Curriculum vitae

DIGAR SINGH, Ph.D.

Assistant Professor (Microbiology),
Department of Botany & Microbiology,
H.N.B. Garhwal University (A Central University)

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Present designation

- ***Assistant Professor (Microbiology)*** ***Aug' 2023 onwards***
- Department of Botany and Microbiology,
  H.N.B. Garhwal University, Srinagar, Uttarakhand, India

Past work experience

 # University of North Texas, Denton, TX, The USA ***Aug' 2022 – July' 2023***

- ***Research Associate***
- Bio-Discovery Institute, Department of Biological Sciences

Advisor: Prof. Ana Paula Alonso

Research Project 1: Non-targeted metabolomic approaches for examining how the fungal endophytes uniquely bio-transforms chemical milieu of plant holobiont (Psychotria species).

Research Project 2: Probing the effects of fungal antibiotic expression (Penicillin and Mycophenolic acid) in host plant's (*Nicotiana bethamiana*) central metabolism.

 # Konkuk University, Seoul, South Korea ***Mar' 2019 – June' 2022***

- ***Research Professor***
- Department of Biosciences and Biotechnology

Advisor: Prof. Choong Hwan Lee

Research Project: Probing metabolite cross-feeding (MCF) between *Aspergillus* and *Bacillus* species. The project involved examining the effects of bi-direction MCF on growth, metabolism, and phenotypes (Fungi: conidiation, Bacteria: biofilm formation) of interacting species.

 # Konkuk University, Seoul, South Korea ***Mar' 2016 – Feb' 2019***

- ***Assistant Professor (KU-Brainpool)***
- Department of Biosciences and Biotechnology

Advisor: Prof. Choong Hwan Lee

Research Project 1: Probing headspace volatilome of *Aspergillus* species using SPME-GC-TOF-MS-based untargeted metabolomics.

Research Project 2: Volatile organic compounds (VOCs)-mediated interaction between Aspergillus species and its effects on growth, morphology, and mycotoxin production.

Major contributions to the field

- Using non-targeted metabolomic approaches, I established the role of '1-Octen-3-ol' in modulating *Aspergillus* metabolism, growth, morphogenesis, and mycotoxin production (Patent KIPO: 10-2236079).
- Determined how the metabolite cross-feeding (MCF) influence niche construction during 'Bacterial-Fungal' Interactions.
- Determined how the fungal leaf endophytes influence plant holobiont and chemical diversity.

Research interests & approaches

- Metabolomic approaches in holobiont and host-microbiome interactions.
- Simulating and testing 'Host-Microbiome' models.
- Computational Metabolomics & high throughput 'multi-omics' approaches.

Education

 # *Ph.D.* ***July' 2009 – July' 2014***

- ***Indian Institute of Technology Guwahati***
- **Specialization:** Fungal entomotoxin alkaloids.
- **Thesis title:** Studies on production, analysis and cytotoxicity of indolizidine alkaloid, swainsonine, from an insect pathogenic fungus *Metarhizium anisopliae*.
- **Coursework CGPA:** 8.17/10 (36 credits)
- **Ph.D. advisor:** Prof. Gurvinder Kaur Saini.
- **Salient features of the Ph.D. thesis work:** We developed a work pipeline toward fermentative optimization, LC-MS/MS characterization, and unraveling entomotoxicity mechanisms of swainsonine on insect cell cultures.

 # *M.Sc. (Microbiology)* ***Aug' 2007 – July' 2009***

- ***G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India***
- **Specialization:** Characterization of endophytic bacteria.
- **Dissertation:** Biochemical and molecular characterization of the bacterial endophytes from native sugarcane varieties of Himalayan region.
- **Coursework CGPA:** 8.17/10 (36 credits)

 # *B.Sc. (Chemistry, Botany, and Zoology)* ***June' 2003 – May' 2006***

- ***Kumaun University, Nainital, Uttarakhand, India***
- **Coursework (marks obtained): 70.51 %**

Research outputs

Patent(s):

- Lee CH, **Singh D**. A Method for Modulating Metabolism of *Aspergillus*. Konkuk University Industry-Academy Co-operation (**Date of application: 13.11.2019**). **Korean Intellectual Property Office (KIPO), Registration No. 10-2236079.**

Publications (selected):

1. SH Kim, **Singh D**, SA Kim, MJ Kwak, D Cho, et al. Strain-specific metabolomic diversity of *Lactiplantibacillus plantarum* under aerobic and anaerobic conditions. **Food Microbiology**, Elsevier, 116, 2023, 104364.
2. Choi SR, Lee H, **Singh D**, Cho D, Chung JO, et al. Bidirectional Interactions between Green Tea (GT) Polyphenols and Human Gut Bacteria. **Journal of Microbiology and Biotechnology,** 33, 10, 2023, 1-12.
3. **Singh D**, Lee SH, Lee CH. Non-obligate Pairwise Metabolite Cross Feeding Suggest Ammensalic Interactions Between *Bacillus* and *Aspergillus* species. **Communications Biology,** Nature Portfolio Group, 5, 1, 2022, 1-12.
4. Kim SH, **Singh D**, Son SY, Lee S, Suh DH, et al. Characterization and temporal dynamics of the intra- and extracellular environments of *Lactiplantibacillus plantarum* using multi-platform metabolomics. **LWT - Food Science and Technology**, Elsevier Science London, 175, 2022, 114376
5. **Singh D**, Son SY, Lee CH. Critical thresholds of 1-Octen-3-ol shape inter-species *Aspergillus* interactions modulating the growth and secondary metabolism. **Scientific Reports,** Nature Portfolio Group, 10, 1, 2020, 1-14.
6. **Singh D**, Lee S, Lee CH. Fathoming *Aspergillus oryzae* metabolomes in formulated growth matrices. **Critical Reviews in Biotechnology,** Taylor and Francis Group, 39, 1, 2019, 35-49.
7. **Singh D**, Lee CH. Volatiles Mediated Interactions between *Aspergillus oryzae* Strains Modulate Morphological Transition and Exometabolomes. **Frontiers in Microbiology,** Frontiers Media S.A. 9, 2018, 628.
8. **Singh D**, Lee CH**.** Intra-species Volatile Interactions Affects Growth Rates and Exometabolomes in *Aspergillus oryzae* KCCM 60345. **Journal of Microbiology and Biotechnology,** Korean Soc Microbiology & Biotechnology, 28, 2018, 2, 199-209.
9. **Singh D**, Lee S, Lee CH**.** Metabolomics for empirical delineation of the traditional Korean fermented foods and beverages. **Trends in Food Science and Technology,** Elsevier Science London, 61, 2017, 103-115.
10. **Singh D**, Son SY, Lee CH. Perplexing metabolomes in fungal-insect trophic interactions: A *terra incognita* of mycobiocontrol mechanisms. **Frontiers in Microbiology,** Frontiers Media S.A. 7, 2016.
11. **Singh D,** Kaur G. Production, HPLC analysis, and *in situ* apoptotic activities of swainsonine in lepidopteran, *Sf*-21 cell line. **Biotechnology Progress**, Wiley, 30, 2014, 1196-1205**.**
12. **Singh** D, Kaur G. The antileukemic cell cycle regulatory activities of swainsonine purified from *Metarhizium anisopliae* fermentation broth. **Natural Product Research,** Taylor & Francis Ltd., 28, 2014, 22, 2044-2047**.**
13. **Singh D,** Kaur G. Swainsonine, a novel fungal metabolite: optimization of fermentative production and bioreactor operations using evolutionary programming. ***Bioprocess and Biosystems Engineering,*** Springer, 37, 2014, 8, 1599-1607**.**
14. Lee S, Oh D, **Singh D**, Lee JS, Lee S, Lee CH. Exploring the metabolomic diversity of plant species across spatial (leaf and stem) components and phylogenic groups. **BMC Plant Biology,** BMC England, 20, 2020, 1, 1-10.
15. Mun HI, Kim YX, Suh DH, Lee S, **Singh D**, et al. Metabolomic response of Perilla frutescens leaves, an edible-medicinal herb, to acclimatize magnesium oversupply. **PLoS One,** Public Library Science, 15, 2020, 7, p.e0236813.

16. Son SY, Park YJ, Jung ES, **Singh D**, Lee YW, et al. Integrated Metabolomics and Transcriptomics Unravel the Metabolic Pathway Variations for Different Sized Beech Mushrooms. **International journal of molecular sciences**, MDPI, 20, 2019, 23:6007.
17. Seo HS, Lee S, **Singh D**, Shin HW, Cho SA, Lee CH. Untargeted metabolite profiling for koji-fermentative bioprocess unravels the effects of varying substrate types and microbial inocula. **Food Chemistry**, Elsevier Science Ltd., 266, 2018, 161-169.
18. Park J, Suh DH, **Singh D**, Lee S, Lee JS, Lee CH. Systematic metabolic profiling and bioactivity assays for bioconversion of Aceraceae family. **PLoS One.** Public Library Science, **13**, 2018, 6, 13:e0198739.
19. Son SY, Lee S, **Singh D**, Lee NR, Lee DY, Lee CH. Comprehensive secondary metabolite profiling toward delineating the solid and submerged-state fermentation of *Aspergillus oryzae* KCCM 12698. **Frontiers in Microbiology**, Frontiers Media S.A. 9, 2018, 1076.
20. Lee S, Lee DE, **Singh D**, Lee CH. Metabolomics Reveal Optimal Grain Preprocessing (Milling) toward Rice Koji Fermentation. **Journal of Agricultural and Food Chemistry,** ACS, 66, 2018, 11, 2694-2703.
21. Jung ES, Park HM, Hyun SM, Shon JC, **Singh D**, et al. The Green Tea Modulates Large Intestinal Microbiome and Exo/Endogenous Metabolome altered through Chronic UVB-exposure. **PLoS One**. Public Library Science, 12, 2017, 11:e0187154.
22. Sim I, Suh DH, **Singh D**, Do SG, Moon KH, et al. Unraveling Metabolic Variation for Blueberry and Chokeberry Cultivars Harvested from Different Geo-Climatic Regions in Korea. **Journal of Agricultural and Food Chemistry,** ACS, 65, 2017, 41, 9031-9040.
23. Park YJ, Jung ES, **Singh D**, Lee DE, Kim S, et al**.** Spatial (cap & stipe) metabolomic variations affect functional components between brown and white beech mushrooms. **Food Research International,** Elsevier Science Ltd., 102, 2017, 544-552.
24. Lee MY, Kim HY, Lee DE, **Singh D**, Yeo SH, et al. Construing temporal metabolomes for acetous fermentative production of *Rubus coreanus* vinegar and its in vivo nutraceutical effects. **Journal of Functional Foods**, Elsevier Science Ltd., 34, 2017, 311-318.
25. Suh DH, Lee HW, Jung ES, **Singh D**, Kim SH, Lee CH. *In vivo* metabolomic interpretation of the anti-obesity effects of hyacinth bean (*Dolichos lablab* L.) administration in high-fat diet mice. **Molecular Nutrition & Food Research**, Wiley, 61, 2017, 8, 1600895.
26. Jang YK, Shin GR, Jung ES, Lee S, Lee S, **Singh D**, et al. Process specific differential metabolomes for industrial gochujang types (pepper paste) manufactured using white rice, brown rice, and wheat. **Food Chemistry**, Elsevier Science Ltd., 234, 2017, 416-424.
27. Lee DE, Lee S, **Singh D**, Jang ES, Shin HW, et al. Time-resolved comparative metabolomes for Koji fermentation with brown-, white-, and giant embryo-rice. **Food Chemistry**, Elsevier Science Ltd., 23, 2017, 251-266.
28. Lee S, Lee S, **Singh D**, Oh JY, Jeon EJ, et al. Comparative evaluation of microbial diversity and metabolite profiles in *doenjang*, a fermented soybean paste, during the two different industrial manufacturing processes. **Food Chemistry**, Elsevier Science Ltd., 221, 2017, 1578-1586.
29. Son SY, Lee S, Kim NK, Lee S, **Singh D**, et al. Metabolite Fingerprinting, Pathway Analyses and Bioactivity Correlations for the Plant Species belonging to Cornaceae, Fabaceae, and Rosaceae Families. **Plant Cell Reports**, Springer, 35, 2016, 9, 1917-1931.
30. Kim HY, Heo DY, Park HM, **Singh D**, Lee CH. Metabolomic and Transcriptomic Comparison of Solid-State and Submerged Fermentation of *Penicillium expansum* KACC 40815. **PLoS One**, Public Library Science, 11, 2016, 2, e0149012.

Conference & Proceedings (selected)

- **Singh D**, Scott KL, Cocuron JC, Slot JC, Chaverri P, Alonso AP (2023). Poster Presentation: Fungal leaf endophytes enrich functional metabolomes in wild Rubiaceae. Metabolomics 2023, hosted by Metabolomics Society, Niagara Falls, Canada.
- **Singh D** (2017). Oral Presentation: Volatiles mediated intra-species interactions among *Aspergillus oryzae* strains effects morphological transitions and exometabolomes. Invited Lecture at XII International Fungal Biology Conference (IFBC), 2017, Seoul, Republic of Korea August 22-25, 2017.

- **Singh D**, Kaur G (2013). Poster Presentation: Mass directed purification, quantification, and *in vitro* cytotoxicity of an indolizidine alkaloid, Swainsonine from *Metarhizium anisopliae*. 5th congress of European Microbiologists (FEMS-2013), Leipzig, Germany, July 21-25, 2013.
- **Singh D**, Kaur G (2012). Poster Presentation: Swainsonine: production optimization and modeling, HPLC quantification and in vitro cell cycle regulatory activities in HL60 cell line. ICEHT-2012, 6th Annual convention of association of biotechnology and pharmacy (ABAP), SVU university, Tirupati, Andra-Pradesh, India. December 20-22, 2012.
- **Singh D**, Kaur G (2010). Poster Presentation: Media optimization and culture conditions for the enhanced production of Swainsonine from *Metarhizium anisopliae*. 51st Annual conference-(Association of Microbiologists of India) AMI, BIT Mesra, Ranchi, Jharkhand, India. December 14-17, 2010.

Journal affiliations

- Invited Reviewer (Nov 2022) – **Frontiers in Plant Science**; 1664462X (Online); Publisher: Frontiers communication.
- Invited Reviewer – **Natural Product Research**; ISSN: 6419 (Print) and 1478-6427 (Online); Publisher: Taylor & Francis online.
- Invited Reviewer (February 2015) – **Journal of Microbiology and Biotechnology**; ISSN: 1017-7825 (Print) and 1738-8872 (Online); Publisher: The Korean Society for Microbiology and Biotechnology (KMB).
- Invited Reviewer (December 2019) - **Food Chemistry**; ISSN: 0308-8146 (Print) and 1873-7072 (Online); Publisher: Elsevier Sci. Ltd. (England).
- Invited Reviewer (July 2020) – **Phytochemistry**; ISSN: 0031-9422; Publisher: Elsevier Sci. Ltd. (England).

Teaching experience (Post-Ph.D.) – 1.5 Years

Guest Faculty in the Department of Botany and Microbiology at **H.N.B Garhwal University (A Central University), Srinagar, Garhwal, Uttarakhand**, **09/2014 – 02/2016.**

- **Subjects:** General Microbiology, Immunology, Agriculture Microbiology, & Environmental Microbiology.

Awards & Honors

- Awarded **'Travel Fellowship by DBT-CTEP'** for attending 5th Congress of European Microbiologists (FEMS-2013), Leipzig, Germany, July 21-25, 2013 by the Department of Biotechnology, Govt. of India towards the **'Grant Proposal Code: DBT/CTEP/02/201300692'**.
- **Best Poster Award at ICEHT-2012**, 6th annual convention of Association of Biotechnology and Pharmacy. SVU university, Tirupati, Andhra Pradesh, India. December 20-22, 2012.
- Qualified **Graduate Aptitude Test Examination (GATE-2009)** in Life Sciences with 95.86 percentile conducted by Ministry of Human Resource and Development (MHRD), Govt. of India.
- Qualified **CSIR-NET-JRF (June 2009)**, a national level examination for the research fellowship and lectureship with all India rank (AIR-249) conducted by Council of Scientific & Industrial Research. Govt. of India.

Technical expertise

- Untargeted metabolomics (MS-DIAL platforms).
- MS raw data alignment (MetAlign) and analysis (MS-DIAL).
- Metabolite annotation (MZMine, MS-FINDER, and Compound Discoverer).
- Metabolite characterizations using online databases (Metlin, MoNA, HMDB, and GNPS).
- Multivariate analyses on SIMCA/ MS-DIAL (PCA, PLS-DA, and OPLS-DA).
- Correlation analyses (PASW statistics, Cytoscape, and MeV).
- Microbiology: All the basic techniques in microbiology including isolation, handling, growth dynamics, and maintenance of fungal and bacterial cultures. Microbial culture analyses based on staining & microscopic methods (light & electron microscopy, *i.e.,* FE-SEM). Isolation and biochemical & molecular characterization of N-fixing sugarcane endophytes.
- Metabolite biochemistry: metabolite extractions (liquid-liquid, SPE, & SPME), quantification (enzymatic and chromatographic), and bioactivity phenotypes.
- Molecular biology and proteomics: Genomic material isolation from Bacteria/Fungi (DNA, RNA or Plasmid). PCR (RT and Gradient), Restriction digestion/ligation, 16s rDNA restriction analysis, agarose gel electrophoresis, proteins estimation, & PAGE (Native & SDS) etc.
- Bioprocess optimization: Basic Knowledge of conventional and modern optimization tools (One factor at a time, PB & RSM, Artificial Neural Network & Genetic Algorithms).

Research theme

I am a versatile microbiologist with specialization in microbial interactions (fungal-insect, fungal-fungal, fungal-bacterial, and fungal endophyte-plant interactions) and a biochemist with strong background in Chromatography (GC/LC) and High-Resolution Mass Spectrometry (HRMS). My experience and expertise can also serve the co-researchers (faculties) through employing the non-targeted MS-based metabolomics as sensitive, reproducible, and robust analytical method. I have experience of working on metabolomics data from **(i)** disease models (NAFLD) for evaluating the effects of UVB irradiation in mice, **(ii)** effects of short-term dietary choices on serum and urine biomarkers in humans, and **(iii)** microbial interactions on food matrices through secreted metabolites. With my specialization in microbiology and non-targeted metabolomics, I wish to work on metabolic signatures of diet, gut microbiome, and its impact on health & diseases. It is well established that the nutritionally poor diets induce a functional dysbiosis of the gut microbiome which in turn influence the metabolite pools (acrylamides, bile acids, and SCFAs) in serum. Hence, my future research plan will aim at examining the impact of dietary choices on taxonomic, functional, and biochemical shifts in human gut microbiome and associated health effects. I strongly believe that my experience on working with non-targeted metabolomics and associated data analysis can help in the development of evidence-based frameworks through providing a snapshot of different physiological states of study subjects unraveling its systems biology.

The overreaching goals of various projects which I am seeking at present involves delineating the metabolite driven microbial interactions within the microbiome as well as with the host species using MS-based platforms (GC-TOF-MS, UHPLC-LTQ-MS/MS, UHPLC-LTQ-Orbitrap).