

# JHADESWAR MURMU, Ph.D

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**RESEARCH INTEREST:** Plant biochemistry, molecular biology and biotechnology

## EDUCATION

- Ph. D. (2005) University of Hyderabad, Hyderabad, India.  
**Thesis:** Regulation of NADP-malic enzyme and phosphoenolpyruvate carboxylase in leaves of C<sub>4</sub> plants
- M. Sc. (1999) University of Hyderabad, Hyderabad, India
- B. Sc. (1997) Utkal University, Cuttack, India

## AWARDS

- NSERC-Visiting Fellowship, NRC-Plant biotechnology Institute, Saskatoon (June 2006- May 2008)
- Council of Scientific and Industrial Research (CSIR)-Fellowship, New Delhi, India (2001-2005)

## UNDERGRADUATE AND GRADUATE STUDENTS CO-SUPERVISED

- Joel Pidutti (B. Sc Thesis) April 2009- Sept 2009, Carleton University, Ottawa, Canada
- Dahn Hahm (High School) Aug 2008-March 2010, Carleton University, Ottawa, Canada
- Caroline Malcolmson (B. Sc Thesis), Sept 2008-April 2009, Carleton University, Ottawa, Canada
- Richard Glen Uhrig (B.Sc Thesis), September 2005-April 2006, Queens University, Kingston, Canada
- Katie Greenham (B. Sc Thesis), September 2005-April 2006, Queens University, Kingston, Canada
- Udaya Kumar Avasti (Ph. D) August 2004-Feb 2005, University of Hyderabad, India
- Eswar Ramireddy (M. Sc.) Aug 2003-May 2004, University of Hyderabad, India

## TEACHING AND RELATED EXPERIENCE

- I have successfully completed Graduate University Teaching Skill (GUTS) program offered by Carleton University (June-August 2010).
- Contributed BOP1/2 recombinant proteins and purification method to undergraduate biology lab Carleton University (2008-2010).
- Taught M. Sc plant biochemistry lab, University of Hyderabad (January - May 2005).

## LEADERSHIP AND MANAGEMENT SKILLS: SKILLS

I am approachable, honest, collaborative, and proactive. During my research career, I have managed the research labs, scheduled, coordinated and accomplished project objectives. Critical thinking was effectively employed to troubleshoot; and scientific articles and emerging technologies were tracked on daily basis to employ in research settings.

**PROFESSIONAL MEMBERSHIP:** The Canadian society of plant physiologists (<http://cspp-scpv.ca/>)

## SCIENTIFIC COLLABORATION

Dr. Jas Singh & Dr. Gopal Subramaniam, (ECORC, AAFC, Ottawa, Canada)  
Dr. Darrell Desveaux (University of Toronto, Canada); Dr. Pierre R. Fobert (NRC-Plant Biotechnology Institute, Saskatoon, Canada); Dr. Shelley R. Hepworth (Carleton University, Ottawa, Canada)

## RESEARCH EXPERIENCE

- **Postdoctoral fellow**, Agriculture and Agri-Food Canada, Ottawa (**Sept 2010 - September 2012**)  
In Dr. Gopal Subramaniam and Dr Jas Singh's laboratory, I employed genomics, genetic interaction, gene expression studies, disease assay and protein-protein interaction studies, to demonstrate the contrasting role of *Arabidopsis* golden2-like (GLK) transcription factors against biotroph (*Hyaloperonospora arabidopsidis* and necrotroph (*Botrytis cinerea*)).
- **Postdoctoral fellow**, Carleton University, Ottawa (**June 2008 - August 2010**)  
The Hepworth lab studies Non-expressor of pathogenesis related-1 (NPR1) family of BTB/POZ Blade-on-petiole (BOP) 1 and 2 genes in *Arabidopsis* leaf and inflorescence development. Employing reverse genetics, gene expression studies, protein-protein interaction and microscopy studies, redundant role of *Arabidopsis* TGA9 and TGA10 transcription factors in anther and pollen development was demonstrated.

- **Postdoctoral fellow**, NRC-Plant Biotechnology Institute, Saskatoon (**June 2006 - May 2008**)  
In the research laboratory of Dr. Pierre R. Fobert, I performed molecular cloning, generation of transgenic plants destined for plant pathology experiments. My research contribution demonstrated that suppressor domain of TGA2 binds to NPR1 protein to negate TGA2 transactivation.
- **Postdoctoral fellow**, Queens University, Kingston (**April 2005 - May 2006**)  
Prof. William C. Plaxton's lab studies the biochemistry of phosphoenol pyruvate carboxylase (PEPC) enzyme that play vital role for carbon metabolism in developing castor oil seeds (COS). While working as PDF in his laboratory, I performed purification, characterization and regulation of PEPC-protein kinase (PEPC-PK) from COS.
- **PhD student**, University of Hyderabad, India (**July 1999 - Feb 2005**)  
In the research laboratory of Prof. AS Raghavendra, I investigated the enzyme kinetics and posttranslational mechanism (i.e. phosphorylation) of PEPC, upon illumination of dark adopted leaves treated with inorganic phosphate (Pi), nitrogen source (i.e.  $\text{NH}_4^+$  or  $\text{NO}_3^-$ ) and calcium ( $\text{Ca}^{2+}$ ) in *C<sub>4</sub>* plant *Amaranthus hypochondricus*. Besides, light activation of chloroplastic NADP- malic enzyme (NADP-ME), which is involved in decarboxylation was established to be redox regulated in *Zea mays*.

## DEMONSTRATION SKILLS and KNOWLEDGE

- **Molecular biology:** RNA, DNA extraction, cDNA synthesis from microorganisms, such as fungi (*Fusarium graminearum*), bacteria (*E.coli*), yeast and plants (*Arabidopsis*, *Commelina*, *Brassica*). I have experience in using polymerase chain reaction technique (PCR) and real-time PCR for the detection, identification, and differentiation of microorganisms such as fungi, bacteria, plant leaf and seeds in a research setting. Primer designing for PCR and cloning purposes. Agrobacterium transformation of plant, transgenic plant selection, T-DNA insertion line screening/selection for studying reverse genetics, Northern and Southern blotting, promoter-GUS construction, transient gene expression studies in *Nicotiana benthaminana* leaves, and microarray data analyses.
- **Plant-pathogen interaction:** Handling and growing biotroph (*Pseudomonas syringae*, *Hyaloperonospora arabidopsidis*), necrotroph (*Botrytis cinerea*, *Fusarium graminearum*). Infection of *Arabidopsis* plants with these pathogens and pathogenecity assay.
- **Microscopy:** Light, fluorescence and confocal microscope, scanning electron microscope, microtome use for preparing thin sections of paraplast and resin embedded specimen, *in situ* RNA hybridization, analysis of gene expression using promoter-GUS studies and protein localization using YFP/GFP gene fusion.
- **Protein and enzyme biochemistry:** Protein purification from plants, recombinant protein expression and purification, SDS and native PAGE, EMSA, enzyme kinetics studies, immuno blotting, UV-Visible spectroscopy, protein-protein interaction study using Tandem Affinity Tags, yeast two-hybrid, BiFC, protein phosphorylation studies i.e. *In vitro* (using  $\gamma^{32}\text{P}$ -ATP), *in vivo* (using ortho- $^{32}\text{P}$ ), using anti-phosphospecific antibody and using pro-Q dimond phosphoprotein stain, 1-Anilino-8-naphthalene sulfonate (ANS) fluorescence binding and spectra analysis, Circular dichroism spectra analysis for protein secondary structure.
- **Computer software:** I have used Microsoft office for data/information management, laboratory operations; DNASTAR lasergene for sequence data analyses; Sigma plot and Adobe Photoshop for compiling graphs and images.
- **Critical thinking:** Ability to critically think and design scientific research experiments and execute.

## RESEARCH PUBLICATIONS: 12

- Khan M, Xu M, **Murmu J**, Tabb P, Liu Y, Storey K, McKim SM, Douglas CJ, Hepworth SR (2012) Antagonistic interaction of BLADE-ON-PETIOLE 1/2 with BREVIPEDICELLUS and PENNYWISE regulates *Arabidopsis* inflorescence architecture. *Plant Physiology* 158:946-960.
- **Murmu J**, Bush MJ, DeLong C, Li S, Xu M, Khan M, Malcolmson C, Fobert PR, Zachgo S, Hepworth SR (2010) *Arabidopsis* basic leucine-zipper transcription factors TGA9 and TGA10 interact with floral glutaredoxins ROXY1 and ROXY2 and are redundantly required for anther development. *Plant Physiology* 154:1492-1504.
- Xu M, Hu T, McKim S, **Murmu J**, Haughn G, Hepworth SR (2010) *Arabidopsis* Blade-on-petiole 1 and 2 promote floral meristem fate and determinacy in a novel pathway targeting APETALA1 and AGAMOUS-LIKE24. *Plant Journal* 63: 974-989.
- Boyle P, Su EL, Rochan A, Shearer HL, **Murmu J**, Chu JY, Fobert PR, Després C (2009) The BTB/POZ domain of the *Arabidopsis* disease resistance protein NPR1 interacts with the repression domain of TGA2 to negate its function. *Plant Cell* 21: 3700-3713.

- **Murmu J**, Plaxton WC (2007) Phosphoenolpyruvate carboxylase protein kinase from developing castor oil seeds: Partial purification, characterization, and reversible control by photosynthate supply. *Planta* 226: 1299-1310.
- **Murmu J**, Raghavendra AS (2005) Marked modulation by  $\text{NH}_4^+$ , but limited effects of  $\text{NO}_3^-$  on phosphoenolpyruvate carboxylase in leaves of *Amaranthus hypochondriacus*, a  $\text{C}_4$  plant. *Physiology and Molecular Biology of Plants* 11: 265-273.
- **Murmu J**, Raghavendra AS (2005) Modulation of phosphoenolpyruvate carboxylase *in vivo* by  $\text{Ca}^{2+}$  in *Amaranthus hypochondriacus*, a NAD-ME type  $\text{C}_4$  plant: Possible involvement in up regulation of PEPC protein kinase *in vivo*. *Journal of Plant Physiology* 162:1095-1102.
- **Murmu J**, Chinthapalli B, Raghavendra AS (2003) Phosphoenolpyruvate carboxylase from leaves of  $\text{C}_4$  plants: Biochemistry and molecular biology of regulation. *Indian Journal of Plant Physiology (Special issue)* 164-173. **A review.**
- **Murmu J**, Raghavendra AS (2003) Biochemistry of Photosynthesis: Recent trends. *Journal of Plant Biology* 30:241-252. **A review**
- **Murmu J**, Chinthapalli B, Raghavendra AS (2003) Modulation by phosphate of phosphoenol-pyruvate carboxylase from leaves of *Amaranthus hypochondriacus*, a  $\text{C}_4$  plant: decrease in malate sensitivity but no change in phosphorylation status. *Journal of Experimental Botany* 54: 2661-2668.
- Chinthapalli B, **Murmu J**, Raghavendra AS (2003) Dramatic difference in the response of phosphoenolpyruvate carboxylase to temperature in leaves of  $\text{C}_3$  and  $\text{C}_4$  plants. *Journal of Experimental Botany* 54: 707-714.
- **Murmu J**, Chinthapalli B, Raghavendra AS (2003) Light activation of NADP malic enzyme in leaves of maize: Marginal increase in activity but marked change in regulatory properties of enzyme. *Journal of Plant Physiology* 160: 51-56.

#### Research papers under preparation:

- **Murmu J**, Singh J, Wilton M, Kirkham C, Allard G, Pandeya R, Desveaux D, Subramaniam G (2013) *Arabidopsis* Golden2-like transcription factors recruit JA signalling components during plant defense.

#### Articles contributed in edited book chapter: 1

- Chinthapalli B, Syed N, **Murmu J**, Raghavendra AS (2001) Cytosolic pH as a secondary messenger during light activation of phosphoenolpyruvate carboxylase in mesophyll cells of  $\text{C}_4$  plants. In: *Signal Transduction in Plants: Current Advances*. (Eds. S.K. Sopory, R. Oëlmüller and S.C. Maheswari). Kluwer Academic Publishers, Dordrecht pp 39-48.

#### PRESENTATION IN RECENT SCIENTIFIC MEETINGS:

- **Murmu J**, Singh J, Wilton M, Allard G, Kirkham C, Pandeya R, Desveaux D, Subramaniam G (2011) GLK transcription factors- An integral component of plant defense in *Arabidopsis*. *Canadian Society of Plant Biologists (Eastern region meeting)*, December 2-3, 2011, Carleton University, Ottawa. **(ORAL)**
- **Murmu J**, Bush M, DeLong C, Li S, Xu M, Khan M, Fobert PR, Zachgo S, Hepworth SR (2010) *Arabidopsis* basic-leucine zipper transcription factors TGA9 and TGA10 interact with floral glutaredoxins ROXY1 and ROXY2 and are redundantly required for anther development. *Canadian Society of Plant Physiologists (Eastern region meeting)*, December 3-4, Brock University, Canada. **(ORAL)**
- **Murmu J**, Bush M, DeLong C, Li S, Xu M, Khan M, Fobert PR, Zachgo S, Hepworth SR (2010) *Arabidopsis* bZIP transcription factors TGA9 and TGA10 interact with glutaredoxins ROXY1 and ROXY2 and are redundantly required for anther and pollen development. *Plant Biology 2010*, July 31-August 4, Montreal, Canada. **(POSTER)**
- **Murmu J**, Bush M, Khan M, DeLong C, Malcolmson C, Fobert P, Hepworth SR (2009) *Arabidopsis* bZIP transcription factors TGA9 and TGA10 are redundantly required for glutaredoxin-dependent regulation of anther and pollen development. *Canadian Society of Plant Physiologists Eastern Regional Meeting 2009 and Plant Development Workshop*. December 4-5, University of Guelph, Canada. **(POSTER)**