

Performance Report 2017-18

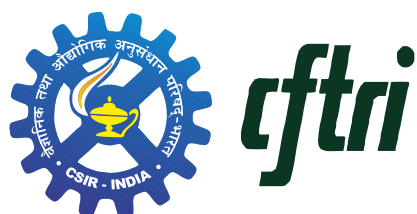


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CSIR-CFTRI PERFORMANCE REPORT

2017-18



CSIR-Central Food Technological Research Institute
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Mysuru - 570 020, India

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CSIR-Central Food Technological Research Institute, Mysuru India

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From Director's Desk.....



It has been a great pleasure to place the CSIR-CFTRI Performance Report of 2017-18 for the benefit of the society, academic community and other stakeholders.

During the year, CSIR-CFTRI had pursued many initiatives towards aligning the Institute activities with National Missions and policies of the Government. The outcome has been very encouraging looking into unfolding challenges.

The Institute had fared well with a good number of scientific publications in peer-reviewed journals, release of new technologies and delivering on socially important projects. A few among these include; development of Automated Ragi Mudde Making Machine, Govt. of Maharashtra project for the enhancement Human Development Index (HDI) and associating with Akshaya Patra Foundation for delivering nutrition through Mid Day Meal Scheme.

Similarly, farmers and Farmers Producers Organisations (FPOs) got increased thrust as the Institute brought an exclusive platform for

farmers-centric training programmes. Also record number of students and entrepreneurs were skilled under a diverse kind of programmes. These include 3-days Farmers-Centric Programmes, 5-weeks Skill Development Programmes and 2-weeks programmes for Startups along with 5-days programmes for entrepreneurs and industry professionals.

On behalf of the organization, I would like to acknowledge the guidance and support provided by Research Council, Management Council, CSIR-Hqs., Funding Agencies, Industries and all other stakeholders towards fulfilling the mandate and goals of the Institute.

Finally, I would like to congratulate each and every one of our colleagues for constantly putting their quality efforts to make us relevant in the emerging scenario of sustainable public R&D in the country.

I look forward to all our well wishers for continued guidance and support.

Date : October 4, 2018
Place: Mysore

Sd/-
(Shri Jitendra J Jadhav)
Director, CSIR-CFTRI



Publications

| | |
|-----------------|-----|
| Research Papers | 141 |
| Reviews | 7 |
| Book Chapters | 14 |



Projects

| | |
|--------------|----|
| Grant-in-aid | 74 |
| Consultancy | 15 |
| Sponsored | 31 |



Industrial Development

| | |
|------------------------------|----|
| Patents Filed | 5 |
| Technologies Transferred | 86 |
| Short Term Courses Conducted | 20 |
| New Technologies Released | 19 |



Human Resource Development

| | |
|----------------------------|-----|
| M.Sc. Students Passed Out | 29 |
| ISMT Students Passed Out | 29 |
| Ph.D Degree Awarded | 40 |
| Skill Development Training | 953 |

Achievements in Brief

1. Research Papers Published

SCI Papers

1. Abhay Kumar N., Prasada Rao U.J.S., Jeyarani T., Indrani D., Effect of ingredients on rheological, physico-sensory and nutritional characteristics of omega- 3-fatty acid enriched eggless cake, *J. Texture Studies*, 2017, **48(5)**, 439-4492
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14. Balaji W. Kanwate, Tanaji G. Kudre, Effect of various acids on physio-chemical and functional characteristics of gelatin from swim bladder of fresh water fish rohu (*Labeo rohita*), *J. Food Sci. Technol.*, 2017, **54**(8), 2540-2550
15. Bharath Kumar S., Prabhasankar P., Enzyme treated flours in noodle processing: a study on an innovative technology, *J. Food Measurement and Characterization*, 2017, **11**(3), 1174-1187
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2. Patents Filed / Granted in India

Filed

- Vacuum frying system
- Antimicrobial peptide and its use thereof
- A stable biochemical fungicidal formulation useful against *Colletotrichum gloeosporioides* penz
- A process for preparation of soluble whole spirulina powder
- A milk like wheat germ beverage and the process of its preparation

Granted

- A process for the preparation of flat papads from cereals and pulses
- A formulation of soy-protein isolate based reduced fat snack and a process for the preparation thereof
- A process for the preparation of probiotic fermented milk beverage which enhances stability and metal ions during storage with adjuvant supplementation
- An improved process for the preparation of coconut jam
- A process for enhanced degradation of dichlorodiphenyltrichloroethane (DDT)

- A culture medium for enhancement of phycobiliproteins in *Porphyridium* species
- A process for preparation of fermented okara (soy residue) based idli batter
- A device useful continuous production of boondi and other traditional deep fat fried products
- A process for the preparation of water-soluble amino acid conjugates of curcumin
- Rosemary herbal beverage powder and a process

3. Processes released for commercial exploitation

The following eighty six processes were released to 136 parties.

- Atta with multigrain
- Blends of coconut oil
- Bottling of sugarcane juice
- Cereal flakes: Jowar
- Chicken wafers
- Chikki/Nutra chikki
- Chlorogenic acid rich coffee conserve from green coffee beans
- Clear lime-lemon flavour blend for soft drink manufacture
- Coffee concentrate
- Coffee flakes based mouth freshener
- Cola flavour concentrate
- Compounded asafoetida
- Date syrup concentrate
- Desiccated coconut
- Egg wafers
- Eggless cake premix
- Energy food

- Fermented & dehydrated ready mixes for Dosa batter
- Fermented & dehydrated ready mixes for Idli batter
- Fish pickle
- Fortified sugarcane beverage in glass bottles
- Fruit jam slices
- Fruit jams & jellies
- Fruit syrups & squashes
- Garlic paste
- Ginger beverage
- Ginger paste
- Groundnut (peanut) butter
- Heat resistant white sesame seeds
- Instant gravy mixes (dehydrated)
- Instant moringa leaves soup mix
- Instant traditional foods: Puliogre
- Instant traditional foods: Pongal
- Instant traditional foods: Sambar
- Instant traditional foods: Bisibelebath
- Instant traditional foods: Rasam
- Instant traditional foods: Urdabath
- Instant traditional foods: Imli poha
- Low GI beverage for diabetics
- Modified atmosphere packaging of minimally processed vegetables - Beans, carrot, cauliflower, palak & beendi
- Moringa seed protein isolate as flocculant
- Multigrain based low fat fortified snack
- Nutra chikki with added spirulina
- Online fortification of atta
- Orange flavour concentrate for manufacturing of soft beverage
- Osmo air-dried fruits (amla, mango, pineapple and jack fruit)
- Paushik atta
- Pickles and chutneys
- Prawn pickle
- Preparation of bael nectar & RTS beverage
- Preparation of beverage from cactus
- Preparation of Ready-to-cook multi-grain whole mix for drink/porridge
- Preparation of Ready-to-eat shelf stable egg crunchy bite
- Preparation of Ready-to-use dosa batter in retail packs
- Preparation of shelf stable egg albumin and egg yolk cubes
- Preparation of shelf stable roti from non-wheat cereal and millet (ragi, rice, maize, jowar, bajra)



Millet halva mix



Millet halva

- Preparation of value added products from kokum rind - kokum jelly candy
- Preparation of value added products from kokum rind - RTS value added products from kokum
- Production of atta (whole wheat flour)
- Production of turmeric powder from fresh turmeric rhizome
- Ready Mix: Jamun
- Ready mix: Upma
- Ready mixes: Vada
- Ready mixes: Dosa
- Ready mixes: Chakli
- Ready mixes: Jalebi
- Ready mixes: Maddur vada
- Ready mixes: Pakoda
- Ready mixes: Flavoured flan
- Ready mixes: Cake doughnut
- Ready mixes: Combination dough mix
- Roasted & flavoured cashew kernel
- RTS fruit juices & beverages
- Rural based bio technological production of spirulina
- Shelf stable biriyani paste
- Shelf-stable chicken biriyani
- Shelf-stable chicken tit-bits
- Shelf-stable & Ready-to-eat foods thermo processed in retort pouches (non-vegetarian foods)
- Spice oleoresin enriched
- Spice oleoresin: Turmeric
- Tamarind candy
- Tutti fruity (papaya/carrot)
- Value added products from coconut - Instant adjunct mix, instant filling mix, coconut rice mix and coconut bites
- Value added products from custard apple
- Virgin coconut oil
- Wheat germ stabilization



Millet upma mix



Millet upma

4. New processes / design drawing ready for commercial exploitation

Nineteen new processes were developed for commercial exploitation as detailed below:

- Kokum - RTS beverages & squash
- Kokum jelly candy
- Moringa seed protein isolate as flocculent
- Design & development of a machine for continuous cooking & dis-charging of Ragi mudde/ball
- Instant upma, halva and rava Idli mix from multigrain semolina
- Instant upma, halva and rava Idli mix from high fiber semolina
- Instant upma, halwa & rava idli mix from high protein semolina
- Instant upma mix from millets and multi millets semolina
- Instant halva mix from millets and multi millets semolina
- Instant rava idli mix from millets and multi millets semolina
- Production of high fiber semolina (sooji/rava)
- Production of high protein semolina (sooji/rava)
- Production of barley / dahlia / semolina
- Roller milling process for multigrain semolina (sooji/rava)
- Roller milling process for semolina (sooji / rava) from millets and preparation of multi millets semolina
- Process know how for bifido curd
- Process know how for soy curd
- A-Hango : Preparation for alle-viating alcohol hangover
- Banana juice



Kokum - RTS beverage & squash products

5. Consultancy/Sponsored/Grant-in-Aid Projects

| Sl. No | Type of project | Completed projects | Ongoing projects as on 31.3.2018 |
|--------|-----------------|--------------------|----------------------------------|
| 1. | Consultancy | 4 | 11 |
| 2. | Sponsored | 4 | 27 |
| 3. | Grant-in-Aid | 24 | 50 |

6. M.Sc. / ISMT / Short-term courses

| Sl. No | Academic Programmes | Degree / Certificate Awarded |
|--------|-------------------------------|------------------------------|
| 1. | M.Sc. (Food Technology) | 29 |
| 2. | Certificate Course in Milling | 29 |
| 3. | Short-term Courses (20 Nos.) | 341 |



Shri Hukm Deo Narayan Yadav, Chairperson, Parliamentary Standing Committee on Agriculture interacting with scientists during their visit to the Institute

7. Symposia, conferences and events organised / sponsored by CSIR-CFTRI

- **National Technology Day (May 11, 2017)**

National Technology Day was celebrated in the Institute. On this occasion, 'techshowcase' was held with presentations by R&D departments on new and innovative technologies. Technology day address was delivered by Director, CSIR-CFTRI.

- **Awards Day (July 10, 2017)**

On the Awards Day, Hon'ble Shri H.D. Devegowda, Former Prime Minister and Hon'ble Member of Parliament (Hassan Constituency) graced the occasion as the Chief Guest and Prof. K.S. Rangappa, Former Vice Chancellor, University of Mysore attended the function. Meritorious awards, medals, scholarships and certificates to the

outgoing students of M.Sc. (Food Technology) and Flour Milling Certificate Courses were distributed. Director, CSIR-CFTRI presided over the function.

- **Hindi Fortnight Celebration (September 14 - 28, 2017)**

Hindi Fortnight was celebrated at CSIR-CFTRI during 14.09.2017 to 28.09.2017. Dr. Alok Kumar Shrivastava, Chief Scientist & Co-Chairman, Official Language Implementation Committee, CSIR-CFTRI formally inaugurated the function. A variety of competitions in Hindi were conducted for the employees and research students of the Institute during the Fortnight celebrations. Dr. Rakesh Kumar Sharma, Director, DRDO-DFRL, Mysuru was the Chief Guest and Shri Jitendra J. Jadhav, Director, CSIR-CFTRI gave away the prizes to the winners of competitions during the Foundation Day Celebrations held on 27th October 2017.



Shri H.D. Deve Gowda, Former Prime Minister and Hon'ble Member of Parliament conferring the Medal to meritorious students of the M.Sc. (Food Technology) Programme on the Awards Day



Inauguration of Hindi Fortnight Celebrations

- **CSIR Platinum Jubilee Capsule Exhi-bition (September 18-20, 2017)**

The parent organisation of CFTRI, Council of Scientific and Industrial Research (CSIR), Ministry of Science & Technology, Govt. of India organized a Capsule Exhibition during Sep. 18-20, 2017 in Mysore as a part of the CSIR Platinum Jubilee Celebrations to make the students, researchers and the general public to get familiarized with the contributions of CSIR in various fields.

The exhibition was inaugurated on September 18, 2017 in the CFTRI campus. Exhibits on the achievements of CSIR in the areas of social intervention, nurturing human resources, intellectual property and entrepreneurship, chemical and petrochemical, water, ecology and environment, leather, materials and minerals, energy, healthcare & generics, aerospace & strategic sector, engineering and infrastructure, agriculture and floriculture, and food and nutrition were showcased.

An Industry-Scientist Inter-action was held on September 20, 2017 in which around 50 Industries / Startups / Entrepreneurs participated.

Panel interaction on the theme “New Initiatives, Co-branding, Business Incubation/

Accelerator from CSIR-CFTRI” was arranged with experts on food packaging, food safety, baking technology, super foods, value added products from fruits, vegetables, meat and grains processing and technology scale-ups.

- **CSIR @ 75 & CSIR-CFTRI Foundation Day Celebration (October 27, 2017)**

CSIR-CFTRI celebrated 75 years of its parent body, Council of Scientific & Industrial Research (CSIR), New Delhi and CFTRI Foundation Day on October 27, 2017 in the campus. The Foundation Day Lecture was delivered by Dr. Rakesh Kumar Sharma, Director, DFRL, Mysuru and Shri Jitendra J Jadhav, Director, CSIR-CFTRI presided over the function.

As part of the celebrations, the employees who retired in the last one year and those who have completed 25 years of service were felicitated. Prizes were distributed to children of the staff for their outstanding performances in academics/ sports and winners of the various competitions held as a part of the celebrations. The prizes were also given to winners of the competitions held as part of the Hindi Fortnight Celebrations. The dignitaries also give away the Annual Institute Awards on this occasion.



Shri Jitendra J Jadhav, Director, CSIR-CFTRI welcoming the Chief Guest of the CSIR-CFTRI Foundation Day, Dr. Rakesh Kumar Sharma, Director, DRDO-DFRL, Mysore

MoU(s) Signed

- **Society for Elimination of Rural Poverty (June 8, 2017)**

The scope of the collaboration is to jointly steer the growth and development of food and nutrition enterprises and producer organisations through creating access to advanced food technology and practices and building necessary capacity building in the state of Andhra Pradesh. The initiative would be helpful for the overall growth of the farmers and entrepreneurs.

- **Akshaya Patra Foundation (October 27, 2017)**

A MoU with Akshaya Patra Foundation was signed on October 27, 2017. Under this MoU, a series of collaborative activities such as developing innovative nutritional adjuncts as supplements under Mid-day Meal (MDM) scheme, Internship programmes, customized training for MDM workers and enabling a policy

framework for implementing robust malnutrition interventions by Central and State governments will be addressed.

- **Human Development Programme, Govt. of Maharashtra (December 4, 2017)**

CSIR-CFTRI signed an agreement with Human Development Mission, Planning Department, Govt. of Maharashtra for enhancing the Human Development Index in the State.

The objective is to enhance the Human Development Index (HDI) in the identified talukas / districts of Maharashtra State with very low HDI and low per capita income with food processing interventions in terms of technology transfer, knowledge exchange, trainings, sharing of expertise and establishing Common Facility Centers (CFCs) with regard to food processing units in coordination with the Farmer Producer Organizations (FPOs) and Self Help Groups (SHG), individual farmers and entrepreneurs who seek to establish food processing industry in the identified blocks.



Exchange of MoU with Akshaya Patra Foundation during CSIR-CFTRI Foundation Day Celebration



Meeting with Ministerial delegation from Govt. of Maharashtra

- **Oinam Awang Leikai Women Development Association (OINAM) (February 25, 2018)**

CSIR-CFTRI signed a multi-party MoU with OINAM, Bishnapur District, Manipur and Dept. of Commerce & Industries (DCI), Govt. of Manipur. Scope of the MoU include:

Augmentation of the food processing facility of Oinam by providing infrastructural and expertise in the area of food processing for the betterment of society and all round growth in the region with the support of OINAM and DCI-Manipur.



Shri H.D. Deve Gowda, Former Prime Minister and Hon'ble Member of Parliament releasing the Automated Ragi Mudde Making Machine at CSIR-CFTRI

8. Awards and Recognitions

Ph.D. Degree Awarded

a) University of Mysore

| Sl. No | Name of the Student | Title of the thesis | Guide |
|--------|----------------------|--|----------------------|
| 1 | Archana KM | Molecular markers for the characterization of yeasts with desirable enological properties | Dr. Anu Appaiah KA |
| 2 | Kavitha MD | Culture optimization, metabolites profiling and bioactivities of <i>Porphyridium purpureum</i> | Dr. Sarada R |
| 3 | Yogesh D | Characterization of fibrinolytic enzyme of <i>Bacillus species</i> isolated from food source | Dr. Prakash M Halami |
| 4 | Sriranjini V | Development of neuroprotective strategies utilizing selected spice actives | Dr. Rajini PS |
| 5 | Shweatha | Metal chelator as a possible enhancer of iron and zinc bioaccessibility from food grains | Dr. Kalpana Platel |
| 6 | Jayalakshmi S | Influence of supplementary levels of iron and calcium on zinc status of experimental animals | Dr. Kalpana Platel |
| 7 | Girish TK | Modulatory effect of biomolecules from black milled by-product on diabetic cataract | Dr. Prasad Rao UJS |
| 8 | Suresh D Sakhare | Roller milling fractionation of fenugreek and utilization of fiber rich fraction in development of wheat based food products | Dr. Prabhasankar P |
| 9 | Arunkumar R | Polymer-lipid hybrid lutein nanocapsules and evaluation of its bio-efficacy in mice retina | Dr. Baskaran V |
| 10 | Anjum Khanam | Selenium content and bioavailability from selected Indian foods | Dr. Kalpana Platel |
| 11 | Mallikarjun Gouda KG | Purification and characterization of bioactive molecules from selected microalgae | Dr. Sarada R |
| 12 | Pavithra K | Characterization and biofunctional applications of mucilage from | Dr. Sashirekaha MN |

| Sl. No | Name of the Student | Title of the thesis | Guide |
|--------|---------------------|---|------------------------|
| | | cladode and pectin from fruit of <i>Opuntia dillenii</i> (Ker-Gawl) Haw | |
| 13 | Meena Kumari | Content and bioaccessibility of trace minerals- copper, manganese and chromium from staple indian foods | Dr. Kalpana Platel |
| 14 | Revathy Baskaran | Biotechnological approaches to prevent development of bitterness in custard apple (<i>Annona Squamosa</i> L) fruit pulp | Dr. Rajarathnam S |
| 15 | Sharavana G | Lutein mediated modulation of retinal angiogenesis in diabetes induced animal model | Dr. Baskaran V |
| 16 | Nandini K | Synthesis of flavors and glycerolipids via β - substituted alcohols | Dr. Bettadaiah BK |
| 17 | Yashaswini PS | Mechanism of inhibition of oxygenases mediated inflammation by lignans from sesame | Dr. Sridevi A Singh |
| 18 | Swarna Latha GV | Studies on CO ₂ assimilation and its effects on cellular constituents in selected microalgae | Dr. Sarada R |
| 19 | Deepa C | Infrared based thermal treatment of grains: Studies on physicochemical properties, shelf-life extension and engineering aspects | Dr. Umesh Hebbar H |
| 20 | Swati Sarabhai | Gluten free ingredients and its variants in bakery products and their validation | Dr. Prabhasankar P |
| 21 | Susmita Barman | Animal studies on the modulation of diabetic complications by zinc supplementation | Dr. Srinivasan K |
| 22 | Nidhina N | Value addition to industrial guar meal by fermentation | Dr. Muthukumar SP |
| 23 | Shaik Akbar Basha | Characterization of bioactive phytochemicals and peroxidase from sprouted green gram (<i>Vigna radiata</i>) | Dr. Prasad Rao UJS |
| 24 | Sabeeta Kapoor | Modulation of metastasis by low molecular weight galectin inhibitors from tomato (<i>Solanum lycopersicum</i>) | Dr. Shylaja M Dharmesh |
| 25 | Jaimee George | Molecular assessment of aminoglycoside resistance in <i>Enterococcus</i> spp. | Dr. Prakash M Halami |

b) AcSIR

| Sl. No | Name of the Student | Title of the thesis | Guide |
|--------|--------------------------|--|---------------------------|
| 1 | Shashidhar M Ghatnur | <i>Cordyceps sinensis</i> : Cultivation, extraction and characterization of bioactive compounds | Dr. Manohar B |
| 2 | Pravin Vasantrao Gadkari | Extraction of catechins from fresh tea leaves and development of emulsion | Dr. Manohar B |
| 3 | Karthik P | Micro and nano encapsulation of omega-3 fatty acids by emulsion and spray-freeze-drying techniques | Dr. C. Anandaramakrishnan |
| 4 | Divyashree | Gamma-aminobutyric acid, a potent neurotransmitter from lactic acid bacteria: Fermentative and bioactivity studies | Dr. Prapulla SG |
| 5 | Anindya Basu | Studies on the production of isomalto-oligosaccharides (IMO) using α -glucosidase from microbes | Dr. Prapulla SG |
| 6 | Chandana Thimme Gowda | Protein engineering of acidic thaumatin - like protein from Sapodilla (<i>Manilkara zapota</i>) | Dr. Rajagopal K |
| 7 | Pradeep Kumar Yadav | Role of yeast DDHD domain-containing lipase in mitochondrial phospholipid remodeling and its regulation | Dr. Ram Rajasekharan |
| 8 | Anu Bhushani | Nanoencapsulation of green tea catechins by emulsification and electrospraying techniques for oral and transdermal delivery | Dr. C. Anandaramakrishnan |
| 9 | Padma Ishwarya | Development of a combined experimental and computational modeling approach to investigate the influence of bran addition on the volume and structural development in bread | Dr. C. Anandaramakrishnan |
| 10 | Gopirajah | Engineered model of human stomach for understanding physical mechanism underlying food digestion | Dr. C. Anandaramakrishnan |
| 11 | Chinnu Salim | Insights into the role of high glucose diet in monocrotophos induced neurodegeneration and associated effects in <i>Caenorhabditis elegans</i> | Dr. Rajini PS |

| Sl. No | Name of the Student | Title of the thesis | Guide |
|--------|----------------------|---|--------------------------|
| 12 | Parthasarathi | Experimental and computational modeling approach for evaluating the absorption of nano-formulated vitamin E in small intestine | Dr. C.Anandaramakrishnan |
| 13 | Mahesh Mansing Patil | Anti-obesic factors and their improvement through fermentation from non-hydroxycitric acid <i>Garcinia xanthochymus</i> | Dr. Anu Appiah KA |
| 14 | Darshan N | Isolation, purification and characterization of prodigiosin from <i>Serratia nematodiphila</i> darsh1 and its antibacterial, antiproliferative and apoptotic properties | Dr. Manonmani HK |
| 15 | Sharmila | Studies on molecular characterization and therapeutic aspects of novel anti-trypsin inhibitor | Dr. Venkateswaran G |

c) Individual Awards

| Sl. No | Award Title | Instituted by | Awardee |
|--------|--|---|----------------------|
| 1 | Microbiologist Award 2017 | SCIRE Science in the International Conference of SciCon Series on Current Trend in Bioscience | Dr. Pushpa S Murthy |
| 2 | APSI-International Plant Scientist Award 2017 | Academy of Plant Sciences, India during its annual meet held at Shree Mata Vaishnodevi University, Katra, Jammu | Dr. Giridhar P |
| 3 | Best Scientist Award | EET-CRS, Mumbai during 6th Science & Technology Awards 2017 held at Mumbai | Dr. Giridhar P |
| 4 | Col O.P. Kapur Annual cash award 2016 | All India Food Processors Association, New Delhi | Mr. Sreenivasa MA |
| 5 | Distinguished Scientist (Wheat Science and Technology) under Venus International Research Awards-VIRA 2017 | Venus International Foundation, Chennai | Dr. Prabhasankar P |
| 6 | Bharath Garuav Award 2017 | India International Friendship Society (IIFS), New Delhi | Dr. Prabhasankar P |
| 7 | Outstanding Scientist in Food Science and Technology | Venus International Research Awards, Venus International Foundation, Chennai, India. | Dr. Suresh D Sakhare |
| 8 | Best Young Scientist Award | The Society of Tropical Agriculture | Dr. Suresh D Sakhare |

d) Recognitions by Academies

| Recognition | Instituted by | Awardee |
|--------------|---|----------------|
| • Fellowship | Andhra Pradesh Akademi of Sciences (FAPAS), Amaravati | Dr. Giridhar P |
| • Fellow | FNAAS (2018) - National Academy of Agriculture Sciences, New Delhi | Dr. Rastogi NK |

e) Other Recognitions

| Awardee | Member / Panel Expert & Host Institution |
|------------------------|--|
| • Dr. Prakash M Halami | FAD 15:1 BIS; Board of Studies - Microbiology (UG); JSS College for Women (Autonomous), Mysore |
| • Mr. Badgujar P M | State Level Cluster Coordination Committee; State Level Cluster Monitoring cum Guidance Apex Committee under MSICDP, Mumbai; Inter Departmental Panel (IDP) of EIA for assessments of approval/ renewal for export of Food processing units, Mumbai; National Horticulture Mission schemes, Pune (Project Appraisal Committee) |
| • Dr. Rajagopal K | Kerala Biotechnology Commission; FAD 15.1 BIS |
| • Dr. Ajay W Tumaney | FAD 13 BIS; FAD 15 BIS; FSSAI |
| • Dr. Venkateswaran G | University of Mysore (BoS); Board of Examiners in Microbiology, University of Mysore, Mysore; Doctoral Advisory committee, Anna University, Chennai; Doctoral Advisory committee, Vellore Institute Technology University; Davangere University (BoS); Goa University (BoS); Board of Examinations, Davangere University, Davangere, Karnataka; Chairman, Board of Examiners for Ph.D Microbiology, Kuvempu University |
| • Dr. Anu Appaiah K A | Panel of experts of FSSAI for State and UT Govt for upgradation of food testing Labs; Chairman, Sub-committee on alcoholic beverages. BIS, Govt. of India; FAD 14 BIS; FSSAI, New Delhi; Gulbarga University (BoS); Mysore University (BoS); Mangalore University (BoS); BOE in Integrated M.Sc. (Molecular Biology) Mysore University, Mysore |

| Awardee | Member / Panel Expert & Host Institution |
|---|---|
| <ul style="list-style-type: none"> Dr. Manohar B | Advisory board member of UGC-DDU Kaushal Kendra at JSS College of Arts, Commerce & Science; Global Technology Watch Group for manufacturing sector, DST-TIFAC |
| <ul style="list-style-type: none"> Mr. Matche RS | PCD 12; PCD 27; PCD 21; Board of Studies, SJCE, Mysore; Academic Advisory Council, Agriculture and Food Management Institute, Mysore; Task force for bifurcation of tinplate standards, MTD4, BIS |
| <ul style="list-style-type: none"> Dr. Pushpa S Murthy | Board of Studies - Biotechnology, Siddaganga Institute of Technology, Tumkur |

f) Other Awards

| Award Title | Instituted by | Awardee |
|--|---|------------------------------|
| <ul style="list-style-type: none"> GASYM Young Scientist Award 2018 | MMK - SDM, Mahila Mahavidyalaya, Mysuru, Global Association of Scientific Young Minds (GASYM), Mysuru | Sandeep GVR (INSPIRE Fellow) |
| <ul style="list-style-type: none"> Fullbright | Nehru Fellowship | Prasad P (SRF) |
| <ul style="list-style-type: none"> Fullbright | Nehru Fellowship | Aprimita Devi (SRF) |
| <ul style="list-style-type: none"> Best Scientist Award | KMS, New Delhi | Muniasamy N (QHS) |

g) Best Research Papers / Posters Awards

26th ICFoST at CSIR-IICT, Hyderabad, December 7-9, 2017

- Shylaja P., Math R.G., Prabhakara Rao P.G., Madhusudhan Rao D, Nagender A., Sridhar R., Srinivasulu K., Utilisation of food Industry waste using benign methods and production of deep fried and halogen fried onions
- Ramesh G., Ezhil Murugan R., Girish K.G., Ullas P., Nagaraju V.D., Design and development of continuous ragi mudde making machine and ball making unit
- Jethani, H., Mishra, A., Patel, P., Chauhan, V.S., Sarada, R. A ready-to-serve beverage based on phycocyanin, a nutraceutical from *Spirulina* : development and optimization by RSM
- Gaurav Kumar Pal, Suresh P.V., Fermentative production of extracellular bacterial collagenase using fish scales powder and its statistical optimization
- Amarjeet Kumar, Kudachikar V.B., Study on antifungal properties of volatile compounds against anthracnose pathogen of mango

Research Papers / Poster awards in other seminars

- Deependra Rajoriya, Umesh Hebbar H., Refractance Window (RW) drying of fruits, International Conference on Food Processing and Agribusiness' 2018 - Emerging Trends, IIPM, Bengaluru, January 18-19, 2018
- Debika Ojha, Neelakanteshwar Patil K., Characterization of *Listeria monocytogenes* RecA protein: Implication in recombination, INDO-US conference on Transcription, Chromatin Structure, DNA Repair and Genomic Instability, Indian Institute of

Science, Bangalore, March 06-10, 2018

- Sneha H.P., Jayalakshmi E., Rastogi N.K., Basavaraj K., Ken-Ichi Kusumoto, Pushpa S Murthy, Enhanced flavour of coffee by acid carboxy peptidase produced by *Aspergillus oryzae*, Current Trends in Bio International Conference, Cochin, August 21-23, 2017 **(Best oral presentation award)**
- James D Bound, Beulah K.C., Pushpa S Murthy, Green coffee with enriched probiotics, synergy, stability and survivability, Current Trends in Bio International Conference, Cochin, August 21-23, 2017 **(Best oral presentation award)**
- Sangeetha Sher Bahadur Singh, Shree Raksha S., Neelakanteshwar Patil K., Screening and identification of natural molecules as AMPK activators: Combating type II diabetes, 86th Annual Conference of Society of Biological Chemists (SBC) on Emerging Discoveries in Health and Agricultural Sciences, Jawaharlal Nehru University, New Delhi, November 16-19, 2017
- Shrikanth C.B., Nandini C.D., Bioactive zerumbone activates AMPK under high glucose conditions in kidney cells, 2nd International Conference on Nutraceuticals and Chronic Diseases, Goa, September 1, 2017
- Anjali P., Navya N., Vijayaraj P., Modulation of lipid metabolic enzymes by nutraceuticals to improve insulin resistance in high-fat-diet-induced obesity, 2nd Asian Conference on Oleo Science (ACOS 2017) and the 56th Annual Meeting of the Japan Oil Chemists' Society, Kagurazaka campus of Tokyo University of Science, Tokyo, Japan, September 11-13, 2017

h) Editors / Editor-in-Chief / Co-Editor / Executive Editor / Associate Editors of reputed journals

- BMC Complementary and Alternative Medicine, BMC-Series Journals, published by BioMed Central (Negi PS)
- International Journal of Genuine Traditional Medicine published by Association of Humanitas Medicine, Republic of Korea (Negi PS)
- Indian Food Industry Mag, Published by AFST(I), Mysuru (Anu Appaiah KA)
- Indian Food Industry Mag, Published by AFST(I), Mysuru (Vijayendra SVN)
- Journal of Food Measurement and Characterization (Prabhasankar P)
- Indian Food Industry (Suresh D Sakhare)
- Journal of Food Process Engineering, John Wiley, USA (Rastogi NK)

i) Editorial Boards

- Journal of Molecular and Genetic Medicine published by Omics Publishing Group, Foster City, CA, USA (Negi PS)
- Blue Biotechnology, Nova Publishers, USA (Prabhasankar P)
- Research and Reviews: Journal of Food Science and Technology (Prabhasankar P)
- International journal of Fermented Foods (Rajagopal K)
- International journal of peptide and therapeutic proteins (Rajagopal K)
- mBio journal RSC publication (Rajagopal K)
- IJGEB (Rajagopal K)
- Nature Scientific Reports (Balaji Prakash)
- International Journal of Food Science and Nutrition Engineering, Scientific & Academic Publishing Co. Rosemead, CA, 91731, USA (Matche RS)

- International Journal of Agriculture Food Science & Technology (IJAFST), Research India Publications, Delhi (Matche RS)
- International Journal of Knowledge Management and Information Technology (IJKMIT), Research India Publications, Delhi (Matche RS)
- Indian Journal of Nutrition, Open Science Publications, Hyderabad (Matche RS)

j) Advisory Board

- Signpost Open Access Journal of Organic and Biomolecular Chemistry, published by Research Signpost, India (Negi PS)

9. Participation in Exhibitions

- **Packing, Packed Foods & Hospitality Expo:** Organised by Infinite Expositions, Bengaluru, April 7 - 8, 2017
- **Organic Millets National Trade Fair:** Organized by Ministry of Agriculture, Govt. of Karnataka, April 27 - 30, 2017
- **Horticultural Expo 2017:** Organized by Commissioner of Horticulture, Govt. of Telangana, Hyderabad, August 27-31, 2017
- **CSIR Platinum Jubilee Exhibition:** Organized by CSIR, New Delhi at CSIR IICT, Hyderabad, September 1-6, 2017
- **Pasumai Vikatan Expo:** Organised by Vikatan Media Services Pvt. Ltd, Chennai at Trichy, September 1-4, 2017
- **Technofest - 2017:** Organized by CSIR-IITR, Lucknow, September 5-7, 2017
- **6th International Food Fest 2017:** Organized by Key2 Green at Colvin Talukdar college Lucknow, October 6-8, 2017
- **India International Science Festival 2017:** Organized by the Ministry of Science and Technology, Ministry of Earth Sciences &

- Vijnana Bharati at Chennai, October 13-16, 2017
- **World Food India 2017:** Organized by Ministry of Food Processing Industries, New Delhi, November 3-5, 2017
- **International Toxicology Conclave (ITC)-2017:** Organized by CSIR- IITR Lucknow, November 5-6, 2017
- **Adamya Chetana Seva Utsav 2018:** Organized by Adamya Chetana, Bangalore, December 30 - January 2, 2018
- **Food Processing Industry Conclave 2018 Conference cum Exhibition:** Organized by Govt. of Andhra Pradesh, January 4-6, 2018
- **Awareness Programme on Food Processing Technology:** Organised by Tamil Nadu Small & Tiny Industries Association & Tirunelveli District Chamber of Commerce & Industry at Tirunelveli, January 7, 2018
- **Suttur Jatra Mahostava: An Annual Fair:** Organized by JSS Mahavidyapeetha, Mysore, January 13-18, 2018
- **10th KSTA Conference & Exhibition:** Organised by Karnataka Science & Technology Academy, Dept. of Science & Technology, Govt. of Karnataka at Reva University, Bangalore, January 18-19, 2018
- **BEST - Be an Entrepreneur of S&T:** Organized by NRDC, New Delhi & Govt. of Andhra Pradesh at Andhra University, Visakhapatnam, January 25, 2018
- **Kisan Mela:** Organized by CSIR-CIMAP, January 31, 2018
- **MSME International Trade Fair:** Organized by MSME, Bhubaneswar at IDCO Exhibition ground, Unit III, Bhubaneswar, March 5-10, 2018

- **MSME Workshop:** Organized by MSME, New Delhi at MSME, Chennai, March 9-10, 2018

10. Entrepreneur Development Programmes (EDPs) Conducted:

No. of EDPs conducted : 8

No. of beneficiaries : 267

11. Visit of International Delegation & Training

- Mr. Haitham Al-Fannah, CEO, M/s. Al-Sulaimi Group Holding company, Muscat-Oman and team visited the Institute for Business Collaboration (April 6, 2017)
- Mr. Daisuke Hirashima, MD, Kyowa Hakko Bio India Ltd., visited the Institute for project discussion (June 13, 2017)
- A team of International delegates from Sri Lanka visited the Institute for study purpose (July 20, 2017)
- A team from Myanmar visited the Institute in connection with the training on rice processing (July 23-24, 2017)
- Four International participants attended various short term training programmes
- Dr. Albert Schram, Vice Chancellor and Prof. S Gopalakrishnan, R&D Head, PNG University visited the Institute and had discussion pertaining to HRD activities (December 29, 2017)
- A team (14 members) of Indo-African Forum participants visited the Institute for training programme (March 12, 2018)

12. Support Department Activities

- Renovation of the Animal House Facility, Hostel Block, R&D laboratories and second phase of the incubation centre were completed.
- Library services were offered to users comprising of e-journal consortium access and Institute repository.
- The Institute website, www.cftri.com was streamlined with a new look and new features.
- The higher-end instruments such as Agilent AES, Waters U-HPLC and Malvern Zetasizer were added to the centralized Instrumentation Facility and Services.
- A total of 5349 visitors comprising of students from schools and colleges, entrepreneurs, farmers and officials were taken around Institute facilities and showcase by the Information & Publicity Department.

Societal Programmes

I. Farmers Centric Activities

A total of 11 farmers-centric training was organised for the empowerment of farmer's groups/FPOs in which a total of 305 candidates participated. The training was custom-made for 2-3 days with more thrust towards hands-on training.

II. Skill Development Programme on Baking Technology (November 6, 2017 to December 8, 2017)

CSIR-CFTRI organized a 5 - weeks Skill Development Program (SDP) for the benefit of prospective bakery industry entrepreneurs in which 15 candidates participated. The Institute has further planned to conduct such programme under the aegis of 'National School of Baking Technology' in future in order to generate quality bakery professionals benefiting the society and industry.

III. Faculty Training and Motivation and Adoption of Schools and Colleges by CSIR Labs

i) JIGYASA (November 7-8, 2017)

'JIGYASA'17', the Scientist -Student connect program was organised during November 7-8, 2017 in the Institute. Dr. R. Subramanian, Chief scientist, Advisor (M & A), CSIR-CFTRI inaugurated the CFTRI exhibition and released

JIGYASA kit to the students and the teachers. The exhibition displayed and demonstrated various technologies and products of Institute. Three KV schools around the city, KV-Mysuru, KV-Kodagu and KV-Hassan participated in this programme with 50 students and 5 teacher instructors.

The two day programme was packed with popular science lecture, science quiz, visits to sophisticated instrument facility, laboratories, interaction with scientists and research scholars, demonstration & visit to various pilot plants and International School of Milling Technology. The main highlight of the programme was to give hands on experience on basic lab experiments, popular science talk by distinguished Scientist from CSIR-CFTRI. The laboratory experiments were planned based on the KVS academic curriculum to provide a glimpse of exciting and inquisitive world of science.

ii) Motivation Program for High School Students (December 13, 2017)

A motivational program to inculcate scientific temperament and inquisitiveness was conducted at Govt. High School, Yelwala and GHS, Hinkal. A total of 680 students were benefited from the program. Three lectures viz. Food safety and its regulation, Nutrition



Students and faculty of JIGYASA 2017

and Health, Spirulina and its applications was delivered by CSIR-CFTRI Staff. Simple tests to detect food adulteration were carried out using the CFTRI Food Adulteration Kit.

A motivational program to inculcate scientific temperament and inquisitiveness was conducted at Govt. High School, Hinkal on January 12, 2018. A total of 189 students were benefited from the program. The lectures on food safety and its regulation, Nutrition and Health, Spirulina and its applications was delivered by CSIR-CFTRI staff. Demonstrations to detect food adulteration using the CFTRI-Kit were done.

iii) Student Camp for Promoting Innovation (December 20-22, 2017)

As part of the school centric program, three day student camp was organized in the Institute. The main objective of the program was to motivate students to take up science as a career and promote innovation in science. This camp was targeted towards meritorious students of 11th Standard/PU and the theme was “Life Sciences for Food and Nutrition”. There were 28 participants from 7 Govt. colleges for the programme. The camp included motivational lectures, exchange of ideas, discussions, student centered learning activities (hands on experiments), funology (science lessons through puzzles), visit to CFTRI pilot plants and live demonstrations in food processing.

iv) Faculty Training and Motivation Programme (February 27-28, 2018)

A two day workshop on “Faculty Training and Motivation”, for degree college lecturers with Biological Sciences background from Mysuru and Mandya was held at CSIR-CFTRI under the theme “Recent Trends in Biotechnology and Allied Subjects”. A total of 25 lecturers from different colleges; Government and Private colleges

participated. An overview of modern tools and techniques used in analytical and R&D activities in Food Science and Biological Sciences were showcased. Also, the importance of molecular biology tools were extensively covered.



Faculty motivation programme in progress

IV. CSIR-CFTRI-KEMI Entrepreneurship Development Programmes (June 5-16, 2017 & November 20 - December 2, 2017)

CSIR-CFTRI in association with Kautilya Entrepreneurship & Management Institute organized two joint programmes to encourage and promote startups in the food processing sector.

The course as 'Entrepreneurial opportunities in food and allied sectors' was designed to address both the technologies and entrepreneurship part for enabling successful ventures in the area of food processing. Accordingly, first week of the programme was held in the CFTRI campus at Mysore and the later component in the Jain University Campus. The programme focused on the technologies on Ready-to-eat foods, Natural beverages, Superfoods, Healthy Snacks, Minimally processed vegetables, FSSAI regulations and so on. The Entrepreneurship / programme will focus on developing opportunities, Customer value proposition, marketing, financing and branding. A total of 38 prospective entrepreneurs attended the programme.

V. SME Corner Application

The Institute launched an online platform 'SME Corner' that connects SMEs with experts at CSIR-CFTRI. The platform is aimed to help Small and Medium Entrepreneurs (SMEs) to support the entrepreneurship. So far, 648 companies/entrepreneurs have registered for availing the services. A total of 24 experts are providing required guidance on 15 broad topics on a day-to-day basis. Those who have registered can post their queries under specific categories and the concerned expert and scientists would provide the required guidance.

VI. FreeTech Portal

The portal is meant to enable the download of the free technologies (15 nos.) offered through Institute website. The portal has 7220 registrations and a download of 38153 technology dossiers have been recorded cumulatively.



Shri Sudhir Mungantiwar, Hon'ble Minister of Finance and Planning & Forests, Govt. of Maharashtra releasing one of the Free Technologies, Pedal Operated Millet Dehuller at CSIR-CFTRI

Progress Under R&D Projects

Engineering Sciences

Mango butter and other bio-actives from mango kernel (*Manohar B*)

Quantitative and qualitative characterization of mango kernel seed oil obtained by solvent extraction techniques was studied. Mechanical characteristics and grinding studies of mango seed kernel was carried out. Influence of defatted mango kernel seed flour addition to wheat flour at various ratios on the rheological characteristics and cookie making quality was analysed.

Ready-to-cook tomato/ vegetable biryani rice paste (*Matche RS*)

Tomato rice is a popular South Indian dish used as a breakfast/ meal menu. The main ingredients of the preparation comprises of tomato, onion, garlic, coconut, cinnamon, chilli, fat and rice. The product was slightly sour in nature. RTE tomato rice products in the market have not found wider acceptability due to quality issues.



This is a RTC product and its quality was found superior to RTE form. The product has been prepared using hurdle technology in which pH is employed as the main hurdle. The other hurdles

are temperature, redox potential and packaging. The product can be consumed by just pressure cooking or open cooking with water which has a shelf-life of more than 6 months. The advantage of this product is the convenience of just pressure cooking and does not involve any pre-processing and adding of rice to curry paste. The microbial and sensory studies have also been completed and the product/ process is ready for commercial release.

Gold nanoparticles incorporated bio-degradable film

Mechanical properties of the different concentrations of eugenol nanoemulsion and gold nanoparticles incorporated films were compared with control films. Results showed that the 2% eugenol incorporated film had high tensile strength and the lowest % elongation while the control film had the high % elongation and low tensile strength. All films showed the yellow tinge. 2% eugenol nanoemulsion incorporated film showed the highest yellow tinge and the film with gold nanoparticles had the slight reddish tinge. FT-IR studies indicated that there was no change in chemical structure of the different films containing eugenol nanoemulsion/gold nanoparticles. WVTR studies show that all the films showed less barrier property to water vapour.

Development of poly lactic acid (PLA) based nanohybrid composite films

Hybrid-nanocomposite films were prepared by solvent casting technique. The PLA/ chitosan/

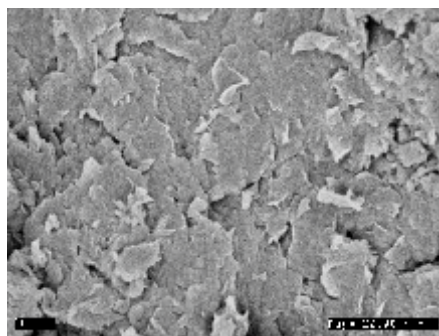
methylecellulose silver nanoparticles composite film with silver nanoparticles were fabricated. Silver nanoparticles were prepared using green synthesis method. Synthesized nanoparticles were characterized using techniques like particles size analyzer and UV-visible spectrophotometer. These green synthesized nanoparticles were used to develop multifunctional film with PLA/ chitosan/ methyl cellulose biopolymer blends. The nanocomposite films were characterized using UTM, WVTR, SEM and antimicrobial properties. Particle size analyzer confirmed the formation of silver nanoparticles which had UV-vis peak at 418.5 nm. The results indicated that the tensile strength of PLA/ chitosan/ methyl cellulose blend film was significantly higher. The tensile strength of silver nanoparticles reinforced PLA/ chitosan/ methyl cellulose blend film did not increase. Antimicrobial study of film samples was tested against four different pathogens (*S. aureus*, *E. coli*, *Klebsiella* and *Bacillus*). The results showed that the antimicrobial properties of the film improved with the addition of silver nanoparticles.

Graphene oxide based nanocomposite films (Arunkumar P)

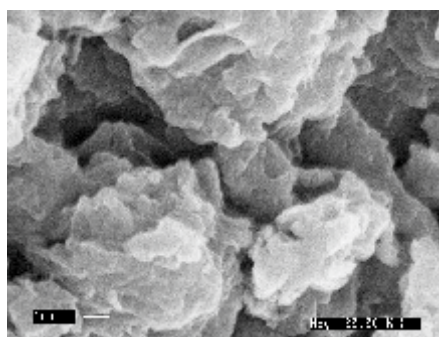
Graphene oxide (GO) was prepared by improved Hummer's method which was confirmed by the presence of intense UV-Visible (UV-Vis) peak at ~ 230 nm. Fourier Transform-Infrared (FT-IR) spectrum of GO showed the presence of vibrational bands corresponding to oxygen containing functional groups such as O-H (3362 cm^{-1}), C=O (1724 cm^{-1}), C=C (1623 cm^{-1}), C-O (1225 cm^{-1}) and C-O-C (1060 cm^{-1}). Scanning electron microscopy (SEM) revealed a flaky morphology for the as-synthesized GO powder (Fig. a).

As obtained GO was converted to reduced

graphene oxide (rGO) by an eco-friendly green approach. The UV-Vis spectrum exhibited a typical absorption peak red shifted to ~270 nm indicating the complete reduction of GO to rGO. The IR spectrum showed absence of GO oxygen moieties which further corroborated the complete conversion. X-ray diffraction (XRD) analysis of the as-obtained powder showed peak at ~ 23° , which can be assigned to the rGO reflection plane (002) without the characteristic peak of GO ~ $10\text{-}11^\circ$. SEM image (Fig. b) revealed that as-obtained rGO sheets appeared to have a crumpled and aggregated morphology.



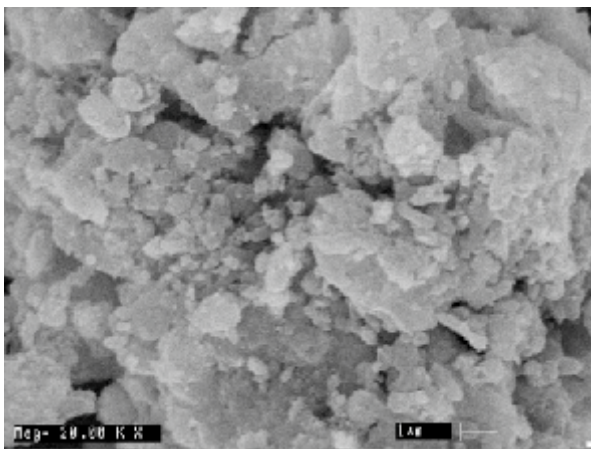
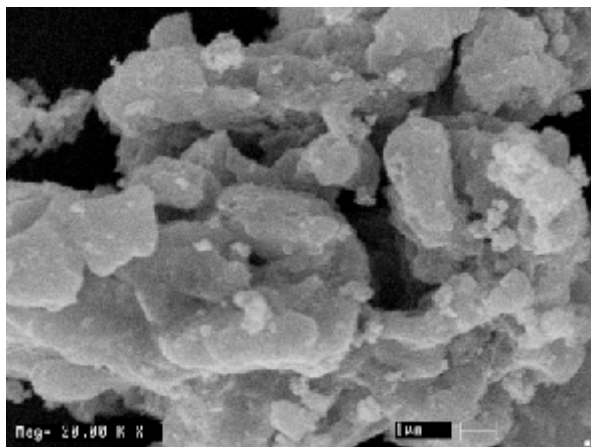
SEM images of (a) GO



and (b) rGO.

Zinc oxide (ZnO) nano sub-micron (NSM) particles were synthesized by ultrasound technique from a single source precursor. As-synthesized materials characterized by XRD revealed the formation of ZnO particles of hexagonal (wurtzite) structure which was further confirmed by UV-Vis with a characteristic peak at ~ 372 nm. SEM image exhibited agglomerated and irregular shaped

particles both in nano and sub-micron range. FT-IR spectrum showed Zn-O stretching vibrations between $500\text{-}600\text{ cm}^{-1}$. Photoluminescence (PL) analysis revealed violet (423 nm), blue (483 nm) and green (510 nm) emissions typical of ZnO.

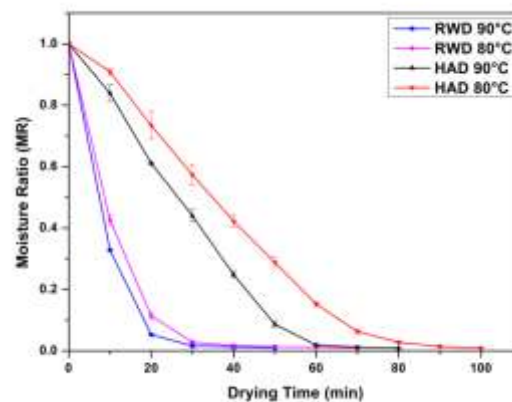


SEM images of ZnO nano-submicron particles

Refractance window (RW) drying of fruits (Umesh Hebbar H)

Dehydration is the most common method of food preservation involving simultaneous heat and mass transfer. Although a number of drying techniques have been employed for drying food products, the conventional techniques suffer from limitations such as poor product quality, high energy cost and longer processing time.

Refractance Window (RW) drying is a novel drying technique that utilizes both radiation and conduction modes of heat transfer to effectively dry food materials in a short time. In this work, a laboratory-scale, batch-type RW drying system was developed in the institute and used for the studies on dehydration of fruits such as apple and banana. Apple slices of thickness 2 mm were dried using RW drying and the product qualities in terms of moisture content, water activity, colour and ascorbic acid content were compared with that of products that were hot air dried (HAD) under similar processing conditions and also with freeze drying. The drying studies were carried out at two different temperatures (90 and 80 °C). During RW drying, the moisture content decreased rapidly to a value below 15% (wb) in about 30 min at both the temperatures. The time required to reach final moisture content (5-6% wb) reduced by nearly 30-37.5% as compared to HAD at temperatures 80 and 90 °C respectively. The lightness values of RW dried samples were significantly close to freeze dried samples and HAD dried samples were darker. Retention of ascorbic acid in RWD slices (~85%) was close to FD (~90%), and higher as compared to that of HAD (~72%). Preliminary studies have showed that RW drying could be a promising technique to dry thin layer of heat sensitive products.



Drying curve (moisture ratio vs. time) of apple slices during RW and HA drying at 90 and 80 °C

Machine for continuous cooking and discharging of ragi mudde/ ball making (Nagaraju VD)

A small continuous power operated machine with a capacity of 50 kg/h on average of 250 ragi mudde (finger millet ball) per hour (each weighing 200 gm) was designed, fabricated and evaluated for its performance on cooking characteristics of ragi mudde. The machine gives the best results with respect to stickiness, colour and hardness accordingly. Trials were conducted in prototype machine by running continuously for 6 h for the performance evaluation and its suitability for commercialization and the performance was found to be very good. Consumer acceptance evaluation was carried out at CFTRI canteen, Mysore and a very good response was obtained.

Table top fruits and vegetable washer (Nagaraju VD)

The fruits and vegetables we consume often contain pesticides and chemicals making them harmful for human health. All fresh produce, even organic, may harbor dirt or harmful microorganisms on the surface. It is desirable to wash the fruit and vegetables before consumption either in raw or cooked form to ensure hygiene and safety. Conceptual model of table top fruits and vegetable washer has been designed, developed and fabrication is under progress.

Technology Development

Shelf stable nutritious wheat based products using natural preservatives (Walde SG)

The objectives was to develop fiber enriched refined wheat flour; utilization of super foods for nutritional whole wheat flour; and development of shelf stable nutritious bakery and traditional (thepla) products using natural preservatives. Various sources of fiber was screened and characterized to analyse their suitability for the development of high fiber wheat flour. Another objective of this work was to develop high fiber wheat flour that can be used for all purposes. The blends prepared were evaluated for their physical, chemical and rheological properties and preparation of products from the blend is in progress. Also, in order to develop nutritional whole wheat flour, development of quinoa enriched atta and shelf stable nutritious cookie cake was initiated. The milling parameters for the quinoa were standardized to produce flour that can be fortified with whole wheat flour. The blends were evaluated for the chemical and rheological parameters. The products made from the quinoa enriched atta were evaluated. The processing conditions and the unit operations were standardized for the preparation of traditional product *Thepala* with quinoa enriched atta.

Multigrain semolina mixes (Suresh D Sakhare)

The processing conditions were standardized for pretreatment and milling of different grains to prepare semolina. Semolina obtained from

different grains were characterized and blended for the preparation of multigrain, high protein, high fiber, low GI, multimillet and gluten free multigrain semolina mix. The coarse (*sooji*) and fine semolina (*rava*) mix forms were used for the preparation of various traditional products such as *Upma* instant mix, *rava idli* instant mix and *halwa* instant mix and processing conditions were standardized.

Microbial and pesticide decontamination of freshly consumed vegetables (Negi PS)

Four of the vegetables viz. tomato, carrot, cucumber and lettuce procured from local markets were subjected to physical and chemical treatments, and the efficacy of treatments for the removal of adhering bacteria and pesticide residues was evaluated. The ultrasound treatment (20 KHz) at 70% amplitude for 5 min with 1s pulse was found most effective for tomato and carrot. However, for the decontamination of cucumber and lettuce 30% amplitude for 10 min with 1s pulse was found more effective. Ozone treatment at 60 g/m³ for 10 min was more effective than other concentrations or decontamination of bacteria and pesticide residue in selected vegetables, and no significant change in nutritional parameters was observed. Lactic acid (2.5%) and sodium acetate (2.5%) dip for 5 min and eugenol (0.3%) and cinnamaldehyde (0.6%) dip for 5 min were also found to be effective for microbial and pesticide decontamination.

Value-added products and by-products from papaya (*Carica papaya*) (Vijayanand P)

Shelf-life extension of papaya fruit: Papaya fruit (var. Taiwan red lady) of optimal maturity (7-8°Brix) was harvested, sorted, graded based on size, colour and firmness. Post-harvest dip treatments were given for 15 minutes with solutions having different biochemical formulations. The fruits were air dried (surface) and stored at room temperature. Fruits pre-treated retained its colour, texture and also the other fruit quality parameters and values were found closer to that of control. Shelf life of pre-treated papaya fruits was 12 days at room temperature as against 8 days for untreated fruits.

Papaya powder as a functional additive: Papaya fruits that are at different stages of maturity viz., unripe, semi ripe and ripe were selected, peeled, sliced and pretreated. Further they were dried in a hot air drier and pulverized to obtain powder. Papaya powder was analysed for physicochemical composition, water holding capacity, swelling capacity and gelling properties. The powder from unripe fruits was found to be a rich source of starch, dietary fiber, pectin and ascorbic acid. Further studies on incorporation of papaya powder as a gelling agent in jams, jellies, beverages are in progress.

Intermediate moisture product from raw and ripe Papaya: The storage studies of the developed low sugar ready-to-eat (RTE) restructured ripe papaya chunks are in progress. The process conditions were optimized to preserve raw mature papaya (breaker stage) cubes (10 mm size) by adopting moist infusion technique. The product is RTE in nature with good acceptable sensorial properties. The product is a good source of total carotenoids and minerals including potassium and calcium. The

storage studies revealed that the dried (12.5% moisture) RTE papaya cubes are stable at room temperature ($29 \pm 2^\circ\text{C}$) for 4 months.



Ready-to-eat dried papaya cubes (10 mm size, 12.5% moisture)

Functional ingredient rich grain based products (Srinivas A)

The two millets selected for the study (foxtail millet and little millet) were processed with minimal polishing required. Both were analyzed for their physicochemical and functional properties. Hydration characteristics indicated higher water uptake and oil absorption capacity for little millet. The total polyphenol content were 95.11 and 13.05 mg% tannic acid equivalents for the foxtail and little millets respectively, with almost twice protein content than latter (7.7%). Both these grains were flaked after suitable processing and mixed together and flavoured to be used as millet based breakfast cereal that could be consumed along with milk. Using these two millets, products like *khara pongal* and *sweet pongal*, were also prepared. The process for RTP millet based *pongal* ready mix is in progress. All the products showed good sensory acceptance and hold promise in the commercial market. However, cooking time and solid dispersion was comparatively higher for the little millet than foxtail millet.



Flavoured Millet Flakes



Millet based Khara



Sweet Pongal

Convenience products from pseudo-cereals like quinoa/amaranth seeds: Quinoa based consumer friendly convenience product formulations for RTE and RTC *upma* and *pongal* and RTE *laddu* were developed and analysed for their nutritional and sensory attributes. *Upma* and *pongal* products packed in retortable, flexible, laminated pouches had 5 months shelf stability at room temperature. The energy value of quinoa *laddu* was calculated to be 516 kcal/100 g. It is devoid of added additives or preservatives and has a shelf-life of 45 days at room temperature.



Quinoa laddu



Quinoa upma



Quinoa pongal

Resistant starch rich RTE fraction/ product from sorghum: The effect of various processing on the carbohydrate digestibility and resistant starch content of sorghum was studied. It was observed that when sorghum was subjected to various modes of heat treatment, the slow digestible and resistant starch content varied with the mode of heat and moisture content. Around 14-20% increase in the resistant starch content was noticed by modifying the conditions of heat processing. The milling and processing protocols are being standardized to obtain a fraction rich in resistant starch content.

Phytochemical enriched millet fractions and millet-based composite flours: Chickpea and its flour are being used extensively in food processing particularly for snack foods in many countries because of its ideal cell wall polysaccharide composition, versatile flour functionality and relatively high content of oil. Incorporation of millet flours into chickpea flour for use in chickpea-based foods could facilitate the utilization of underutilised millets as food ingredients. Three composite flours containing chickpea, foxtail millet and pearl millet of different combinations were produced and their nutritional compositions were determined. Their nutritional composition revealed that foxtail millet-based composite flour has more protein (16.41%) and carbohydrate contents (70.91%) whereas fat (6.17%) and ash contents (1.39%) were more in pearl millet based composite flour. Both composite flour exhibited similar water absorption capacities (1.2 g/g) and emulsion activities (37%). However, pearl millet-based composite flour showed higher oil absorption capacity and foaming activity. Functional properties observed in these millet-based composite flours make them suitable for the development of nutritious snack products. Evaluation of anti-nutritional components indicated that pearl millet flour has higher content of phenolic compounds and phytates than foxtail millet flour. Production of ready-to-eat snack product from these composite flours and estimation of product nutrient contents is in progress.

Instant multigrain drink mix as breakfast food: Instant iron fortified nutrigrain drink mix was made by appropriate processing of grains, blending with pulses and nuts, size reduction, hydrothermal treatments and fortification with iron. The product was having desired colour, particle size distribution, sedimentation value,

micro viscoamylograph properties, sensory attributes and storage quality.



Instant iron fortified nutri-grain drink

Dhokla from multiple dhals: Ready-to-cook *dhokla* mix was formulated using various legumes and processing conditions were standardized. The *dhokla* mix formulated is being analysed for proximate and functional properties and shelf-life studies.

Neutral/ alkaline bacterial phytase and assessment of potential in de-phytinization of oil-cake-rich animal feed (Mukesh Kapoor)

Treatment of high-phytate food with PhyCk showed improvement in mineral bioaccessibility maximally for defatted sesame flour (DSF) (Fe 45.5%; Zn 50.7%) followed by wheat flour (WF) (Fe 13.5%; Zn 14.4%), green gram flour (GGF) (Fe 0.7%; Zn 3.8%) and defatted groundnut flour (DGF) (Zn 5.6%). The in vitro protein digestibility (IVPD) of WF increased from 48.83% to 65.04%, GGF from 45.04% to 57.12%, and DSF from 47.34% to 55.7% after Phy-Ck treatment.

Mathematical modelling of regulatory networks in bacteria (*Sutapa Mukherjee*)

The work is focused on studying the stress response of bacteria responsible for food spoilage. In order to have preliminary understanding of the bacterial stress response in general, work on *E. coli* which is found to be a potential food pathogen was initiated. Several features are now understood in connection with the genetic network that regulates the response of the *E. coli* under stress associated with oxygen and energy availability. In connection with *E. coli*'s stress response under oxygen and energy availability, particular subnetwork involving both protein and sRNA mediated regulation was looked at. It was found that subtle changes in this motif can bring in drastically different effects on the gene expression. In particular, our studies showed that a threshold response in gene expression changes to a bistable response as the regulation on sRNA synthesis or sRNA degradation was altered. The bistable response corresponds to two possible equilibrium states with low and high sRNA concentrations. These results are obtained under deterministic (noise-free) conditions. The gene expression, however, is known to be noisy because of noise associated with various biochemical processes related to trans-cription, translation, mRNA degradation, and also other external perturbations unrelated to the gene. Hence, noise was incorporated in the network models and obtained probability distributions for concentration levels of proteins and sRNAs. These probability distributions are bimodal with peaks at high and low sRNA concentrations. Probability distributions obtained for different noise strength showed that the relative height of the peaks change significantly as the noise strength is increased.

Protein rich ingredients from plant seeds (Flaxseed) (*Rajagopal K*)

Traditionally flax seed is used for oil extraction without processing, which results in degradation of quality of oil due to extraction of mucilage. The cake obtained after extraction will be black in color due to hull content. Development of efficient demucilaging methods is indispensable for producing better quality oil and meal. The presence of mucilage which swells during extraction of proteins is one of the major hindering factors in the development of methods for protein isolate. In the present work, an efficient method was developed for demucilaging of flax seed meal. After demucilaging and dehulling, the protein content of the meal was enriched from 24% to 48-52%. There was a noteworthy increase in solubility of protein (58%) after demucilaging. There was ~21% loss after demucilaging and 8.3% yield of protein rich meal when a batch of 25 kg flaxseed was demucilaged and defatted to get protein rich meal. Protein isolate was prepared from the meal by isoelectric precipitation. The retrieval of protein from the demucilaged linseed meal was 30%. The protein substance of the isolate was 91%. The amino acid analysis indicated that the protein isolate is rich in branched chain amino acids (Val, Leu and Ileu) and arginine. The Lys/Arg ratio of protein isolate was 0.24 compared to 0.57 for flax seed meal. The Lys/Arg ratio of flaxseed protein isolate was lower compared to soya protein isolate (0.71). Since flax seed protein isolate is rich in branched chain amino acids and arginine, it can be a beneficial component in the medicinal formulations required for cardiac patients and special diets for patients with malnutrition or liver failure.

Probiotics for antigen delivery(*Rajagopal K*)

The main objective of this work was exploitation of probiotic microbes such as *Lactobacillus/Bifidobacteria* for the delivery of antigen hTNF- α . Tools like transformation technologies

suitable for prokaryotes as well as for eukaryotes have been successfully developed. It is well known that the microorganism required for delivery of antigen is a probiotic. In this work, *Enterococcus raffinosus* was isolated and identified. Subsequently, it was sequenced to understand at genome level. *Enterococcus* plays an important role in food fermentation and is extensively used as probiotic microbes to improve human or animal health. They also cause severe nosocomial diseases, urinary tract infections and bacteremia etc. Sequencing was performed using Illumina - Hi Seq 1000 technology (Illumina Inc., California). A total of 13,777,040 paired end reads (insert size 150 bp) of 131-nucleotide length were obtained. NGS QC tool kit (v. 2.2.1) was used to filter the data for high quality (HQ) (where 70% cut off read length, and 20 as quality cut off score), vector/ adaptor-free reads were used for assembly with Velvet (v. 1.2.07). The final assembly contained 193 contigs with a total size of 4207547 bp, and a N50 contig length of 77.065 kbp. Length of the contig's ranged from 200 bp to 201,862 bp with G+C mol % of 39.49 %. Gene prediction was performed by PRODIGAL (Prokaryotic Dynamic Program-ming Gene finding Algorithm, v. 2.60); tRNA was predicted by using with tRNA scan-SE (v. 1.21) and rRNA were predicted using RNAmmer (v. 1.2). Total 4,242 genes were predicted, including 54 tRNA, and 7 rRNA (5S-23S-16S). The annotation of the genome of *E. raffinosus* reports the presence of a Tn554 element, but lacks the virulent traits such as gelatinase (gelE), and serine proteinase (spr). However, cytotoxins were observed in the genome of *E. raffinosus*, along with phage infection proteins, Mu like proteins etc.

Novel anticancer protein from quinoa bran

Chenopodium quinoa a pseudocereal cultivated since 3000 B.C. and is native to the Andean

origin. The quinoa is gaining attention due to its nutritional facts. Quinoa is not only known for its high protein content but also has balanced amino acid spectrum. It is known to contain a considerable amount of fiber, minerals along with antioxidants such as polyphenols. Bran is a byproduct of milling and is being discarded despite having a high concentration of proteins (22.3-32.2 %) and lipid (14.2-17.8 %) due to its bitter and toxic compounds like Saponins. Studies carried out on proteins isolated from other cereal bran have shown important biological activities like anti-cancer and immunomodulatory properties. Therefore in this work, extraction and partial purification of quinoa bran was done to study the biological activities. The proteins from bran were extracted and purified using a conventional chromatographic method. Partially purified samples were studied for their effect on the growth of HepG2 cells by MTT assay. Results revealed that these partially purified proteins are effective in inhibiting the growth of cancer cells. These results indicated the presence of bioactive proteins in the quinoa bran, but it requires a detailed study to understand the molecular basis involved in it.

Millet arabinoxylan oligosaccharides (AXOS) induced anti-cancer effect in gastrointestinal cancer (Sachin M Eligar)

The current work aims to understand the molecular signaling pathway in millet arabinoxylan oligosaccharides (AXOS) induced anticancer effect in gastrointestinal cancer cells. AXOS from pearl millet bran were isolated and purification was standardized using different chromatographic techniques. The standardized method will be used to isolate AXOS from proso millet bran. Initial studies on the growth inhibitory effect work carried out and results suggest that AXOSs have the growth inhibitory

effect on gastrointestinal cancer cells. Further detailed kinetics and molecular signaling are in progress.

Improving the bioavailability of sesame nutraceuticals (Sridevi A Singh)

Bioaccessibility of sesame lignans sesamin, sesamol and sesamol were analyzed in whole seeds. Sesamin and sesamol had very low bioaccessibility, while sesamol had a comparatively better serum bioaccessibility of 9.31%. In order to improve the bioaccessibility of sesamol, encapsulation in phosphatidylcholine micelles was carried out. Sesamol was entrapped in phosphatidylcholine mixed micelles (PCS) with 96.8% efficiency. The encapsulation was confirmed by fluorescence measurements and particle size measured to be 3 ± 0.6 nm. Bioavailability along with anti-inflammatory efficacy of PCS in comparison with free sesamol (FS) was tested using caco-2 and RAW 264.7 cell lines. PCS had an enhanced bioaccessibility of 8.58% compared to FS in caco-2 monolayer cells. The transport across caco-2 monolayer and cellular uptake was higher by 1.5 and 1.2 fold, respectively, compared to FS. PCS showed better down regulation of inducible nitric oxide synthase (iNOS) protein expression (27%), nitric oxide (NO) production (20%), ROS (32%) and lipoxygenase inhibition ($IC_{50} = 31.24 \mu M$) compared to FS. Thus, PCS showed better bioavailability and anti-inflammatory activity compared to FS and could be a good vehicle for delivery.

Proteins/enzymes of probiotic lactobacilli involved in beta-manno-oligosaccharides catabolism (Mukesh Kapoor)

Guar gum was hydrolyzed by using purified GH-26 recombinant endo-mannanase ManB-1601. The B-mannooligosaccharides (GG-B-MOS) mixture

obtained was subjected to size exclusion chromatography (Bio-Gel P2) which resulted in seven well separated peaks (P1, P2, P3, P4, P5, P6 and P7). Characterization of peaks using Electron spray ionization mass-spectrometry showed that P1, P2 and P7 were not having a single species while, P3, P4, P5 and P6 represented pentasaccharide (DP5), tetrasaccharide (DP4), trisaccharide (DP3) and disaccharide (DP2) respectively. DP2 and DP3 GG-B-MOS were structurally characterized by NMR (1H and ^{13}C), FTIR and XRD. DP2 oligosaccharide was composed of two species (A) mannopyranose β -1,4 mannopyranose and (B) α -1,6-galactosyl-mannopyranose while, DP3 oligosaccharide showed presence of three species i.e. (A and B) α -D-galactosyl- β -D-mannobiose (Galactosyl at reducing and non-reducing end respectively) and an un-branched mannotriose (mannopyranose β -1,4 mannose β -1,4 mannopyranose). *In vitro* fermentation experiments showed that DP2 and DP3 resulted in higher growth of *Lactobacillus helveticus* (NCIM 2126) and *L. acidophilus* (NCIM 2285). Among DP2 and DP3, the former showed better growth of tested probiotic strains than latter. On the contrary, *L. plantarum* (NCIM 2372) did not show any significant improvement in growth parameters in presence of DP2 and DP3. *In vitro* fermentation of probiotic strains *Lactobacillus plantarum* (WCFS-1), *L. caesi* (NCIM 2126) and *L. rhamnosus*, showed better growth in DP-3 in comparison to glucose. The growth of *Salmonella typhi* was less in media containing DP2 and DP3 when compared to FOS.

Moringa seed protein for water purification (Radha C)

Moringa seed protein isolate (MPI) was prepared from defatted moringa seed flour at optimum conditions. Model turbid water was treated with moringa seed protein isolate and the quality of

treated water was analyzed and compared with that of water treated with alum. Based on the previous data further experiments were carried out in synthetic turbid water and mud water. The coagulation activity of MPI was compared with 15 mg/l of alum and found that both had similar activity. Residual turbidity was reduced by more than 97% for highly turbid waters on treatment with 15 mg/l of MPI and 15 mg/l of alum. This shows that MPI can be used as a substitute for alum in potable water treatment for reducing turbidity of high turbid water. Water samples were collected from different locations such as rivers and lakes in and around Mysore city and quality parameters were checked after treating with MPI to check its efficacy as a coagulant. Experimental parameters were optimized for the fabrication of a water purifier using MPI as a coagulant.

Development of bioactives, technologies for select spice, sugarcane product and analytical method for sugar (Borse BB)

Beet colour concentrate was prepared from locally procured Red Beet. Beet colour concentrate was encapsulated using nano emulsion. Suitable food grade carrier materials were selected and different ratios of beet colourant:carrier:fat:emulsifier were used for the preparation of nanoemulsion. Effect of different ratios of colourant, carrier, emulsifier on particle size of nanoemulsion, zeta-potential value, encapsulation efficiency and the color co-ordinate (L^*, a^*, b^*) values of nano emulsions prepared were evaluated.

A feasible oxidation of oximes derived from aldehydes and ketones to afford carbonyl compounds by the RuO_4 catalyzed reaction was developed. The oximes derived from aromatic compounds such as vanillin, p-methyl acetophenone, benzaldehyde and cyclic

saturated ketone like cyclohexanone were conveniently oxidized in a near quantitative yield in shorter duration (3 h). Ruthenium (IV) oxide was generated by the reaction of Ru(III) chloride and NaIO_4 . In a typical reaction, oximes (1 equivalent) were made to react with the mixture containing Ru(III)chloride (0.1%) and NaIO_4 (1.5 equivalent) in ethyl acetate: acetonitrile: water (3:3:1) at 0-5°C. These reactions are straight forward and formed exclusively the parent carbonyl compounds. The oximes derived from zerumbone and carvone, substrates having reactive double bonds, were preferentially afforded double bond oxidized products and no deoximation was observed.

The feasibility of extraction of bioactive compounds in Zingiber zerumbet was studied. The extraction techniques applied are conventional solvent extraction, microwave assisted extraction, ultrasonic-assisted extraction, hydro-distillation, Soxhlet extraction. Enzyme treatment was also checked using cellulase, pectinex, hemi-cellulose, α -amylase and viscozyme. The best result was obtained for the extraction of volatiles and non-volatiles under microwave-assisted methanol extraction (6.96%). Among the enzyme treated samples, 1% viscozyme treatment found to be affording highest essential oil isolation by hydro-distillation method. Proximate analysis was also carried out on the zerumbet dry powder and filter cake from microwave-assisted methanol extracted samples. The results suggest that the shampoo ginger has 6.33% ash and 5.98% protein.

Quantification of essential oils was checked by three analytical methods namely, GC, GC/MS and qNMR. Hydro-distillation of the selected spices was carried out in a Clevenger trap for extraction of essential oils. The yields obtained were near to the values reported in the literature. Qualitative and quantitative analysis of essential oils were

undertaken by GC and GC-MS techniques. The GC and GC-MS results of cardamom oil showed the presence of α -terpineol (56.79%) and 1,8-cineol (21.61%) as the major components; while linalool acetate (70.41%), cinnamaldehyde (77.42%), 2-hydroxy-4-methoxybenzaldehyde (50.91%), eugenol (61.12%), anethol (75.60%), carvone (64.69%), zerumbone (74.45%) were obtained as major components in coriander oil, cinnamon oil, swallow root oil, clove oil, aniseed oil, mint oil and shampoo ginger oil respectively. These oils were analyzed by quantification NMR using TSP as internal reference standard. The percentage of major character impact compounds in clove oil, cinnamon oil, coriander oil, aniseed oil, mint oil obtained are eugenol (83.7%), cinnamaldehyde (84.00%), linalool acetate (74.86%), anethole (64.37%), carvone (77.30%) respectively. GC and GC-MS reports of shampoo ginger oil revealed zerumbone in 66.9% and 74.45% respectively, but the value obtained by qNMR was 48-50%.

Value added products from green coffee (Pushpa S Murthy)

There is a growing interest in the dietary supplementation of Chlorogenic acid (CGA) as a nutraceutical agent in food formulations due to its various medicinal properties. Method of preparation of green coffee extract (GCE) with decaffeinated (85 \pm 5%) and enriched with CGA (60 \pm 5%) using GRAS solvents (ethyl acetate) was developed. The antioxidant activity of the conserves was 85 \pm 10 % and, microbial safety and absence of ochratoxin was met as per food safety norms. Further, the green coffee extracts were encapsulated with maltodextrin (10%) as a carrier material and the nanoemulsion (droplet size 80-100 nm) was spray dried. The investigation signified the nanoencapsulation of green coffee conserves (5%) and were thermally stable upto 249°C. The nanoencapsulation efficiency was found to be 80% and have

confirmed the retention of chemical properties. The storage stability of spray dried nanoencapsulated green coffee extract is being studied at accelerated temperature and various relative humidity conditions. However, considering the cost effectiveness and techno feasibility micro-encapsulation was explored with different wall material (maltodextrin, skim milk) and core material (green coffee conserve). Microencapsulation of green coffee conserves (10%) with maltodextrin in the ratio 1:1 yielded 80% and was thermally stable.

Flavour proteases from *Aspergillus oryzae* and value addition (Pushpa S Murthy)

Aspergillus oryzae was isolated from coffee by-product and screened for maximum production of acid carboxypeptidase and confirmed by ITS region (600 bp) PCR and sequencing. Growth studies indicated that maximum carboxypeptidase activity was 2.552×10^3 nkat for every gram of wheat bran with mycelium. The response-surface methodology was employed to generate a predictive model of the combined effects of independent variables such as moisture, temperature, inoculum concentration and fermentation time. The statistical design indicated that all four independent variables have significant effect on acid carboxypeptidase production. Optimum factor levels are moisture 35%, incubation temperature 29°C, inoculum concentration 10^8 CFU/ml, and fermentation time 100 h to yield a maximum activity of 4810 nkat/g. The acid carboxypeptidase was partially purified by DEAE Sepharose Column and specific activity of 3675 nkat/mg with a molecular weight of 50 kDa optimal pH 3.6 and temperature 35°C. The enzyme activity was stable with the addition of 50% glycerol and BSA (2 mg/ml). The inhibitor studies revealed that it is serine protease. The serine protease treated coffee was effective in improving the flavour profiles of low-grade

coffee when compared to the untreated with hedonic scale rating 6 and 4.5. Enhanced flavour annotations were exemplified by GC-MS analysis with sweet and fruit notes followed by debittering and find potential scope as value addition for coffee industry to improve low grade coffee.

A. oryzae was screened for aspartic protease. UV mutagenesis improved the productivity of the parent strain with survival rate of 76%. The mutant strain CPO 025 produced 13115 U/ml, which is 1.53 fold higher than the parent. The mutant strain was subjected to statistical optimization of solid state fermentation process parameters using wheat bran as a substrate. The studies revealed optimum moisture (35%), inoculum (6.5 CFU/ml), fermentation duration (108 h), and temperature (28°C) for aspartic proteases. The crude aspartic protease was partially purified by DEAE-Sepharose column with specific activity 6082 U/mg. The enzyme was characterized for its optimum pH and temperature (3.6, 35°C respectively) and molecular weight was determined (35 kDa). The enzyme activity was enhanced by β -mercaptoethanol and inhibited by iodoacetic acid which indicates that it is cysteine protease. The cocoa treatment with cysteine aspartic protease increased the flavour profile with hedonic scale rating 7.5 whereas, untreated bean was 6. Further the cocoa samples treated with aspartic enzymes were roasted, grinded and subjected to GC-MS analysis using SPME column. Pyrazines like dimethyl pyzarine and ketone 3, 5-bis (tert.-butyl)-4-hydroxy-propiophenone showed increase in concentration with improved cocoa flavour and related notes. The treated beans had hint of fruity and sweetish flavour with decrease in bitterness.

Starter culture technology for coffee processing (Pushpa S Murthy)

In the process of coffee fermentation through microbial enzymes, mucilage composition of pectin and sugar (which imparts flavour and aroma to beans) are degraded. Isolation and screening of microbial isolates responsible for pectin degradation were carried out in simulation media. Based on the enzymatic activity, microbial isolates were streamlined. The consortia of isolates showed the varied effect on degradation than individual cultures. Preliminary studies indicated that consortia of *Saccharomyces cerevisiae* (yeast), *Lactobacillus plantarum* (LAB) and *Bacillus sphaericus* (BS) with a range of 10% inoculums, results in good quality of coffee beans. CCRD was employed to study the effect of inoculums size (10%) of the consortia on fermentation with prime parameters such as alcohol, pectin and sugar as response variables. Based on the statistical design, isolates providing best activities were selected for the formulation of consortium. Under optimized conditions, production of primary and secondary metabolites of starter culture was alcohol (70.26 mg/ml), sugar (5.5 mg/ml) and pectinase enzyme (11.66 units/ml) when compared to control. The sensory profile with 10% inoculum scored 6.5 on a hedonic scale.

Processes for texturized fish products (Rathina Raj K)

Shelf-life studies of texturised fish meat products: Fish cubes prepared as per optimized formula were packed in metallized polyester pouches, and stored at 5°C and -20°C. For shelf-life studies, periodical sampling was done and total plate count (TPC), texture profile and rancidity were analyzed. TPC remained static throughout one month period of study in case of

samples stored at -20°C . There was slight increase in TPC value of samples stored at 5°C from the initial value of 2.65 log cfu to 3.11 log CFU at the end of 30 days of storage. There was no increase in thiobarbutric acid value in both types of storage, indicating no or insignificant change in rancidity. Texture profile revealed slight reduction in the hardness of both type of storage over a period of one month. Similar trend is being observed in other texture parameters. Shelf-life study will be continued for another 5 months.

Preparation of dried surimi powder: Effects of different drying methods (hot air drying, spray drying and vacuum drying) and hydrocolloids (tragacanth, acacia and xanthan gum) at various levels (1, 2 and 3% w/w) in combination with trehalose (3, 4 and 5%, w/w) and sorbitol (2%, w/w) on physicochemical and functional properties of surimi prepared from pangasius fish (*Pangasius bocourti*) were evaluated. Surimi incorporated with 1% xanthan gum along with 5% trehalose and 2% sorbitol dried in vacuum shelf dryer exhibited the best physicochemical and functional properties as compared to control and other incorporated hydrocolloids and drying methods counterparts. The result indicated that 1% xanthan gum along with 5% trehalose provided the best cryoprotecting effects in vacuum drying to retain the functional quality of dried surimi. Prepared dried surimi powder from pangasius could be used as an alternative to wet surimi for preparation of surimi-based products/ or surimi analogs. Furthermore, the low-fat mayonnaise from optimized surimi powder was prepared. Physicochemical and functional properties as well as storage stability of prepared low fat mayonnaise are in progress.

Proteinaceous materials from waste water

streams of fish/meat processing (Tanaji M Kudre)

Fish/ meat processing wastewaters/ effluents (surimi wash water and wastewaters from beef, mutton, chicken and fish slaughter houses) were collected locally. Total Viable Count and total *Escherichia coli* (fecal coli-form) of all waste waters ranged from $2.15\text{--}6.48 \times 10^5$ CFU /ml and $4.20\text{--}5.80 \times 10^2$ CFU/ml respectively. Proteins were recovered by pH shifting method from all these wastewaters and highest protein yield (78.22% dry basis) was obtained in surimi wash water (SWW) as compared to slaughterhouse wastewater ($P < 0.05$). Furthermore, protein recovered from slaughterhouse wastewaters displayed the major bands of blood proteins (γ -globulin and albumin components) while SWW exhibited muscle proteins as major bands (MHC, actin and tropomyosin). Recovered proteins from slaughterhouse wastewater and SWW were mixed in equal amounts and ground to obtain blended protein (BP) powder. Blended protein (BP-equal amounts of all recovered protein) showed higher contents of lysine (18.26 g/100 g protein) and glutamine (12.69 g/100 g protein). The BP was used for the preparation of protein hydrolysates using enzymatic (alcalase, flavourzyme and trypsin) and fermentation process (*Lactobacillus plantarum*, *L. plantarum* subspecies *plantarum* and *Pediococcus loli*) and further optimized by response surface methodology (RSM) using a central composite design. Flavourzyme and *P. loli* were selected as best protease and *Lactobacillus* strain for optimization of enzymatic and fermentative hydrolysis process by RSM. The degree of hydrolysis (DH) and antioxidant activities were considered as the significant response factors. Hydrolysis time of 38 h, carbohydrate

concentration (0.3% w/v) and protein hydrolysate concentration (10% w/v) were found to be the optimum conditions. The fermentative hydrolysate prepared by *P. loli* exhibited potential antagonistic activity against *E. coli*, *L. monocytogenes*, *Staphylococcus enteritidis* and *S. aureus* when compared to enzymatic hydrolysates. Overall, fermentative preparation of the protein hydrolysate from fish/meat wastewaters recovered protein was found to be more efficient than enzymatic hydrolysis in yielding higher antioxidant and antagonist activities and hence has the potential to be a protein-rich ingredient for use in formulated poultry/ animal feed which also helps in reduction of oxidative stress as well as bacterial contamination.

Value addition to exotic vegetables and application of microwaves for dis-infestation of millets (*Math RG*)

Ridge gourd peel was separated and preserved by dehydration in a tray dryer. The total dietary fibre was analysed using the Sigma dietary fibre kit. Extraction of total dietary fibre from vegetable peel wastes from ridge gourd was carried out based on a method using acetate and HCl-KCl buffer followed by precipitation using alcohol. The method helped enhance the total dietary fibre from 45% to about 70%.

Multipurpose spiced paste, gravy paste and extruded hyacinth beans (*Shailaja R*)

The multipurpose spiced paste and gravy paste formulations were standardised. Bulk preparation and storage studies are in progress. Extruded hyacinth beans product was also standardised.

Translational Research

Health benefits of wheat bran and wheat germ oil (Suresh Kumar G)

Concentrate was prepared from wheat bran oil using silicic acid coupled with solvents like acetone (WBA) and hexane (WBH). WBA had enhanced color, viscosity and less altered fatty acid composition. WBA was enriched with fat soluble nutraceuticals mainly sterols, oryzanol like compounds, tocopherols and carotenoids as substantiated by NMR. WBA displayed better ability to limit oxidation of DNA and LDL compared to WBH/native oil. The animal feeding studies with high fat diet along with WBA treatment at 2% and 3.5% levels reduced the lipid profile and ameliorated antioxidant enzymes (SOD, Catalase, GPx and GR) and MDA level along with down regulation of HMG CoA reductase protein and gene expressions in liver of high fat fed mice model.



Native wheat bran oil; Nutraceutical striped wheat oil; Wheat bran oil concentrate

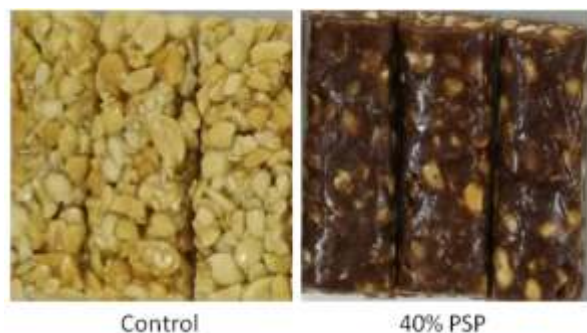
Diabetic nephropathy (DN), is a micro-vascular complication of chronic diabetes. Sterol regulatory element binding protein1 (SREBP1) participation in the development of DN is reported. Oryzanol Concentrate (OC) at 0.1 and 0.3% was tested for its antioxidant and

hypolipidemic effects. Diabetic animals were divided into four groups and fed on starch, high fat Oryzanol concentrate (OC) and control diet (SFC/SFD, HFC/HFD, OFC/OFD). The markers of DN like glomerular filtration rate and kidney weight increased in HFD group. Antioxidant enzyme activities, lipid peroxidation and expressions of lipid associated biomolecules (SREBP1 and FAS) were ameliorated in OC fed groups. Further, OC reduced the increased ECM accumulation of glycoproteins, particularly type IV collagen, fibronectin and SREBP1 associated gene TGF- β . These data suggest that there could be an involvement of SREBP nuclear protein and TGF- β gene interaction in development of DN.

Pomegranate bioactive based health food (Singh RP)

Pomegranate seeds are inadvertent waste emanating from the processing industries. Pomegranate seeds contain oil (pomegranate seed oil, PSO) which is characterized by high content of punicalic acid. It is a polyunsaturated fatty acid (18:3 n-5), classified as a conjugated linolenic acid (CLnA). PA is also referred to as a "super CLnA" which is more potent in exhibiting beneficial properties than CLnA from any other source. The oil rich fraction obtained from pomegranate seed powder (PSP) was incorporated into a product chewy bar (Pome Grain) at different levels. The Pome Grain with 40% PSP showed the best results in terms of sensory, colour and texture. The moisture content of the product was 7.56% and the yield of

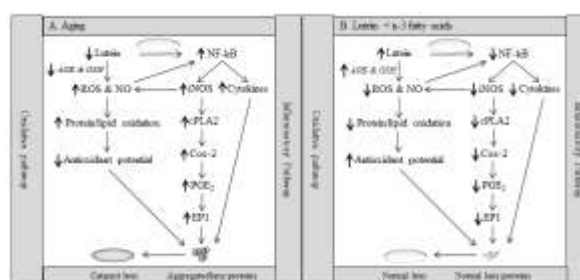
the oil was 26%. The product showed the retention of 82% punicic acid content based on the GC analyses.



Efficacy of lutein and fatty acids on cataract prevention (Baskaran V)

Effects of lutein (L) and fatty acids [linoleic acid (LA), eicosapentaenoic acid (EPA) + docosahexaenoic acid (DHA) and oleic acid (OA)] on oxidative stress and inflammation in cataract were assessed. Cataract was induced in male Wistar rat pups (11 days old) by giving a single dose of sodium selenite (25 mM/kg body weight) by IP. Lutein (1.3 mmol/kg body weight) was given one day before and five days after selenite injection as a micelle with 7.5 mM LA, or 7.5 mM EPA + DHA or 7.5 mM OA. Serum and lens oxidative stress and inflammatory parameters having a bearing in cataract were assessed. Serum and lens nitric oxide, MDA and protein carbonyls significantly ($p < 0.05$) increased in cataract, compared to control and experimental groups. Catalase, SOD, glutathione peroxidase and glutathione transferase activity and glutathione levels in serum and lens of cataract group significantly ($p < 0.05$) decreased. Serum eicosanoids (PGE₂, LTB₄, and LTC₄) and cytokines (CRP, TNF- α , IL1- β , and MCP-1) significantly ($p < 0.05$) increased in cataract. The activity of cPLA₂ and Cox-2 in cataract lens were higher ($p < 0.05$), compared to other groups. EP-1, NOS-2 and NF- κ B expression were high ($p < 0.05$) in cataract. The ratio of water insoluble to

water soluble protein was high in cataract lens. The group administered with L + EPA + DHA exhibited highest cataract prevention compared to L + LA and L + OA. Pups given lutein with EPA + DHA had the highest amount of lutein in the lens. The anti-cataract activity of lutein was influenced by fatty acids and found to be highest with EPA + DHA compared to LA or OA. It is concluded that lutein in combination with EPA + DHA could serve as anti-cataract food component.



Effect of lutein and fatty acids on oxidative stress and inflammation in cataract.

Prebiotic potential of resistance starch (Muralikrishna G)

Resistant starch is one of the prebiotics with several health benefits analogous to dietary fibre components. The mode and mechanism of resistant starch degradation by lactic acid bacteria is not yet understood. In the previous studies, a membrane bound α -D-glucosidase from *Lactobacillus fermentum* NCDC 156 (LFAG) was purified and characterised which was found to degrade resistant starch. In this study, LFAG was cloned and expressed in *E. coli*. The optimal temperature for the cloned enzyme activity was found to be 35°C and 85% of catalytic activity was lost at 55°C, which is uncommon for lactic acid bacteria. Hg²⁺ and CO₂ (5 mm) inhibited the enzyme to 90 and 49%, respectively. The cloned enzyme was able to hydrolyze maltooligosaccharides varying in degree of polymerisation (2 to 7) and liberated glucose

from the non-reducing end of the substrates. This is perhaps the first report on the cloning of α -glucosidase from the *Lactobacillus fermentum* grown on resistant starch.

Cereal and herb based anti-diabetic food formulation (Baskaran V)

Currently traditional medicine/food is one of the emerging fields to target life-style diseases like diabetes. Hence, the objective was to 1). Develop functional food by integrating traditional knowledge (Ayurveda) and modern food processing methodology for diabetes and validate nutritional, phytochemical bio-actives, and antidiabetic property. Barley (Yava) or wheat (Godhuma) flours (base material) was blended separately with triphala (Ayurvedic herb mix - Haritaki, Vhibitaki and Amalaki, 10%), sesame oil (10%), ghee (10%), turmeric (0.5%), and black salt (for taste). The mixture was homogenized to slurry and processed by drum drying. Products were evaluated for nutrient, bioactive components and α -amylase and α -glucosidase inhibition. Barley based product (Bbp) contained (dry weight basis/g) phenolics (18.37mg), flavonoids (12.6 mg) and tannins (18.48 mg). Wheat based product (Wbp) contained 19.08 mg, 13.49 mg and 36.43 mg of phenolics, flavonoids and tannins, respectively. The total protein (%), lipid (%) and carbohydrate (%) content of Bbp and Wbp was 12.5, 5.7 and 64.3 and 12.8, 5.8 and 68.5 respectively. The energy value (kCal) for Bbp and Wbp was 428 and 440 respectively. The α -amylase and α -glucosidase inhibition (IC_{50}) was higher for Bbp (8.6, 108.4 mg/mL) than Wbp (12.6, 120.5 mg/mL). The products are highly nutritive with α -amylase and α -glucosidase inhibition property and can be therapeutic food for management of diabetes. Significance of the study is the integration of traditional knowledge with modern food processing techniques in the development of health food targeting diabetes.

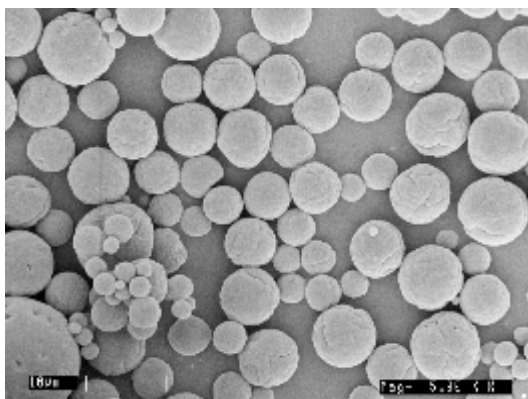


Cereal and herb based antidiabetic food

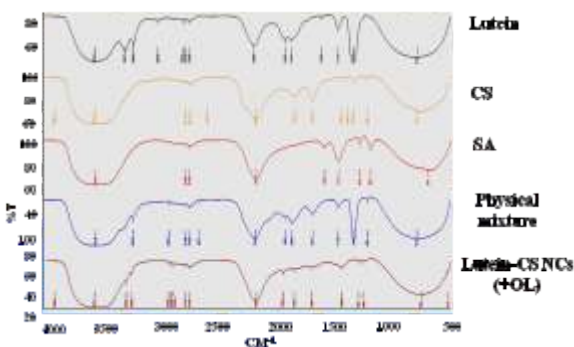
Chitosan and oleic acid nano-carrier system for improved lutein bioavailability (Baskaran V)

Lutein is known to reduce the risk of cancer, obesity and diabetic retinopathy. However, its bioavailability is partial due to poor aqueous solubility. Hence, a lutein-chitosan-oleic acid nano carrier system using an ionic gelation method was developed with an aim to improve the solubility and bioavailability of lutein. Size distribution of nano carrier displayed particles ranged from 40-100 nm (mean = 60 nm). The zeta potential values +30 to +50 mV showed that the lutein-chitosan-oleic acid nanoparticles were more stable and not degraded or aggregated. Lutein encapsulation efficiency was found to be $90 \pm 3\%$. Bioavailability (micellar formation) of lutein in vitro from nano carrier was $90 \pm 5\%$. FT-IR analyses revealed no chemical interaction between chitosan and lutein, indicating possible weak intermolecular forces like hydrogen bonds. DSC analysis revealed that the nature of lutein within the nano carrier is amorphous (aqueous soluble). Aqueous solubility of lutein-chitosan-oleic acid nano carrier was significantly ($p < 0.05$) higher (~1000 times) than free lutein. Results show that chitosan + oleic acid system can be an efficient carrier for enhancing hydrophilicity of lutein which in turn is expected to help in improved bioavailability. Chitosan based nano

carrier system for lipophilic molecules with improved aqueous solubility and bio-availability could make a major impact on food and pharmaceutical industry for delivery of lutein to treat cancer, obesity and retinopathy related complications.



SEM image of nano-lutein



FT-IR analyses of nano-lutein

Defatted *Moringa oleifera* seed flour on diet-induced hypercholesterolemic mice (Muthukumar SP)

The effect of bound phenolic and catechins extracted from defatted *Moringa oleifera* seed (DMSF) flour on diet-induced hypercholesterolemia was evaluated for the effective use of byproduct bioactives. C57BL6 mice were divided into four groups: group one received AIN 93M diet (control), group two and three received high-fat cholesterol diet (HFCD) and four received HFCD along with bound phenolic and catechins,

through oral administration at the dose of 25 mg/Kg body weight daily for 8 wks. Blood and tissue analysis showed that bound phenolic and catechins were able to reduce plasma and liver cholesterol significantly ($p < 0.05$). And these extracts were also able to reduce stress enzymes and molecules level in liver. The bound phenolic and catechins extracts from DMSF were able to increase plasma HDL level and lower atherogenic index in the treated groups. The data suggests that the combination of HFCD and bound phenolic or catechins extracted from DMSF as a source of antioxidants was beneficial. DMSF is a processing waste left over after extraction of oil, hence it is cost-effective. The catechins (catechin and epicatechin) as well as combination of catechin-rich bound phenolic containing gallic acid, protocatechuic acid, ferulic acid, and catechin gallate were studied for its hypercholesterolemic effect. The results revealed that combination of bound phenolic and catechins were comparably beneficial in reducing cholesterol and atherogenic index in diet induced mice model, which is the critical risk factor for atherosclerosis.

Pathogenesis and amelioration of obesity-associated breast cancer (Ravi Kasiappan)

Objective of this study was to find out if there were any miRNA expression changes in obesity-associated breast cancer cells, in which, breast cancer cells (MDA-MB-231) were co-cultured with mature adipocytes (CC-MDA-MB-231 cells). Small RNA sequencing to find out the global miRNA pattern changes in obesity-associated breast cancer cells was performed. Of 2588 total miRNAs in humans (miRBase v21, September 2016), 452 miRNAs were identified in both samples based on the sequences ≥ 16 bp and ≤ 40 bp length and considered for further analysis. Among 452 miRNAs, 190 miRNAs were commonly expressed in both MDA-MB-231 and

CC-MDA-MB-231 cells from which 49 miRNAs were upregulated (\log_2 intensity >1) and 49 miRNAs were downregulated (\log_2 intensity <1) in CC-MDA-MB-231 cells as compared to MDA-MB-231 cells. These results reflect a dramatic change in miRNAs in obesity-linked breast cancer cells, indicating that such miRNAs can likely serve as a pool for biomarker candidates. Forty up and downregulated miRNAs (20 each) (>5 -fold) and heatmaps were generated for MDA-MB-231 and CC-MDA-MB-231 of differential gene expression (DGE). Of these, eight miRNAs, namely miR-181a-5p, miR-34c-3p, miR-149-5p, miR-23b-3p, miR-3184-5p, miR-34b-5p, miR-210-3p, miR-31-5p were significantly upregulated in CC-MDA-MB-231 cells. Further, six miRNAs, namely, miR-27a-5p, miR-25-5p, miR-181c-3p, miR-1343-3p, let-7b-3p, miR-146b-5p, miR-423-3p, were substantially downregulated in CC-MDA-MB-231 cells when compared to MDA-MB-231 cells. These results suggest that these miRNAs are important for the regulation of obesity-linked breast cancer.

Further, the RNA seq data was validated by using qRT-PCR. Five miRNAs (miR-3184-5p, 7704, 34c-3p, 34b-5p, -31-5p) were significantly induced (upregulated) in the co-cultured cancer cells (CC-MDA-MB-231). Similarly, 5 miRNAs (miR-1343-3p, 25-5p, 27a-5p, 181c-3p, let-7b-3p) were significantly suppressed by cancer cells co-cultured with adipocytes. These data were well correlated with our RNA seq data, indicating that these miRNAs might be important for the regulation of obesity-associated breast cancer progression. In order to identify genes possibly targeted by changes in miRNA expression, TargetScan 7.2 and miRanda was used to predict mRNA targets of the up/down-regulated miRNAs and identified that 6793 genes in both MDA-MB-231 and CC-MDA-MB-231 regulated miRNAs, among them 1182 genes were unique to CC-MDA-

MB-231 regulated miRNAs. Using Gene Set Enrichment Analysis (GSEA) with Enrichr tool, the gene families represented by the genes predicted to be targeted by miRNAs in CC-MDA-MB-231 were identified.

Metabolic engineering of *Saccharomyces cerevisiae* for overproduction of squalene (Sarma MVRK)

In-silico flux-balance analysis of the genome scale metabolic model, iMM904, has led to the identification of two gene deletion targets viz., *GENE1Δ* and *GENE2Δ* for enhancement of flux towards squalene in *S. cerevisiae* using a metaheuristic algorithm FOCuS. *GENE1* deletion has led to a 2-fold enhancement of squalene, with a yield of 33 mg/g DCW, whereas, *GENE2* deletion led to squalene yield of 30 mg/g DCW, which is a 1.8-fold increase over the wild-type strain. Combination of *GENE1Δ* and *GENE2Δ* has led to the squalene yield of 38 mg/g DW, which is 2.3-fold higher over the control strains. Further, the strains were integrated with *tHMG1* and *POS5* genes which were earlier established for enhanced squalene synthesis to develop a stable strain. The resultant strain has produced squalene of 65 mg/g DW which is 2-fold higher than the *GENE1Δ GENE2Δ* strain and 4-folds higher than the control strain (BY4741) at the end of 18 h. A novel homogenization-based extraction method recovered Squalene by 3.5 to 16 folds higher yield when compared to standard procedures.

Anti-microbial compound produced by food-fermenting bacteria (Prakash M Halami)

Food-preservative 'nisin' with its 9 variants represent an important peptide antibiotics being used for food preservation and therapeutic purposes. Only three natural variants of subtilin, produced by *Bacillus subtilis*, are known. In this

project, the diversity of subtilin and nisin obtained from food fermenting bacteria were investigated by employing cell reporter assays that detect the presence of target compound and its natural variant at nanomolar concentration. Inhibitory zone producing *Bacillus* cultures were obtained against *Kocuria rhizophila* ATCC 9341 and further subjected for qualitative beta-gal induction using reporter, *B. subtilis* BSF 2470 (cell wall specific) and BS2 (subtilin specific). Results indicated at least five interspecific subtilin-like antibiotic producers notably, *B. licheniformis* MCC 2512 and non-subtilis type. Similarly, ten nisin-like antibiotic producing LAB were identified, when the reporter CG02 was used. Quantitative beta-gal induction suggested that there was variation among auto-induction ability between the isolates which differed from standard reference strains. Molecular typing of these antibiotic producing cultures indicated that there is a high diversity in the taxonomy of the cultures since they are obtained from different ecosystems.

Gene organization, mechanism of action (MOA) and application in foods (Prakash M Halami)

An antibacterial compound (ABC) producing *B. licheniformis* MCC2514 (BI2514) is known to inhibit RNA biosynthesis of target bacteria. Influence of media components on higher ABC production was studied. Among the eight-different media used, Tryptone-Yeast extract (TYE) medium supplemented with 0.25% NaCl was found to produce the highest concentration of ABC. Upon 14 h of fermentation under the controlled conditions in a 2 L capacity bioreactor, the ABC was found to be 133.33 AU/ml with a 1.5-fold increase in the ABC. Upon treatment of the cell-free supernatant (CFS) with proteinase K (PK), significant reduction in activity was observed and reduction was high with increased concentration of the enzyme. To verify the MOA

of ABC produced by BI2514 as a RNA biosynthesis inhibitor, it was assayed against the reporter, *BsPyvgS* showing blue coloration due to beta-gal induction. However, it did not show beta -gal induction with cell wall reporter, BSF2470. The PK treated CFS did not induce beta-gal of *BsPyvgS* indicating the RNA biosynthesis inhibiting compound can be proteolytically inactivated. The intensity of blue coloration shown by the untreated CFS was more than the enzyme treated CFS and these observations also coincide with antibacterial activity assay against *K. rhizophila* ATCC9341, wherein, loss of antibacterial activity was seen.



Proteolytic inactivation of ABC produced by *Bacillus licheniformis* MCC2514

Microbes and their metabolites for food and health (Venkateswaran G)

Liquid glucose and CSL have been used as carbon and nitrogen sources for the cultivation of baker's yeast and nutritional yeast. Components were optimized and the composition analysis for CSL and the obtained yeast were enumerated. Batch cultivations at 4 L and 35 L working volume were carried out in a controlled bioreactor which resulted in promising yield. However, studies need to be carried out to further optimize the medium composition as the CSL used in the study contains several impurities which may be affecting the yields of baker's yeast and nutritional yeast. Coarse dead-end filtration and centrifugation on processes are planned for removing the impurities in CSL for its further use for yeast production. Standardization of fruit

vinegar using raw materials like banana, coconut water, tomato and water melon is being carried out. Effort for a single stage 2-step inoculation methodology is being carried out. The organic acid and polyphenol profile of the final products will be used as indicators for fruit vinegar authentication.

Profiling and functional characterization of rice bran lipases (Vijayaraj P)

Aim of the study was to identify acylhydrolases from rice bran by activity-based proteome profiling (ABPP) and genome sequence analysis. Activity-based protein profiling reveals that there are 11 proteins which contain the serine hydrolase domain and the sequence was identified by LC-MS/MS. Further, 112 possible lipases based on the sequence were identified. The expressional profile of the predicted lipases was monitored, and each lipase was expressed at different time point depending on its substrate preferences as well as availability. Further, the functional validation of the genes could pave the way for new technology to improve the bran oil contents.

Reduction of insulin resistance by inhibiting monoacylglycerol lipase with food-based small molecules (Vijayaraj P)

Aim of the study was to create an integrated platform for the functional characterization of lipid metabolizing enzyme and its therapeutic potentials. The human monoacylglycerol lipase gene was cloned and overexpressed. The purified recombinant protein was used as enzyme source to screen inhibitors from food sources based on the traditional knowledge and as well as human consumption. Promising results were observed with polyphenolic compounds and further functional characterization as well as in vivo validations to be carried out before product

development. The deliverable will be the potent mono-acylglycerol inhibitor molecules from food sources for the management of obesity and diabetes.

Bio-active protein synthesis *in-vitro* with cell-free platform (IVSP4) (Muniasamy N)

Identification of a novel biomarker: CD44 was identified as a novel surface biomarker on Retinal Pigment Epithelium (RPE) cells for AMD by inducing oxidative stress in ARPE-19 cells. CD44 expression in ARPE-19 cells was confirmed by Western blot and immunofluorescence.

Lysosomal delivery of aptamer to treat AMD: RPE specific endosomal and lysosomal localization of CD44 aptamer was confirmed. Thus, CD44 aptamer has a potential for RPE specific lysosomal drug targeting for the treatment of AMD.

Production of bio-ethanol and organic baker's yeast in a green media: Conditions were optimized for the production of baker's yeast in tender coconut water (TCW) followed by bio-ethanol production and confirmed by GC-MS. The organic baker's yeast produced from above process was used for preparing bread that had higher sensory parameters as compared to yeast grown in YPD.

Polyunsaturated fatty acid accumulation in chia (*Salvia hispanica*) seeds (Ajay W Tumaney)

The suitable internal reference genes for quantitative real time PCR studies in *S. hispanica* was identified for the first time. Apart from reproductive stages, which includes different stages of seed development, the stably expressed genes in various vegetative stages (stem, root, leaf, cotyledons) was also checked by inducing abiotic stresses (NaCl, abscisic acid, polyethylene glycol, salicylic acid, cold and high

temperatures). Results were obtained by using two widely used statistical algorithms: geNorm and Normfinder. Genes that are both stably expressed as well as least stable genes for each category have been obtained. GAPDH and CYP were stably expressed in abiotic stress treatments while 18S rRNA and SAMDc were least stable. In reproductive stages, CAC and PP2A were most stable while 18S rRNA and RCA were least stable. Finally, in the vegetative stage group, GAPDH and α -TUB were the stably expressed genes and RCA was least stable. Together, these results provide the best internal reference genes for qRT-PCR expression studies in this crop.

In addition, for the first time, five key genes (ShDGAT1, ShPDCT, ShCPT, ShLPCAT & ShPDAT1) have been cloned from *S. hispanica* that are involved in TAG biosynthesis. Further, the expression & functional activities of these enzymes in yeast will be looked into.



Amplicons of the expected size for all the cloned genes A: ShDGAT1, B: ShPDCT, C: ShPDAT1, D: ShLPCAT, E: ShCPT. M: Marker, bp: base pairs

Fixed oils from the Indian spices (Ajay W Tumaney)

Research on spices has mainly focused on essential oils because of its aromatic and medicinal property. However, fixed oil remains an untouched entity. Hence, 14 spices procured were subjected to steam distillation to remove essential oil and solvent extraction was done to obtain fixed oils. Colour and refractive index analysis of the fixed oil and fatty acid profiling of the fixed oil through GC-MS was done. Further,

the fixed oils were subjected to antioxidant screening (DPPH, TEAC, FRAP) and nutraceutical profiling (total phenolic and phytosterol content).

Poppy seeds showed the highest amount of fixed oil while greater galangal showed the least amount of fixed oil. Presence of alpha-linolenic acids was detected in kokum, tejpat and black pepper fixed oil. Overall most of the spices were rich in both monounsaturated and polyunsaturated fatty acid. However, the saturated fatty acid percentage was more in kokum, black pepper, nutmeg and tejpat fixed oil. Kokum fixed oil showed high antioxidant property owing to its high phenolic content.

Algae-based CO₂ sequestration and conversion to value-added products (food, feed, fuel-grade) (Mudliar SN)

Life cycle assessment (LCA) of fresh water microalgae, *Scenedesmus dimorphus*, cultivated in open raceway pond for biofuel production was carried out. Eight scenarios were modelled for integrated CO₂ capture and conversion to biogas/biodiesel along with nutrient addition and recycling. The LCA results indicated a huge energy deficit in both the biodiesel/ biogas production systems and is majorly due to higher energy requirements of paddle wheel for mixing of culture. The net atmospheric CO₂ Equiv. ratio (NACR) analysis for both the biofuel production systems indicated a net CO₂ negative in terms of CO₂ capture. However, the LCA predictions has demonstrated that enhancement of biomass productivities and employing energy efficient motors for cultivation will significantly improve the performance of biofuel production system from an energy and environment outlook. The sensitivity analysis indicated that variability in the biomass productivity has predominant effect on the primary energy demand and global

warming potential (GWP, Kg CO₂ Equiv.) than specific energy consumption for mixing algal culture. Also, recycling of nutrient rich wastewater remained after primary harvesting have facilitated considerable reduction of overall energy demand and GWP. The LCA results indicated that biogas conversion routes from microalgae were energy efficient and eco-friendly than biodiesel routes.

Further, a comparative life cycle assessment has been conducted to evaluate the microalgae mediated CO₂ sequestration in closed airlift photobioreactor and open raceway pond under Indian conditions. The results revealed that primary energy demand and GWP of airlift photobioreactor was 3.7-fold higher than raceway pond. The NER_{CO_2} (defined as net emission ratio of CO₂ and is estimated as ratio of CO₂ sequestered/CO₂ emitted) of raceway pond was 4-fold higher compared to airlift photobioreactor, however, both the cultivation systems were observed to be net negative in terms of CO₂ sequestration. Nevertheless, the process can become net CO₂ positive provided a 4-fold and 7.5-fold enhancement in biomass productivities for raceway pond and airlift photobioreactor, respectively.

Nutraceutically important phytochemicals from *Physalis minima* and *Carissa spinarum* fruits (Nandini P Shetty)

The main objective of the project was to screen bioactive compounds in fruits and leaves of *Physalis minima* and *Carissa spinarum*. The screening of the metabolite was carried out by screening the major compounds such as phenolics and flavanoids and other health beneficial compounds. *C. spinarum* fruits was found to be rich in anthocyanin, resveratrol and vanillic acid. The fruits of *P. minima* showed presence of withanoloids. Further, the

compounds from these fruits were fractioned and these fractions alone and with combination was tested for anticancer properties in cell lines. Anthocyanin rich beverage was also developed where the stability of the pigment was stable. Also, osmodried product from *C. spinarum* fruits was prepared which retained its nutrient.

Bioactive metabolites from *Malpighia glabra* and *Ixora coccinea* (Giridhar P)

Stability and storability of the fresh ripe fruits of *Ixora coccinea* and *Malpighia glabra* (acerola) were studied at four different temperatures; RT, 4, -4 and -20°C. The fruits stored at RT started deteriorating on 3rd and 2nd day respectively along with the phytoconstituents. Under -20°C, *I. coccinea* fruits were stable till 25th day after which there was gradual decrease in phytoconstituents and fruit browning was observed, whereas *M. glabra* fruits were stable up to one year but the gradual decrease in the phytoconstituents after six months of storage was observed. Considering the stability, storability, phytonutrient composition and the fruit availability, ready-to-drink beverage and fruit crush were formulated from the acerola fruits. The prepared fruit crush was further incorporated into different food formulations such as marzipan and yoghurt. Ready-to-drink beverage was prepared from mid-ripe and ripened fruits of acerola which contained 10% of fruit pulp. The beverage showed higher content of ascorbic acid 0.12% and antioxidant activity was significant with EC₅₀ value of 0.66 mg. Nutrient profiling and sensory analysis gave better results than the control samples and the microbial load was well within the permitted level. However, Marzipan showed higher microbial growth because of the presence of almond, hence the standardization is under process. An attempt was made to retain the phytoconstituents as of the fresh fruits.

Bioengineering of 4-hydroxy isoleucine and diosgenin production in fenugreek (Nandini P Shetty)

Eight different kinds of germplasm was collected and screened for polyphenols, diosgenein and 4-hydroxy isoleucine in fenugreek seeds. Further, these seeds were germinated and samples collected at different stages of life cycle and the bioactive (4-hydroxy isoleucine and diosgenin) were analyzed in different stages. The germplasm which showed higher amount of metabolites were further used for in vitro growth. From the callus suspension, culture was established and used for augmentation studies. The effect of jasmonic acid, methyljasmonate and salicylic acid on the production of diosgenin and 4-hydroxy isoleucine was studied in cell suspension cultures. Salicylic acid at 0.1 mM and 1 mM concentration was efficient in promoting the production and/or accumulation and release in the culture medium of diosgenein however did not show much effect on 4-hydroxy isoleucine. Methyljasmonate was highly effective in stimulating both metabolite endogenous accumulation, as well as their release into the culture medium. Jasmonic acid was less efficient than methyljasmonate in promoting endogenous diosgenin accumulation.

Microalgae as alternate source of bio-available vitamin B₁₂ (Sarada R)

Vitamin B₁₂ bioavailability from *Spirulina* was confirmed with the previous experiments on Wistar rats. *Chlorella* is also reported to contain a natural form of vitamin B₁₂ (methyl cobalamin 44 µg/100g). *Chlorella* as a source of bioavailable vitamin B₁₂, experiments were conducted in rat model. The rats were grouped as 1) The control group, diet was prepared with vitamin mix containing the Vitamin B₁₂, 2) Deficient group,

Vitamin B₁₂ deficient diet was prepared with the vitamin mix devoid of Vitamin B₁₂. 3) *Chlorella* 1X group, the vitamin B₁₂ deficient diet was mixed with known quantity of *Chlorella* biomass (41.5 g *Chlorella* biomass per Kg of diet) to match the half the vitamin B₁₂ content of control diet. 4) *Chlorella* 2X group, diet supplemented as 83 g of *Chlorella* biomass per Kg of diet to meet the vitamin B₁₂ content equal to the control diet. The experiment was conducted for 100 days.

There was no significant difference between the body weight gain between experimental groups. Red blood cells Osmotic Fragility test indicated vitamin B₁₂ deficient group RBC were more susceptible to fragility when suspended in hypotonic solutions. Increase in the testes, thyroid gland, and brain weight was observed. Vitamin B₁₂ content in serum and plasma was almost 50% less in vitamin B₁₂ deficient rats while *Chlorella* biomass fed groups showed almost similar to the control group. Similar trend was observed in the liver and kidney vitamin B₁₂ contents. Plasma and serum homocysteine concentrations were almost doubled in vitamin B₁₂ deficient rats than in control and *Chlorella* biomass supplemented rats. Homocysteine levels higher in plasma (17.18±3.57 µmol/L) and serum (14.58 ± 0.12) in deficient group correlated with lower vitamin B₁₂ in serum (202.32±19.75 pg/mL), plasma (252.69±1.46 pg/mL), liver (5.60±0.13 ng/g) and kidney (8.62±0.48 ng/g). In *Chlorella* biomass fed group rats increase in the erythroid precursors was observed.

Abnormal changes in the kidney, liver and lungs caused by vitamin B₁₂ deficiency was modulated in the *Chlorella* biomass fed group. Results clearly indicated that vitamin B₁₂ from the *Chlorella* biomass is bioavailable in the wistar rats and it can be one of the alternative sources of bioavailable vitamin B₁₂.

Plant cell wall deconstruction of crop-residues and biotransformation to value-added products (*Mudliar SN*)

Techniques namely dilute acid (DAP) and alkali pretreatment (ALP) was evaluated for the pretreatment of rice husk and was compared with the wet air oxidation (WAO) technique. The comparison was based on the total reducing sugar (TRS) yield obtained post enzymatic hydrolysis (EH) of the pretreated biomass. The EH of acid pretreated biomass indicated the TRS yield of 73.1 mg/g, while the same was 675 mg/g for ALP treated. As the ALP gave superior TRS yield, further detail optimization of the pretreatment conditions on the sugar yield was done using statistically guided experiments using Box-Behnken design. The statistical design had 29 runs based on initially 3 factors (biomass loading, NaOH loading and time), which was subsequently upgraded to 4 factors (biomass loading, NaOH loading, particle size, time). The multi-scale visualization of the pretreated biomass samples at the different conditions was evaluated via SEM, XRD and FTIR analysis is in progress. The characterization of major inhibitors namely furfural, HMF, acetic acid and formic acid was also conducted.

Biodiesel production using indigenous microalgae of North-East India (*Sarada R*)

Under North East twining programme, the joint project funded by DBT with Assam university, Microalgae strains were obtained from Assam Central University (ACU), collected from different areas of North-East India. The cultures included both cyanobacteria and green algae. The cyanobacterial strains included *Anabaena*, *Oscillatoria*, *Weshlopsis*, *Lyngbya*. The green microalgae included *Chlamydomonas*, *Chlorococcum*, *Scenedes-mus*, *Chlorella vulgaris* and *Chlorella sp.* and *Tribouxia*. The strains were

plated repeatedly on agar media for isolation and purification. The isolated strains were perpetually maintained as liquid cultures and solid agar slants in the culture room at a temperature of $25 \pm 1^\circ\text{C}$ under 3000 Lux light intensity with a photoperiod of 16:8 hour light and dark (L:D) cycle.

The growth profile for all the green algae was carried out. Optical density versus biomass correlation between absorbance and biomass concentration was determined for the selected strains. Specific growth rate ($\mu \text{ day}^{-1}$), doubling time (hrs), biomass yield (g L^{-1}) and Productivity ($\text{g L}^{-1} \text{ day}^{-1}$) were calculated. The total chlorophyll and carotenoids were determined. Protein, carbohydrate and lipid content were estimated. *Tribouxia* and *Chlamydomonas* contained around 25% carbohydrates and 16 and 21% of lipid content respectively. The fatty acid profile of *Tribouxia* indicated presence of DHA (docosa hexaenoic acid) along with palmitic (35%), stearic (6.0%) oleic (18%), linoleic (13%) and ALA (10%) and lignoceric acid (6.0%). A bioflocculant was evaluated for harvesting of the green algae and it was found to be efficient and 91% flocculation was achieved. Scaling up of the *Tribouxia* culture is under progress in both tubular photobioreactor and prototype open pond.

Biosynthetic pathway genes of root specific flavour metabolite 2-hydroxy-4-methoxy benzaldehyde in *Decalepis hamiltonii* (*Giridhar P*)

Decalepis hamiltonii is widely known for its flavour molecule 2-Hydroxy-4-Methoxy Benzaldehyde (2H4MB), a structural isomer of vanillin. Nothing is known about the 2H4MB biosynthesis, hence we proposed that 2H4MB origins could be from phenylpropanoid pathway (PPP). Accordingly, by employing PPP inhibitors

(viz. piperonylic acid, MDCA and propanil) against *in vitro* root cultures of *D. hamiltonii* we tried to find the branch of PPP which catalyses the 2H4MB formation. As an aid to this study, ferulic acid (FA) was fed to the *D. hamiltonii* *in vitro* culture medium. HPLC analysis was carried out to quantify 2H4MB levels in control and respective inhibitor treated root cultures *in vitro*. We noticed that piperonylic acid did not inhibit 2H4MB biosynthesis in the given period, whereas MDCA and propanil had the marked inhibitory effect. Meanwhile, incorporation of ferulic acid as a precursor to *in vitro* cultures showed an increase in 2H4MB and vanilla related metabolite levels. However, ferulic acid in conjunction with propanil did not show any increase in 2H4MB levels. This clearly explains that ferulic acid is channelled through the 4-CL (4-coumarate CoA ligase) enzyme, where it would be converted to feruloyl-CoA and could be further converted to 2H4MB in *D. hamiltonii*.

Investigations on metabolite profile & betalain biosynthesis in *Basella* spp. (Giridhar P)

Basella rubra L. (Basellaceae) *in vitro* callus cultures establishment with pigment production were carried out. The seeds collected from local markets of Andhra Pradesh were propagated in green house conditions maintained at CFTRI, Mysore. An optimized protocol for *in vitro* explant development for callus initiation with a mucilage rich source has been explored. Similarly the influence of different plant growth regulators for *in vitro* friable callus production in MS such as full and half strength medium with NAA (0.1 mg/L), 2,4-D (0.1 mg/L), IAA (0.1 mg/L), and varying concentration BAP (1-10 mg/L) and kinetin (1-10 mg/L) with varying concentrations were screened and found a best suitable medium for callus initiation from cotyledonary leaves. Always generation of green, hard callus is predominant and it turns to brown

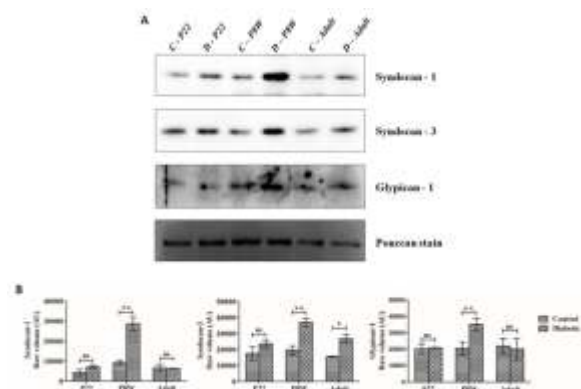
under prolonged growth on the same medium. This callus doesn't have any significance from tissue culture point of view. Occasionally light greenish and soft callus from cut surface of explants occurred and the same was rescued and subcultured. The initiation of callus suspension cultures for betalains rich callus production studies were in progress.

An instant natural nutraceutical mix for beverage and food applications (Chauhan VS)

Objective of the work was to develop an instant natural nutraceutical mix for beverages based on *Spirulina* and plant extracts. The *Spirulina* powder for the beverage base is under development. Different carrier materials are being evaluated to improve the physico-chemical properties of the *Spirulina* powder. The fruit extract of mulberry (*Morus alba*) is also being evaluated for formulation of a RTS beverage.

Effects of maternal diabetes on brain glycosaminoglycans and modulation by dietary factors which cross the placental and blood-brain barrier (Nandini CD)

Earlier it was determined that offsprings from hyperglycemic mothers become hyperphagic at the end of 8 weeks into their adulthood which correlated with overexpression of proteoglycan (PG) levels.

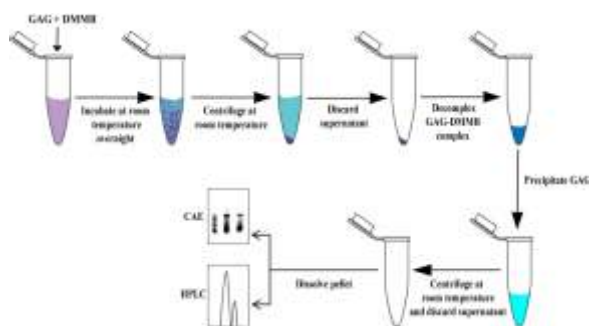


Effect of diabetes on hypothalamic proteoglycans

Pgs play an important role in modulating feeding behaviour especially in hypothalamus. The effect of maternal hyper-glycemia on PG expressions in hypothalamus of offsprings was determined. There was overexpression of PGs, syndecan-1 and -3 as well as glypican-1.

Effect of maternal hypercholesterolemic diet on liver glycosaminoglycan metabolism of pre- and post-natal rats (*Nandini CD*)

Glycosaminoglycans (GAGs) isolated from liver of foetus, pups as well as mothers showed quantitative changes in sulfated GAGs. There was a significant increase in levels of GAGs in hypercholesterolemic group compared to the control group. Also, an improvised method for the analysis of GAGs based on dye-binding assay was developed. Graphic representation of the methodology is as shown



Schematic representation of improvisation of DMMB dye-binding assay

Dietary modulators on key targets in diabetes (*Balaji Prakash*)

DPP4 inhibitors are now in the therapy regime for the treatment of T2D. However, several adverse side effects associated with these drugs press the need for natural and safe inhibitors. With more than 60 peptide drugs reaching the market to prevent/control diseases such as diabetes, obesity, and cardiovascular problems, peptide/functional food/ food based therapeutics has

gained increased interest during recent years. Hence, several potential peptides from food sources have been generated and screened using *in vitro* high throughput screening. These bioactive peptides need to be further validated in cells and animal models of diabetes. In addition, a dietary molecule which is a polyphenolic acid has been studied for its potentiation of glucose stimulated insulin secretion activity. Results from INS1 cell line study show that the identified dietary molecule stimulates insulin secretion in a dose dependent as well as glucose dependent manner. Cytotoxicity studies on INS-1 have shown that the studied molecule is non-toxic.

Non-alcoholic fatty liver disease (NAFLD) is a global burden especially alarming in India due to life style modifications, metabolic disturbances, Obesity and others. Natural bioactive compounds are much attractive candidates for treating NAFLD. Till now few studies were done on treatment of NAFLD by natural bioactive compounds .1- Octacosanol, a bioactive compound (isolated from natural source of plants) has been shown to lower the cholesterol, however, the exact role of this compound in ameliorating NAFLD is largely unknown. Proteins such as Apoc-3, SREBP-1, Perilipin play a key role in the progression of NAFLD. Hence, it is assumed that the 1-octacosanol may have effect on these key proteins thereby reducing the cholesterol and triglycerides in NAFLD.

Bioactive peptides mediated protection of prediabetes / diabetes associated cardiomyopathy (*Poornima Priyadarshini CG*)

Diabetes mellitus (DM) is a common risk factor for cardiovascular diseases (CVD). The prolonged prediabetic state reported to play an important role in CVD. Among the many complications of CVD, diabetes induced Diabetic cardiomyopathy

(DCM) is severe and is characterized by structural and functional changes in the myocardium. Thus, emphasizing importance of early identification of cardiac changes in prediabetic/insulin resistant condition that could be a better strategy to prevent the evolution to most serious stages of the disease.

Dipeptidyl peptidase 4 (DPP4), a circulating exopeptidase is known to play a role in the progression of DCM in diabetic patients and also acts an important clinical marker of prediabetes. However, the relevant therapeutic strategies towards the management of prediabetes is still unclear. Therefore, it was attempted to develop and study DCM in prediabetic animal model and to generate and characterize DPP4 inhibitor peptides derived from food sources that may contribute to alleviation of prediabetic symptoms and associated CVD.

FAD synthetase is a bifunctional protein where N-terminal is a FMN adenylyltransferase domain and C terminal is riboflavin kinase domain. The FAD synthetase gene from *S. aureus* has been cloned and expressed in pET28a followed by purification of recombinant protein by metal affinity chromatography. Biochemical studies shows that FMN adenylyl transferase domain is only active under reducing conditions whereas the kinase domain is active under both reducing and non-reducing conditions. Further, enzyme kinetics have been performed to determine the Km and Vmax for riboflavin to FAD and FMN to FAD conversion.

Mechanism of bacterial chromosome condensation and segregation (Ravi Kumar)

Chromosomal condensation and segregation of *Mycobacterium smegmatis* was studied. In addition to characterization of scpB knockout

strain, a hypothetical SMC homolog MsMukB is also being characterized. The 125 kDa protein has been cloned, overexpressed and purified using metal affinity chromatography. The protein is found to be a dimer in solution by analytical size exclusion chromatography. MsMukB exhibits both DNA binding activity and ATPase activity. DNA binding activity is demonstrated by gel shift assay using oligonucleotides of varying sequences and lengths.

Anti-proliferative and apoptosis-inducing potentials of carotenoids against human breast cancer cells (Ganesan P)

Investigation on the molecular mechanisms underlying the growth inhibitory effect of lutein in MCF-7 cells was investigated. Results show that purified lutein at 5 μ M and above concentrations sensitize MCF-7 cells by inhibiting growth and antioxidant signals and also by inducing apoptosis. The protein expression studies show that lutein at 5 μ M concentration effectively decreases the expression of the anti-apoptotic protein, Bcl-2. The apoptotic effect of lutein was observed by elevated caspase -3 activity and increased chromatin condensation in MCF-7 cells. It also inhibited the activation of intracellular growth signalling proteins, Akt and ERK1/2. Further, this carotenoid significantly inhibited the expression of endogenous antioxidant enzymes, SOD-2 and HO-1, and the transcription factor, Nrf-2. These findings show the key function of lutein as an anti-cancer agent against breast cancer cells.

Anti-angiogenic potentials of marine algal carotenoids (Ganesan P)

Effect of lutein isolated from marine alga *Chaetomorpha* sp. was analysed for *in vitro* tube formation using human umbilical vein

endothelial cells as model. The results indicate that lutein dose-dependently increased endothelial tube formation. Together these data show that lutein promotes endothelial cell tube formation (angiogenesis) via activating cell migration but, not through activation of cell proliferation. The mRNA expression studies show that lutein did not affect the expression of angiogenic growth factors such as VEGF-A and FGF-2. The molecular mechanism focusing migration signals in endothelial cells will be analysed in future studies.

Pomegranate seed oil epigenetically stimulates hepatic IGF-1 expression to promote peak bone mass achievement in growing rats (*Kunal Sharan*)

Peak bone mass (PBM) achieved at adulthood is a strong determinant of future onset of osteoporosis and maximizing it is one of the strategies to combat the disease. Recently, pomegranate seed oil (PSO) has been shown to have bone-sparing effect in ovariectomized mice. However, its effect on growing skeleton and its molecular mechanism remains unclear. In the present study, we evaluated the effect of PSO

on PBM in growing rats and associated mechanism of action. PSO was given at various doses to 21-days old growing rats for 90 days by oral gavage. The changes in bone parameters were assessed by μ -CT and histology. ELISA was performed to analyze the levels of serum IGF-1. Western blotting from bone and liver tissues were done. CHIP assay was performed to study the histone acetylation levels at IGF-1 gene. The results of the study show that PSO treatment significantly increases bone length, bone formation rate, bio mechanical parameters, BMD and bone micro-architecture along with enhanced muscle and brown fat mass. This effect was due to the increased serum levels of IGF-1 and stimulation of its signaling in the bones. Studies focusing on acetylation of histones in the liver, the major site of IGF-1 synthesis, showed enrichment of acetylated H3K9 and H3K14 at IGF-1 gene promoter and body. Further, the increased acetylation at H3K9 and H3K14 was associated with a reduced HDAC1 protein level. Together, the data suggest that PSO promotes the PBM achievement via increased IGF-1 expression in liver and IGF-1 signaling in bone.

Food Protection and Safety

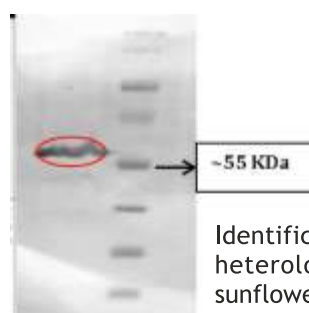
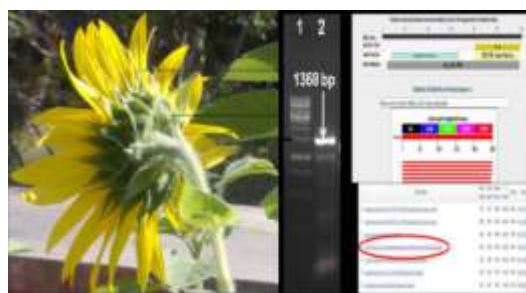
Detection and quantification of food adulterants and contaminants (Prasanna Vasu and Usharani D)

Adulteration of edible oils and fats has attracted more attention among researchers and consumers in recent years for demanding high quality and nutritious edible oil. Compositions of fats are modified during adulteration in most of the marketed ghee samples. Identifying this composition is challenging due to complex fatty acid profile in animal fats and it is difficult to obtain the standards for quantification. Therefore, advanced methods are needed to identify the detection of adulterants quickly to ensure the food safety and good quality of ghee. Comprehensive lipid profiling and discrimination of the ghee samples was studied using Fourier Transform Infrared Spectroscopy (FT-IR), a rapid and non-invasive method. Eighty samples of ghee of different origin (cow, buffalo) and regions of India were analysed. The preliminary results indicated a finger print region for discriminating the origin of the ghee samples, while building the model for authentication of ghee samples is under way.

Unraveling wax synthase from *Helianthus annuus* (Asha Martin)

Wax esters are used for various commercial applications, including lubricants or coatings for food applications and personal care products. Natural wax esters are formed by enzymatic reactions catalyzed by a fatty acyl reductase and

a wax synthase. Commercially used wax esters are mainly obtained from Jojoba. Extraction costs and limited availability constrains their use. At present, only a few plant wax synthases have been characterized, but diversity of wax esters found in nature reveal that there are other resources of wax esters for various potential applications. Sunflower (*Helianthus annuus*), an important oil seed crop of India is also a source of C36 - C48 wax esters. Sunflower wax synthase (WS) gene was identified using bioinformatics approach. Using degenerate primers and chromosome walking PCR, sunflower WS gene was isolated and the same was confirmed by DNA sequence analysis. Sunflower WS gene was directionally cloned using pYES2 NTC expression vector and heterologously expressed in *Saccharomyces cerevisiae*. Functional characterization of sunflower WS protein is in progress.

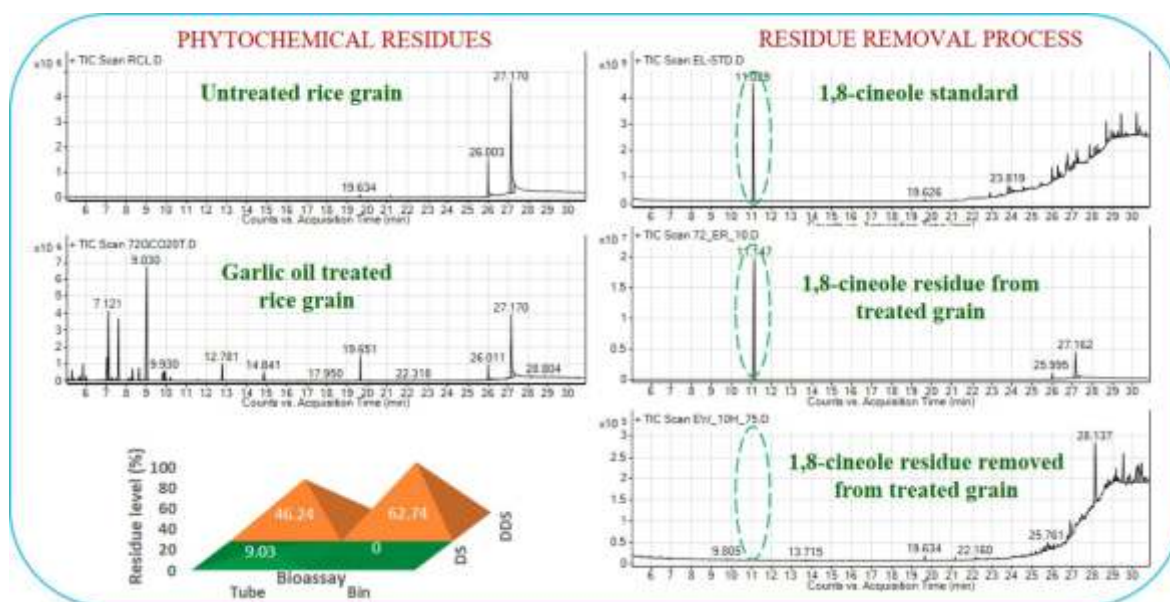


Identification, isolation and heterologous expression of sunflower wax synthase gene

Storage bin for control of insect pests in stored food grains (Ezil Vendan)

Plant volatiles are potential alternative sources to toxic fumigants which can be developed as a bio-fumigant formulation against stored product insect pests. In this view, a model domestic scale storage bin has been developed in the present study. Essential oils of *Allium sativum* and *Zingiber officinale* were evaluated for their insect control efficacies under 1 kg storage capacity. The adults of the insect species *Callosobruchus maculatus*, *Oryzaephilus surinamensis* and *Sitophilus oryzae* were exposed to essential oils along with either green gram, rice and wheat commodities based on their host specificity. Upon treatment, the phyto compounds from the essential oils vapourised and diffused into stored commodities exhibiting

repellent and insecticidal properties. Remarkably, 100% insect control (mortality) was achieved significantly ($P \leq 0.05$) within 24 h of exposure for all the insect species at a test concentration of 240 $\mu\text{l/kg}$ of *A. sativum*. The GC-MS data revealed that, diallyl sulfide, diallyl disulfide, diallyl trisulfide and methyl allyl trisulfide were the major ingredients in *A. sativum* oil responsible for exhibiting insect control. Diallyl disulfide and diallyl trisulfide were detected as the major residues in the fumigated grains. In addition, bio-fumigation and further residue removal studies with 1,8-cineole indicated that, about 98% of 1,8-cineole residue could be removed from fumigated rice grains by aqueous process as confirmed by GC-MS analysis.



Phytochemical residues detected from garlic oil and 1,8-cineole treated rice grains

Fast Track Translational Projects

Arabinoxylan rich polysaccharides (Muralikrishna G and Baskaran V)

Proximate and physicochemical characteristics of arabinoxylan rich polysaccharides isolated from wheat and rice brans were analysed for properties such as moisture, ash, silica, fat, protein and crude fibre. Calcium hydroxide extracted samples consisted of high amount of carbohydrate followed by hemicellulose-B and hemi-cellulose-A extractions. Protein, crude fibre (lignin and cellulose) and fat contents were negligible. Rice hemicellulose-A extracted arabinoxylan consisted of relatively high amounts of silica followed by calcium hydroxide extract. Hemicellulose-B of wheat was found to be the most viscogenic among all the arabinoxylan containing poly-saccharides followed by wheat calcium hydroxide extract.



Arabinoxylan

Rice calcium hydroxide extract was the least viscogenic among all the extractions. Products (soup crackers) incorporated with arab-inoxylan (0.5%) rich extracts along with buck wheat flour,

quinoa and maida have been tested for sensory evaluation. However, optimization of sensory characteristics needs to be carried out. Second batch of isolation of arabinoxylans from both wheat bran and rice bran have been completed at pilot plant scale.

Non-thermal processing of liquid foods (Rastogi NK)

Initial experiments showed that the high pressure treatment (350 MPa, 50°C, 10 min) of sugarcane juice reduced the total bacterial count by 3.29 log CFU and significant reduction in enzymes (PPO and POD), while no changes were observed in ascorbic acid content. High pressure processing facility (2.0 L) is being indigenously designed and developed.

The fresh tender coconut water, ozone, heat treated and ultra sound treated tender coconut water were examined for sensory analysis. Treated tender coconut water was stored under refrigeration condition and same was also evaluated after each week of storage studies. Fresh tender coconut water was highly acceptable with a sensory score of 12.9. The overall quality sensory score for ozone treated was 9.0. The heat treated TCW score was 9.3. Overall quality of ultrasound treated tender coconut water was 9.5.

Technology for carbonated fruit juice beverage from selected fruit crops (Vijayanand P)

Technology for the carbonation of fruit juice beverages from a few select fruits viz., mango,

guava, grape, lime, pomegranate, apple, orange were developed. Carbonated fruit juice beverages from these fruits were analysed for nutritional, microbiological and sensory evaluations. Sensory evaluation by quantitative descriptive analysis indicated that the products are highly acceptable in terms of colour, flavour, taste and overall quality. Microbiological analysis

of these products showed no growth of microbes. The beverages packed in PET bottles were stored under different storage conditions and periodically analysed for quality characteristics. Storage studies indicated that the products were stable up to 3 months at room temperature ($29\pm 2^{\circ}\text{C}$) and 5 months at low temperature ($8\pm 2^{\circ}\text{C}$).



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