pea plants as model system in his monastery garden for resolving the big mysteries of genes and inheritance.
- Highlighted the importance of *Caenorhabditis elegans* as a central and key toolkit for different kinds of research for biomedical sciences.
- Explained his research work on multicellular soil nematode *C. elegans* as a model to study the impact of various phytomolecules especially from medicinal and aromatic plants for their anti-ageing and cognitive enhancer activities.
- Discuss about the rosmarinic acid, a polyphenol-containing hydroxy acid as major component of well-known medicinal herb rosemary (*Rosmarinus officinalis* L.) which possesses several biological activities such as anti-inflammatory, immuno-regulatory, anti-depressants and anti-aging.
- Explained the age related disorder like Parkinson’s. Parkinson’s disease is characterized by alpha-synuclein aggregation leading to bradykinesia like symptoms.
- He reported significant decline in alpha-synuclein aggregation, a hallmark of Parkinsonism pathology in treated worms, as compared to control.

- He recorded significant enhancement in dopaminergic transmission in response to 1-nonanol in rosmarinic acid treated worms in comparison to untreated vehicle control.
- Furthermore, he demonstrated considerable alleviation of intracellular reactive oxygen species (ROS) on exposure to rosmarinic acid as estimated through intracellular ROS quantification (using H<sub>2</sub>-DCFDA) and oxidative stress assay (Juglone induced oxidative stress).
- He also explained number of phytomolecules isolated from medicinal and aromatic plants against cognitive disorders using *C. elegans* model system.
- He also hypothesized the possibility to introduce such protein in the plant host to target plant parasitic nematodes as they become serious threat for successful cultivation of medicinal and aromatic plants.
- He highlighted the importance of free living nematode and its use in understanding the plant pathogen biological networks to promote plant resistance against pest and pathogens.

**Dr. Ranjeet R. Kumar** Senior Scientist, IARI, New Delhi  
Lead Speaker

**Dr Ranjeet R. Kumar** has delivered talk on “**Advances in Proteomics: A Challenging but Powerful Tool for Crop Improvement**”. Some of the key points of the talk are –

- Proteome provides entire set of proteins, produced or modified by an organism or system and differs from cell to cell and from time to time.
- Has been used exhaustively in characterizing the mechanism associated with abiotic and biotic stress tolerance, nutritional quality of the crops, growth response, signalling, etc.
- Highlighted the importance of gel-free proteomics in elucidating different mechanisms operating inside the plant system.



- Explained different techniques like 2-DE, IEF, ICAT, MS, nLC-MS, etc. along with some of the free accessible software's to be used for characterizing the proteomic data.
- Highlighted the importance of different sub-sections of proteomics like Quantitative Proteomics, Phosphoproteomics, Proteogenomics, Glycoproteomics, etc.
- He explained some of the limitations of proteomics like costly instrument, non-availability of instrument, lack of expertise and training program in respective areas, costly software's, public database are not easily accessible, etc.
- He suggested some of the steps for making this technique more popular among the researchers – common facility for proteomics, free software's, dedicated training program under CAFT, Cost Effective High Throughput Tools for Proteome, freely accessible Databases.
- Suggested novel areas which need to be targeted like Exploring Redox Proteome, Connecting Genome with Proteome, Computing – Functional Proteome and lastly Connecting Proteome with Phenome.

**Mr. Sandeep Kumar**      PhD Student, IARI, New Delhi  
**Speaker**

**Mr. Sandeep Kumar** has delivered talk on “**Metabolome for Characterizing Flavones Biosynthesis Pathway**”. Some of the highlights of the talk are –

- He introduce different terminology used in the area of metabolomics and highlighted the importance of this technique in characterizing secondary metabolite pathway.
- Explained the different separation techniques like Gas Chromatography (GC), Capillary Electrophoresis (CE), High Performance Liquid Chromatography (HPLC), Ultra Performance Liquid Chromatography (UPLC) and Detection Techniques like Nuclear Magnetic Resonance Spectroscopy (NMR) and Mass Spectrometry (MS).
- Highlighted the importance of metabolome in System Biology approach.

## ACKNOWLEDGMENT

This one day National workshop on “*Proteomics and Metabolomics: Application in Agriculture for Enhancing Grains Productivity and Processability*” was possible because of the financial support received from the Society for Plant Biochemistry and Biotechnology. We acknowledge the ideas, support and help received from **Dr. Shelly Praveen** (Secretary, SPBB) and **Dr. S. L. Mehta** (President, SPBB).

**Dr. Ranjeet R. Kumar, Dr. S. Goswami** and **Dr. Vinutha T.** (Organizing secretaries) extend their deep sense of gratitude to the steering committee of SPBB, New Delhi for approving the proposal for organising the one day National Workshop under the banner of the society.

We are highly indebted to **Dr. C. Viswanathan** (Coordinator, School of Basic Sciences & Head, Division of Plant Physiology), and **Dr. Rajat Sandhir** (Prof. & Pri. Sci., PU, Chandigarh) for organizing the first session as Chair and Co-chair. The efforts of other renowned lead speakers from different part of India are highly appreciated.

We are highly thankful to all the participants for coming all the way from their home for attending this Workshop and the members of different committees for helping us in all possible manners.

## Committees

Organizing Secretaries	Dr. Shelly Praveen, Head, Division of Biochemistry, IARI Dr. Ranjeet R. Kumar, Sr. Scientist, IARI, New Delhi Dr. Suneha Goswami, Scientist, IARI, New Delhi Dr. Vinutha T., Scientist, IARI, New Delhi
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