Performance Report
2015-16

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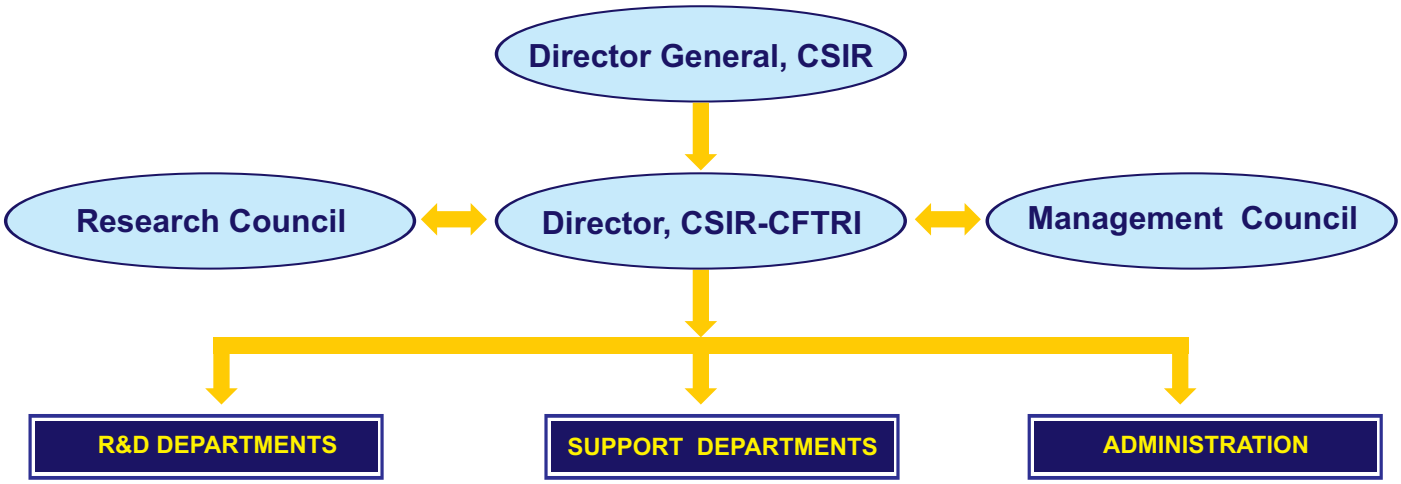

R&D DEPARTMENTS

- Department of Biochemistry
- Flour Milling, Baking & Confectionery Technology
- Food Engineering
- Food Protectants & Infestation Control
- Food Packaging Technology
- Food Safety & Analytical Quality Control Laboratory
- Fruit & Vegetable Technology
- Meat & Marine Science
- Grain Science Technology
- Lipid Science
- Microbiology & Fermentation Technology
- Molecular Nutrition
- Plant Cell Biotechnology
- Protein Chemistry & Technology
- Spices & Flavour Sciences

SUPPORT DEPARTMENTS

- Central Instruments Facility & Services
- Computer Centre
- Construction & Civil Maintenance
- Department of Technology Scale-Up
- Design & Fabrication Unit
- Engineering & Mechanical Maintenance
- Human Resource Development
- Information & Publicity
- Library
- Planning, Monitoring & Coordination
- Technology Transfer & Business Development
- Resource Centres : Hyderabad, Lucknow & Mumbai

ADMINISTRATION

- General Administration & Establishment
- Finance & Accounts
- Stores & Purchase

CSIR-CFTRI
PERFORMANCE REPORT

2015-16

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From Director's Desk . . . . .

It has been a wonderful year in which we were able to explore the vast potential of food technology R&D in the country in delivering quality products and services.

We had a good number of publications in peer-reviewed journals, Science-driven products, fruitful collaborations with various agencies and Institutions in taking forward our prime agenda of food & nutritional security to the Nation.

The Institute could reasonably contribute through good number of outreach programmes as well. Women empowerment, Village adoption and catalyzing Farmers Producers Organizations (FPOs) are notable along them.

The Institute has been extremely successful in meeting the milestones under the XII Five Year Plan projects with tangible outcomes and potential leads.

I thank each and every stakeholders who have contributed their mind and might in realising the Institute goals and objectives.

Of course, my colleagues altogether played an important role in achieving the mandate. I once again assure you all that the Mission will be continued with much more vigour, innovation and inclusiveness.

Sd/-

Prof. Ram Rajasekharan
Director, CSIR-CFTRI

Date: 27 March 2017
Place: Mysore

Achievements at a glance

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Achievements
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1. Research Papers Published

SCI Papers

1 Aadinath W., Anu Bhushani J., Anandharamakrishnan C., Synergistic radical scavenging potency of curcumin-in-β-cyclodextrin-in-nanomagnetoliposomes, *Materials Sci. Eng.: C*, 2016, **64**, 293-302

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1 Arunkumar Ranganathan, Baskaran V., Polymer-lipid hybrid nanocapsules improves lutein solubility, stability and bioavailability in mice, Nano2015-proceedings entitled Bio-nanomaterials for biomedical technology, Ed: Rajendran V., Prabhu P., Geckeler K.E., 2015, 169-172

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1 Prasada Rao U.J.S., Calcium carbide as fruit ripening agent: Association health hazards and risk management, *Indian Food Industry*, 2015, **34(4)**, 55-57

2 Srinivasan K., Spices and flavoring crops: Uses and health effects, *Encyclopedia of Food and Health*, 2016, **5**, 98-105

3 Srinivasan K., Derive maximum nutritional benefits from plant foods, *The Global Fruit and Veg Newsletter*, December 2015, **5**, 4

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Books Published

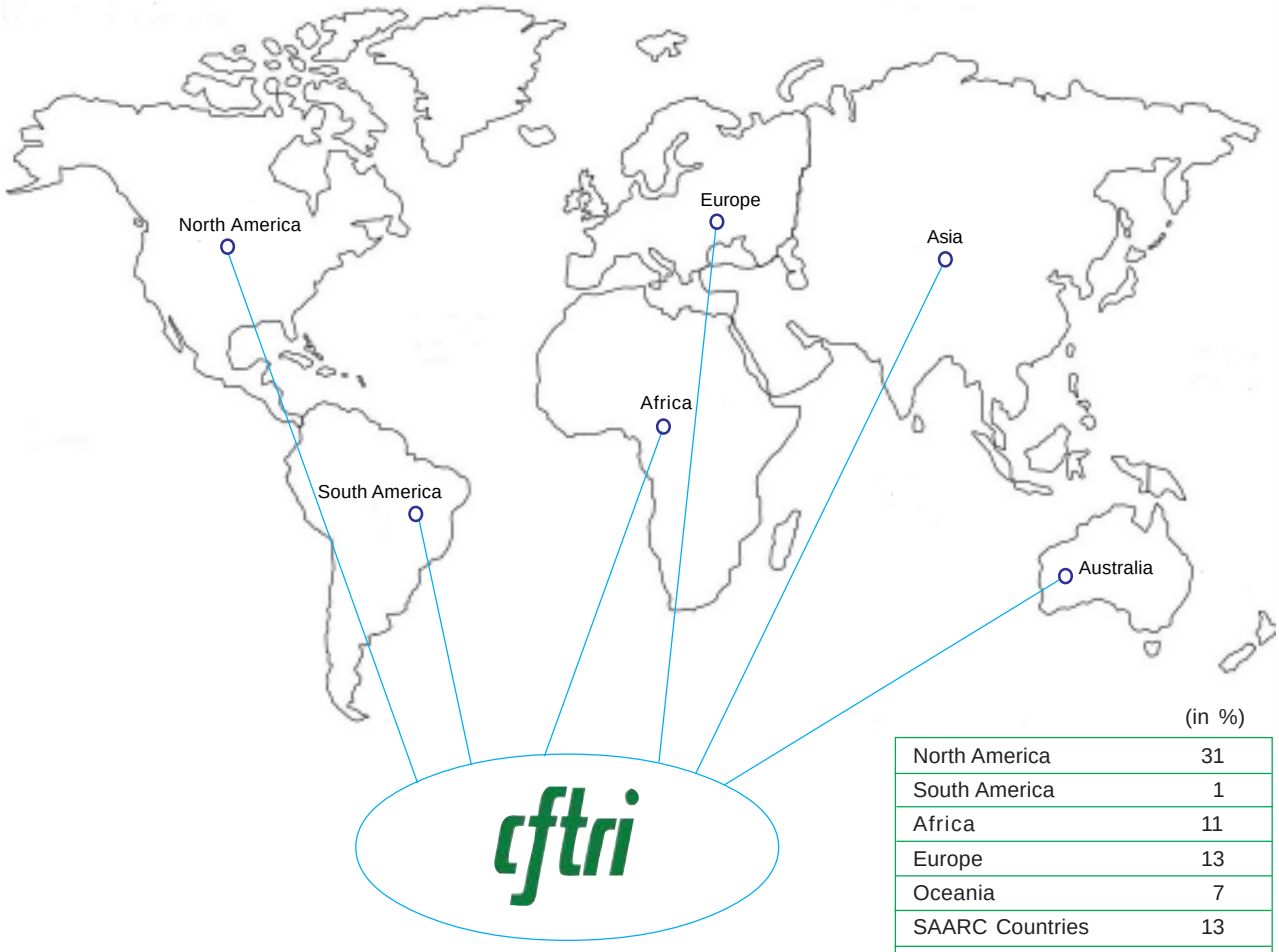
1 Advances in membrane technologies for water treatment: Materials, processes and applications, *Edited by: Basile, A., Cassano A., Navin K. Rastogi,* Published by: Woodhead Publishing Ltd., UK, 2015

Short Communications/Short notes/ Editorial notes

1 Shashirekha M.N., Bioactive components in fruit and vegetables: The case of polyphenols, *The Global Fruit and Veg Newsletter, France*, December 2015, **5**, 2

2. Patents filed

- A process for simultaneous extraction of karanjin (a bioactive compound) and oil from karanja seed
- A device useful for continuous cooking and discharging of Ragi Mudde and other similar kind of dumpling products



Global CSIR-CFTRI Patent Portfolio

(in %)

North America	31
South America	1
Africa	11
Europe	13
Oceania	7
SAARC Countries	13
Other Asian Countries	24

Name of the Country	No. of Patents
• USA	35
• Sri Lanka	15
• Japan	10
• Australia	9
• United Kingdom	9
• China	5
• Mexico	5
• Singapore	5
• Bangladesh	4
• Germany	4
• Indonesia	4
• Kenya	4
• South Africa	4
• Canada	3
• African Intellectual Property Organization (OAPI)	2
• Asia Pacific Region	2

Name of the Country	No. of Patents
• Brazil	2
• France	2
• Malaysia	2
• Vietnam	2
• Denmark	1
• Egypt	1
• Lebanon	1
• Madagascar	1
• Malawi	1
• New Zealand	1
• Norway	1
• Philippines	1
• Republic of Korea	1
• Sweden	1
• Turkey	1
• Uganda	1
• United Republic of Tanzania	1

3. Processes released for commercial exploitation

- Bottling of sugarcane juice
- Cereal flakes: Jowar
- Chicken wafers
- Chikki/ nutra chikki (3 formulations)
- Coconut beverage from tender coconut
- Coconut oil blends with other vegetable oils
- Coffee concentrate
- Compounded asafoetida
- Dehydrated bitter gourd
- Dehydrated drumstick powder
- Desiccated coconut
- Eggless cake premix
- Energy food: New formulation
- Flaking of ragi
- Fermented and dehydrated ready mixes for idli/ dosa batter
- Finger millet (ragi) based murukku
- Foods for diabetics
- Fortified whole wheat pasta
- Fruit jams & jellies: Preparation
- Fruit jam slices
- Fruits & vegetables dehydration: Grapes, banana, onion, potato, peas & green chillies
- Ginger beverage
- Garlic paste
- Ginger paste
- Gravy paste for different Indian cuisine
- Groundnut (peanut) butter
- High protein rusk
- Improved maize flour
- Instant gravy mixes: Dehydrated (11 formulations)
- Instant traditional food: Sambar
- Layered parotta (south Indian)
- Low sugar milk burfi
- Maize chips
- Making superior quality white pepper
- Meat wafers
- Milk chocolate
- Milk chocolate with no added sugar
- Modified atmosphere packaging of minimally processed vegetables
- Multi-grain sweet mix
- Nutra chikki with added spirulina
- Online fortification of atta (whole wheat flour)/ maida (refined wheat flour)
- Osmo-air dried: Fruits (amla, jackfruit, pineapple & mango)
- Pickles & chutneys
- Pomegranate juice & products
- Preparation of cereal bar
- Purified wax from rice bran wax sludge
- Production of atta (whole wheat flour)
- Production of turmeric powder from fresh turmeric rhizome
- Pulse based papads
- Quick cooking, germinated & dehydrated pulses
- Ready mix: Dosa
- Ready mix: Jamun
- Ready mix: Jelebi
- Ready mix: Vada
- Ready mix: Upma
- Ready spice mix: Pulao
- Ready spice mix: Rasam
- Ready to cook multi grain whole mix for drink/ porridge
- Refined wheat flour, semolina & resultant atta by roller milling

- Roasted & flavoured cashew kernels
- RTS fruit juices and beverages
- Sausage preparation: Chicken
- Sesame: Dehulling
- Shelf stable chapati
- Shelf stable chicken tit-bits
- Shelf-stable & ready to eat foods thermo processed in retort pouches (vegetarian)
- Shelf stable jowar flour
- Shelf stable roti from cereals & millets (rice/ragi/ maize/jowar/bajra)
- Spirulina choco bar & spirulina cereal bar
- Sugar free bread
- Tomato products
- Value added products from figs *(Ficus carica l)*
- Virgin coconut oil
- Wheat vermicelli

Ragi based murukku

Demonstration to BVoc students of JSS Arts & Science College, Mysore

4. New processes ready for commercial exploitation

Twenty new processes were developed for commercial exploitation as per the list given below:

- Millet based cookies
- Low glycemic index noodles
- *Gongura* leaf powder
- Instant *moringa* leaves soup mix
- Preservation of ready to eat breakfast foods (Idli, dosa, paddu, chutney & sambar)
- Purified wax from rice bran wax sludge
- Table top continuous wet cum dry grinder
- *Thepla* and *Khakra* processing machine
- Continuous *pani-poori* sheeting & cutting machine
- Production of husk free flour from small millets using roller mill
- Atta with multi grains/multi whole grain flour
- Tender coconut water concentrate with sugar
- Process for production of DAG oil for salad / spread
- Process for instant products from *moringa* leaves
- Preparation of crunchy banana cereal bar
- Preparation of instant broccoli soup mix
- Production of gelatin from chicken feet
- Microbial inoculums for the management of coffee pulp effluent
- Improved process for preservation of *Neera*
- *Neera* concentrate

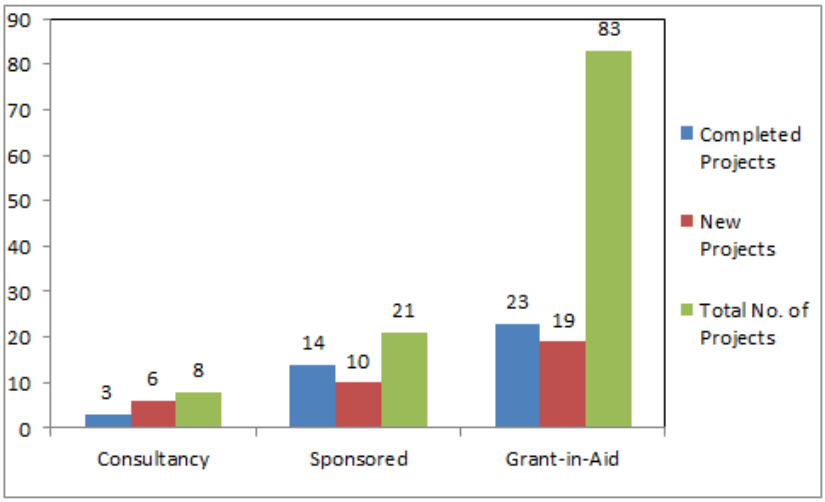
Low glycemic index noodles

Crunchy banana cereal bar

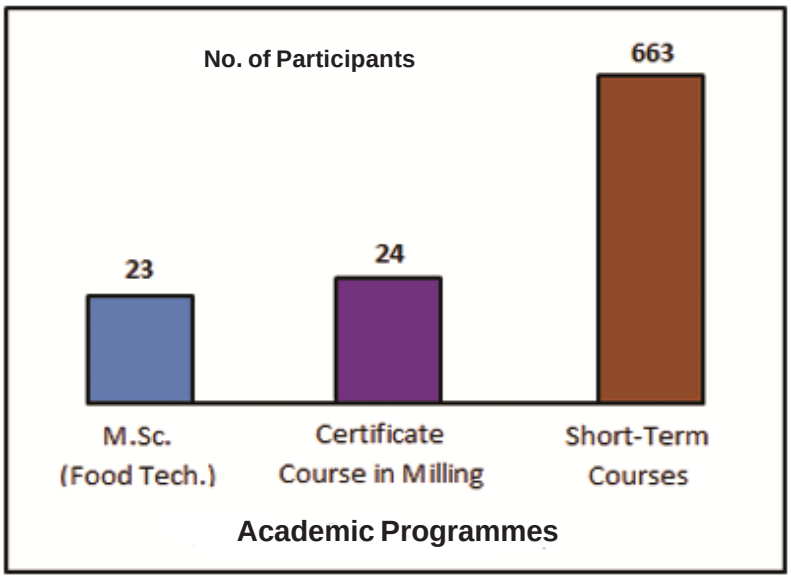
Gongura leaf & powder

Table top continuous wet cum dry grinder

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



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



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

Awareness cum Workshop for MSMEs (May 29, 2015)

CSIR - Central Food Technological Research Institute (CFTRI), Mysore in collaboration with Confederation of Indian Industry (CII), Mysore Chapter organized the MSME meet on 'Value added Agriculture & Food Processing' at CSIR - CFTRI, Mysore on 29 May, 2015. The programme was coordinated under the banner of CSIR MSME Initiative supported by Department of MSME, Govt. of India, New Delhi. The focus of the meet was to provide a wider platform for scientists - entrepreneurs interaction. A total of 124 participants from the areas such as spices, grains, fruit & vegetables, packaging and food safety. attended this workshop. Prof. Ram Rajasekharan, Director, CSIR-CFTRI, Mysore delivered the keynote address. Mr.M.I.Ganagi, Chief General Manager, NABARD talked about scope of Agro & Food processing industry in Karnataka. Experts from CSIR-CFTRI made Presentations on various topics related to food processing industry. The technology for production of turmeric powder from fresh turmeric rhizomes and table top multipurpose roti processing machines were demonstrated. During the meet, an MoU was signed between CSIR-CFTRI, Mysore and CII, Mysore Chapter. Under this MoU, it is planned to undertake activities towards promotion of best Agriculture practices & Food processing in the Mysore district.

Dakshin Bharat Mahila Krishi Jagriti Karyasala (August 19, 2015)

A workshop was organised exclusively for women farmers in the Institute. Mrs. Indira Oinam, Founder Secretary, Women's Income Generation Centre, Manipur, inaugurated the event in which 130 women farmers participated.

Hindi Fortnight Celebration (September 14-28, 2015)

Hindi Fortnight was celebrated from 14.09.2015 to 28.09.2015. Variety of competitions in Hindi were conducted for the employees and research students during the fortnight. Prizes to the winners of the competitions were distributed by the Chief Guest Dr. G.K Sharma, Chief Scientist, Defence Food Research Laboratory, Mysore in the valedictory function held on 1st October 2015.

CII-CFTRI Meet on Value added agriculture

A session with the participants of Dakshin Bharat Mahila Krishi Jagriti Karyasala

CSIR Foundation Day (September 26, 2015)

CSIR Foundation Day was celebrated in the campus. Prof. B.N. Thorat, Head, Dept. of Chemical Engineering, Institute of Chemical Technology, Mumbai delivered the Foundation Day Address.

CFTRI Foundation Day- Open Day Celebrations (October 21, 2015)

CSIR-CFTRI Foundation Day was celebrated in which Dr. A.K. Srivastava, Director, ICAR-NDRI, Karnal (Haryana) delivered the Foundation Day Address.

The Institute also allowed the public to visit the Institute on Oct. 20th and Oct. 21st 2016. Shri B. Dayananda, IPS, Commissioner of Police, Mysuru inaugurated the event.

Make in India Meet on Food Processing & CEOs Meet (January 4, 2016)

Hon'ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan inaugurated the event on January 4, 2016, Dr. Girish Sahni, DG-CSIR and other dignitaries were present on the occasion. Prof. Ram Rajasekharan, Director, CSIR-CFTRI presided over the function.

In the business meet, "**Catalysing Make in India for growth in agri-food processing**", over 30 CEOs from Industries and Corporates deliberated on various issues such as Make in India: Challenges and Opportunities, Govt. Policy initiatives, Ecosystem for start-ups, R&D linkages with industry and regulatory issues. Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences, addressed the CEOs.

Launching of carbonated fruit juice by Hon'ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan during Make in India on Food Processing and Inspecting the Make in India assemble

CEOs Meet in progress during Make in India Meet

Visitors interacting with staff during CSIR-CFTRI Open Day

8. MoUs signed

9. International Collaborations and Networking

Two-days Workshop on food safety for the participants from Bangladesh Council of Scientific & Industrial Research (BCSIR) was held during Sep 10-11, 2015 at CSIR-CFTRI. It provided a platform to understand the current challenges in both the countries and chalked out couple of collaborative program as a way forward.

Students of University of Wisconsin - River Falls, USA attended a short term training programme in the Institute during January 14-18, 2016.

Food Safety Workshop for scientists of BCSIR

Faculty & Students of University of Wisconsin - River Falls, USA along with CSIR-CFTRI Team

10. Awards and Recognitions

a) University of Mysuru

Name of the student	Title of the thesis	Guide
• Aduja Naik	Bioprocessing of coconuts for value added product development	Raghava Rao KSMS
• Ajit Singh Bhatnagar	Studies on processing of oil and extraction of bioactive molecules from indian niger seeds (guizotiaabyssinica (L.f.) Cass)	Gopalkrishna AG
• Ashwini N Bellary	Development of functional foods by impregnation of bioactive compounds in solid food matrix	Rastogi NK
• Avinash Kumar	Characterisation of promoter and trascription factors of coffeasp. With special reference to caffeine metabolism	Giridhar P
• Baby Latha R	Physical, chemical and biological characteristics of rice bran oil during heating and reheating cycles	Gopalkrishna AG
• Bharath Kumar S	Modified low glycemic index ingredients in wheat based food processing	Prabhasankhar P
• Bijesh P	Elicitor-mediated enhancement of folates in coriander (Coriandrumsativum L.) and elucidation of molecular mechanisms	Bhagyalakshmi N
• Deepak MB	Isolation and characterization of yeasts for detoxification of aflatoxin	Anu Appaiah KA
• Gobinath D	Prebiotic galactooligosaccharides: enzymatic synthesis, characterization and bioactive studies	Prapulla SG
• Gokul	Insights on the modulatory role of non-digestible saccharides against developmental neurotoxicants	Muralidhara
• James Bound D	Synthesis and bioactive attributes of 2, 3-dideoxyglucosides of terpene phenols and alcohols	Srinivas P
• Lalith Kumar V	Protien as a response modifier of lead (Pb)-induced neurotoxic implications	Muralidhara
• Lokesh V	Molecular characterization and expression profiling of genes involved in ripening banana	Baghyalakshmi N
• Lyned Dafny Lasrado	Study on the utilization of xylo-oligosaccharides by lactobacillus sp. with an emphasis on the biochemical characterization of a xylanolytic enzyme	Muralikrishna G
• Manjunath MJ	Synergistic neuroprotective effects of withania Somnifera with specific dietary derived polyphenols	Muralidhara
• Manjunatha JR	Synthesis of water-soluble curcumin derivatives and evaluation of their bioactive and anti-amyloid aggregating properties	Srinivas P

Name of the student	Title of the thesis	Guide
• Padmaja RJ	Characterization of leukotoxin producing staphylococcus aureus and development of antibody based method for leukotoxin detection in bovine milk samples	Prakash M Halami
• Prashanth Kumar PK	Palm stearin for preparation of vegetable oil blends and foods	Gopalkrishna AG
• Praveen K Srivastava	Characterization of mannanase from bacillus sp. and its biotechnological applications	Mukesh Kapoor
• Raghavendra CK	Antilithogenic potential of dietary tender cluster beans (cyamopsistetragonoloba) in experimental animal models	Srinivasan K
• Rajeev Ranjan	Studies on luciferase enzymes for their application in assessing hygiene state of selected food samples	Thakur MS
• Ravi G	Antibodies to ribitol and its phosphate: Application in immunoassays for riboflavin and its coenzymes	Singh RP
• Rohinishree	Molecular characterization of toxigenic staphylococcus spp. For stress responses under simulating conditions of food processing in model food systems	Negi PS
• Santhosh Kumar SC	Synthesis of important flavour and bioactive molecules from limonene and zerumbone	Bettadiah BK
• Shipra Tiwari	Understanding, characterization and nutrient bioaccessibility of specialty food gels for health benefits	Suvendu Bhattcharya
• Sinjitha S Nambiar	Identification of bioactive compounds with anti-atherosclerotic properties from emblica officinalis fruit	Nandini P Shetty
• Varnashree BS	Studies on processing curry leaves (Murrayakoenigii L. Spreng) for bioactive conserves	Nagarajan S
• Veenashri BR	Xylo-oligosaccharides isolated from ragi (Eleusinecoracana) bran: Determination of their structure and function	Muralikrishna G
• Vijendra Kumar N	Synthesis and bioactivity studies of key phenolic compounds of ginger and their derivatives	Bettadaiah BK
• Vismaya	Impact of selected organophosphrus insecticides on small intestinal functions in rats – intrinsic and interactive effects in experimentally induced diabetic rats	Rajini PS

b) AcSIR

Name of the student	Title of the thesis	Guide
• Ezhilarasi PN	Micro and nanoencapsulation of biomolecule (hydroxycitric acid) and its effect on stability and bioavailability	Anandharamakrishnan C
• Narayansing Vithalsing Chhanwal	Computational modeling of bread baking process under hybrid heating modes	Anandharamakrishnan C

c) Individual Awards

Award Title	Instituted by	Awardee
• Platinum Jubilee Lecture Award	103rd Indian Science Congress Association held at University of Mysore, Mysore	Nandini CD
• SERB Young Scientist Start-up Research Grant Award	SERB	Kunal Sharan
• Young Investigator grant award	DBT under Cancer Biology	Ganesan P
• Early Career Research Award	DST-SERB	Tanaji Kudre
• VIFRA-Outstanding Scientist Award in Biotechnology-2015	Venus International Foundation, Chennai	Giridhar P
• Early Career Research Award	DST-SERB	Sachin M Eligar
• Dr. J.S. Pruthi Memorial Award	AFST(I), Mysuru	Prabhakara Rao P
• Nagaraja Rao R Jagadale Memorial Award 2014	All India Food Processors Association (AIFPA)	Math RG
• VIFRA-Outstanding Scientist Award in Biotechnology-2015	Venus International Foundation, Chennai	Aashitosh A Inamdar
• Young Scientist Award	AFST(I), Mysuru	Aashitosh A Inamdar

CSIR-CFTRI intervention on malnutrition with innovative nutritious products in Anganwadis

d) Recongnitions by Academies

Recognition	Instituted by	Awardee
• Fellow	AFST(I), Mysuru	Dr. Bhaskar N

e) Other Recognitions

Fellowship / Programme	Awardee	Host Institute
• Advisory Member	Manohar B	UGC-DDU KAUSHAL Kendra, JSS College of Arts and Science, Mysore
• Member, Board of Studies	Anandharamakrishnan C	University of Mysore
• Member, Board of Studies	Anandharamakrishnan C	VIT University, Vellore
• Member, Board of Studies	Anandharamakrishnan C	Kongu Engineering College, Coimbatore
• Member, Board of Studies	Anandharamakrishnan C	Periyar Maniyammai University, Thanjavur
• Panel Expert	Shashirekha MN, Negi PS & Vijayanand P	FSSAI, New Delhi
• Member, Board of Studies	Shashirekha MN	American College, Madurai
• Member, Board of Studies	Shashirekha MN	University of Mysore
• Member, Board of Studies	Sridevi Annapurna Singh	University of Mysore
• Member	Sridevi Annapurna Singh	FAD 13, BIS

National Science Day Celebration - 2016

f) CFTRI Annual Awards

On the occasion of CSIR-CFTRI Foundation Day on October 21, 2015, CFTRI Annual awards were presented to the exemplary performance of staff and students for the year 2015-16. Details of the recipients are given below:

- **Individual Awards for Best Scientific and Technical Contributions**

  Group IV:

  - Shylaja M Dharmesh, *Department of Biochemistry*

  Group III:

  - Sowbhagya H.B., *Spice & Flavour Science*

- **Individual Awards for Technical Contributions**

  Group III:

  - B. Jayakumar, *Electrical & Mechanical Maintenance*
  - Sanjailal K.P., *Central Instrument Facility and Services*

- **Individual Awards for Best Support Staff**

  Group II:

  - M. Rajesh, *Design & Fabrication Unit*

  Group I:

  - Rajashekara, *Establishment - III*

- **Best Research Paper Published by Staff**
  - Anitha Vijayakumar, Vijayaraj P, Arun Kumar V. & Ram Rajasekharan, *Department of Lipid Science*

- **Best Contribution Award for Administrative Support**
  - A. Shenbaganathan, *Stores and Purchase*

- **Best Student Award**
  - Kamlesh Kumar Yadav, *Senior Research Fellow, Department of Lipid Science*

- **Best R&D Department**
  Plant Cell Biotechnology

- **Best Support Department**
  Construction & Civil Maintenance

- **Best Technology Developed**
  Production of husk free flour from small millets using roller mill, *Suresh D Sakhare, Inamdar AA, Usha Dharmaraj, Basavaraj Mundalamani & B.V. Sathyendra Rao*

g) Best Research Papers / Posters awards

I. 24th ICFoST, College of Food Technology, VNMK University, Parbhani, Maharashtra, December 18-19, 2015

1 Padma Ishwarya S., Srinivasulu Naladala, Kiran M. Desai, Anandharamakrishnan C., A model for bubble growth and coalescence in bread dough

2 Memthoi Devi H., Singh N.I., Nutritional profile and antioxidant activity of *Rhus chinensis* Mill (Heimang) fruit and its products

3 Parvinder Kaur, Balaji W. Kanwate, Tanaji G. Kudre, Biodiesel production using oil from fresh water fish processing wastes

4 Swapna Sonale R., Ramalakshmi K., Manohar B., Characterization of compounds from Neem leaves volatiles employing supercritical carbon dioxide extraction

II. Research Papers / Posters awards in other seminars

- Sowmya Shree G., Arpitha H.S., Yogendra Prasad K., Pratyusa C., Ganesan P., Isolation and characterization of beta-carotene from Chenopodium album and its anti-cancer molecular mechanism in human breast cancer (MCF-7) cells, International Conference on Stem Cells and Cancer (ICSCC-2015), Pune, October 2-5, 2015
- Srinivasulu, Korra, Athira, P., Sulochanamma G., Sathiya Mala K., Formulation and quality assessment of pumpkin blended muffins, 47th National Annual Conference of NSI, NIN, Hyderabad, October 9-10, 2015
- Aashitosh A Inamdar, Prabhasankar P., Influence of differential milling on grinding characteristics of wheat and chapati making quality of atta (whole wheat flour), First International Conference on Advances in Food Science and Technology (ICAFST – 2015), Kottayam, Kerala, November 20-22, 2015
- Suresh D Sakhare, Prabhasankar P., Study of fenugreek fiber enriched *chapatti*, First International Conference on Advances in Food Science and Technology (ICAFST – 2015), Kottayam, Kerala, November 20-22, 2015
- Arjun S., Nagaraju V.D., Sridhar B.S., Value added processing of makhana (*Euryaleferox*) seeds, International conference on Converging Biotechnological Innovations for Health, Food and Environmental Welfare, Karunya University, Coimbatore, December 2-4, 2015
- Siddharth Priyadarshi, Ravi Ramsamy, Madhava Naidu M., Development and quality evaluation of flavourant from coriander seeds, National symposium on Spices, Medicinal and Aromatic Crops (SYMSAC-2015), Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, December 16-18, 2015
- Gokul Ashok, Prashant Upadhyay, Samrudha S. Kumar, Tanaji G. Kudre, Optimization and scale up of biodiesel production from marine fish wastes, National Conference on Perspectives and Prospects in Aquatic Research, Kongunadu Arts and Sciences College, Coimbatore, Tamil Nadu, February 16, 2016
- Bhushani J.A., Anandharamakrishnan C., Electrospraying as a nanoencapsulation technique for green tea catechins, 2nd Food structure and functionality forum symposium-from molecules to functionality, Singapore, February 28 - March 2, 2016

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

- Innovative Food Science & Emerging Technologies, Elsevier (Rastogi NK)
- International Journal of Membrane Science & Technology, Cosmos Scholars (Rastogi NK)
- Journal of Food Science and Technology, Springer (Anandharamakrishnan C, Rajini PS, Bhaskar N, Sridevi Annapurna Singh)
- International Journal of Genuine Traditional Medicine, published by Association of Humanitas Medicine, Republic of Korea (Negi PS)
- Indian Food Industry (Vijayendra SVN, Anu Appaiah KM, Suresh D Sakhare)
- Egyptian Journal of Aquatic Research (Bhaskar N)
- mBio (RSC), Microbial Cell Factories (ASM) (Rajagopal K)

i) Editorial Boards

- Journal of Food Engineering, Elsevier (Rastogi NK)
- Journal of Engineering, Hindawi (Rastogi NK)
- The Scientific World Journal, Hindawi (Rastogi NK)
- Research and Reviews: Journal of Food Science & Technology, STM (Rastogi NK)
- Journal of Membrane Science & Technology, Omics (Rastogi NK)
- Journal of Food Research and Technology, Jakraya (Rastogi NK)
- Journal of Food Science and Engineering, David Publishing Company (Anandharamakrishnan C)
- Food Science Journal, Academy Science Society (Anandharamakrishnan C)
- Journal of Nutrition and Nutritional Epidemiology (Anandharamakrishnan C)
- International Journal of Applied Nanotechnology (Anandharamakrishnan C)
- Computational Biology Journal (Anandharamakrishnan C)
- 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)
- Journal of Molecular and Genetic Medicine, Omics Publishing Group, Foster City, CA, USA (Neg i PS)
- Signpost Open Access Journal of Organic and Biomolecular Chemistry, Research Signpost, India (Negi PS)
- Pharmacognosy Magazine (Suresh Kumar G)

Visit of IAS Officer Trainees - Interaction with Director, CSIR-CFTRI

11. Participation in Exhibitions

- **Exhibition on Science and Technology:** Organized by Council of Science and Technology, BKT Govt. of UP, Lucknow, May 30, 2015
- **Exhibition based on CSIR-CFTRI Technologies:** Organized by Uttar Pradesh Khadi Village Industry Board, Govt. of UP, Lucknow, June 2, 2015
- **Farmers meet to promote Chia and Quinoa:** Organized by Farmer & Tafe Distributer, Tirunelveli, Tamil Nadu, June 29, 2015
- **Exhibition based on CFTRI technologies in Zonal PMEGP:** Organised by KVIC, Govt. of UP, Lucknow, November 15-24, 2015
- **Women Enterpreneurs Summit 2015:** Organized by KSIDC, Cochin, November 19, 2015
- **Exhibition based on CFTRI Technologies:** Organised by Uttar Pradesh Council of Science and Technology, Govt. of UP, Lucknow, November 24 - December 5, 2015
- **India International Science Festival (IISF):** Organized by Ministry of Science & Technology & Earth Sciences, Govt. of India, IIT, Delhi, December 4-8, 2015
- **Innovation in Science Pursuit for Inspired Research (INSPIRE), Science Camp-2015:** Organized by Department of Botany, Yadava College, Madurai, Tamil Nadu, December 23-27, 2015
- **One day Workshop-cum-Exhibition on Food Processing:** Organized by Anil Agarwal Foundation, Bhubaneswar, Odisha, January 8, 2016
- **Food Tech Kerala:** Organized by Govt. of Kerala, Kochi, January 26-28, 2016
- **Machinery Expo 2016 Kerala:** Organized by Department of Industries & Commerce, Govt. of Kerala, Kochi, January 27-30, 2016
- **Invest Karnataka-2016:** Organized by Govt. of Karnataka, Bangalore, February 3-5, 2016
- **YUREKA 2016 - The Science Fest:** Organized by Yuvaraja's College, Mysore, March 5-6, 2016
- **Krishi-Unnati Mela 2016 :** Fish meat bone separator (FMBS) developed under National Fisheries Development Board (NFDB) project was exhibited at the exhibition under the aegis of NFDB at IARI, New Delhi, inaugurated by the Honorable Prime Minister of India, March 19-21, 2016

Invest Karnataka Meet at Bengaluru

Training to Food Safety & Testing Analysts from Kerala Govt.

- **Pasumai Vikatan Agri-Expo 2016:** CSIR-CFTRI participated in the Pasumai Vikatan Agri-Expo 2016 organised by Ananda Vikatan Publishers Pvt. Ltd. Chennai during February 12-15, 2016 at Trichi
- **State-level conference of women entrepreneurs and business-to-business meeting:** Organised by the Laghu Udyog Bharati-Karnataka, was held at Bengaluru on March 18-19, 2016 on the theme 'Women entrepreneurship and their empowerment in the path of inclusive growth and development. The meet was inaugurated by Union Minister of State for Commerce and Industry, Smt. Nirmala Sitharaman.

12. Support Dept. Activities

Headspace Analyser HS-10 for Shimadzu GC-2014 was installed at the Central Instrumentation Facility and Services department.

Through the CSIR network, access to around 4183 e-journals was provided by the library to the staff and students of the institute. The databases such as Scopus, Scifinder, Proquest and Medicines Complete were added to the e-resources of the library.

Renovation of the Silver Jubilee Block to house the Nutra-Phyto Incubation Centre and Common Instrumentation Facility was undertaken.

Over 5000 visitors were handled by the Information and Publicity department comprising of students from schools and universities, entrepreneurs, farmers and officials. Audio, video and multimedia services were provided for institute seminars and invited lectures. Press and multimedia interactions were handled for institute functions as per the requirement. Photographic services were also provided to the project leaders, students and all the institute functions.

The Institute web site was revamped. Also a new VC room was created with the Polycom HDX 8000 – 1080p. Also the work towards Aadhar Enabled Biometric Based Attendance System (AEBAS) and the upgradation of campus network was initiated.

CSIR-CFTRI Stall during Yureka 2016

CSIR-CFTRI Stall at Pasumai Vikatan Agri-Expo 2016

Laghu Udyog Bharati-Karnataka Meet - Visit by Union Minister of State for Commerce and Industry, Smt. Nirmala Sitharaman to CSIR-CFTRI stall

Societal Programmes

Workshop on enabling specially abled

With an objective to give special persons an impetus to lead an independent life, the Central Food Technological Research Institute (CFTRI) organized a one-day workshop. Inaugurating the workshop 'Enabling the specially abled with CFTRI technologies', Prof. Sharat Chandra said that as per a survey conducted by the women and child department, the state has around nine lakh people with disabilities. "Of them, over 3.5 lakh are children under 19 years," he said. CFTRI director Ram Rajasekharan said there is a big change in the way people treat those with disabilities. "These days, they get more opportunities. Some of them are highly skilled. They make immense contributions to society. We should empower such people by making them independent and self-reliant," he added.

Participants at the workshop were given hands-on training in papad preparation, sambar powder making. Members from Mathru Mandali Shishu Vikas Kendra, Ashiana, and Mysore District Parents Association for Empowerment of Developmentally Disabled (MDPAEDD) participated.

Dakshin Bharat Mahila Krishi Jagriti Karyashala

A program to empower women farmers of Southern India was held at CSIR-CFTRI on August 19, 2015.

Farmers are the primary entrepreneurs of the world. The mission was to support a transformative process by addressing improved food security and nutrition security by empowering women farmers with knowledge on food processing. Developing food industries at farm gate levels is a key solution to foster sustainability and to help achieve inclusive and equitable growth optimizing agriculture and reducing post-harvest wastes.

The program encompassed demonstrations of various food processing technologies viz. sugar cane juice preservation, papad making, jam preparation and packaging of cereals. The program was attended by over 130 participants from across South India.

Indira Oinam, a social entrepreneur from Manipur and founder secretary of the Women Income Generation Centre, inaugurated the programme. In her address, she said the CFTRI should come up with programmes for empowering women from north-eastern States. State Sugarcane Growers Association president Kurubur Shanthakumar complimented the CFTRI for developing technologies that help sustain farmers' income. He suggested that the government need to introduce a scheme to provide loans at lower interest rates to encourage women farmers, similar to the one in China.

Prof. Ram Rajasekharan, Director, CSIR-CFTRI presided and spoke about the upcoming initiatives and importance of food security and nutrition.

Later, farmers had an interactive session with various government and semi-government agencies rendering specific information on finance and regulatory aspects among others.

Chennai Flood Relief

As Chennai city witnessed its worst flood in last 100 years, in the first week of December 2015, CSIR-Central Food Technological Research Institute, a constituent of Council of Scientific & Industrial Research based at Mysuru felt the urgency to act and render help to the those who are battered badly in the neighbouring state.

The Flood Relief Food preparations began on 3rd December at CSIR-CFTRI immediately after chalking out a detailed plan for preparing ready-to-eat food items

Participants from Workshop on Enabling specially abled at CSIR-CFTRI

Demonstration to women entrepreneurs during Dakshin Bharat Mahila Krishi Jagriti Karyasala

which is palatable to the people of the region. The food items included Imli Phoha- reconstitutable and ready-to-eat, Chapatis, Energy food, Sesame paste which is highly nutritious which can be consumed after smearing it on biscuits, Tomato curry, Mango Tokku, Gul Pavate- a traditional sweet, Roasted Masala ground nut etc. Similarly Buns, Rusks, Cup Cakes, Puffed rice and Corn flakes were sourced from our licensees to meet the time target. The operations were launched at multiple sites simultaneously with the Food Engineering Pilot Plant as the nerve centre. Other locations included the pilot plants of Fruit & Vegetable Technology, Protein Chemistry & Technology, Grain Science & Technology and Food Engineering Centre. Quality and hygiene were monitored at every stage of the food preparation. The entire Staff and students participated in the process of procuring, cleaning, cutting, roasting, seasoning, cooking, packing for the preparation of various food items. All the food items were packed with proper labelling with their shelf life and usage. Prof. Ram Rajasekharan, Director, CSIR-CFTRI steered the whole mission with his valuable guidance and direction.

As the people of Chennai were badly affected due to non-availability of drinking water, on the first day 8000 bottles (300 ml each) were arranged as part of the first consignment. The food packets included Chapatis (3000 packets of 2 numbers each) along with Tomato curry (3000 packets of 100g each), reconstitutable Impli-Poha (11500 packets of 100 g each), Buns (5500 packets of 2 each), Rusks (980 packets of 100g each), Cup Cakes (500 packets of 6 each), Cream Buns (575 packets of 2 each), Energy Food (600 packets of 25g each), Sesame Paste (600 packets of 10g each), roasted masala groundnut (6000 packets of 50 g each), Corn flakes (4950 packets of 50g each) etc. The first shipment of around 5 Tonnes of food items were made ready by mid-night 12.00 and the container truck was flagged off in the presence of large number of staff and students. A group of staff members separately also left for Chennai to assist in the local operations. Necessary arrangements were worked out with our sister laboratory, CSIR-Central Leather Research Institute (CLRI) at Chennai for ensuring the proper logistics and enabling the last mile delivery. The truck reached around 11.00

Team CSIR-CFTRI in the field during Chennai Flood Relief Operations

am next day at Chennai and immediately after that, distributions of food packets were started with the support of CSIR-CLRI Team .

The first day operations continued till early morning of the next day. Team CFTRI continued the second day operations and with the support of the local industry, water bottles, candles and match boxes were sourced. As we got the information from Chennai regarding the acute scarcity of drinking water, the second truck was loaded with water bottles, candles and match boxes. A total of 6000 bottles of 300ml and 19700 bottles of 500ml each, Candles (10000) and Match boxes (10000 nos.) were included in the second consignment.

The Third consignment included 20000 packets of Mango Tokku, Chapatis (5000 packets of 2 each), Buns (2954 packets with 2 each) , rusks (1139 packets of 100 g each), Cup cakes (2500 packets of 4 each), Energy food (2820 packets of 25g each), Sesame paste (1080 packets of 10g each), Biscuits (3000 packets of 50g each), Ready-to-eat Imli Poha (9500 packets of 200g each), Gulpavate (10000 packets of 50g each), Corn flakes (5050 packets of 50 g each) and Puffed rice (500 L). Also for the supply to Orphanages and relief camps, bulk packing (2 Kg each) of 70 packets of Tomato Curry was also made. Both the trucks left around 9.00 pm on 4th December for Chennai along with CSIR-CFTRI student volunteers.

Simultaneously another batch of 15000 Chapatis were arranged through one of our licensee at Coimbatore. Two consignments were transported on 4th and 5th of December for Chennai. And this consignment was redirected to Cuddalore after repeated requests were received from the District Administration. The logistics was worked out in collaboration with a local NGOs.

The final consignment was arranged on Dec. 5, 2015 in association with MTR Foods, an established market player in the traditional food sector from their Bengaluru Plant. The item included 14250 packets consisting of Sambar rice, Bisibelebath, Pongal, Vegetable Pulao. The items were transported to Cuddaloor district.

Altogether approximately 20 tonnes of food items along with 33700 Water bottles and other essentials were arranged by Team CSIR-CFTRI. The timely intervention by CSIR has helped large number of people affected by one of the worst crisis encountered in the recent past by the Chennai city.

All these food products were developed earlier by CSIR-CFTRI and successfully transferred to industry over a period. The products are certified as safe for consumption with adequate shelf life. To say about a few of the products, Tomato curry along with Chapatis were bulk supplied to Police force while combating the naxals in the Malanad (Western Ghat) region. Energy food was distributed to Anganwadis as part of the ICDS scheme implemented by various states. Sesame paste was developed as part of the malnutrition intervention through Anganwadis with the involvement of Karnataka Government. Also the sweet was added for the first time as a high energy food for the disaster operations. The ingredients of the sweet included Jaggiri, Ghee, Wheat, Dry coconut powder along with dry fruits. Our earlier experiences with Gujarat Earthquakes, Kargil war, Tsunami and Utharkhand helped to gear up to the challenges and intricacies of preparing the large volume of food in time at the time of national crisis.

In this process, we got the whole-hearted support from DG-CSIR and CSIR HQs in fulfilling the '***Mission Chennai Flood Relief'.*** Also some of the licensees of the Institute, local industry and well-wishers contributed immensely at the Hour of national crisis.

Village Adoption Programme at Puttegowdanahundi: Prof. Ram Rajasekharan, Director, CSIR-CFTRI addressing in a function arranged for launching the Papad Processing Unit

Village Empowerment Programme

Puttegowdanahundi, an agrarian village which is around 25 Km from Mysuru city was selected by CSIR-CFTRI for empowerment under the Rural Development programme. Initially, AcSIR doctoral students interacted with local people and devised a strategy for intervention with the participation of SHG, Farmers group and Teachers of Govt. Upper Primary School and Anganwadi of the village.

Awareness to farmers on new super food crops such as quinoa and Chia was held initially. Useful agrarian practises were shared by students and scientists with farmers for growing these crops successfully. Earlier, CSIR-CFTRI had facilitated a sustainable model for Chia cultivation in the Mysuru region. The Institute is trying to bring these farmers also under this arrangement.

There was no organised post-harvest processing in the village. A few of the housewives were involved in making Papads at their home and sold it to local shops and households. The Institute found an opportunity for empowering by establishing a Papad Manufacturing Unit. Training was arranged to two of the SHG Members in the Institute. A Leg operated Papad making (CFTRI design) and Dough Mixing machine were bought from the machinery suppliers. The team went around the village and suitable place was identified for establishing the unit.

A brief function was arranged on March 22, 2016 at Puttegowdanahundi, in which the machines were physically handed over to the SHGs by Prof. Ram Rajasekharan, Director, CSIR-CFTRI. The entire village consisting of farmers, Members of SHG, Teachers, Caretaker of Anganwadi, students, and village representatives were present.

Also Water filtration units, developed by CSIR-IMMT, Bhubaneswar, were handed over to representatives of School, Anganwadi and SHG in the function. The School was also provided with Laptops for enhancing the ICT education.

An Adulteration Test Kit was given to School for creating awareness in the children on food safety. Later CFTRI Team demonstrated functioning of the Kit to the children and Teachers of the School.

Awareness Programme on Food Hygiene to Street Vendors

Street foods account for a significant proportion of daily urban food consumption for millions of consumers in urban areas, representing the least expensive and most accessible means of obtaining a meal outside home. However, these street foods often do not meet proper hygienic standards and may lead to food-borne illnesses. The main objective of the present study was to assess the adherence to food hygiene practices and FSSAI guidelines by street food vendors in Mysuru city. Also effect of design, construction and maintenance of street food cart and their effect on food quality was assessed. The survey was conducted by AcSIR doctoral students of CSIR-CFTRI, Mysore.

Training to Street Vendors on food hygiene & safety

Vendors and Consumers were selected randomly for 9 zones in the city. In Each zone, 22 vendors and 22 consumers were interviewed with a questionnaire in Kannada. Overall it included 200 vendors and 200 customers, which is equal to 14% of number of street vendors. Major findings are listed below:

- The major serving from the carts included Chats such as panipuri, South Indian food like dosa, idli and Chinese items like gobimanchurian. The survey has also highlighted that only 6 % of food was cooked at home, 62% partially at home and the rest at the vending site.
- Preference is found more for vegetarian dishes at the vending cart.
- The street vendors expressed that cart used by them is very inadequate as it involves lot of physical labour. This is the area which needed lot of attention
- 52% of the vendors used water from the supply of Municipal Corporation and 15% from mineral water. Rest 33% was sourced from borewell. The customers expressed preference for mineral water and usage of ecofriendly plates.
- Around 75 % of the vendors displayed food without covering which is a major area of safety concern.
- Majority of the food vendors are found too close to thoroughfare, which exposes food to dust and particulate matter.
- Consumers expressed that the proposed food zones by Corporation can address these issues for evolving a better and hygienic surroundings for street vendors.
- Further more awareness regarding hygienic practices and FSSAI rules are suggested by street vendors

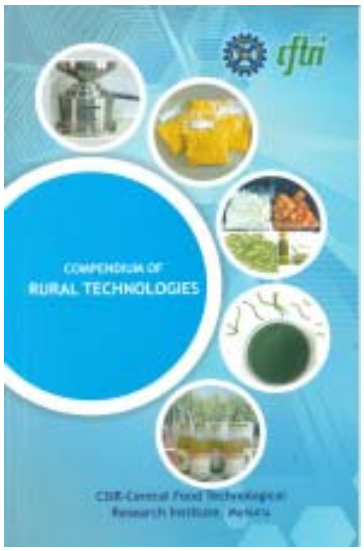
A half-a-day workshop, "**ENSURING SAFE STREET FOOD IN INDIA'S CLEANEST CITY**" was organized on March 17, 2016 at the Institute. The participants, around 100 of them, are provided with a basic kit consisting of apron, gloves, caps, sanitisers along with relevant information booklet. The workshop was aimed at shedding light on issues such as the common problems faced by street vendors, maintenance of hygiene in and around the vending spots, empowering street vendors with basic knowledge about food safety and so on. The programme was inaugurated by Dr. C.G. Betsurmath, Commissioner, MCC and presided over by Prof. Ram Rajasekharan, Director, CSIR-CFTRI, Mysuru.

Speaking of the workshop, Prof. Ram Rajasekharan stated that CSIR-CFTRI would like to impart its scientific knowledge and expertise for ensuring clean, safe, nutritious and affordable street food in Mysuru city by creating awareness and disseminating basic and essential knowledge to street vendors, making them responsible food handlers, especially in the context of the city having been declared as the cleanest city in India for the two consecutive terms.

Compendium on Rural Technologies

A Compendium on Rural Technologies was brought out. CSIR-CFTRI involved post-harvest technology R&D has large number of technologies under the broad areas such as Fruits, Vegetables, Bakery products, Cereals and Pulses, Spices, Nuts and Oilseeds, Poultry and Meat and other miscellaneous items. These post-harvest technologies outlined will be helpful to entrepreneurs and Farmers Produces Companies.

The Raitha Mitra Farmers' Producers Company Ltd. wanted to join hands with the country's premier food



laboratory, the Central Food Technological Research Institute (CFTRI) in Mysuru, for research and promotion of seeds grown by farmers.

CFTRI and Raitha Mitra signed a memorandum of understanding (MoU) with Nutriplanet Foods Private Ltd. for a collaborative effort to explore the scientific progress in nutraceuticals and taking up research in the field.

Under this MoU, Raitha Mitra agreed to supply the seeds of Chia and Quinoa to Nutriplanet Foods and CFTRI will transfer the technologies for the preparation of high energy foods to the firm.

Outreach activities

- Farmers from Tamil Nadu visited CSIR-CFTRI to explore farm gate food processing techniques for their produce (July 2015).
- CSIR-CFTRI in partnership with Karnataka Council of Technical upgradation (KCTU), Govt. of Karnataka organised 2-day empowering workshop on Aug 25-26, 2015 at CFTRI with the participation of Simhasakthi Okkuta from Sirsi. A total of 40 participants were trained on the processing of value added products from jackfruit, banana and Kokum fruits.
- Exposure Visit of Farmers to CSIR-CFTRI from Andhra Pradesh Community Based Tank Management Project (APCBTMP), Govt. of AP on Feb 11, 2016 for familiarizing with post-harvest technologies.
- Sevabharathi Shikshana Samsthe Team from Chamarajnagar Dist. (Karnataka) held an interaction on Feb 18, 2016 for creating a sustainable model for rural-agri enterprises jointly at their place. Prof. Ram Rajasekharan, Director, CSIR-CFTRI and Ms. Chaya Nanjappa, MD, Nectar Fresh were present.
- A Team from Vanavasi Kalyana, an organisation working in the area of tribal development in the state visited and interacted with CFTRI team for planning and initiating various outreach programmes in the area of pre- and post-harvest processing in selected villages.

Valedictory function for the participants of the training programme sponsored by Karnataka Council of Technical Upgradation (KCTU)

Members of Sevabharathi Shikshana Samsthe at CSIR-CFTRI

Members of Vanavasi Kalyana in an interaction with Team CSIR-CFTRI

Progress Under
R&D Projects

VALUE ADDITION TO AGRICULTURAL RESOURCES

Ganoderma sp. for pharmaceutical applications *(Manonmani HK)*

Ganoderma sp. was grown in laboratory by SSF and SmF techniques. The fruiting bodies and mycelia were harvested and bioactives extracted in mycelia and fruiting bodies using different solvents. Bioactives were then screened on few food borne pathogens for antimicrobial activity. The fruiting body extracts showed better antimicrobial activity compared to mycelial mass. From the fruiting bodies, polysaccharide was isolated, purified and characterized. Polysaccharide was screened for anticancer activity *in vitro* against gastric cancer cell lines (AHS). The isolated polysaccharide also exhibited anti-inflammatory and fibrinolytic activities. The *Ganoderma* powder was used in few food formulations such as chocolate, ice cream, coffee and was found to be sensorially acceptable.

Freshness keepers for the extended shelf-life of mung sprout (*Vigna radiata*) *(Sathish HS)*

Guava leaves *(Psidium guajava)*, colocasia leaves *(Colocasia esculenta)* and gooseberries *(Ribes uva-crispa)* were collected from the orchard, dried, powdered and extracted using water and ethanol separately. The GC-MS analysis was conducted to identify the active components in the freshness keepers. The freshness keepers were then tested for its antibacterial activity against *Micrococcus, E. coli, Listeria, Salmonella, Staphylococcus aureus, Psuedomonas, Bacillus cereus, Klebsiella.* Shelf life studies of the sprouts were carried out using freshness keepers. The sprouts were kept at room temperature and at 7°C. The shelf-life was evaluated based on the physical appearance, and also by checking for any visible microbial growth. The extracts contained certain active compounds like the squalene, caryophyllene, oleic acid, 2-pentanone-4-hydroxy-4-methyl which are proved to have antimicrobial effects. The sprouts kept along with the infused filter paper kept at room temperature showed the shelf-life was same as that of the control and the ones kept at 7°C showed an increased shelf-life ranging from 9-14 days.

Nanoginger incorporated films for food packaging applications *(Sathish HS)*

The work focused on the preparation of nanoginger particles and evaluation of its particle size. Efficiency of ginger and nanoginger particles in terms of microbial inhibition was compared and biodegradable film using methyl cellulose incorporated with nanoginger particles was prepared and its mechanical properties were evaluated.

The fresh ginger rhizome was surface sterilized, sliced and dried at 50°C in ventilated oven. Dehydrated ginger was powdered and used for further studies. Known quantity of ginger powder was extracted using solvent system comprising of 60% water, 20% ethyl acetate and 20% chloroform. Ethyl acetate and chloroform were removed using flash evaporation. The obtained ginger extract was homogenized using high speed homogenizer. Homogenization was followed by ultra-sonication. Ginger nanoparticles were successfully synthesized by ultrasound method at 70% amplitude in water. The films were prepared by wet casting of the aqueous solution containing methyl cellulose as the main polymer, water as the solvent and glycerol as plasticizer. Films were prepared with various concentrations of ginger nanoparticles. The solutions were poured on a glass plate covered with teflon sheet and dried in ambient temperature.

The nanoginger particles synthesized by ultrasonication method had lower particle size (0.035 μm) when compared to the nanoparticles synthesized without ultrasonication (0.775 μm) and aqueous ginger solution (1.673 μm). Ginger nanoparticles showed efficient anti-bacterial activity against *E. coli*, *S. aureus*, *Salmonella* and *Listeria*. No inhibition was observed on the control. Little or no inhibition was found in the aqueous ginger powder solution. Ginger powder in solvent system with and without ultrasonication showed good inhibition zone. The best results were observed in the ginger solution with ultrasonication. Thus, it is evident that ginger nanoparticles are more efficient than ginger. After the incorporation of ginger nanoparticles into methyl cellulose, the tensile strength increased from 8.3 N/mm^2

(Blank MC film) to 25.5 N/mm^2, and elongation % increased from 9.4% to 21.47%. This showed that there is an increased interaction between nanofillers (ginger nanoparticles) and the polymetric matrix of methyl cellulose.

Functional attributes of green tamarind and wild apple *(Ng Iboyaima Singh)*

Shelf-life extension of fresh tamarind: The objective was to optimize the pre-treatment concentration and storage conditions on the shelf life extension and post-harvest quality maintenance of fresh tamarind. Optimally matured fresh pods of tamarind (9-10^{0}B) tamarind (var. local) were pre-treated with solutions of calcium chloride (0.25%, 0.50%) and phenyl acetaldehyde (500 ppm) as dip treatments for 15 minutes and were stored along with untreated control fruits at different conditions (LT 4±1^{0}C); 90-95% RH and RT (29±1^{0}C); 75-80% (RH) storage conditions. Results on RT and LT storage studies indicated that tamarind responded very well to calcium chloride at both levels (0.25%, 0.50%) in terms of retention of fruit quality parameters (color, texture, ascorbic acid, and other quality parameters, with effective storage life of 28 and 14 days respectively at optimum LT (4±1^{0}C; 90-95% RH) and RT (29±1^{0}C; 75-80% RH) storage conditions as against 14 and 7 days in untreated controls in LT and RT storage conditions respectively.

Processing of green tamarind into value added products: Green tamarind pods were washed in water. Pulp, peel and seeds were separated. It was analysed for the chemical compositions. Green tamarind pods were found to contain high acid content (4.0% as tartaric acid) and TSS 6.2%. The pulp from green tamarind was extracted by the optimized method. Ready-to-serve beverages were prepared from green tamarind pulp. These samples were analysed for chemical composition and conducted storage studies at RT conditions. The data indicated that the beverages containing tamarind pulp up to 15% level was acceptable till three months with excellent sensory quality attributes. The tamarind bar and tamarind sauce were also prepared and analysed for chemical analysis. The storage studies indicated that the green tamarind bar and sauce were acceptable for three months at RT conditions.

Wild Apple: The fruits procured from Manipur and Nagaland States were analysed for its proximate composition and other bioactive compounds. The fruit was highly acidic and it was observed that the immature *D. indica* fruit extracts had high concentration of total phenolics and flavonoids, and they exhibited higher antioxidant activity in DPPH and FRAP assay. Although no definite trend was seen in antibacterial activity assay, extraction with mixture of methanol, acetone and water showed higher antibacterial activity against tested bacteria. However, their potential as antifungal agent or antiviral agents need to be studied, as *D. indica* fruit extracts are rich in various phenolic compounds, which are known to be good antiviral agents. The antioxidant and antibacterial compounds present in various extracts of *D. indica* showed its potential for utilization as food preservative, however their behaviour in food system needs deeper study.

Products like dried slices, candy, preserve, IMF and juice were developed. Apart from these, other products like wild apple sweet and spicy thokku, wild apple chutney powder, wild apple halwa, wild apple pickle and wild apple gravy were also developed in lab scale. The products were found to be good in taste and acceptable in overall sensory quality.

Intermediate moisture food from wild apple: An intermediate moisture product was developed from wild apple by soaking the segment in a solution and further drying in a cross flow air drier. There were no significant changes in water activity and acidity in all the samples stored at different temperature up to 30 days.

Osmo-dried wild apple slices: Process conditions like type of solute, solute concentration, slices to solute solution ratio, incubation temperature and drying time were optimised for the preparation of osmo-dried wild apple slices. Based on the trials carried out, it was observed that formulation comprised of hypertonic solute concentration (60°Brix) along with 0.25% citric and 1000 ppm SO_2 was found to be adequate for good quality osmosed wild apple slices. Thereafter, the osmosed slices were dried at 65°C till the moisture content reached 13-14%. The yield of the final product was 28-30% based on prepared weight basis. Storage studies revealed that the product had 4 months shelf-life with good sensorial acceptance.

Concentrate spicy beverage from Wild Apple Aqueous Extract (WAAE): Process conditions were optimized for the preparation of concentrated spicy beverage (65°Brix and 1.5% acidity) from wild apple aqueous extract (WAAE). The concentrated spicy beverages with the addition of WAAE (as per batch size), required concentrations of spices (cumin, black pepper and red chilli), sugar, salt, and citric acid were prepared, pasteurized and filled in PET bottles. The optimized concentrated spicy beverage can be diluted with pre-chilled water in the ratio of 1:5 before consumption to get 13°Brix and 0.3% acidity in the beverage (ready-to-drink). The storage studies of the packed (PET bottles, 200 ml capacity) concentrated spicy beverage revealed

that the product has good sensorial acceptance even after six months at 27°C.

Shelf-life extension of mangoes *(Gothwal PP)*

Development of pre and post-harvest protocol for mango vars. Dasheri and Langra for export by ship: Pre and post-harvest treatment of *Dashehari* and *Langara* has been done for one season at RC Lucknow. At least 3 seasons are required for optimization of process parameters. Results indicated 21 days (var. *Langra*) and 25 days (var. *Dashehari*) of storage life at 12-13ºC with $CaCl_2$ treatment. In terms of shelf-life extension, 10 days for var. *Dashehari* and 8 days for var. *Langra* was observed. The shelf-life period was not sufficient for export, hence, confirmation of results and further improvement in extension of shelf-life is required. Spoilage is reduced by 25% in both the varieties. Ripening was normal after storage period and the sensory parameters were normal and scored excellent.

Composite processed fruit products
(Shashirekha MN)

Composite formulations were developed based on mango, banana, papaya, bitter orange, pomelo fruit juices along with xanthone extract of mangosteen fruit excarp. Spectrum of composite fruit products were developed like beverages, osmo-dried and spray dried products. Retention of ascorbic acid, limonin, naringin, hesperidin, β-carotene and xanthones were evaluated, which on HTST operation was found relatively high. Bitter orange fruit fractions that demonstrated anti-obesity activity (pancreatic lipase inhibition) and pomelo fruit fractions that displayed anti-diabetic property (inhibition of α-glucosidase, α-amylase and amyloglucosidase) were used for the development of these products. Structural elucidation of anti-diabetic component was spelt out as naringin.

Native wine yeast cultures for the production of Indian wine *(Anu Appaiah KA)*

Pomegranate arils were juiced and fermented with native isolates. Two sets of experiments were performed, one with only yeast and other with a combination of yeast and bacteria for a period of 7 days. Samples were withdrawn at regular intervals for analysis. Microbial growth dynamics was monitored by the serial dilution method. There was no significant difference between the two systems with respect to total reducing sugars, alcohol content, and total polyphenol, though the polyphenol content had reduced in comparison to must/ juice and the total alcohol was approximately 13% in both the wines. Alcohol composition of these two wines was analyzed. HPLC analysis was carried out for analyzing the sugar and organic acid composition in the wine and juice. Organoleptic analysis indicated that the wine obtained by co-inoculation with yeast and bacteria had a higher overall rating than the one with only yeast.

Clarified banana juice was obtained from banana pulp by pectin digestion using pectinase. The banana juice had an initial Brix of 22-24 and pH of 4.4-4.5. The pH of the juice was adjusted to 3.6 with 25 mM tartaric acid. Clarified banana juice was inoculated with a native yeast culture KTP along with 0.05% ammonium sulphate. Fermentation was carried out for about 21 days. Fermenting must was sampled during an interval of 5 days. Microbial growth dynamics was monitored by serial dilution method which showed complete absence of lactic acid bacteria. Total polyphenol content was 1.1 mg/ml in the juice which reduced to 0.94 mg/ml by the 21st day of fermentation.

Shelf-life extension of meat and meat products *(Sachindra NM)*

Studies were carried out to evaluate the oxygen scavenging ability of the mixture containing acid and alkaline salts along with a moisture absorber. Initial studies with a mixture of ascorbic acid or citric acid, sodium bicarbonate, sodium carbonate and gum acacia indicated that the oxygen level in the glass vials could be brought down by 40-98% depending on the amount of mixture used. The oxygen scavenging ability of the mixture was activated by injecting the water into vials containing the mixture. The oxygen scavenging ability of mixture containing citric acid was higher than the mixture containing ascorbic acid. When the experiments were carried out in 100 g metalized polyester pouches, it was observed that the oxygen levels in the pouches were reduced by 30-70%. However, in the mixture containing citric acid, the bulging of pouches was observed due to release of CO_2. Hence, the experiments were carried out with a mixture containing both ascorbic acid and citric acid, and it was observed that the oxygen level in the pouches reduced by 66-92% depending on the amount of oxygen scavenging mixture used. In order to further reduce the CO_2 level in the packs and to avoid bulging of packs, a CO_2 absorber ($Ca(OH)_2$) was added to the mixture and evaluated. By addition of $Ca(OH)_2$, the CO_2 level in the vials was brought down from 78% to 40%. The formulation of oxygen scavenger with ascorbic acid: citric acid: sodium bicarbonate: sodium carbonate: calcium hydroxide: gum acacia was standardized. The oxygen scavenging of the formulation was evaluated for shelf life extension of minced chicken meat at refrigerated temperature. It was observed that the lipid oxidation level

and microbial load was lower when oxygen scavenger formulation was used.

Eggs coated with extracts from *Aloe vera* gel for shelf-life extension was studied. They are highly perishable and can lose their quality rapidly if not treated and stored properly. Presently eggs are coated with whey protein isolates, mineral oils and chitosan. *Aloe vera* extracts were used for coating of eggs. Mucilaginous gel extracted from *Aloe vera* was diluted with water in different ratios. These gels were used for coating of eggs with or without plasticizer. *Aloe vera* gel with 1:3 dilution with water enhances the shelf-life of eggs even up to 5 weeks of storage. Addition of glycerol as plasticizer resulted in egg with Haugh unit of more than 60 even after 5 weeks of storage.

Chitosan based coating formulation *(Harish Prashanth KV)*

Scale up studies with respect to the shelf-life of Alphonso mango was done up to 700 kg level capacity in 2015 season at Devgad, Maharashtra. The current study was conducted to investigate the shelf-life extension of mangoes using chitosan based formulation on different quality parameters. Standardized chitosan-based coating (with additives) was used to delay ripening and achieved prolonged shelf-life of Alphonso mangoes stored at room temperature (29±2°C) for ~10 days. The data revealed that applying of chitosan coating effectively prolongs the quality and improves the sensory attributes with the extension of the shelf-life of mango. Coating decreased the incidence of microbial spoilage of fruits too.

Scale up shelf-life study of Alphonso mango

Bioactive properties of irradiated bran from different rice varieties *(Jayadeep A)*

For pigmented, red rice bran 0.4 kGy and 1 kGy showed 3 and 5% significant increase respectively and 2 kGy showed no change in soluble polyphenols compared to control value. In case of bound polyphenols, retention at 0.4 kGy, 1 kGy and 2 kGy was 91, 83 and 80% respectively. In the red rice bran, results showed that 0.4 kGy showed no change, but on increasing the dose concentration (1 kGy, 2 kGy) retained 87 and 83% of total flavonoid content. Total oryzanol content retention was 76-100% at different doses. In case of total antioxidant activity, red samples at 0.4 kGy irradiation showed no change, whereas further increase in dose (1 and 2 kGy) retained 93 and 91%. In pigmented red rice bran samples, γ-irradiation showed no change in scavenging activity and resulting 100% retention. After the application of gamma radiation to pigmented jyothi samples at doses 0.4, 1 and 2 kGy, the reducing power retention was 110-114%. Black rice bran retained 96 and 90% of soluble polyphenols on exposure to 0.4 kGy, 1 kGy doses and 2 kGy showed 3% significant increase to control, whereas in case of bound polyphenols 0.4 kGy showed 2.7% increase, 1 kGy and 2 kGy retained 94 and 90% respectively compared to control. Total flavonoid at 0.4 kGy showed no change, 1 kGy retained 90% to control value whereas 2 kGy showed no change. Total anthocyanin content on exposure to 0.4 kGy results in 7.4% increase, 1 kGy results in 21% loss and 2 kGy showed 7% increase compared to control. In black irradiated samples, retention of total oryzanol content was in the range 88-110% as compared to non-irradiated samples. Total antioxidant activity in black irradiated samples showed no change on exposure to 0.4 kGy, whereas 1 kGy retained 90% and at 2 kGy, content was comparable to the control. 0.4 kGy and 1 kGy result in loss of DPPH activity and retained 86 and 73% respectively of free radical scavenging activity whereas 2 kGy exposure resulted in 89% retention compared to normal.

Irradiation of turmeric *(Madhava Naidu M)*

Rhizomes were dried using cross flow dryer at 55^{0}C± 5^{0}C for 3-4 h to reduce the moisture up to 10-12%. Dried rhizome was subjected to hammer mill using the 0.77 mm sieve. Samples of dried turmeric rhizome and powder (-30 mesh) were also packed in metalized polyster polythene laminated pouches. The packed rhizome and powder samples were loaded into the irradiation chamber separately and exposed to an irradiation dosage of 0, 2, 4, 6, 8 and 10 kGy to optimize the dose level. Samples were packed in the same packaging material but without irradiation served as control. After irradiation all the samples were analyzed for physical chemical and microbial quality. The samples was studied for their microbial load and quality parameters namely curcumin, moisture, volatile oil and oleoresin content. Also, the volatile oils distilled from both irradiated and control samples were analyzed to find the effect of irradiation on volatile oil constituents. The quality of turmeric rhizomes and powder was assessed.

Colour of powder, determined using the principle of reflectance indicated marginal changes in colour parameters such as hue, chroma and brightness. The extracted colour (curcumin), oleoresin and volatiles were also determined, and were subjected to further analysis using GC and GC/MS to ascertain the effect of irradiation on volatile oil constituents. The volatile oil, curcumin and oleoresin in turmeric powder were 3.0%, 2.6% and 8.4% respectively when it was treated with 10 kGy. The irradiation dose did not show any marked changes in volatile oils and curcumin contents in turmeric powder. The microbial load decreased from 10^6/g to about 3 x 10^2/g at a dose rate of 10 kGY while pathogens (coliform) were eliminated at dose rate of 6 kGy.

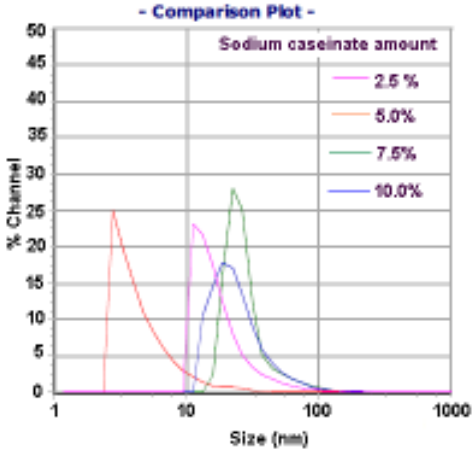
Water solubility of curcumin: Native curcumin, Native curcumin with 5% and 10% sodium caseinate dispersed in TD water

Nano-encapsulation of curcumin *(Pooja J A Rao)*

It is quite common to use inorganic/organic solvents during the encapsulation of curcumin. Therefore, it is not suitable to realize the food applications of this bioactive compound. In the present work, the objective was to employ a solvent-free green chemistry approach to encapsulate curcumin in nano-form. The milk fat was used as oil medium and the milk protein sodium caseinate as a wall material. Varied concentrations of wall material were systemically studied and the transmission electron microscopic images confirmed the particle size of spray dried powder to be in the range of 40-250 nm. The encapsulation efficiency was calculated to be 91% and loading capacity was 0.9% with respect to 0.99% theoretical loading for the sample having an optimum amount of 5% of wall material. The antioxidant activities of this nanoencapsulated curcumin were found to be higher than its native counterpart. The nanoemulsion/ nanocurcumin powder have been evaluated for its stability at gastric pH 2 and intestinal absorption at pH 7.4, higher antioxidant, antimicrobial and quorum sensing attributes than native curcumin for applications as nutraceutical foods.

Fish processing waste oil for biodiesel production *(Tanaji Kudre)*

Fish oil was recovered from marine fish processing waste (viscera, head, skins, frame, etc) using wet reduction (cooked at 70^{0}C for 45 min), acid ensilage (5% formic acid, 2% NaCl) and solvent method (waste: hexane, 1:3 w/v). The highest oil yield from marine fish waste (93.3%) was obtained by wet reduction method in which minced fish waste was added with water (1:1 w/w) and cooked at 70°C for 45 min. Oil recovered from marine fish waste and obtained from marine fish processing plant was used for biodiesel production through the trans-



Comparison of particle size of NC samples with varying amounts of sodium caseinate

esterification reaction. Various alcohols (methanol, ethanol, 2-propanol and butanol) and catalysts (NaOH, KOH, CaO and MgO) at different levels, reaction temperature and reaction time were evaluated for biodiesel production. The maximum yield of biodiesel (92.9%, v/v) from oil recovered from marine waste was obtained at 1% KOH, 1:1 oil to methanol ratio, 60°C reaction temperature, 90 min of reaction time and 200 rpm stirring rate. Whereas, oil from marine fish plant showed maximum biodiesel yield (96.3%, v/v) at 1% NaOH, 1:1 (v/v) oil to methanol ratio, 50°C reaction temperature, 60 min of reaction time and 200 rpm stirring rate for flask level. Glycerin is the major waste byproduct of biodiesel production which was purified using sulfuric acid (H_2SO_4), hydrochloric acid (HCl) and phosphoric acid (H_3PO). HCl was found to be the best purifying agent and gave 94.6% and 90.4% purity in glycerol derived from marine and fresh water fish oil biodiesel production respectively. Physicochemical properties of fish oil obtained from fish wastes, biodiesel from fish oil and glycerin recovered from the byproduct of biodiesel production were studied.

Value addition of nutrient and micronutrient dense millets *(Jyothirmayi T)*

Bakery biscuits and cakes were prepared with the millet flours, ragi, korra, jowar and bajra with 15% bakery fat and 25% sugar. Vermicelli and noodles were prepared using millet flours and Bengal gram flour (20%) replacing maida to yield gluten free products. Bajra noodles were prepared with urad and sago at 20% level. Extruded soup sticks, multi grain extruded product was developed with cereals, millets and pulse combination. Instant breakfast upma ready mix with millet sojis was prepared and evaluated. Popped grains were prepared using jowar and bajra and the popped ones were incorporated into chocolates for making puffed millet incorporated confectionery products.

A gongura spice mix formulation (GSM) with 25% gongura leaf powder to yield an acceptable sprinkling powder for fried corn chips was standardised. GSM was stable for 6 months without affecting the overall acceptability. Gongura paste and chukka kura pastes were found to be stable and microbiologically safe after 6 months. The antioxidant activity of fresh and dehydrated leafy vegetables of *Hibiscus cannabinus* (gongura), *Rumex vesicarius* (chukka kura), *Basella rubra* (bachali kura) and *Alternanthera sessilis* (ponnaganti kura) was evaluated. HPLC analysis of the leafy vegetables was carried for quantification of organic acids using reverse phase C18 column with a mobile phase of 0.002 N sulphuric acid (2 pH). It was found that all the leafy vegetables were rich sources of oxalic acid.

Value added products from pumpkin
(Sathiya Mala K)

Studies were carried out to optimize different pre-treatments for the preparation of pumpkin flour in order to incorporate to extruded products. Quality characteristics of pumpkin flour affected by pre-treatments during storage were studied. β-carotene rich muffins were standardised with application of pumpkin flour at different levels and 20% was found to be acceptable.

Instant pumpkin soup cubes with enriched β-carotene was developed, which can be instantly reconstituted in hot water. Vermicelli, noodles and pasta was prepared by incorporating pumpkin flour at different levels and 10% was found to be acceptable in all the three extruded products. Pumpkin pulp was used in the preparation of pumpkin-maize and pumpkin-ragi flakes by drum drying. The flakes were incorporated in the preparation of kulfi, which was found organoleptically acceptable.

Processed products from underutilized fruits/ vegetables *(Gothwal PP)*

Standardized various value added products such as fresh juice, fruit drink with 10% pulp, RTS-beverages, herbal jam and jellies, pectin, vegetable curry, pickles, canned/ dehydrated slices from underutilized wild plum, galgal, lasoda and kadwa karela grown in UP and Uttaranchal as per the FPO/FSSAI specifications. The nutritional profile analysis (with or without added herbal based micronutrients and nutrients) of these products showed significant levels of essential micronutrients and nutrients. The storage studies of these products at room temperature 7°C and 37°C indicated no significant changes with respect to TSS, acidity, total sugar, minerals, vitamin C, fruit fibres and aroma after nine months of storage. The products were evaluated for sensory evaluation at various intervals.

Beverage concentrate/ paste of various fruits in collapsible tubes *(Shailaja R)*

Five different beverage concentrate/pastes (Totapuri mango, pineapple, strawberry, guava and mixed fruit and vegetables) were enriched with natural sources of β-carotene and minerals such as carrot, sweet potato and brown sugar respectively (9 variations). Based on sensory scores, colour and viscosity, studies were carried and the products were finalized. The finalized products were prepared and filled in the collapsible tubes and storage studies were carried out. Nutritional

labelling, microbiological and â-carotene analysis of the standardized products are under progress.

Value added products from underutilized rhizomes *(Madhava Naidu M)*

New crop sources including *Zingiber zerumbet,* which is native to India and they are stem less herb with long fleshy fibrous roots, terminating in oblong tubers. Rhizomes were dried, powdered and starch was isolated. Proximate composition such as moisture, ash, fat, crude protein, sugars and starch content in *Zingiber zerumbet* starch were determined.

The shapes of the granules were disc-shaped as well as ovoid and average granule size was 26.15 - 3.5 μm in length and 16.9 - 4.8 m in width with a thickness of about 3 m. The extracted starch was analysed for moisture 12.5%, protein 1%, fat 1.48%, dietary fibre insoluble 7.44% and soluble fibre 1.25%. It contains 81% starch by DNS method and amylose content in this starch is about 31±0.95%. The pasting and thermal property analyses showed that *zerumbet* starch having high gelatinization temperature (88-95°C) would constitute as a satisfactory texture agent for foods. Functionality of *zerumbet* starch is being comparable to those of other tuber/ rhizome starches.

Value added products from green coffee *(Pushpa S Murthy)*

Green (raw) coffee is a major source of CGA in nature (5-12 g/100 g) with potential health benefits for consumers. Green coffee extraction and antioxidant rich conserves were prepared using Robusta cherry coffee beans which are low grade coffee and generally used for instant and commercial blends. The coffee were ground and sieved (<720 m), using a hammer mill and pre-treated with steam for 20 min at 121 lbs pressure. Further the samples were defatted, decaffeinated and dried. The decaffeinated samples were extracted for polyphenol enriched extract using aqueous solution. The pre-treated green coffee extract yielded two folds compared to the untreated samples with 20% total polyphenols. The extracts contained major compound as chlorogenic acids in the ranges of 32±5% and less than 3% caffeine. The green coffee extracts from Robusta exhibited 90% antioxidant activity on evaluation by 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assays. Optimized extraction and GRAS solvents enable potential application of green coffee extracts for use in food formulations and beverages. Value added products such as caffeine obtained during the process can be minor processed and used for commercial purpose. Also, green coffee oil/fat (10%±5) is a rich source of valuable bioactive phytochemicals and antioxidant activity.

Dehulling of niger seeds *(Sridevi A Singh)*

An improved method for dehulling of niger seeds has been developed with dehulling efficiency of >90% compared to ~65% in the earlier process. The step of gravity separation was removed effectively and a dry method for separation of hull from kernels was introduced. The hull is rich in polyphenols and other pigments. In order to value add to the nigerseed, pigments from the hull were recovered and characterized. They were brown in colour and stable against UV light as well as in the dark. Some loss was seen (~15%) when exposed to sunlight for 48 h. The FT-IR, NMR spectra revealed that the pigments were complex in structure. The yield and recovery were quantified. The study would help to value add to nigerseed, an indigenous seed crop of India grown by the small and marginalized farmers of our country in rain fed regions.

HEALTH FOODS & NUTRACEUTICALS

Multigrain semolina mixes *(Suresh D Sakhare)*

The process for production of semolina from cereals, pluses and millets were standardized. Response surface methodology (RSM) was used for the optimization of milling process by varying break system (Design Expert, Version 9). Grains were milled at different break roll gap using the two breaks (B1 and B2) system with 13 variable adjustments provided by the software. Roller milling technology for the production of semolina showed yield of 95% semolina from the husked millets and pluses. The produced semolina from different grains were evaluated for the physico-chemical, rheological and functional properties. Different multigrain semolina blends were prepared and the studies on its product making properties are in progress.

Functionally improved bakery, traditional and pasta products *(Prabhasankar P)*

Multi whole grains were ground to produce nutritious multiwhole grain flours. The effect of this formulation on physico-chemical, rheological and chapati quality characteristics were studied. Development of nutri health mix using a combination of millet, fruit and vegetable powders, vitamin and mineral mix bread making showed that 10% was optimum in bread. In order to increase polyphenol content in bread, wheat bran was added at different 0-20% levels and nutritional evaluation was carried out.

Studies on high protein and high fibre eggless cake were carried out. Modification of whole wheat flours by heat treatment showed reduced immunogenicity against gliadin. These flours were used in bread and chapati making and immune validation was done using ELISA.

Buck wheat and sorghum flour were used in the production of high fibre pizza base. Hydrocolloids and emulsifiers were used to improve the quality of pizza base made with optimized grain blends. *Centella asiatica* leaves were used in the preparation of cookies. Nutritious wheat and chestnut flour based pasta has been developed.

Finnish-Indian ingredients for improving food safety and health *(Akmal Pasha)*

The supercritical fluid CO_2 extracts from Flavex (lemon myrtle, curcuma, fennel, ajowain, thyme, clove bud, basil, schisandra, garlic, cinnamon bark, oregano, margosa, licorice, hop, sage and rosemary) were found to have repellency against the stored-product insects, *Rhizopertha dominica, Tribolium castaneum*, *Sitophilus oryzae*. These extracts were effective against all the three insects which were denoted by the class of repellency attributed to the extract by standard formulae. The extracts showed Class V repellency against *Tribolium* which meant that these extracts repel up to 80% of insect population away from the extract. *Sitophilus* and *Rhizopertha* were also repelled by the extracts but not to the extent seen with *Tribolium.* The essential oil samples procured from market were previously assayed for observing insecticidal activity which gave the mortality but the levels used were very high. They were further assayed at permitted levels by fumigation assays. Some of the oils (clove leaf, cumin, caraway, nutmeg, ajowain, oregano, basil, lemon, thyme and mint) were selected based on the acceptance along with the food and the mortality caused. LC_{50} and LC_{90} values were determined for those selected oils and the results showed that these oils can be used as fumigant compounds.

Locally procured plant based extracts were assayed against *S. oryzae* to find the insecticidal activity which did not show any mortality. Later these powders as such were used in 0.25 and 1% along with wheat in culture tubes. 1% Boswellia extract along with wheat showed up to 70% insecticidal activity. Guggul and coleus extracts at 1% also showed insecticidal activity. At 0.25% all the powder extracts were not as efficient as at 1%. Coleus 1% extract was also efficient in reducing the F_1 generation compared to the control.

A. ochraceus, A. flavus, A. niger, F. oxysporum, P. thomii, P. verrucosum, A. parasiticus were procured from MTCC. Flavex extracts were effectively used against almost all these fungi. Ajowain and thyme were effective in inhibiting growth of almost all the fungi used, whereas curcuma extract was least effective.

Health promoting exopolysaccharide *(Prapulla SG & Prakash M Halami)*

Three native isolates were investigated for biosynthesis of exopolysaccharide (EPS). *Pediococcus lolii* and *Lactobacillus plantarum* strains (n=2) and the sub-species of *Lactobacillus* were confirmed by *recA* multiplex PCR assay as *L. paraplantarum* (SL209) and *L. pentosus* (SK31). Simultaneously, co-polymers were analysed using HPLC, which revealed the heteropolymer polysaccharide with repeats of rhamnose and galactose. Genotyping of key enzymes in EPS production using gene specific primers, revealed the presence of glycosyltransferase (GTF), dTDP-glucose hydratase and dUDP galactose 4 epimerase.

Further the expression of GTF gene in the presence of different sugars was investigated. Expression of GTF gene was found to be 1 to 3 folds more in lactose compared to sucrose in *P. lolii* A4 and *L. paraplantarum* SL209. In this study, the heteropolymer-EPS of rhamnose and galactose by native isolates was reported. The study could also show the impact of sugar substrate on gene expression as a measure of metabolic activity.

Nigerloxin, an aldose reductase inhibitor from *A. niger* *(Avinash Sattur)*

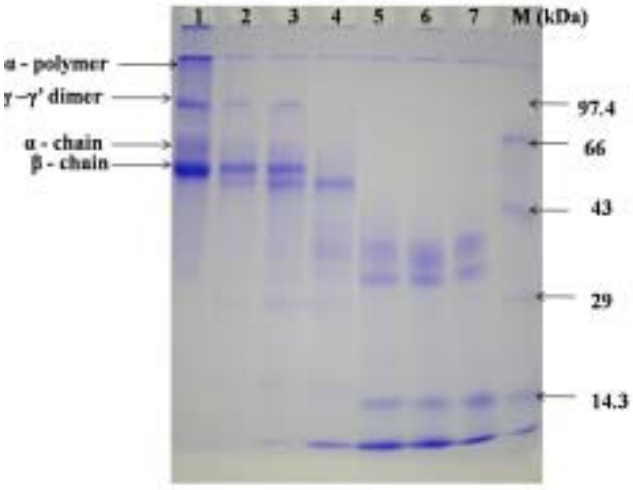
Large scale production of nigerloxin was carried out by solid state fermentation of wheat bran. Purified nigerloxin was crystallized using dioxane and methanol. The crystals were subjected to single crystal X-ray diffraction study. The structure was found to be slightly different when compared with the earlier reported structure. An analytical method was developed to detect nigerloxin in plasma through HPLC and LC-MS/MS. Retro-synthetic analysis on the synthetic route of nigerloxin has been initiated. Hydrogenation of nigerloxin was conducted and column chromatographic separation, characterization of the pure product is under progress.

Rapid detection of probiotic lactic acid bacteria *(Prakash M Halami)*

Potential probiotic native isolates of *Lactobacillus fermentum* were characterized by molecular biology tools. These cultures showed high antioxidant (37-77%) and cholesterol reducing properties (49-76%) *in vitro*. The isolates were differentiated using molecular tools like RAPD and rep-PCR. PCR detection using genus and species specific primers revealed the presence of probiotic marker genes like bile salt hydrolase, mucin binding protein and fibronectin binding protein. Also, multiplex PCR for probiotic *L. fermentum* was developed for rapid identification. Acute toxicity and sub-chronic toxicity studies of *L. salivarius* FIX and *L. fermentum* Cu05 revealed that they were safe for probiotic application. The cultures also showed inhibition of *E. coli* as well as cholesterol reducing property *in vivo.* In another study, *L. fermentum* (MCC 2759 and MCC 2760) and *L. delbrueckii* (MCC 2775) showed anti-inflammatory effect in carrageenan induced paw edema in Wistar rats. *L. salivarius* FIX *L. delbrueckii* (MCC 2775) and *L. fermentum* Cu05 also displayed ability to ferment soy milk and skim milk.

Molecular and biochemical characterization of beneficial microbes *(Prakash M Halami)*

A potent protease with both fibrinolytic and fibrinogenolytic activity was purified and characterized from native *Bacillus amyloliquefaciens* CFR15. The molecular weight of purified enzyme was 32 kDa. All the chains of fibrin were effectively degraded by the protease. The nature of the enzyme was found to be metallo protease and observed to be with greater preference towards fibrin compared with other protein substrates. Based on fibrin degradation pattern, the enzyme was found to possess endopeptidase activity and all the chains of fibrin were completely degraded by



Time dependent fibrinolytic activity of 32 kDa protease from *B. amyloliquefaciens* CFR15. 1) 0 h, 2)1 ½ h, 3) 3 h 4) 5 h, 5) 11 h, 6) 15 h, 7) 25 h and M-protein standard marker

the enzyme. The optimum temperature and pH for the activity were 45°C and 10.5 respectively. Considerable inhibition was observed with the serine protease inhibitors PMSF and EDTA.

The metal ion Mn^{2+} was found to enhance the activity of the enzyme. The protease was found to be having anti-coagulant activity as indicated by *in-vitro* increase in Activated Partial Thromboplastin Time and Prothrombin Time. These experimental results indicated that the protease from *B. amyloliquefaciens* CFR15 can be effective fibrinolytic agent blot clot disorders.

Foodborne microbes and their toxins in food and feed *(Anu Appaiah KA)*

Selected food products sold by street vendors in Mysuru were screened for foodborne pathogens like *Bacillus cereus* and *Staphylococcus aureus*. Five different varieties of rice based food, chats and deserts/bakery products were analysed. Among the rice based products, lemon rice had high load of *B. cereus* (2×10^3 cfu/g) and bisibele bath showed 54×10^2 cfu/g of *S. aureus*. Among the deserts, bhadusha had 54×10^2 and 2×10^4 cfu/g of *B. cereus* and *S. aureus,* respectively. Cake had the maximum count of *B. cereus* (2×10^4 cfu/g). A high load of *B. cereus* and *S. aureus* were recorded in the less cooked chat items. Panipuri masala had *B. cereus* (3×10^3 cfu/g) and dahipuri had *Staphylococcus* (3×10^4 cfu/g). Based on the microscopic observation and biochemical tests, 10 isolates were found to be positive for *B. cereus* and seven isolates for *S. aureus.*

Phytochemicals and probiotic lactic acid bacteria in stimulating a desirable gut environment *(Praveena B Mudliar)*

Plectranthus amboinicus Lour also called Indian borage is native to India and the Mediterranean. The hot water extract (HWE) of *P. amboinicus* leaves inhibited the growth of foodborne pathogens namely *E. coli* (30-60%) and *S. typhimurium* (30-90%) while increased the growth of probiotic *L. plantarum* more than one fold at concentrations ranging from 200-1000 µg/ml. Further evaluation of its growth stimulatory effect showed that there was near 1 log increase in the growth of *L. plantarum* in HWE supplemented milk in comparison to the control after 24 h incubation. The adhesion property of the bacterium also increased ~2.5 fold when grown in the presence of the extract in comparison to the control. Qualitative phytoconstituent analysis of HWE showed the predominance of polyphenols and soluble sugars. *L. plantarum* could produce phenolic acid decarboxylase and β-galactosidase to utilize the polyphenolic and sugar component respectively of HWE. This probably led to the stimulated growth of the probiotic organism.

Immunomodulatory and probiotic genetic loci among *Lactobacillus* sp. *(Manjulata Devi S)*

Different *Lactobacillus plantarum* strains were characterized by RAPD PCR. They were identified as *L. paraplantarum, L. pentosus, L. plantarum* subsp. *plantarum, L. plantarum* subsp*. argentoratensis* and *L. arizonensis.* The probiotic marker genes such as *fbp*, *mub*, *msa* gene were targeted and observed that *mub* showed maximum diversity. Detection of 10 MUB domains is reported for the first time in 3 strains of *L. paraplantarum* (SR409, SP221 and MTCC 9483). Further, the relative expression of the *mub* gene was assessed and observed a 7 fold increase of *mub* gene expression with 10 MUB domains. Subsequently, the isolates with 9 and 8 MUB domains showed 4 and 2 fold increase in expression. The present study has provided a platform for rapid detection of probiotic LPG strains with good adherence ability. Such cultures with more adherence ability and anti-microbial activity can act as a good bio-preservative and thereby improving the shelf-life of a food product.

Reverse transcriptase PCR (RT-PCR) technique and meat borne pathogens detection *(Sachindra NM)*

Conditions were standardized for detection of *Salmonella enterica* (MTCC 3223 and MTCC 9844), *Yersinia enterocolitica* (MTCC 3238) and *Listeria monocytogenes* (MTCC 657) by PCR techniques, employing the target genes invA (244 bp) and iroB (606 bp) for *Salmonella* sp., ystB (122 bp) for *Yersinia* sp. and hly (713 bp) for *Listeria* sp. The standardized PCR conditions for detection of *Salmonella* were validated by isolating *Salmonella* from chicken samples and confirming by phenotypic method and developed PCR technique. Same target genes were used to develop multiplex PCR for simultaneous detection of all the three pathogens in a single reaction, where the DNA from all the three organisms and the gene specific primers were used in a single reaction. The multiplex technique was validated by using the DNA isolated from a co-culture of all the three organisms. To develop RT-PCR technique, RNA was isolated from all the three pathogens, treated with DNAse to obtain DNA free RNA, converted into cDNA using commercial cDNA synthesis kit and cDNA was amplified by PCR using the standardized conditions. Further, the expression of selected genes during growth phase was tested by isolating RNA at different time interval of growth, converting to cDNA and testing for specific gene by PCR. Effect of temperature on specific gene was evaluated by subjecting the culture suspension to different temperature for specific time and isolating RNA and performing RT-PCR.

Carrageenan oligosaccharides in food and biomedical applications *(Sachindra NM)*

Potential carrageenolytic isolates showing degradation of carrageenan in carrageenan containing solid medium were evaluated for carrageenase production using carrageenan containing minimal medium. One of the isolates showing highest activity and identified as *Microbulbifer* sp. isolated from rotten seaweed was evaluated for enzyme production under different culture conditions. Enzyme production was highest at 18 h of growth, growth medium pH of 7.0, growth temperature of 37°C and a carrageenan concentration of 0.2%.

Use of carrageenan containing seaweed instead of pure carrageenan also induced enzyme production. Purification of crude enzyme was attempted by ammonium sulphate precipitation followed by ion exchange chromatography. The purity of the enzyme was increased by 5.15 fold by precipitation at 80% ammonium sulphate saturation.

Microalgae as alternate source of bioavailable vitamin B_{12} *(Sarada R)*

The need to identify plant-derived foods that contain high levels of vitamin B_{12} to prevent its deficiency in vegetarians was felt. Cyanobacterial species are reported to contain a high amount of vitamin B_{12}, but the forms of vitamin or their bioavailability was not elucidated. Other than *Porphyra*, a macroalga (sea weed) none of the other algal forms were reported for bioabvailability of vitamin B_{12}.

In this regard, commercially important GRAS status microalgae such as *Spirulina*, *Chlorella*, *Dunaliella* were evaluated for vitamin B_{12} form and content. *Spirulina* and *Chlorella* were found to contain methyl cobalamin while *Dunaliella* contained adenosylcobalamin. These forms were identified and characterised by HPLC, LC-MS, MS/MS methods. Further studies on bioavailability of vitamin B_{12} from the algal biomass were planned in experimental rats.

World over, the above mentioned algae are grown in outdoor ponds. To understand whether algae synthesize vitamin B_{12} or acquire through symbiosis, the algal stains need to be made axenic and grown under closed bioreactor and substantiate the presence of vitamin B_{12} in the algal biomass. Therefore attempts were made to obtain axenic cultures of *Dunaliella salina, Chlorella vulgaris* by treating with individual and combination of antibiotics at various concentrations. There was no growth observed on nutrient broth plates when antibiotic treated algal strains were plated. Further absence of associated bacteria needs to be substantiated by scanning electron microscope.

Caffeine biosynthesis in *Coffea* sp. *(Giridhar P)*

Theobromine synthase (2nd NMT gene) promoter deletion fragment activity measured in terms of expression of *smgfp*, defined the minimal promoter to the region between -101 to +57 nucleotide position with respect to the transcription start site (TSS) was characterized. Tobacco BY-2 cells transformed with promoter deletions::*smgfp* fusion when challenged with different stress stimuli like salicylic acid (SA), methyl jasmonate (MeJ), salinity, PEG-induced drought and 400 lux bright light exposure for 10 h, showed a difference in the levels of GFP proteins in comparison to the control identical transformed cultures. SA and MeJ caused over expression of *smgfp* in cultures transformed with pORE:PD1 promoter::*smgfp* fusion whereas salinity, drought and light exposure led to reduction of the levels of GFP protein as measured by the absorbance reading of ELISA. The promoter region from -253 to +57 may be a possible role player in the SA mediated responses as predicted by an altered GFP induction in reporter cassettes PD8, PD9 and PD10 or PD11 under the SA treatment when compared to the SA inducible PD1

Carrageenan plate

Carrageenan degradation (pit formation) by carrageenolytic isolate

promoter. *In silico* analysis of promoter also found to have two downstream WRKY factors binding elements or W-Boxes at locations +67 and +76 with respect to TSS. Salinity at 100 mM NaCl concentration was shown to induce the PD1 promoter fragment. One pPINC1 transformed plant, fourteen pPINC6 transformed plants and twenty four pCAMBIA 1301 transformed plants were regenerated as putative transgenic plantlets.

Bioactive metabolites from the fruits of *Malphigia glabra* and *Ixora coccinea* *(Giridhar P)*

Screening of fruits of Barbados cherry (*Malphigia glabra* and *Ixora coccinea*) for phytoconstituents of nutritional value was initiated. The fruit samples of *M. glabra* and *I. coccinea* were collected from Mysore and Mangalore districts. Analysis of phytoconstituents viz., total carbohydrates, total proteins, total phenolics, moisture content, chlorophyll- chl a, chl b, and total chl, total flavonoids, etc were carried out for *M. glabra* fruits at different ontogenial stages.

The screening of *I. coccinea* fruits for bioactive compounds through spectrophotometry and HPLC quantification was completed. Up to 5.2% of carbohydrates, 0.62% of total proteins, 0.97% of phenolics and 0.27% of flavonoids were recorded in ripened fruits of *M. glabra*. There was a progression in the content of both carbohydrates and proteins from immature to ripening stage of fruits, however an inverse trend was evident in case of phenolics and flavonoids. But once the fruits are allowed to overripe, a change in phytoconstituents was noticed.

Phytochemicals from *Physalis minima* and *Carissa spinarum* fruits *(Nandini P Shetty)*

The main aim of the project was to characterize the bioactive compounds from two important fruits *Physalis minima* and *Carissa spinarum*. The fruits of *P. minima* were collected from the waste lands of rice fields at three different stages. The collected fruits were then analysed for their phytochemical content and also checked for anti-inflammation parameter. The *P. minima* fruits at two different stages of ripening were analysed for their nutrient content such as ascorbic acid, carbohydrates, sugar content. *P. minima* fruits are known to be antioxidant in nature and suitable for consumption in both unripe and ripe stages. It was found that in the unripe fruit, methanol extract had higher antioxidant activity compared to that of ripe fruits as measured by DPPH, nitric oxide scavenging assay and phosphomolybdate assay and LDL oxidation inhibition assay. Further the unripe fruits were shown to have higher foam cell preventing activity than ripe fruits as seen by their abilities to prevent ox-LDL uptake by RAW 264.7 macrophages. The efficiency of unripe fruits to scavenge nitrite radicals in lipopolysaccharide stimulated RAW 264.7 macrophages were very high compared to that of ripe fruits. The methanol extract of unripe fruits had higher total phenolic content (6 µg gallic acid equivalent/mg dry wt.) than that of ripe fruits (3.92 µg gallic acid equivalent/mg dry wt.). HPLC analysis showed that unripe fruits had excess cinnamic acid (2.29 µg/mg dry wt.), sinapic acid, ferulic acid (8.91 µg/mg dry wt.), chlorogenic acid (2.89 µg/mg dry wt.) and coumaric acid compared to that of ripe fruits and this was validated by MS. The fraction was collected and these are being analysed for their anticancer parameter.

Similarly the fruits of *C. spinarum* were also subjected to phytochemical profiling. The fruits showed a very high accumulation of anthocyanin and resveratrol. The HPLC analysis was carried out to identify the anthocyanin and five major anthocyanins were present in these fruits and this was validated by MS.

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

The seed samples of fenugreek were collected from local markets. The seeds were sown in pots with two part of red soil, one part of sand and vermin-compost each and plants were established under greenhouse conditions as a backup for experiments. Seeds were surface

Ixora coccinea (Jungle flame) natural habitat and ripened fruits

sterilized and inoculated into MS media for seed germination. After germination, the leaves were placed in media containing different combinations of 2, 4 D and kinetin. The callus initiation was best obtained in 1.5 mg/L of 2, 4 D and 0.5 mg/L of kinetin. In order to get green callus, the calli were sub-cultured three times into the same media. HPLC profiling for the diosgenin content in leaves, seeds and callus culture were standardized. The preliminary results revealed that the diosgenin levels in seeds were in the range of 0.45% DW, in callus 0.25%, and in leaves 0.2%. Further analysis for 4-hydroxy isoleucine is being standardised in fenugreek.

Proteins and micro-constituents of flax seed and pumpkin seed *(Sindhu Kanya TC & Prasanna Vasu)*

Flaxseed:

Flaxseed detoxification: Evaluation of anti-nutritional factors showed hulls which have high tannins (0.44%) and phytic acid contents (0.91%), but are devoid of trypsin inhibitor activity and saponins. Total cyanogenic glycosides were found in whole seed (54 mg/100 g) and hulls (65 mg/100 g), and mainly contained linamarin (63.2% and 70.9%). Various treatments of seeds with mild acid and different salt concentrations reduced tannins (~32%), phytic acid (~65%), linamarin (32-33%) and trypsin inhibitor activity (48%).

Demucilaging: A method for demucilaging was developed, in which dry seeds were moistened in water and heated at 50°C (for 2 h), 70°C (1 h), 80°C (30 min), or 90°C (15 min). The protein content of defatted meal was 45-46% (96% purity). The amino acid profile revealed high amount of Asp, Glu and Arg in protein isolate, but limited in Lys, Met and Cys. The low Lys:Arg ratio (0.24) is suitable for infant food formula.

Protein extraction (globulin): The dehulled and defatted flax seed meal was fractionated to predominant globulins (45% ± 2), albumins (35% ± 2), glutelins (16% ± 2) and prolamins (9% ± 2). The globulin isolate contained 93% protein and are completely digestible. Five week globulin-intake study did not show any significant difference in lipid peroxidation and ascorbic acid levels in high cholesterol induced rats compared to control, indicating that globulins maintain these levels, which would otherwise alter under such conditions.

Pigment: Brownish yellow pigment (2.7% hull) showed good antioxidant and anti-inflammatory activity.

Carbohydrate digestive profile: Increasing prevalence of hyperglycemia demands foods that release glucose at slower rate. Flaxseeds and endosperm showed the least value for rapidly digestible starch (RDS), attributed to fiber and/or high protein and fat. Seeds lowered RDS in flour formulations more effectively.

Nitrogen source for media: A low-cost, solubilized-defatted flaxseed meal supplemented medium was developed, which enhanced the industrially potential ManB-1601 enzyme and biomass production, by 4.61-fold (8406 U/ml), and 2.53-fold (3.30 g/l), respectively in Phase-I. Under Phase-II, economization of medium resulted in 3.25-fold higher ManB-1601 production (5926 U/ml), with 4.2-fold (phase-I medium) and 3.0-fold (phase-II medium) reduction in cost compared to LB media.

Pumpkin Seed:

Pumpkin seed protein concentrate: Protein content of pumpkin seeds was 27-30% (Kjeldahl method), and several extraction methods were executed. A bulk sequential extraction of protein from 100 g defatted 'Kashi Harit' variety pumpkin seeds yielded 46%, of which the major fraction was NaOH-soluble glutelins (40.8%). The pH solubility profile of different fractions indicated that solubility decreased at pH 3 to 5, and increased to various degrees at higher pH (pH 7-12). Electrophoresis (SDS-PAGE) revealed that the protein profile is characterized by storage protein bands (from 4 to 110 kDa). The amino acid profiling of NaOH- soluble proteins revealed that it is rich in branched chain amino acids; Val, Leu and ILe (18.4%) and Arg (12.8%), but is limited in Lys (3.24%). Additionally, functional characterization (emulsion and foaming stability, etc.) also indicated that these proteins are suitable in assimilating into infant food formulations.

Physico-chemical characterization and fatty acid profiling: Fatty acid profile of 'Kashi Harit' indicated that the seed oil (yield, 33.77% by Soxhlet method) is rich in oleic (40.7%), linoleic (26.5%), and palmitic acid (19.7%). Parameters like BRR, RI, acid value, saponification value, iodine value and BTT (54.9, 1.4625, 1.3467%, 188.64, 81.59, and 27pC, respectively) showed similarity to groundnut oil (except BTT).

Phytochemical profile: HPLC of 90% acetone extract revealed that it mainly contained β-carotene ranging from 0.28 to 0.59 mg/100 g peel, and 0.11 to 0.59 mg/100 g pulp (green and orange fruits). LC-APCI-MS of prominent peak revealed different unknown carotenoids of m/z 551.43, 563.58, 607.18, 663.32, 727.44 Da.

Development of snack bar: A method for preparation of chewy bar and chikki from roasted pumpkin seeds (42 and 50%) with liquid glucose (26 and 10%), and sugar (10%) or jaggery (40%), was developed. The products displayed attractive colours, glossy appearance, with high protein (~37%) and fat contents (~49%), and had

good sensory attributes (overall quality score of 12.1-12.9) with better nutritional benefits.

Probiotics for antigen delivery *(Rajagopal K)*

This proposal deals with the exploitation of probiotics such as bifidobacterium as a vector to target therapeutic gene expression to tumors and its usefulness in cancer therapy. The fact that necrotic regions exist only within tumors and not in normal tissues is exploited. A toxic agent that could be specifically delivered to these areas was to be developed, and in theory they could kill the surrounding viable tumor cells. Anaerobic bacteria were chosen for investigation. It has been recognized for a half century that such bacteria could selectively proliferate in the hypoxic regions of tumors. Human Tnf-α is targeted in this proposal as a model antigen for bifidobacterial mediated delivery into tumors. hTNF-α protein cannot be used for cancer therapy because of its high systemic cytotoxicity, because of its affinity towards its receptors which are present in almost all the cells of the human body, because of which the side effects such as ischemia, systemic cell killing and initiation of unusual signal transduction pathways have been observed. The best possible way of inhibiting the systemic cytotoxicity is either inhibiting the interaction of hTNF with its receptors, or by delivering the TNF through the live vectors such as bifidobacterium which has affinity towards cancer cells/necrotic regions of cancer cells. The bifidobacterium secreting hTNF can be one of the best methods of curing the cancer.

Biomolecules from moringa seeds *(Radha C)*

Moringa oleifera seeds were found to be a potential source for dietary fiber. The yield of the isolated soluble dietary fiber from defatted moringa seed flour was 6.5% w/w. Biochemical characterization of moringa seed soluble fiber revealed that it is a glycoprotein with 94% protein and 5% neutral sugars. Xylose and arabinose were the major neutral sugars identified by GLC. The moringa seed soluble fiber was identified as protease resistant glycoprotein and termed as moringa seed resistant protein (MSRP). MSRP was found to be homodimer (18 kDa) containing 9 kDa monomeric units with p*I* 10.8 as revealed by SDS–PAGE and IEF analysis. Animals supplemented with 3% MSRP significantly encountered hypercholesterolemia induced by high cholesterol feeding. Plasma total cholesterol and triglyceride levels were lowered by 36.8% and 32%, respectively in MSRP supplemented group. Hepatic cholesterol and triglycerides were reduced by 36.4% and 28.8%, respectively in MRSP treated subjects. Microbial analysis of fecal material and intestine of experimental animals showed significant increase in lactic acid bacteria count in intestine and fecal sample of MSRP groups (5.58 and 6.3 log cfu/g, respectively) in comparison with control group (3.23 and 4.87 log cfu/g, respectively). The study concludes that the moringa seed resistant protein alters gut microflora which could facilitate cholesterol reduction.

Evaluation of antihypertensive property of moringa seed protein: Moringa seed protein hydrolysate was prepared from defatted moringa seed flour using optimised conditions. It was aimed to investigate the effect of moringa seed protein hydrolysate on diet induced hypertension rat model. 40 male Wistar rats were taken and divided into four groups; control group were fed with AIN 93 M diet and other three groups were fed with fructose and salt diet. After six wks 10 mg/kg body weight of the protein hydrolysate was given through oral administration to third group. At 13th week, the hypertension was confirmed by tail cuff non-invasive blood pressure measurement with MRBP system with mean BP of 120-130 mmHg. It was noticed that there was significant decrease (94±9.5 mmHg) in hypertension in third group. In hypertensive rats (120-130 mmHg) of 4th group the therapeutic effect was evaluated at 15th week which showed gradual decrease (85 mmHg) and peak activity in third hour and gradually increased after 5th hour (89 mmHg) and reversed back at 8th hour (122 mmHg). These results showed that moringa seed protein acts as potential antihypertensive molecule. The analysis of biochemical parameters such as HDL, LDL, total cholesterol, triglycerides, total protein, albumin, uric acid and urea also supported the same.

Health beneficial physiological effects of cardamom *(Sowbhagya HB)*

Cardamom (*Elettaria cardamomum*) is an aromatic seed spice grown extensively in India and used as a flavourant in sweets. The anti-hypercholesterolemic effect of cardamom was evaluated in Wistar rats by inducing hypercholesterolemia with a high cholesterol diet for 8 wks. Dietary interventions were made with cardamom powder (5%), cardamom oil (0.3%) (equivalent to 5% cardamom powder) and de-oiled cardamom powder (5%). Significant reduction in the blood total cholesterol (31%) and LDL cholesterol (44%) was observed by oral administration of cardamom oil in hypercholesterolemic rats accompanied by a marked decrease in serum triglycerides by 42%. Cholesterol content of cardiac muscle was beneficially lowered by 39% with administration of cardamom oil in hypercholesterolemic rats. Liver triglycerides were reduced by 33%.

Incorporation of cardamom oil/powder in diet did not alter the pattern of feed consumption in rats. The compromise in the activities of hepatic antioxidant enzymes under hypercholesterolemic situation were generally countered by dietary intervention with cardamom. Treatment with de-oiled cardamom as well as cardamom oil countered the diminished activity of catalase in hypercholesterolemic animals. Cardamom also enhanced the activity of heart superoxide dismutase in hypercholesterolemic situation. Ascorbic acid concentration in circulation was significantly increased by dietary cardamom or its fractions in hypercholesterolemic situation.

Dietary intervention with cardamom oil was evidenced in the animal study to beneficially reverse the alterations in lipid homeostasis to a significant extent in conditions of hypercholesterolemia. Significant reduction of atherogenicity index with the dietary intervention of cardamom powder and cardamom oil indicates the potential cardio protective effect of cardamom in rats.

Flavour and taste interaction in health foods *(Roopa BS)*

Studies were carried out on sweeteners on using stevia, polyols, sucralose and sugar. Syrups for traditional food such as *jamun* were optimized using response surface method. Similarly sprinklers were optimized with different sweeteners. Instrument analysis was carried out for viscosity determination of syrup.

Salt substitutes are good option for many people who are trying to cut back on sodium in their food. From the results of the study it can be concluded that KCl can be used as a partial salt substitute in papad preparation. The physico-chemical and sensory quality of the product showed that the papad could be prepared without affecting the acceptability by substituting NaCl with KCl up to a level of 75%. The results suggested that 24% sodium reduction is possible in fried product without significant impact on basic taste sensory perception. It is concluded that KCl (100%) cannot be used as an alternate for NaCl due to dominating metallic taste and lingering which makes it less acceptable.

Health benefits of purslane *(Sukumar Debnath)*

Purslane (*Portulaca oleracea* L.) has several health benefits attributed to the presence of bioactive molecules. The investigation was undertaken with an objective of analyzing the antioxidant capacity of purslane leafy vegetable (PLV) and testing their efficacy on fortified oils with purslane extracts. Oil was analyzed for antioxidant activity by standard methods. The ethanol extracts of LV were added to refined sunflower and groundnut oils in different concentrate starting from 500 to 3000 ppm. Polyphenols, tocopherol, antiradical activity and β-carotene were estimated using spectrophotometer. Fatty acid composition of fortified oil and individual oil were analysed by GC and the chemical changes taking place during fortification were investigated.

In cholesterol induced hyperlipidemic model, the groups treated with the extracts of *Portulaca oleracea* L. and lovastatin demonstrated a significant decrease in the serum TC, LDL-C, VLDL-C, TAG, besides an increase in serum HDL-C levels when compared to cholesterol induced hyperlipidemic control group. The groups treated with the extracts of *Portulaca oleracea* L. and lovastatin demonstrated significant decrease in the LDL-C:HDL-C risk ratios, and also a remarkable decrease in the levels of SGOT, SGPT and ALP activities when compared to cholesterol induced hyperlipidemic control group. The groups treated with the extract of *Portulaca oleracea* L. also showed decrease in body weight when compared to cholesterol induced hyperlipidemic control group.

The usefulness of the aqueous extract of *Portulaca oleracea* L. in the treatment of hyperlipidemia was investigated. The administration of extract concluded that 150 mg/kg body wt. is a potent cardio protective agent and it significantly lowered the lipid levels, SGOT, SGPT, alkaline phosphatases and increased the HDL levels. The study revealed that the use of aqueous extract of *Portulaca oleracea* L. as antihyperlipidemic agent has preventive and curative effect against hyperlipidemia.

Oil extraction using three phase partitioning *(Sukumar Debnath)*

Study demonstrates that three phase partitioning (TPP) is efficient for downstream proteome analysis and emphasizes the importance of protein extraction method in achieving optimal separation and identification of proteins using SDS-PAGE and mass spectrometry. In TPP method, ammonium sulphate concentration (30%) as well as solvent water ratio 1:1 was the optimum for proper three phase separation. In the other method, namely mild acid precipitation in pH range 4-5.5, it was observed that maximum protein gets precipitated. It was found that mild acid precipitation method was superior to other tested method for purslane leaf analysis.

Healthy mayo spread *(Chetana R)*

A nutra mayonnaise was formulated by replacing refined vegetable oil with rice bran oil (RBO), sesame oil (SO) and blends of both RBO: SO. The emulsion was

formulated using xanthan gum in place of egg. The effect of replacing xanthan gum on varying oil blends (RBO: SO) on the physicochemical properties such as texture (stiffness), stability, viscosity, oryzanol and sesamol content of the prepared mayo spread were studied. The pH of the samples was 3.9-4.0, whereas the fat content ranged between 63-65% for formulations made using xanthan gum. Control product prepared with egg had 78% fat. The texture or stiffness of the mayonnaise with desired spreadability ranged between 1.2 N to 1.6 N and the mayonnaise prepared with egg was 1.44 N. Below 1.1 N they were thinner in consistency. The stability of these spreads was found to be better than the control at 27°C and 80°C. An acceptable mayonnaise with desired colour, optimum spreadability and excellent emulsion stability was prepared using 100:0; 90:10 and 80:20 of RBO: SO oil blends. Rheological studies suggest that mayonnaise made from RBO and blends of RBO and SO (90:10) were similar to the traditional mayonnaise prepared with egg. These products also had oryzanol content above 0.5% and sesamol content above 0.1% which are known to provide health benefits. Consumer acceptance studies suggested that mayo spread with added health benefits of RBO and SO was much preferred than the control which had a typical egg smell. The products had high sensory acceptability scores.

INNOVATIVE FOOD PROCESSING

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

Traditional methods of making ragi ball was studied by visiting Mysuru Central Jail and Shri Suttur Maha Kshetra, Mysore, where large quantity of ragi balls were prepared. The particle size analysis of ragi flour was carried out. Experiments were conducted on different types of cooking method for ragi ball making such as sigma mixing and kettle using steam as a heat source. Triplicate trials were conducted on each type and physical characteristics like color and texture were studied.

Conceptual design was made and the prototype machine was fabricated in-house.

Spouted bed roaster for green coffee beans

A compact spouted bed roaster (CSBR) for roasting of coffee beans and other grains (using prototype 1/2 kg batch size roaster) was developed. A detailed compact spouted bed roaster was designed based on the critical design parameters. A prototype of compact spouted bed roaster was fabricated based on these design drawings using economical and efficient manufacturing processes.

The spouted bed roaster is a more efficient, eco-friendly and compact in size which makes it portable. The unit was tested for the roasting of other food materials like corn, groundnut, Bengal gram and green peas. Similarly popping or expansion of extruded dry snacks was tested. The physical properties of coffee bean were studied and the performance of the machine was optimized for roasting of coffee beans. The quality characteristics of coffee roasted by different methods were evaluated.

Infusion of bioactive compounds *(Rastogi NK)*

High pressure treatment was explored as a technique for infusion of bioactive compounds (anthocyanin) into solid foods matrix (apple). The rate of mass transfer of moisture, solid and anthocyanin content with or without the application of high pressure were studied over a wide range of concentration of osmotic solution (0 to 50% sucrose). The increase in concentration of osmotic solution resulted in reduced infusion of anthocyanin. The application of pressure (100-350 MPa for 10 min) resulted in higher infusion (821 mg/100 g) as compared to the infusion that took place at ambient condition (375 mg/100 g). The infusion was found to increase with an increase in pressure. The maximum infusion of anthocyanin was found to be maximum at 250 MPa (821 mg/100 g) and beyond which it decreased. Application of high pressure also resulted in partial inactivation of enzymes such as PPO (80%) and POD (75%). The present study concluded that high pressure treatment of solid foods could be a feasible technology

Ragi balls preparation by Kettle method & Sigma mixing method

Compact Spouted Bed Roaster

for infusion of bioactive compounds without significantly altering its matrix. This work elucidates important aspects of the science of pressure-enhanced infusion.

Extraction of bioactive compounds *(Rastogi NK)*

The present study, reports for the first time the effect of high pressure on extraction of oleoresin from ginger (*Zingiber officinale* R.). The percentage of increase in oleoresin yield and 6-gingerol content was found to increase upto 28.29 and 30.43%, respectively, with increase in pressure compared to the untreated samples. The high pressure treatment resulted in the increased drying rate of fresh ginger due to cell permeabilization thereby reducing drying time. The effective moisture diffusion coefficient was found to increase from 0.54 to 4.21×10^{-9} m^2/s with increase in high pressure from 0.1 to 400 MPa. The high pressure assisted extraction was shown to be a feasible technique to enhance yield and content of bioactive compounds during extraction.

Rice bran protein concentrate *(Subramanian R)*

Among the selected varieties, IR64 bran exhibited the maximum recovery of water (29.1%) and salt (38.0%) soluble proteins followed by Basmati and Agonibora and Jyothi under the standardized conditions. Sequential extraction of IR64 bran with water followed by salt resulted in a higher overall protein recovery (42.5%) compared to direct salt extraction (38.0%). Besides, this approach also gave a scope to obtain relatively high purity globulins. Physical assisted methods were employed for extracting albumins and globulins from rice bran. Homogenizing substantially improved the protein recovery by 48% and 10% with IR64 bran under water and salt environment, respectively. The water soluble protein recovery obtained with homogenization assisted extraction (39.0%) was closer to corresponding salt extraction (40.6%). Dialysis of extracts revealed that the increased protein extractability in water environment was due to the increase in both albumin and globulin recovery.

Based on the laboratory extraction studies, IR64 bran was chosen for further evaluation of bran protein fractions in animal experiments and assessing the functional properties. Large quantity of water-, salt- and alkali-soluble proteins were produced in several batches in the pilot scale level (5-10 kg of bran/batch) from 3.5 MT of IR64 paddy involving multiple unit operations starting from milling, hexane-defatting, extraction, clarification, ultrafiltration, concentration/ precipitation and drying. The efficacy of the membrane process is being assessed in terms of protein enrichment, elimination of salt and reduction of anti-nutritional factors such as phytic acid and trypsin inhibitor. Further, the water, salt and alkali soluble protein concentrates obtained would be characterized in terms of their functional properties. Animal studies on the three bran-protein fractions are in progress including nutritional recovery of induced malnourishment in male Wistar rats.

Pomegranate peel based product *(Singh RP)*

Pomegranate peel powder was extracted with hydro-alcoholic mixture of ethanol-water (1:1, v/v, eco-friendly solvent system) at 28-30°C (low consumption of energy) overnight. The radical scavenging activity (RSA, DPPH method) and polyphenol content of the extract were monitored at different stages. The solid to solvent ratio were optimized and maintained at 1:10 throughout. The extraction was carried out for 1, 10 and 50 g batch (laboratory level) and 1 kg batch (pilot scale).

The extract was centrifuged and filtered and distilled to remove alcohol. The RSA profile and polyphenol content of the extracts were found to be independent of the batch size. Attempts were made to dry the extract using vacuum, freeze and spray drying methods. Vacuum drying resulted in 22% loss in RSA and 21% loss in polyphenols while freeze drying caused 40% loss in both RSA and polyphenols. Spray drying resulted in higher losses of both RSA and polyphenols, hence vacuum drying could be the method of choice for drying the extract. Attempts were made to prepare peel powder incorporated pasta at 2.5, 5 and 7.5% level. The product with 5% was found to be sensorily acceptable.

Visco-elastic characterization of fabricated foods *(Suvendu Bhattacharya & Chakkaravarthi A)*

Shape of batter droplet and fried product formation: Chickpea flour batter droplet is used as a model system to study the shape of the batter droplets and fried snack (boondi). An increase in the concentration of chickpea flour and/or gum Arabic forms ovoid/elongated shaped product. Model flour dispersion droplets with varied concentrations of chickpea flour (37-43%) and gum Arabic (1-5%) were fried, and the physical, mechanical, sensory, microstructural and imaging characteristics of the product were determined. An increase in the concentration of chickpea flour and/or gum Arabic decreased the oil content in the fried snack up to 20.3%. Fracture strain (12.0-19.5%) indicated that all the fried samples were soft-crisp products. An increase in chickpea flour and/or gum changed the spherical shape of the fried snack to an ovoid/oblong shape. Near spherical product could be obtained by using 37% chickpea flour containing 0-2% of gum Arabic or with 40% chickpea flour containing 0-1% gum Arabic.

Instant curd and Lassi powder: The concept of agglomeration has been applied to develop instant mix which can form a curd or lassi within 2 min wherein the adequate number of health benefiting lactic acid bacteria is present.

Gel cubes: Hydrocolloid based gel cubes were developed along with mango pulp. Subsequent drying of the cubes in a dehumidifier-assisted dryer increased the shelf-life of the product to provide convenience to the consumers.

Reduction of oil content in fried product: An increase in the concentration of chickpea flour and/or gum Arabic solid decreases the oil content; the highest oil content of 61.1% is with the 37% chickpea flour batter without gum Arabic, while the lowest value of 48.7% is associated with 43% and 5%, respectively meaning a maximum of 20.3% reduction in oil content is possible.

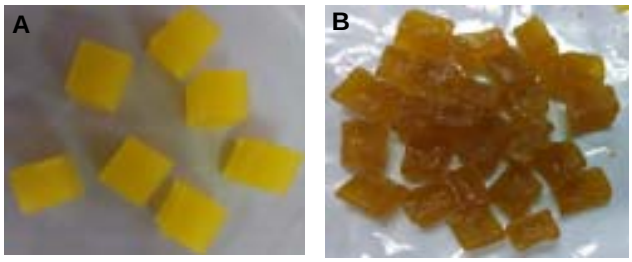
Process modelling: An artificial neural network (ANN) structure of 2-9-2 with a learning rate of 0.7 and 24452 iterations has been found to be an optimum network for the prediction of overall sensory acceptability and oil content of *boondis* obtained with different moisture and gum Arabic contents.

Nanopatterning for instant foaming soluble coffee
(Anandharamakrishnan C)

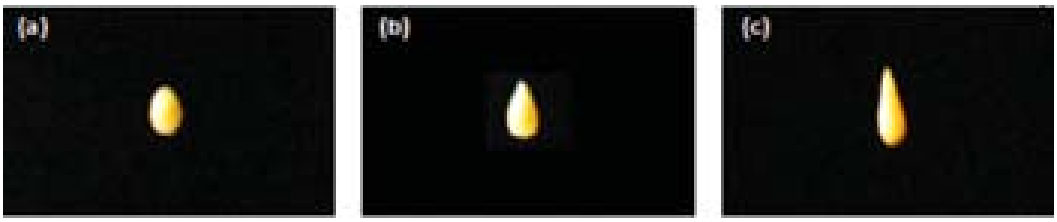
Pressurized particles are produced by applying the pressure on the whey protein solution in fabricated pressure vessel and atomized using twin fluid nozzle to obtain the spray dried whey protein powder. Later, these particles were evaluated for the morphological characteristics using scanning electronic microscope (SEM). Additionally, moisture content, particle size distribution and density were also evaluated. Moreover, coffee solution was also pressurized with the nitrogen gas in pressure vessel to obtain the pressurized coffee powder having higher foaming characteristics. Nano-spray freezing rig was designed and fabricated for obtaining the nanoparticles by spray-freezing method.

Engineered nano food particles
(Anandharamakrishnan C)

Curcumin is a highly potent nutraceutical associated with various health benefits. However, its hydrophobic nature affects its bioavailability and bioactivity and limits nutraceutical applications. Drug-in-cyclodextrin-in-liposome has the ability to mask the hydrophobic nature



Mango gel cubes (A) before drying and (B) after drying



Chickpea flour dispersion droplets with chickpea flour content (w/w) of (a) 37%, (b) 40%, and (c) 43%

Chickpea flour dispersion droplets with chickpea flour content (w/w) of 40% in presence of (a) 1%, (b) 3%, and (c) 5% gum Arabic (w/w)

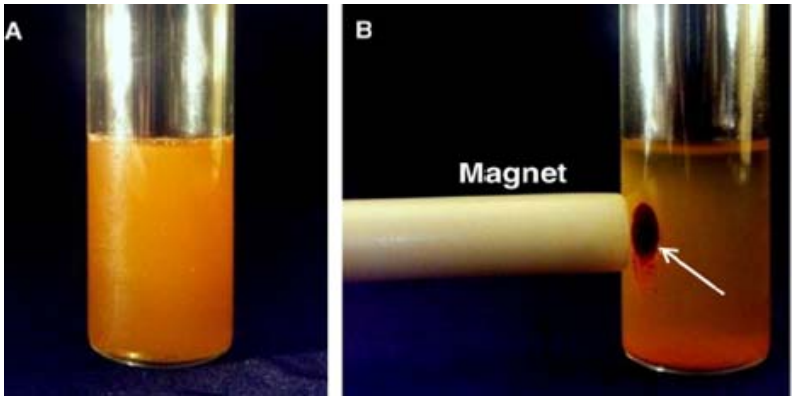
of drug and achieve better encapsulation. Also, encapsulating iron oxide nanoparticles (IONPs) within liposomes endow additional beneficial functionalities of IONPs. In the present study, curcumin-β-cyclodextrin inclusion complex (IC) and IONPs were co-encapsulated within liposomes (curcumin-in-β-cyclodextrin-in-nanomagnetoliposomes) to achieve the synergistic antioxidant potential of curcumin and IONPs. IC of curcumin-β-cyclodextrin was prepared by a simple rapid method and successful inclusion was confirmed by Fourier transform infrared spectroscopy (FTIR) and nuclear magnetic resonance (NMR). Mean diameter of IONPs was found to be 180 nm and X-ray diffraction pattern confirmed the formation of hematite nanoparticles. Band gap energy calculated using absorption spectra was 2.25 eV, which falls in close proximity with the theoretically calculated values of hematite. Mean diameter of curcumin-in-β-cyclodextrin-in-nanomagnetoliposomes was 67 nm and encapsulation efficiency of curcumin was found to be 71%. Further, the co-encapsulated particles possessed significantly low IC_{50} value (64.7791 μg/ml, $p < 0.01$) compared to conventional curcumin liposome and IONPs, indicating its synergistically enhanced radical scavenging property.

Wheat bran addition and volume/ structural development in bread *(Anandharamakrishnan C)*

Bubble growth during bread-making process is beyond the scope of a diffusion problem. In addition to diffusion, bubble expansion in bread dough is also a function of the 'coalescence' phenomenon that occurs during the latter stages of fermentation and initial stages of baking. Coalescence-mediated bubble growth is observed to be retarded in the presence of wheat bran, which is quantified by means of an empirical model for bubble coalescence frequency. This model demonstrates the relationship between bubble behaviour and rheological properties. Coalescence-mediated bubble growth had an inverse relationship with bran concentration, owing to increased dough overpressure and elastic modulus. The impact of bran addition on bubble dynamics during baking can be explained by the hindered glass transition and the consequent retardation in crumb softening at temperature greater than the glass transition temperature. Larger the mean bubble size in dough and bread crumb, greater is the softness of bread loaf. Experimental trials are on for the modulation of wheat bran particulate size to improve bubble growth and volume development.

Ultrasound assisted ozonator for the processing of liquid foods *(Rastogi NK)*

Shelf-life of fresh sugarcane juice is limited due to inherent rapid enzymatic browning and high microbial load. A study was undertaken to analyze the individual and combined effect of non-thermal food processing technologies i.e. ozone and lactic acid on sugarcane juice browning, nutritional and microbiological quality. Combination of ozone (1.2 g/h) for 10 min and lactic acid (0.5%) reduced total bacterial count of sugarcane juice by 4.1 log reduction, and controlled of enzymatic activity to a moderate level (reduction of 60 and 72% activity of PPO and POD, respectively). Sugarcane juice treated with ozone and lactic acid individually and in combination along with untreated and heat treated juice were stored at refrigerated conditions (5±1ºC), and analyzed for physico-chemical parameter, microbial quality, enzyme activity and sensory quality. The results showed that combined treatment was at par with heat treated juice for maintaining overall quality of sugarcane juice initially as well as during storage of one month under refrigerated conditions. This study showed the effectiveness of non-thermal technology for preservation of sugarcane juice.



Curcumin-in-b-CD-in-magnetoli posomes (A) before and (B) after exposing to externally placed magnet

Amla grating machine *(Venkatesh Murthy K)*

Amla is an extensively used herb in making ayurvedic medicines. It is used in many forms like juice or dry powder or candies of *Amla.* During processing of raw Amla fruit, the seeds need to be removed for proper conversion into either juice or powder. There are no methods available for separation of seed. A machine has been conceived for grating of Amla and removing Amla seeds, which will help the tribal/rural communities and also for small-scale industries for value addition of the forest produce. Also, drying protocol to retain green color in grated Amla will be standardized. Preparation of design drawings was completed and prototype is under progress.

Novel processing system for wastewater treatment *(Parande AK)*

Food based industrial effluents were collected and preserved in the lab for further analysis. The waste water characteristics analysis was carried out as per standard methods for the examination of water and wastewater testing. Physico-chemical characteristics of the industrial waste was analyzed for BOD and COD values and also for other parameters such as total solids, total crude protein, total suspended solids, total dissolved solids, volatiles and heavy metals. Aeration unit and its performance were carried out. Feasibility studies were conducted in the lab using aerators integrated with microbial culture.

Structurally modified natural compounds *(Akmal Pasha & Manivannan S)*

Preparation of semi-synthetic derivatives: Preparation of (1) 4-formyl-2-methoxyphenyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate 4-formyl-2-methoxyphenyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate was prepared from vanillin. The yield was 17.9 g. The compound however did not show much insecticidal activity. (2) Methyl 2-[(dimethoxyphosphorothioyl)oxy]benzoate was prepared from methyl salicylate. Traces of the starting material methyl salicylate were observed in the product which was adsorbed on basic alumina using a glass column. The yield was 6.48 g. (3) Methyl 2-[(diethoxyphosphorothioyl)oxy]benzoate was prepared from methyl salicylate. Traces of the starting material methyl salicylate were observed in the product which was adsorbed on basic alumina using a glass column. The yield was 7.65 g.

Toxicity Studies *(Akmal Pasha & Manivannan S)*

The contact toxicity of methyl 2-[(dimethoxyphosphorothioyl)oxy]benzoate and methyl 2-[(diethoxyphosphorothioyl)oxy]benzoate was evaluated on the adults of *R. dominica* by following filter paper impregnation method. The results revealed that, both the methyl and ethyl phosphorothioates of methyl salicylate were highly effective against the adults of *R. dominica*. The present study indicates that, both the ethyl and methyl derivatives have greater potential as insecticides over stored product insect control.

Influence of different edible vegetable oils on coleopteran beetles *(Sumithra Devi S)*

Edible vegetable oils like mustard oil, sunflower oil, palm oil and coconut oil were evaluated for their efficacy to control infestation of wheat by *Sitophilus oryzae* and *Callosobruchus chinensis* in different pulses viz., cowpea, Bengal gram, black gram, green gram and horse gram. These oils were effective in wheat at concentration of 250 ppm against *S. oryzae.* The effect of these oils on *C. chinensis* varies with type of pulses and concentration of the oil. Germination test for seed viability of the treated wheat grains and pulses had no inhibitory effect up to nine months of storage.

Insecticidal potential of *K. galanga* against *S. oryzae and C. chinensis*

The *K. galanga* powder on wheat at 1, 3 and 5% level exhibited 5, 50 and 80% mortality of *S. oryzae* by 16 days and 41, 83 and 95% mortality by 21 days respectively. *K. galanga* powders also significantly reduced the emergence of F1 population of *S. oryzae*. Petroleum ether extract of *K. galanga* against *S. oryzae* of wheat at 1000 ppm level was the most effective resulting in 90% mortality of *S. oryzae* by 3 days and 100% kill by 7-10 days. In case of *C. chinensis* petroleum ether extract resulted in 95% kill of insects by 2 days.

The results of the biochemical tests of the various extracts revealed the presence of terpenoids. TLC analysis of the *K. galanga* and *A. galanga* extracts revealed the presence of three to four major components in case of *K. galanga* and two major constituents in case of *A. galanga.* GC-MS and LC-MS analysis of the extracts were initiated and further work need to be carried out to identify the major constituents responsible for the insecticidal activity.

Fumigant toxicity of *trans* anethole

Maximum fumigant toxicity of *trans* anethole to *S. oryzae* adults was observed at concentration of 150 µl/L air by 24 h as represented by 100% kill of insects as compared to nil in untreated control insects. Significant fumigant toxicity of *trans* anethole on *C. chinensis* was observed at 60 µl/L air, total mortality of insects was recorded at

100 ppm level by 24 h. *Trans* anethole at LC_{50} inhibited *in vivo* activity of acetylcholinesterase activity in *Sitophilus oryzae* by 10.98, 25.92, 34.91 and 42.55% at 6, 12, 18 and 24 h exposure period respectively. In *C. chinensis* 0.71, 11.27, 13.63 and 20.13% inhibition of acetylcholinesterase activity was recorded at 6, 12, 18 and 24 h exposure period respectively.

Prebiotic pectic-oligosaccharides (POS) from coffee pulp *(Prapulla SG & Anu Appaiah KA)*

Coffee pulp, the first by-product obtained during wet-processing of coffee is rich in pectin. In this study efforts for the production of POS from coffee pulp using pectinase from fungal systems were carried out. Two fungal strains isolated from coffee pulp and rotten coffee husk were identified as *Aspergillus fumigatus* P-1007(CCA-100) and *Aspergillus fumigatus* strain HA1(CCA-101) respectively based on its 18s rRNA sequencing. The selected organism was grown under submerged fermentation conditions for the production of the pectinase. Effect of different temperature on the growth of *Aspergillus fumigatus* P-1007(CCA-100) and *Aspergillus fumigatus* strain HA1(CCA-101) yield and the activity of the pectinase were studied. It was observed that CCA101 strain exhibited higher endo-pectinase activity and low exo-pectinase activity compared to CCA100. Equivalent weight and methoxyl content (%) of the pectin extracted from pulp and husk were estimated. However it was observed to be higher than that is generally reported, probably due to the interference by polyphenols and other compounds. Tannic and vanillic acid were found to be the most prevalent phenolics in coffee pulp and coffee husk. Efforts were made to partially purify the pectin recovered from the pulp and the husk by treating with ion exchange resins such as LX-17, PVPP beads. Treatment with LX-17 was found to be more effective for the removal of the polyphenols. The production of galacturonic acid after enzymatic hydrolysis of commercial pectin and crude pectin extracted from coffee was analyzed using TLC and HPLC.

Fermentation of distillate of alcohol industry *(Anu Appaiah KA)*

In the distillery industry, the water generated after distillation is reused for the subsequent cycles of fermentation to make the process more cost effective. *Saccharomyces cerevisiae*, strain KTP was used to produce alcohol from sugarcane molasses. Total residual sugar (TRS) of ~17% i.e. 26-27°B was maintained before starting the fermentation. Fermaid (Fermaid- amino acid) was used as yeast growth promoter which results in higher yield of alcohol. The efficiency of the fermaid treated and non-fermaid treated fermentation was compared. Comparatively, production of alcohol was higher by 0.8-1.0% in fermaid treated fermentation against non fermaid treated set. Distillate water obtained from first fermentation was reused for the following cycle. Increase in volatile fatty acid (VFA) was observed in distillate with every fermentation cycle which resulted in decrease in pH. The water can be recycled upto 4 cycles under the current experimental conditions. By 3rd cycle of distillate use, growth of yeast was very low eventually leading to low production of alcohol. This decrease or inhibition in yeast growth might be attributed to increased VFA, which was in the range of 5700-5900 ppm in the recycled water.

***Jatropha curcas* seed cake for meal feed** *(Somashekar D)*

The biopesticidal activity of *Jatropha* seed cake extracts and oil were tested against two insect pests. The invasive yellow crazy ant, *Anoplolepis gracilipes* are a problematic pest in both urban and rural environment because of their extreme foraging behavior. The use of non-edible oil seeds of *Jatropha curcas* containing phorbol esters has been considered as a potential source of biopesticide. The *Jatropha* seed oil (25, 50 and 100%), *Jatropha* seed cake (2, 4 and 6 g), *Jatropha* seed cake cold water extract and hot water extract (5, 10 and 20%) were evaluated for insecticidal activity by studying the mortality rates of the adult workers of *A. gracilipes.* The bioassay studies indicated that 100% mortality was observed using *Jatropha* seed oil at 50 and 100% concentrations. The hot water and cold water extracts of *Jatropha* seed cake at 5, 10 and 20% levels exhibited an increase in mortality with increasing concentrations and exposures. *Dinoderus minutus* (Coleoptera: Bostrychidae) is a serious pest of bamboos in the tropical regions of the world. The contact toxicity of *J. curcas* oil was evaluated against *D. minutus* using 20, 40, 50 and 60% concentration. The results showed that 60% *Jatropha* seed oil caused 100% mortality over 96 h exposure. The mortality of bamboo borers was due to bioactive compounds like phorbol esters present in *Jatropha* seed oil. The bamboo blocks (5 x 3.5 cm^2) were treated with 60 and 100% *Jatropha* seed oil to examine the feeding deterrence and mortality of *D. minutus.* The percent reduction in the weight loss of bamboo blocks owing to *Jatropha* seed oil treatments at 60 and 100% concentrations in comparison to control were 15.69 and 9.8% respectively. The maximum wood protection against *D. minutus* was observed at 100% *Jatropha* seed oil concentration.

Algae-based value-added products *(Sandeep Mudliar & Chauhan VS)*

Life cycle assessment (LCA) of three scenarios for biodiesel production from fresh water microalgae *Scenedesmus dimorphus* cultivated in open raceway ponds using primary and secondary data was carried out. The key differences in the scenarios were related to biomass productivity, mode of culture mixing and type of energy source. The process steps included algal cultivation in open raceway ponds, harvesting by chemical flocculation, dewatering by mechanical drying option (MDO) followed by extraction, reaction and purification. The scenarios were evaluated for energy demand, emissions and environmental impacts within the boundary conditions grounded on a "cradle-to-gate" inventory. In all the scenarios, raceway pond cultivation systems were found to be the most energy intensive process with mode of culture mixing and biomass productivity being the major determinants. The major environmental impact in all the scenarios was found to be Global Warming Potential (GWP) contributing about 99% of total environmental impacts. The impacts were found to be directly linked with energy demand and had an inverse relationship with biomass productivity. The geographic location of energy sources affected the environmental impact of a given process. Further LCA studies on biogas production directly from post harvested algal slurry along with nutrient recycling are under progress.

Computational Fluid Dynamic (CFD) modeling of algal photobioreactors *(Sarada R & Sandeep Mudliar)*

An airlift photobioreactor of 3.4 L working volume was indigenously designed and installed and evaluated for cultivation of *Scenedesmus obtusus*. The effect of reactor hydrodynamics, light intensity and photoperiod on the growth and biochemical composition of *S. obtusus* was evaluated. An increase in the biomass concentration and productivity was observed with increase in gas flow rates. The maximum biomass productivity of 0.103 g L^{-1} day^{-1} was obtained at an illumination of 150 μmol $m^{-2}s^{-1}$ under continuous light regime. The biochemical characteristics indicated no significant variations in carbohydrate and lipid content under different conditions. The fatty acid profiles of *S. obtusus* indicated palmitic acid (C16:0), α-linolenic acid (C18:3), linoleic acid (C18:2) and oleic acid (C18:1) as the major fatty acids.

Further the internal draft-tube airlift photobioreactor has been modeled and simulated for the prediction of hydrodynamics, gas holdup, light intensity and volumetric mass transfer coefficient using computational fluid dynamics and its experimental validation is under progress.

Also, to elucidate and understand the role of light, the microalgae *Scenedesmus obtusus* was cultured outdoors under non-mixing (static) conditions operated at different culture depths under nutrient replete condition. The pond with 3 cm culture depth showed the highest biomass productivity (49.05±11.74 mg L^{-1} day^{-1}). The high surface solar irradiance (1831 μmol photons $m^{-2}s^{-1}$) led to a decrease in chlorophyll content (from 12.21 to 4 μg mg^{-1}). The long duration exposure to lower temperatures (≤ 20ºC) during night led to an increase in poly unsaturated fatty acids (PUFAs) content (47.21±2.83% mass fraction of FAME). The omega-3 α-linolenic acid (ALA) content rose significantly reaching 31.01±3.79% mass fraction of total fatty acids. The high content of lipid (21.55±1.43% w/w), carbohydrate (23% w/w), palmitic acid (30% w/w) and ALA in outdoor cultures makes this microalga a potential candidate for outdoor cultivation for food, feed and fuel applications.

Scale-up and downstream processing of *Morus alba* *(Nandini P Shetty)*

The major aim of the project was to popularize and commercialize the process for better use of underutilized fruit *Morus alba*. It also aims at generating data on the nutritional and nutraceutical benefits. Even though the fruits are consumed the nutritional potential of these fruits have not been exploited. Hence the data generated from this project could be published and this information would impart knowledge on the nutrient potential of this fruit which can be further exploited and commercialized. In addition to essential primary metabolites, there are many other compounds in this fruits such as anthocyanin, resveratrol and deoxyneojirimycin which are important metabolites especially for food industry. Further these compounds are also rich in phenolic compounds which impart health benefit. These compounds were detected by screening different varieties and stages of leaves and fruits and the germplasm with high amount of these compounds were used to establish *in vitro* culture systems. The scaling up of these high-value metabolites would enhance the production of the metabolites which could be used in food products.

Moringa seed protein for water purification *(Radha C)*

The objective of the study was to develop a process for water purification using moringa seed protein. Moringa seed protein isolate was prepared from defatted moringa seed flour at optimum conditions to get a final product having >90% protein with 60-62% yield. The prepared

protein isolate presented good coagulant activity showing that it can be used as an alternative to alum in potable water treatment. 15 mg of the protein isolate was sufficient to reduce 97% of the turbidity in one litre of synthetic turbid water of 375 NTU similar to that of alum activity. The coagulation activity was confirmed by particle size analysis and scanning electron microscopy. The TDS and conductivity remained unchanged for both alum and moringa seed protein treated water. Studies on water quality parameters like heavy metal chelation, taste and odour, antimicrobial properties and shelf life of treated water are under progress. The product will be formulated in tablet/ sachet form for rural area application.

Terpenolipids synthesis and limonene biotransformation *(Bettadaiah BK)*

Synthesis of 1-thymoloxy-2,3-diacylglycerols and 1-carvacroloxy-2,3-diacylglycerols: A convenient synthesis of 1-thymoloxy-2,3-diacylglycerols and 1-carvacroloxy-2,3-diacylglycerols has been developed. The target compounds were synthesized by attaching thymol or carvacrol with glycidol and followed by ring opening with TFA. The resultant thymol glycerol and carvacrol glycerol were esterified with fatty acids of various chain lengths (Scheme). The products were well characterized and their thermal stability by DSC indicated that these compounds are quite stable. A study of their applications is being taken up.

Upgradation of *Neera* technologies
(Ramalakshmi K)

Neera is a highly nutritive sugar containing juice obtained by tapping the unopened spadix of the coconut palm which ferments very quickly. A process was developed for the preservation of *Neera.* Process assures the reach of unfermented and safe premium *Neera* to the customers. Coconut sap was collected in a chilled condition, filtered and formulated with permitted additives followed by pasteurization and hot filled in food grade PET bottles. The colour and taste of the processed *Neera* is close to original *Neera* with the shelf-life of two months at room temperature. Process parameters were standardized for coconut sap concentrate which on dilution with water in the ratio of 1:5 or 1:6 produced the coconut sap which is almost like fresh *Neera*. This concentrate can also be distributed as a carbonated beverage through vending machines. Two technologies were developed and are ready for commercialization.

Edible confectionery chews and functional beverage mix for sports personnel *(Chetana R)*

Various raw materials were screened for their anti-fatigue properties. A carbohydrate rich diet is known to improve endurance performance and malted cereals are best known for their use in most beverages. A blend of malted wheat and ragi were chosen as the base materials for formulation of the mix. Research has linked endurance performance during exercise and pre-exercise muscle glycogen concentration to the type and amount of carbohydrates consumed. In long-duration exercise, a greater contribution of exogenous carbohydrate (carbohydrate ingested in beverages or other foods) will spare liver glycogen, prevent a drop in blood glucose concentration and help maintain the high rate of carbohydrate oxidation. Rich source of biologically active compounds with potential therapeutic values were incorporated into the functional beverage mix (FBM) for improved health benefits and anti-fatigue properties.

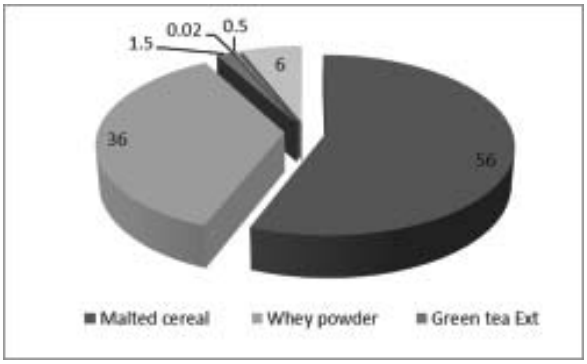
Other materials chosen for anti-fatigue properties were whey powder - a good source of branched chain amino acids which play a major role in sports nutrition especially in beverages. Green tea extract, curcumin and dark chocolate which are good sources of polyphenols and potent antioxidants were also chosen along with a few additives for making a beverage mix. A beverage mix was formulated using the above mentioned raw materials. After many preliminary trials wheat and ragi were chosen for the study. The cereals were soaked overnight, sprouted for 32-36 h, dried and then roasted

Processed *Neera*

Neera concentrate

to obtain a malted flavour. This was then ground into a fine flour, sieved through a 150 mesh sieve for obtaining extremely fine flour. The sieved flour was cooked to gelatinize the starches and all the other ingredients were added carefully so as to get a homogenous solution. The resultant solution was then spray dried to obtain a FBM. The formulation and processing parameters for preparation of the beverage mix were standardized.

DNA protection activity of the functional beverage mix was shown by using Fenton's reagent which causes DNA fragmentation (as visualized by increased electrophoretic mobility of DNA) and recovered with the treatment of water extract of FBM prior to oxidative stress. A significant protection to native DNA during oxidation in the presence of the FBM extract was observed.



Formulation of the functional beverage mix

LONG TERM STRATEGIC RESEARCH

Benefit of zinc supplementation along with iron and calcium *(Kalpana Platel)*

Negative interactions between minerals interfering with each other's absorption are of concern when iron and calcium supplements are given to pregnant women and children. Previous findings indicated that supplemental levels of iron and calcium inhibited the bioaccessibility of zinc, and compromised zinc status in rats fed diets with high levels of these two minerals. It was further observed that supplemental levels of iron and calcium interfered on the recovery of zinc status during a zinc repletion period in experimental rats rendered zinc-deficient.

The effect of zinc supplementation along with iron and calcium on recovery of zinc status in zinc deficient rats was evaluated. Zinc was added exogenously along with supplemental levels of iron and calcium to the diet. Zinc deficient rats were maintained on these diets for a period of 10 days. Body and organ weights, zinc concentration in serum and organs, and activities of zinc-containing enzymes were studied at the end of the dietary regimen. The body and organ weights of rats supplemented with zinc during repletion period were higher as compared to unsupplemented rats. There was no negative effect of iron and calcium on body weight and organ or bone weights during repletion, when supplemented along with zinc. There was a significant improvement in zinc concentration is serum, bones and organs such as kidney, liver and spleen.

Supplementation with zinc also brought about significant increase in the activities in zinc containing enzymes in serum and liver. The activities of these enzymes remained higher even when iron and calcium were present at supplemental levels. Thus, supplementation with zinc along with iron and calcium may be necessary to counter the negative effects of iron and calcium.

Zinc supplementation in experimental diabetic rats *(Srinivasan K)*

Oxidative stress plays a major role in the pathogenesis of diabetes mellitus which further exacerbate cardiac, hepatic and renal damage. This animal study documented the potential of zinc supplementation in modulating oxidative stress and showing cardio protective effects in diabetic rats. Experimental diabetes was induced in Wistar rats by streptozotocin administration. Groups of diabetic rats were subjected to dietary interventions for 6 weeks with zinc supplementation (5-fold and 10-fold normal level). Supplemental zinc fed diabetic groups showed significant lowering of diabetes induced oxidative stress in terms of altered antioxidant enzyme activities and concentrations of antioxidant molecules. Hypercholesterolemia and hypertriglyceridemia were significantly countered by zinc supplementation. The pathological abnormalities in cardiac and hepatic tissue architecture of diabetic animals were significantly ameliorated by dietary zinc intervention. Elevated hepatic and cardiac markers in circulation of diabetic animals were controlled by dietary zinc supplementation.

The present study also explored if zinc supplementation protects against diabetic nephropathy through modulation of kidney oxidative stress and inflammatory transcription mRNA expression. Supplemental zinc fed diabetic animals showed significant control on kidney index, and glomerular filtration rate. There was a significant reduction in protein glycosylation, oxidative stress as well as hyperlipidemic condition of kidney in diabetic animals maintained on a zinc supplemented diet. Significant alteration in mRNA expression of inflammatory markers (COX-2, NF-κB and TNF-α) and transcription factors (RAGE and TGF-β1) in diabetic kidney concomitant with reduced AGE fluorescence was also indicated by zinc supplementation. The pathological abnormalities in renal architecture of diabetic animals were significantly ameliorated by dietary zinc intervention.

Flavonoids in green gram and its exudate *(Prasada Rao UJS)*

The total flavonoid content, vitexin and isovitexin content in different tissues of green gram obtained during milling and the exudates obtained during early germination of green gram were determined. Flavonoid content was higher in husk (31 mg/g husk) followed by plumule,

aleurone and germ rich fraction, whereas dhal had the least (0.6 mg/g). Vitexin and isovitexin were found to be the highest in husk and the lowest in cotyledon.

Purification and biochemical characterization of green gram root peroxidase *(Prasada Rao UJS)*

Peroxidase activity increased in whole sprouts and also in all tissues during germination of green gram. Peroxidase activity was significantly increased up to 300-folds in germinated green gram seed. Among different tissues of 5 day germinated seed, root has the highest specific activity followed by shoot, cotyledons, first pair leaves and seed coats had the least. As green gram roots had the highest specific activity of peroxidase than other tissues, root peroxidase purified sequentially using three different chromatographic steps, viz., Octyl-Sepharose, Con A-Sepharose and Sephadex G-100. Purified peroxidase showed a single peak on C-18 RP-HPLC column and on SDS-PAGE it showed a band with a molecular weight of 45 kD. The metal ions, Li^{+}, Mg^{+2}, Mn^{+2}, Ca^{+2}, Al^{+3}, Na^{+}, K^{+} and Hg^{+2} inhibited the peroxidase activity whereas Cu^{+2} increased three-fold activity but there was no inhibition by Zn^{+2} and Fe^{+3} ions. DTT and L-cysteine HCl inhibited 100% peroxidase activity at 5 mM and 10 mM levels, and sodium azide (5 mM), hydrazine, CTAB, oxalic acid, citric acid inhibited 50% of peroxidase activity. However, EDTA and guanidine-HCl did not show any enzyme inhibition. The purified peroxidase was immobilized in sodium alginate beads. Native and immobilized peroxidase was used for the removal of phenolic compounds such as phenol and *p*-chlorophenol in an aqueous system. Native green gram root peroxidase removed 90% phenolics whereas immobilized peroxidase removed 78% phenols and horseradish peroxidase 84% phenols from aqueous mixture.

Ferulic acid esterase activity *(Muralikrishna G)*

Xylanase, xylosidase and ferulic acid esterase (FAE) activity were increased during fermentation of both wheat bran and xylo oligosaccharides (XOS). The enzyme activity was maximum in extracts of *Aspergillus niger CFR1105* grown on wheat bran as compared to XOS.

The 120 h extracts of wheat bran (WB) and XOS showed maximum xylanase activity (9.26×10^{-6} µM/ml/sec-WB; 2.91×10^{-6} µM/ml/sec-XOS). Wheat bran extract showed threefold more xylanase activity as compared to the XOS extract. The 96 h extract of wheat bran showed maximum xylosidase activity (32.3×10^{-8} µM/ml/sec) whereas 144 h extract of XOS showed maximum xylosidase activity (5.77×10^{-8} µM/ml/sec). Wheat bran extract showed 5-6 fold increase in xylosidase activity compared to the XOS extract. The 120 h extracts of wheat bran and XOS showed maximum FAE activity (4.03×10^{-10} µM/ml/sec-WB; 4.63×10^{-10} µM/ml/sec-XOS). Wheat bran extract showed more or less same FAE activity as compared to the XOS extract. These studies showed that wheat bran was found as a better substrate for the growth of *Aspergillus niger CFR1105* with respect to the induction of arabinoxylan degrading enzymes as compared to XOS. Thus purification of FAE was done from wheat bran extract.

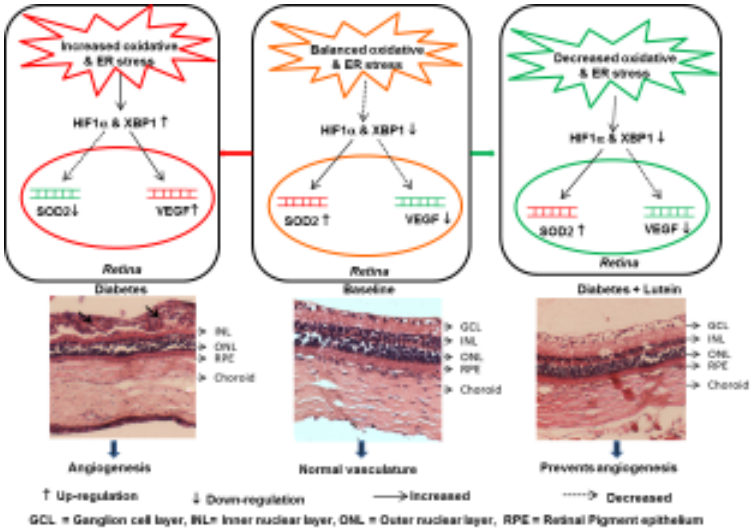
In wheat bran extract a very low FAE activity was detected at 24 h. After 24 h, the secretion of FAE increased progressively up to 5 days and reached the maximum (4.03×10^{-10} µmol/ml/sec) on 5th day. Therefore for the purification of enzymes, the 5th day wheat bran extract was used.

The extract was subjected to ammonium sulphate precipitation and about 70% activity was present in 35-65% saturated ammonium sulphate fractions, which was loaded on DEAE – cellulose ion exchange column after dialysis. The bound proteins were eluted with linear gradient of NaCl (0-0.5 M) which yielded FAE activity peaks. These major FAE activity peaks were purified on Sephacryl S-100 and their N-terminal analysis is being done. These enzymes will be cloned in *E. coli* / yeast.

Age related macular degeneration *(Baskaran V)*

Lutein, an essential retinal carotenoid was assessed for retinal angioprotective efficacy via hypoxia inducible factor (HiF1α) and X-box binding protein 1 (Xbp1) pathway in streptozotocin induced diabetic rats. Streptozotocin induced diabetic rats were gavaged with lutein or without lutein for 8 weeks. Lutein prevented the upregulation of VEGF and downregulation of SOD2 in retina of diabetic rats and also prevented ganglion cell degeneration in diabetic retina. At transcriptional level, lutein decreased the levels of Hif1α and Xbp1 as evidenced by immunofluorescence. The study suggests that the anti VEGF property of lutein is via decrease in the mRNA expression of Hif1α and Xbp1 and via increased expression of SOD2 at both protein and mRNA level.

Also, the effect of lutein on cardiac and renal polyol pathway enzymes and oxidative stress markers in streptozotocin (STZ)-induced hyperglycemic rat model was investigated. Lutein administered diabetic rats showed better glucose tolerance as evidenced with OGTT and biweekly urine glucose when compared to diabetic rats (negative control). Activities of aldose reductase and sorbitol dehydrogenase were decreased in heart and



Possible mechanism of lutein in ameliorating retinal VEGF upregulation in diabetic rats

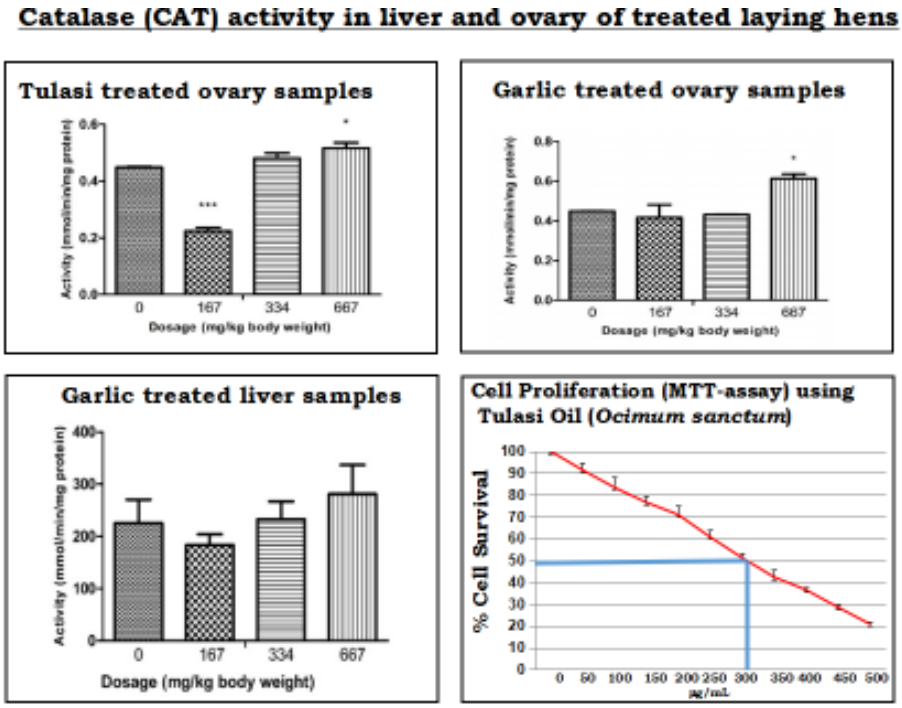
kidney in lutein fed diabetic group. Also, lutein fed diabetic rats had significantly ($p<0.05$) decreased malondialdehyde levels (66, 34 and 33%) and increased reduced glutathione level (81, 18 and 92%) in serum, heart and kidney which was altered in diabetic rats and was comparable with positive control rats. Altered antioxidant enzyme activities like superoxide dismutase, catalase, glutathione peroxidase, glutathione reductase and glutathione transferase were also affected in serum, heart and kidney of lutein fed diabetic group. Lutein prevented cardiac and renal injury in STZ-induced hyperglycemic rats due to potential amelioration of altered activities in polyol pathway and oxidative stress markers.

Non-alcoholic fatty liver disease *(Mahesha H Gangadhariah)*

Nonalcoholic fatty liver disease (NAFLD) is emerging as an important cause of liver disease in India. The role of metabolites of arachidonic acid produced by Cytochrome P450 during diseased condition such as NAFLD was studied. For inducing fatty liver, a diet induced model was chosen, wherein rodents were given a modified fast food diet (FFD) comprising of normal diet supplemented with cholesterol and cholic acid along with a microdose of CCl_4 (0.5 ml/kg bwt). Ten week old Wistar rats were used. Animals were randomly assigned to two groups, consisting six animals per group per sex. Group G1 comprised of animals on chow diet, G2 animals were fed a Fast food diet (FFD) and received a CCl_4 micro dose of 0.5 ml/kg b.wt. The FFD consisted of 2 g cholesterol and 0.5 g cholic acid mixed with normal chow diet made up to 100 g to increase calorie content in comparison to the chow diet. Further, 15 g fructose was mixed in 100 ml drinking water for G2 animals. Group G2 was administered CCl_4 (assay purity: >98%) at 0.5 ml/kg b.wt by oral gavage after dissolving in corn oil once weekly for the first two weeks and then on alternate weeks thereafter (i.e., 4th, 6th and 8th wk). Livers from all animals on FFD with CCl_4 appeared pale enlarged and showed a significant increase in liver weight ($p < 0.025$). All animals on the FFD with CCl_4 animals lost >10% weight compared to the chow diet-fed animals without any change in weekly food consumption. Fasting blood glucose levels showed significant difference between chow diet-fed animals and modified FFD, with the animals on FFD having higher levels compared to chow fed animals. Oral glucose tolerance test showed severe glucose intolerance in FFD + CCl_4 animals compared to chow diet-fed animals. Estimation of liver injury was done by assessing the serum biochemical profiles. AST, ALT and ALP, known serum markers of liver injury was elevated significantly in animals on FFD compared to chow fed animals. Liver TG was significantly elevated in FFD animals. To assess the extent of reactive oxygen species mediated damage, the level of glutathione was measured which significantly depleted in FFD animals and liver TBAR level was elevated in FFD animals suggesting that FFD caused oxidative stress. Histological examination of liver tissue showed hepatocellular ballooning and infiltration of inflammatory cells. Further studies are in progress to evaluate fibrosis and the effect on Cytochrome P450 under such pathological conditions and its modulation by nutraceuticals.

Laying hen a spontaneous model of human ovarian cancer *(Nawneet K Kurrey)*

Allium sativum (garlic), *Ocimum sanctum* (tulasi) and *Asparagus racemosus* (shatavari) are traditionally used for remedies for particular ailments, but systematic and scientific studies have not been conducted to validate



their role in modern age diseases such as cancer. Different parts of plant were taken tulasi (leaves), garlic (bulb) and shatavari (root) for extraction. Ovarian cancer PA-1 cells were exposed to various concentrations of extracts to determine the level of cytotoxicity. Extracts showed concentration dependent significant reduction in cell viability and altered cell morphology in ovarian cancer cells. The MTT result showed that the oil extracts from tulasi exhibited significant cytotoxic effects in PA-1 cells with an IC_{50} value of 307.96 µg/mL. Concurrently, animal experiments were conducted using one and half year old laying hens. Hens were fed diet supplemented with 167, 334 and 667 mg/kg body weight doses of *Allium sativum* (garlic), *Ocimum sanctum* (tulasi) and *Asparagus racemosus* (shatavari) for 21 days and changes in surrogate endpoints were evaluated to determine the optimum dose for long term study. In initial analysis, catalase an antioxidant enzyme was assayed for liver and ovary tissues. Results showed a dose dependent increase in catalase activity in ovary and liver tissues with garlic and only ovary tissues with tulasi treatment groups compared to control group. Further, *in-vitro* and *in-vivo* studies are going on to validate the role of these natural products in ovarian cancer.

Multi–targeted nutraceuticals in breast cancer models *(Hema Kumar & Shylaja M Dharmesh)*

Different cancer cell lines such as MCF-7 (breast cancer cell line), MDA-MB-293 (breast cancer cells) were maintained in the laboratory and tested for sulfatase 2 activity, which is a maker for aggressive tumorigenicity of breast. Both the cell lines showed significant activity. Sulfatase 2 enzyme cleaves off sulfate from estrogen sulfate, thereby increasing the level of estrogen which in turn activates breast cell proliferation and malignancy. Blocking of sulfatase 2 enzyme activity was thus addressed using dietary sources. Of the sources screened, ginger (*Zingiber officinale*), bael (*Aegle marmelos*) and turmeric (*Curcuma longa)* were selected for the study. Results were compared with known sulfatase inhibitor for sulfatase – 2,4-disulfo phenyl ter-butyl nitrone – NXY - 059) and Suramin (Sn), which are used in anticancer therapy for breast cancer. Results of the analysis indicated that ginger and bael fruit extract inhibited sulfatase 2 activity with IC_{50} of ~3.2 µg/mL and 9.12 µg/mL respectively. Since turmeric extract also showed potent sulfatase 2 inhibitor activity, the active component of turmeric - curcumin was compared with known sulfatase inhibitors – NXY-059 and Sn. Data revealed that curcumin offered 50% inhibition at 16 µM, while NXY-059 and Sn inhibited at ~312 and 167 µM suggesting ~10-20 fold increase in activity in curcumin when compared to that of the known inhibitors. Curcumin also showed potent antiproliferative activity against a breast cancer cell line, MCF-7 at 3 µg/mL level. Data thus may highlight that dietary component like curcumin may have the potential to target breast cancer via probable inhibition with sulfatase 2, a rate limiting enzyme in breast cancer carcinogenesis.

Impact of nutrition education *(Deepa Prakash & Akhilender Naidu)*

The study was aimed to assess the impact of nutrition education based on a psychometric model with positive reinforcement on food behaviour, nutrition knowledge, nutrition status, cognitive performance and physical endurance of police personnel in Mysuru city. Pilot testing is in progress to assess and standardize all protocols. Cognitive performance (n=11) was measured using Digit Span Test (Digit Forward Scores=4.09±0.70, Digit Backward Scores =1.18±0.75), Raven's Progressive Matrices (Score=30.09±9.41) and Manual Dexterity Test (433.55±80.98 seconds). Average Body Mass Index (n=37) was found to be 25.50±3.28. The study also entails biochemical assessment to determine the overall nutrition status of the subjects.

Fortified beverage for improvement of cognitive performance and physical endurance *(Deepa Prakash & Akhilender Naidu)*

The study is aimed at induction of dehydration and rehydration with beverages to improve the cognition and physical endurance. 10 male Swiss albino mice were taken and observed for feeding and drinking behaviour for a period of 30 days. The per capita mean daily water and feed intake was recorded as 6±0.8 ml and 6±1.03 g, respectively. The average water intake during 6 pm to 6 am (night) was recorded as 5.1± 0.8 ml and during 6 am to 6 pm (day) was recorded as 1.13±0.44 ml. The mice were dehydrated overnight and rehydrated them again in the morning with 50% daily allowance. The animal could drink 10, 25, 40, 50% of the allowance within 5 min, 15 min, 2 and 4 h, respectively. Assessment of physical endurance and cognitive performance using Morris Maze study, T Maze study, Y Maze study, Eight Armed Maze study and rotorod apparatus are under progress.

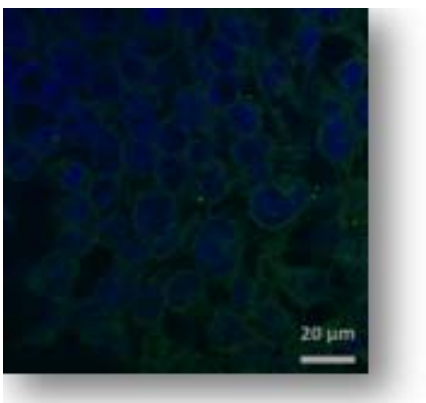
Diabetes and pathology of the lung *(Ravindra PV)*

Diabetes profoundly affects multiple organs in the body such as kidney, heart, brain, liver and eyes in long term. The gradual loss of function in these vital organs contributes for the mortality. Nonetheless, the effects of diabetes on the lung tissue are not well explored. The study demonstrates that diabetes induces inflammatory and fibrotic changes in the lung. These changes were mediated through the TGF-β activated epithelial to mesenchymal transition (EMT) through the involvement of both SMAD-dependent and -independent signalling pathways. Additionally, the study also revealed that calorie restriction (CR) promoted the mesenchymal to epithelial transition (MET) and substantially reduced the expression levels of inflammatory, fibrotic and EMT marker genes in cells cultured from the lung of diabetic rats suggesting that diabetes-induced EMT was mediated in part through the effect of hyperglycemia and that CR can ameliorate above pathological changes.

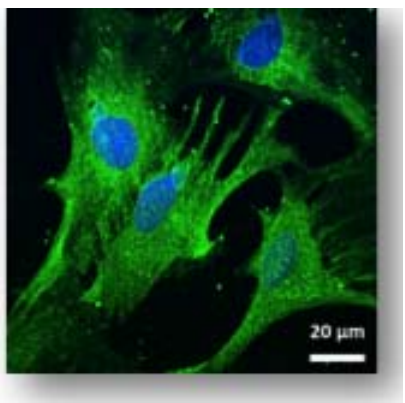
Bioactive lipid for modulation of inflammation *(Ramprasad TR)*

The production of cytokines 1 and expression of inflammatory genes like COX-2 and lipoxygenase was studied. Reducing the biological activities of cytokines can decrease the impact of arthritis. Blocking IL-1 or TNF has been highly successful in patients with rheumatoid arthritis. Hence the systemic level of IL-1 β, IL-6, MCP-1 and TNF-α was studied. In arthritis, all the inflammatory cytokines studied were found to be significantly higher compared to the controls and piroxicam administered rats. Feeding native SO and RBO significantly reduced the level of IL-1 β, IL-6, MCP-1 and TNF-α compared to GNO fed animals. However, removal of minor components significantly influenced the effect by reducing the e=cytokine lowering effects.

Control



Diabetic



Galectin-3 inhibitory potential of modified citrus pectin *(Shylaja M Dharmesh)*

Citrus pectin of varied size was prepared based on optimized conditions as per the norms of the company. Approximately 26 samples were analysed for galectin-3 inhibitory property, which depicts the anti-metastatic potentials of the compounds. Results of the study were compared with S13 - Pectasol – C (CP) which is also a pectin isolated by citrus pectin and commercialized in USA. Data revealed that LMCP, a low molecular weight (<3 kDa), acid unwashed modified citrus pectin showed ~10 folds better galectin-3 inhibitory activity as opposed to that of unprocessed citrus pectin (UCP) as well as S13. Series of tests conducted both *in vivo* and *in vitro* substantiated that LMCP is a potent anti-proliferative, apoptotic and cyto/DNA protective compound with better efficacy than S13. Attempts are being made to understand its structure to establish structure - function relationship to explore further as a potential anti-metastatic agent similar to or better than that of S13.

Maternal diabetes on brain glycosaminoglycans *(Nandini CD)*

Gestational diabetes is one of the major complications during pregnancy. Maternal hyperglycemic conditions retard neural development of the fetus. Brain is a fundamental organ which starts to develop during early stages of embryonic period and glycosaminoglycans (GAGs) are one of the key molecules involved in animal development in general and neuritogenesis in particular. Present study focuses on the effect of *in-utero* hyperglycemia on pre- and post-natal brain glycosaminoglycans. Pregnant rats were rendered diabetic by injecting streptozotocin intraperitoneally. First group of pups were euthanized on the day of delivery (post-natal day 0, P0), second group at the end of weaning period (post-natal day 22, P22) and the last group euthanized after 8 wks, when they reached adulthood (P8W). Brains from all developmental periods were taken up for further analysis. Offspring of diabetic mother showed decreased body weight and brain weight and became hyperphagic when they reached adult hood, which was attenuated by quercetin and naringenin treatment. Further work towards deciphering changes in key molecules in brain development namely the proteoglycans/ glycosaminoglycans are under progress.

Maternal hypercholesterolemic diet on liver glycosaminoglycan *(Nandini CD)*

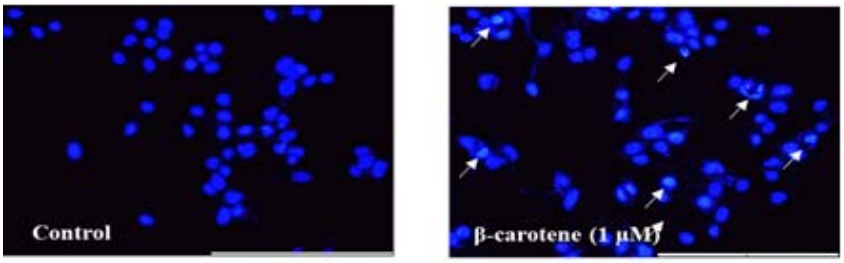
The main aim of this project was to elucidate changes in liver glycosaminoglycans as a result of feeding cholesterol in pregnant rats. Liver glycosaminoglycans are one of the key molecules involved in liporoptein metabolism and are regarded as one of the co-receptors for lipoproteins along with LDL receptors. Furthermore, maternal diet is known to play important roles in growth and development of the organism and its predisposition to various diseases when it reaches adulthood as a result of maternal environment exposure. Despite these, no studies have been carried out so far to determine the importance of maternal hypercholestrolemic on foetal outcomes in terms of glycosaminoglycan metabolism. Animal experiment is under progress.

Carotenoids against human breast cancer cells *(Ganesan P)*

The methods for the isolation and purification of carotenoids, lutein and β-carotene were standardized. With the standardized protocol, the purity of lutein and β-carotene obtained from *Spinacia oleracea* and *Chenopodium album* was 95 ± 2%. The purified carotenoids inhibited the growth of human breast cancer (MCF-7) cells in a dose dependent manner. Further, these carotenoids were found to induce apoptosis in MCF-7 cells. This growth inhibitory effect was in association with reduced expression of Bcl-2, NF-kb and SOD-2 proteins.

Chromosomal segregation of *Mycobacterium smegmatis* *(Ravi Kumar)*

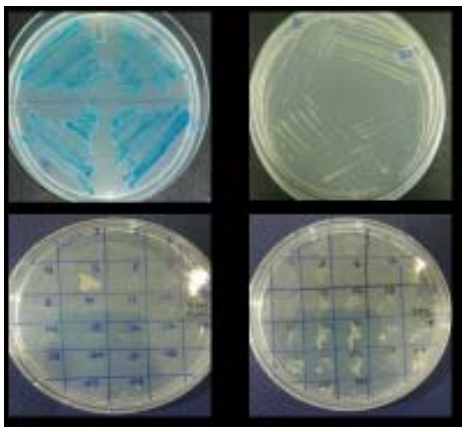
Chromosomal segregation in bacteria is a crucial phenomenon which regulates the controlled segregation of chromosome in the new daughter cell and the process of segregation of chromosome is quite different from that of the eukaryotes. The study focuses on the



chromosomal segregation of *Mycobacterium smegmatis*. A few crucial proteins such as ParA, ParB, ScpA and ScpB involved in chromosomal condensation and segregation have been overexpressed and purified by metal affinity chromatography. In addition an unmark deletion of scpB gene in *M. smegmatis* chromosome have been generated to further characterize its role in bacterial cell division.

FAD synthetase from *Helicobacter pylori* *(Ravi Kumar)*

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 *H. pylori* was cloned in an expression vector pET28a and the protein of interest was purified by metal affinity chromatography. Further biochemical and biophysical characterization of this protein is under progress. In addition, a homology model of FAD synthetase of *H. pylori* was generated and the active site in the C-terminal domain of the protein has been docked with FMN.



Generation of scpB deletion strain of *M. smegmatis* involving a two-step strategy of single cross over (SCO) and double cross over (DCO)

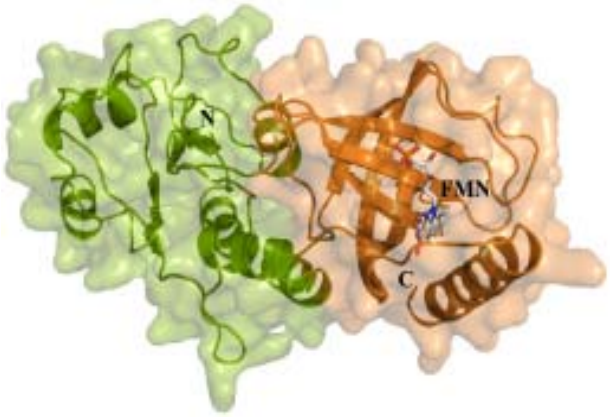
Osteoanabolic agents in food for the prevention and/or treatment of post-menopausal bone loss *(Kunal Sharan)*

Ten pure molecules and enriched extracts from food source for their effect on osteoblast survival by MTT assay were screened. Out of these ten, 4 were found cytotoxic to the primary osteoblast cells. The non-cytotoxic pure molecules and extract obtained were checked for their ability to enhance osteoblast cells differentiation by alkaline phosphatase activity assay. Out of these six molecules PSO was found to activate osteoblast cells differentiation. Besides osteoblast differentiation, the ability of PSO to stimulate *in vitro* mineralization by osteoblast cells was also checked. The result of this study showed that PSO was able to increase the mineralized nodule formation by primary rat osteoblast cells under differentiating conditions.

It was next checked whether PSO could enhance modeling directed bone formation in growing rats by stimulating mineral apposition to promote the peak bone mass. The results showed that PSO was not only able to improve the bone mineral density and microarchitectural parameters of bone, but it could also enhance the linear growth by increasing the bone length of the animals.

Novel phages targeting food pathogens *(Poornima Priyadarshini CG)*

Food contamination and food borne diseases are mainly due to bacterial pathogens such as *E. coli*, *Salmonella*, *Campylobacter* and *Listeria monocytogenes.* Bacteriophages are naturally occurring viruses of bacteria that infect and multiply within their specific bacterial hosts.



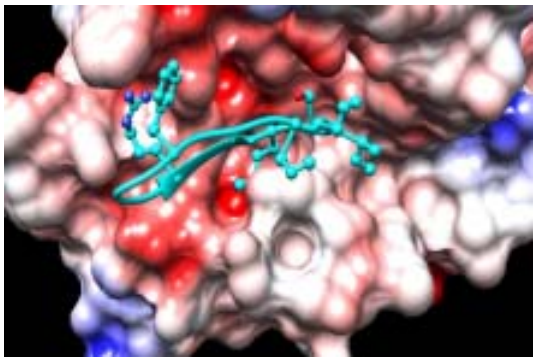
A homology model of FAD synthetase of *H. pylori*

Hence, the phages have been tried as biocontrol agents against various bacterial pathogens. However, with the increasing incidences of foodborne illness, hospitalization and deaths in animals and humans across the globe, there is greater interest in developing novel procedures for detection of these pathogens in food that are fast and enable rapid implementation of suitable control strategies. Thus the proposed study aims to isolate novel phages and characterize them.

Preservatives to contain food spoilage bacteria *(Balaji Prakash)*

Strategies typically used in structure based drug design were employed to identify molecules against food spoilage bacteria and food borne pathogens. Cloning Rel from various sources, optimization of overexpression, solubility and purification of Rel proteins from *Salmonella* and *Shigella* was carried out. Using structural bioinformatics and modelling, strategies were developed to design a small chimeric peptide inhibitor against serine proteases from *Salmonella*. The possibility of using Rel from *Salmonella* as a candidate target protein was explored. Preliminary studies were encouraging to begin a thorough study to target Rel. Similarly, peptide inhibitors were designed using modelling and bioinformatics and were subsequently synthesized for evaluation of its anti-trypsin activity. Basic criteria for its stability and inhibition were established. The peptides are heat stable to 95°C and are therefore ideal candidates for further studies to design a peptide inhibitor against specific *Salmonella* proteases.

Peptide inhibitor bound to serine protease



Exposure to monocrotophos (MCP) and hepatic lipid metabolism in rats *(Rajini PS)*

Earlier study had shown that monocrotophos (MCP), an organophosphorus insecticide (OPI), possesses the propensity to induce insulin resistance (IR) in rats on long-term exposure. IR is a multifaceted syndrome responsible for NIDDM, dyslipidemia, obesity, and hepatic steatosis and liver is the primary organ which regulates metabolic homeostasis. Hence, the present study was aimed to understand the impact of duration of exposure to MCP on mechanistic changes in hepatic lipid metabolism and its consequence on liver and plasma lipids in rats. The rats were orally administered MCP for 15 d (short-term) and 180 d (long-term). Plasma was collected and used for biochemical analysis and the liver removed, snap frozen with liquid nitrogen was used for mRNA quantification of the main regulatory genes and enzymes in hepatic lipid metabolism comprising cholesterol, triglycerides and lipoproteins metabolic homeostasis. The liver lipogenic machinery was downregulated after 15 d whereas 180 d exposure was associated with an increase in expression of transcription factors along with increased activity of key enzymes which regulate hepatic lipid metabolism. Rats exposed for long-term to MCP exhibited insulin resistance with hyperinsulinemia, hypoadiponectinemia, increased glucocorticoids levels along with impaired glucose and insulin tolerance test. Interestingly, a positive correlation between impaired insulin action and dysregulated hepatic lipid metabolism was found. Increased mRNA expression of SREBP1, ACC, FAS and SRB1 correlated with plasma and liver lipids. Findings demonstrated that long-term exposure to OPI, alter liver metabolic homeostasis and hence might be one of the major reason for increasing complications in metabolic syndrome in exposed individuals.

Metabolic dysfunction: Short term exposure of 15 days and long term exposure of 180 days to MCP was carried out to untie the relation between insulin resistance and perirenal adipose response. In conclusion, prolonged exposure to MCP alters TAG metabolism through circulatory hormonal changes, as witnessed by biochemical and molecular studies in plasma and PR adipose of MCP exposed rats. These findings validated the earlier study, which had revealed MCP exposure adversely characterizes hyperglycemia, hyperinsulinemia and hypertriglyceridemia which may lead to type-2 diabetes.

New azurin peptides as cell proliferation inhibitors (*Manonmani HK*)

Azurin, a copper-containing redox protein is produced by the bacterium *Pseudomonas aeruginosa*. Azurin is

a low molecular weight protein (128 aa – 14 kDa), having anticancer, antiviral and antiparasitic activities. The effect of azurin derived hexapeptides on *in vitro* proliferation of human cancer cell lines, human colon carcinoma (HCT 116) and *Ehrlich ascites* carcinoma (EAC) was studied. The antiproliferative activities were evaluated using the MTT cell growth assay. Apoptosis was confirmed by microscopic and FACS analysis. The hexapeptides studied exerted significant dose and time related apoptotic effects. Peptide 4 was observed to be the best among 4 peptides studied. Nystatin, Filipin and CPZ inhibitors of caveolae-mediated endocytosis completely blocked the entry of peptide 4. AFM and STEM scanning analysis of peptide 4 treated cells showed that the ultrastructure of the cell membrane to be substantially changed, with membrane roughness showing a particularly evident increase. Molecular docking studies were carried out with four different types of azurin derived peptides as ligands for inhibition against the MDM2 and to disrupt the p53/MDM2 interaction. Docking study with four peptides showed strong interaction across MDM2 pocket which indicated the inhibition of MDM2 and blocking the interaction with p53. Docking studies of the native peptide fragments of azurin indicated that the amino acid methionine plays crucial role in binding to the DBD of p53. Additionally, their mutational sequences also highlighted the importance of methonine and its position in the sequence, for efficacious binding to p53 DBD site.

Phosphine fumigation *(Manivannan S & Akmal Pasha)*

Field evaluation trials were conducted at food storage depots to establish effective phosphine fumigation protocols to eradicate strongly phosphine-resistant stored product insects. Two currently developed phosphine fumigation methods *viz.,* improved and extended protocols were evaluated for their comparative efficacy over the current method for insect resistance management. Experimental treatments with improved sealing using PVC glue and post fumigation preventive measures were evaluated performing field trials with 7 days of exposures, at average temperatures of 27 ± 2^{0}C. The data on the gas concentration profiles of the fumigated stacks were recorded at daily intervals until the termination of gas. Both pre and post fumigation counts of live adults were recorded at weekly intervals for eight weeks of post fumigation period. The results suggested that, the gas concentration reached its peak on the 2nd day of fumigation, while improved protocol recorded maximum concentration (1803 ppm), followed by the current (1574 ppm) and extended protocol (1122 ppm). The mean terminal concentrations of phosphine in the stacks treated under current (5th day), improved (7th day) and extended protocols (7th day) were 1190, 1132 and 800 ppm respectively. Peripheral sampling of the fumigated grain stacks, recorded maximum number of live adults (27 nos., 11- *O. surinamensis* and 16- *T. castaneum*) in the grain stacks fumigated with current protocol on 6th week after fumigation. The implications of the present study indicated that the current dosage of 3 tablets/tonne over 7 days exposure was capable of controlling all the natural infestation and the resistant test insect populations provided the sealing of the fumigation trap to the floor sheet was done properly. However, the use of tarpaulin for extended period after fumigation will be a probable key in limiting the occurrence of cross infestation/ re-infestation in the fumigated grain stacks.

Acrylamide mitigation study *(Ashok Maurya)*

Chakkali was chosen as the food matrix for development of mitigation strategies because of its high acrylamide content. Five molecules viz., L-citrulline, ascorbic acid, L-glutamine, L-leucine N-acetyl cysteine were tried as mitigation agent. Among all the compounds screened, N-acetyl cysteine was found as the best mitigating agent. At 0.08 M concentration the acrylamide contents was reduced from 5 ppm to 1 ppm.

Saffrole validation and occurrence

A simple RP-HPLC method was developed and validated for simultaneous determination of saffrole in cumin. The calibration curve was created at five levels, good correlation coefficient ($r^2 \geq 0.995$) was obtained. Method of trueness was assessed by recovery studies using blank matrix spiked in different spiking levels. Inter and intra assay recoveries ranged 90-110% and RSD (%) was $\leq$ 12. The limit of detection was 0.3 ppm and limit of quantification was 1 ppm. The expanded uncertainty was calculated $\leq$ 8.55% from validation data. The method validation data indicated that safrole in cumin complies with current regulatory requirements. Ten cumin samples were collected randomly from different locations of Mysore city, the safrole concentrations were ranged 8.05-20 ppm. Five samples were collected from Pilibhit district of North India randomly and screened for safrole, the values ranged from 15-25 ppm.

ω-Gliadin gene detection in wheat *(Rajashekhar Ballari & Asha Martin)*

Celiac disease (CD) is an immune mediated disease, triggered in genetically susceptible individuals by the ingestion of gluten. A strict lifelong avoidance of gluten in the diet is the only effective management of this

disease and for the prevention of subsequent complications. There is a need to develop cost effective, fast and reliable quantitative method to quantify gluten in the food samples. A 121 bp target sequence of ω-gliadin gene (U86029) was cloned in to pJET cloning vector and positive clone confirmed by PCR and DNA sequencing. Serially diluted plasmid reference material from 100000 copy to 10 copy was used as real time PCR standard. Different concentration of wheat samples were prepared by mixing wheat flour in quinoa seed flour background. Real time PCR detected as low as 0.01% of wheat which was estimated by ELISA to be 3.44 ppm of gluten. The developed real time PCR detection method for testing gluten-free products is more sensitive and reliable and can be used for testing gluten free food products.

Quantification of *Bt* cauliflower *(Rajashekhar Ballari & Asha Martin)*

The implementation of labelling regulations necessitates the development of robust GMO quantitation methods. Certified reference materials are not available for all GMOs released globally thus hindering the validation procedures applicable to testing. Dual target plasmid reference material pC35S-Cry1Ac-Hmg for the detection of Bt cauliflower was developed by inserting 126 bp P35S-Cry1Ac cross border sequence and 121 bp DNA fragment of cauliflower endogenous gene HMG-I/Y in 1:1 ratio. Applicability of the constructed plasmid as a calibrant for quantitative real time PCR was studied. The results showed that the plasmid reference material pC35S-Cry1Ac-Hmg can be used to reliably quantify 0.1% target DNA.

Evaluation of obestatin and its fragment analog Nt8U *(Uma V Manjappara)*

mRNA from the epididymal and brain tissues of mice treated with obestatin, Nt8U and saline were extracted, checked for integrity. The next generation sequencing (NGS) is under progress. Analysis of NGS data is being carried out and the differentially regulated genes to be assigned to respective pathways. Preliminary analysis of the NGS data showed upregulation of enzymes involved in lipolysis and sequestration of triglycerides in the adipose tissue. Few of the genes regulated by obestatin and Nt8U were oxidised low-density lipoprotein receptor 1, arachidonate 15-lipoxygenase and glycerol kinase-like.

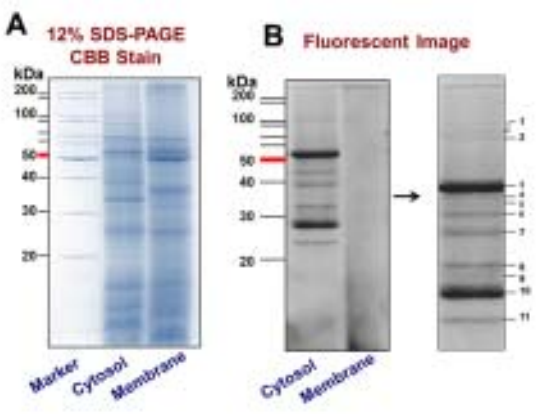
Rice bran lipases *(Vijayaraj P)*

Though there are many vegetable oils available for human consumption, rice bran oil (RBO) is known as the healthiest oil in the world. The major challenge to produce RBO is the rapid deterioration of the oil quality in the bran due to the presence of a lipolytic enzyme, which is activated during the milling process. Aim of the proposed work is to provide comprehensive knowledge about rice bran lipases and significance of the motifs responsible for catalytic specificity. This study facilitates to understand the molecular and functional characteristics of rice bran lipases and it could pave the way for new technology to improve the bran oil contents. The activity-based protein profiling of rice bran revealed 11 proteins that contain active serine hydrolases. Identified proteins were enriched by Immuno-pulldown (IP) assay, and the sequences of major proteins were identified by in-gel digestion followed by LC-MS/MS analysis.

Identification of acyl-hydrolase in rice bran by activity-based protein profiling. A. Rice bran cytosolic and membrane protein were visualized using CBB stain. B. Active serine probing of rice bran cytosolic and membrane protein. The active serine hydrolases were visualized by scanning of the gel using phosphorimager

Lipid biosynthetic enzyme modulators
(Ajay W Tumaney)

In mammals, acyl CoA:monoacylglycerol acyltransferase (MGAT) catalyses important enzymatic re-esterification reaction of the MAG pathway in enterocytes for absorption of dietary fats. Recent studies suggest that MGAT inhibition is the way to protect against obesity and other related metabolic disorders. In this project, effect of natural modulators of MGAT, is being studied. Shortlisting of foods that are implicated in weight management, lipid profile management and energy expenditure was performed. A total of 30 leads were shortlisted. These leads are being procured from authentic sources and aqueous and hydroalcoholic extracts are being prepared from shortlisted food sources. MGAT assay from mouse intestinal homogenates is being standardized and extracts will be initially screened in this system. Extracts are also



being screened to study their effect on *in vivo* accumulation of lipids in yeast.

Towards a designer lipase *(Uma V Manjappara, Sunny D Rupwate, Usha Rani D, Vijayaraj P & Ajay W Tumaney)*

A genome wide survey for identification of suitable lipase gene was carried out in non-redundant protein sequences. Seven families of triacylglycerol hydrolysing lipase gene which includes, bacterial, fungal and mammalian species were identified by using various tools related to sequence and phylogenetic analysis. Analysis of the non-redundant PDB structures of representative gene family illustrates that these lipase enzyme have a conserved alpha/beta fold and serine, histidine and aspartic acid triad in the active site which are crucial for catalysis. The detailed analysis of various crystal structures of bacterial class illustrated that there were crucial insertions near to the catalytic domain which could account for differences in substrate selectivity. Based on the key structural and catalytic features of bacterial lipases, *Bacillus subtilis* Lip A (mol. wt. 19,348) is short listed as one of the most suitable candidate for further evaluation.

Antibiotic resistance genes *(Prakash M Halami)*

Antibiotic resistant (AR) determinants along with *int* (integrase), *xis* (excisionase) of Tn*916* in *L. plantarum* and *tnp*A, *tnp*R of Tn*917* also *xis* of Tn*916* class of transposon in *E. faecium* was investigated. The bifunctional gene was also identified with a moderate gentamicin MIC values in the range of 128-256 ìg/ml. The PCR detection of the kanamycin resistance gene, *aph*(3´)IIIa revealed its prevalence in enterococci. Conjugation experiments revealed two native isolates – *E. faecium* M3G and *L. plantarum* S11T, were able to transfer antimicrobial resistance to the recipient strain. The bifunctional gene *aac*(6')Ie-*aph*(2½) Ia was found to be transferred in *E. cecorum* I40a and *E. avium* CS31+. These results were also supported by *in vivo* studies.

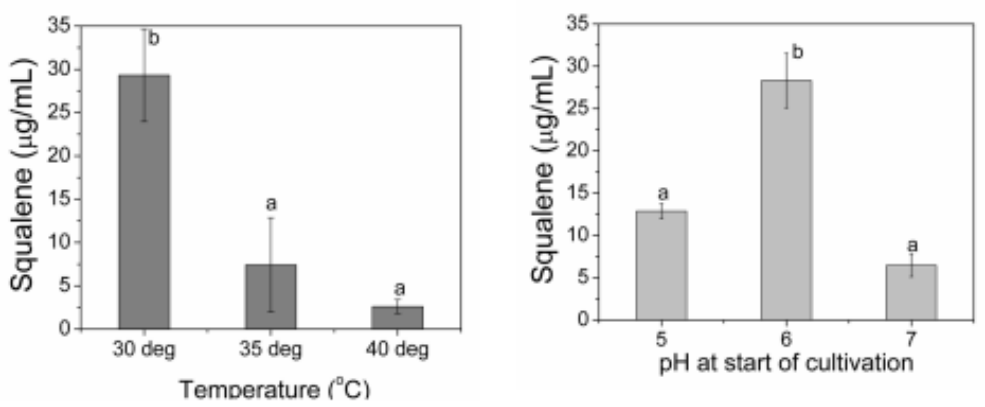
An inducible effect of tetracycline on the *tet*(M) gene was observed among transconjugants.

Aptamer based biosensing and food toxins detection *(Praveena B Mudliar)*

In vitro selection of aptamers against SPX (an algal toxin) was carried out using the affinity based SELEX protocol. Oligonucleotide which are able to bind to toxin were selected by affinity chromatography on streptavidin agarose column. After 12 rounds of SELEX cycles, an aptamer pool was obtained. The oligonucleotide pool was cloned and sequenced. Among the 30 different sequences of the pool, oligonucleotides were segregated into 7 groups based on their homology with each other using ClustalW analysis. The sequences will be further evaluated for their binding properties using both *in vitro* and *in silico* models.

Novel antimicrobial and anticancer metabolites from marine sources *(Mohan A Dhale)*

Marine bacteria are a rich source of latent valuable antimicrobial molecules. Samples collected from Chennai and Trivandrum were plated on suitable media for the isolation of bacteria. The pure colonies were sub-cultured and maintained at -20°C as glycerol stock. The isolated colonies were grown in Zobell marine broth for screening the antibacterial activity. The ACT-103, ACT-104, GM-010 isolates have shown the activity against the pathogens *Escherichia coli, Klebsiella sp., Salmonella sp., Staphylococcus aureus, Listeria sp., Bacillus cereus, Bacillus subtilis, Micrococcus sp., Pseudomonas aeruginosa.* Potent isolates were identified as *Alcanivorax jadensis, Kocuria sp.* and *Exiguobacterium sp.* respectively based on 16S rRNA sequence. Each of the above three strains were grown at bench scale (2L). Efforts were made for further extraction of the active metabolites from the cell free culture filtrate for further screening at CSIR-CDRI, Lucknow.



Effect of tHMG-CoA overexpression on squalene and OD (600 nm)

Food-grade terpenes *(Sarma MVRK)*

Segregation of wildtype and single deletion EUROSCARF strains of *Saccharomyces cerevisiae* for squalene synthesis was carried out. Squalene separation from the cell culture was carried following freeze drying, lyophilization, sonication, extraction and flash evaporation. Quantitative analysis of squalene was carried out using RP-HPLC. HMG-CoA gene was overexpressed in the selected *S. cerevisiae* strains using inducible GAL promoter and constitutive promoters (TEF/PGK). It was observed that there was significant increase in the squalene production in all the overexpressed strains probably due to the availability of HMG-CoA reductase. Results showed that there were 4.7, 9.9 and 8.9 fold increase in BY4741, Erg6Δ and Erg11Δ strains, respectively when tHMG-CoA gene was overexpressed using GAL promoter cassette. The increments although significant were not very high when constitutive promoter, TEF was used for overexpression of tHMG-CoA.

Detection of pesticides/ bacteria in food and environmental samples *(Punil Kumar HN)*

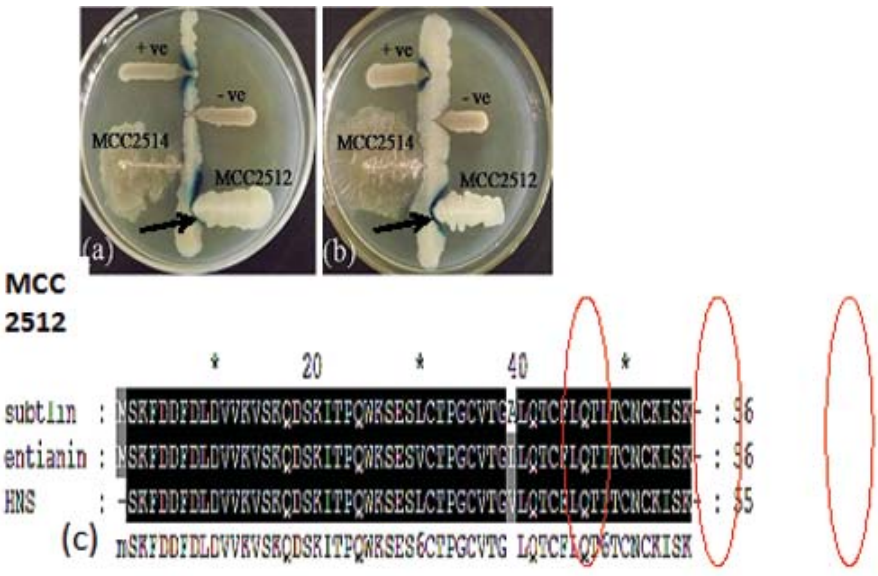
The control and detection of organophosphorous pesticide residue in food, water and environment plays a very important role in food safety. A sensitive, quick, simple chemiluminescence (CL) method has been used for the determination of methylparathion (MP) and fenthion (F) based on the reaction of organophosphates with luminol-H_2O_2 in an alkaline medium. The CL method for the determination of organophosphorous pesticides MP and F is based on the phenomenon that MP and F can apparently enhance the CL intensity of the luminol-H_2O_2 system. The optimal conditions were: luminol concentration 5.0×10^{-4} mol/L, H_2O_2 concentration 0.05 mol/L, pH value 13. Under the optimum reaction conditions, CL was linear with the concentration of MP in the range of 0.02 μg/mL-1.0 μg/mL and F in the range of 0.02 μg/mL-1.0 μg/mL. This method was successfully applied to the detection of MP and F in water, soil and food samples. The developed method was compared with GC. The average recoveries for range of MP and F by developed method and GC were comparable.

Food grade *Bacillus* sp. as probiotics *(Shobharani P)*

Study was carried out to validate the safety and efficacy of previously characterized potential probiotic *Bacillus* spp. ie., *Bacillus flexus* MCC2427 and *Bacillus licheniformis* MCC2512. *B. flexus* MCC2427 has been reported to have cholesterol reducing ability. *B. licheniformis* MCC2512 was found to produce board range of antimicrobial activity with subtilin-like bacteriocin. The antimicrobial compound produced by MCC2512 was having two amino acid variation as compared to subtilin and entianin.

Mode of action of *Bacillus* spp. by chromogenic plate assay with cellular biosensor; (a) *B. subtilis* BSF2470; (b) *B. subtilis* B168.BS2 (Arrow indicate the positive response of *B. licheniformis* MCC2512 that activated the biosensor culture to induce β-galactosidase enzyme which acts on x-gal to produce blue coloration at the junction (c) Comparison of amino acid sequence of MCC2512 with known antimicrobial peptide subtilin and entianin.

*In vivo a*cute toxicity and sub-chronic studies using Wistar rats didn't reveal any toxicity related criteria. Reduced serum cholesterol with improved HDL-



cholesterol specified the cholesterol reducing ability of the cultures. Probiotic cultures positively altered the gut microflora with increased *Bacillus* count, unaltered lactic acid bacterial count and reduced pathogenic bacteria (*E. coli, Staphylococcus aureus*, *Clostridium* spp. and *Camphylobacter* spp.). Further, a sensitive and rapid tool was developed using strain-specific qPCR-primers, through which appropriate estimation of test culture in feces was made possible.

Molecular regulation of pigments and folates in submerged carrot cultures *(Giridhar P & Nandini P Shetty)*

The anthocyanin content of callus culture of *Daucus carota* was assessed in conditions of varied ratio of ammonium nitrate and potassium nitrate or phosphate availability. In both systems, a significant inverse relationship was observed between nutrient availability and anthocyanin accumulation, with higher nitrogen concentration or limiting phosphate promoting the greatest increase in anthocyanins. Anthocyanin synthesis was linearly related to the increase in pigmented cell ratio, which increased with time and reached a maximum value of 0.787 mg/100gm FW at day 6. Total carbohydrate uptake was closely associated with increase in cell growth and sucrose was utilized. Anthocyanin induction was significantly augmented in the presence of 0.45 mM concentration of phosphate and 20 mM: 37.6 mM of NH_4NO_3: KNO_3 in MS medium. Similarly, increasing the ratio (NH_4NO_3:KNO_3) also inhibited anthocyanin production. Hence, showing that an optimum level of phosphate or NH_4NO_3: KNO_3 was required to enhance the production of anthocyanin.

Elucidating the roles of signal molecules formed during the colonization of endophytes in *Moringa oleifera* and its influence on nutrients profile of foliage was done. In order to confirm whether the effect of endophytes are due to localization or elicitation by some cell wall component, *in vitro* studies were carried out using cell free extract. Accordingly, *in vitro* cultures of *Moringa oleifera* were initiated on MS medium. After obtaining it, they were treated with cell free extract of selected organism. The data obtained in this regard revealed that the effect on metabolites were mainly due to endophyte localization. The root exudates were also collected at different intervals and analysed for yield, pH, total flavonoid content. At 72 h it was found to be maximum in treated samples which can be considered as best time of analysis.

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

The objective of this project was to understand the mechanism of bacterial stress response under different kinds of stress conditions. In order to achieve this, one of the well studied model organisms as well as a potential food pathogen, *E. coli* was chosen. In *E. coli*, one of the key stress response regulators is σ^s or RpoS subunit of the RNA polymerase. σ^s was regulated at various levels such as synthesis, activity and degradation. It was found that in *E. coli*, in response to the oxygen availability and the energy status of the cell, a three component, ArcB/ArcA/ArcZ, system regulates the synthesis of σ^s. This three component system consists of feed forward and feedback loops that operate both at the transcriptional and translational levels. So far there is no clear understanding as how this three-component network functions in regulating the synthesis of σ^s. This network was extensively studied by describing the reactions in terms of differential equations and using computational tools to simulate the network. The results suggest that in equilibrium, several rate constants were crucial for maintaining the desired level of concentrations of various proteins and mRNAs.

Oil cake rich animal feed *(Mukesh Kapoor)*

Partially purified Phy-Ck exhibited maximum activity at pH 5 and was stable in a broad pH (4-8) range by retaining more than 40% of its activity after 3 h of incubation. Phy-Ck was optimally active at 70^{0}C. Ca^{2+} was found to marginally stimulate Phy-Ck while, moderate to complete inhibition of enzyme activity was observed in the presence of metal ions and EDTA. Thermal inactivation kinetics of Phy-Ck at 50-63^{0}C in the presence of Ca^{2+} led up to 12.33-fold improvement in half-life ($t_{1/2}$) and better values for thermodynamic parameters. The K_m and V_{max} of Phy-Ck were 0.408 mM and 3.586 ìmoles/ml/min respectively. Phy-Ck was able to dephytinize agro-industrial residues with concomitant liberation of inorganic phosphate and soluble protein. Statistical optimization of phytase production from *Citrobacter koseri* PM-7 in SmF was carried out by response surface methodology (RSM) and resulted in 2.4-fold (1.038 U/ml) increase in enzyme production. Studies on purification of Phy-Ck obtained from SmF was done using a combination of ammonium sulphate precipitation, ultra-filtration and CM-Sepharose chromatography and resulted in removal of contaminating proteins.

Aroma compounds in *basmati* varieties *(Radhika Reddy K)*

Basmati samples (50), comprising of traditional as well as crosses - *HBC-19*, *Pusa basmati* and *Pusa 1121*, from different States were tested for rice length and elongation ratio (ER) as a part of confirmation of varieties collected. Rice volatiles were extracted using Head Space Solid Phase Micro-Extraction (HS-SPME) under standard conditions and separated using Perkin Elmer/ Shimadzu Gas Chromatograms against a few available standards. The chief volatile component of *basmati*, 2-acetyl-1-pyrroline, is being synthesized in the laboratory to use as a standard for testing *basmati* varieties. The volatile components were also identified on the basis of mass spectra and relative retention indices using GC-MS which is being continued. Calibration of new GC and Headspace analyzer was completed.

PROGRESS UNDER XII PLAN PROJECTS

Biological Sciences Cluster

I. New initiatives to boost Agriculture productivity through maximizing pre and post–harvest yields (AGROPATHY) *(Sathyendra Rao BV)*

Curing paddy and rice

Head rice yield: Head rice yield (HRY) is one of the important criteria for the rice milling industry. Apart from having poor cooking quality, freshly harvested paddy is also known to have a low milling yield and hence stored for a minimum of 3 months to equilibrate and to improve the milling yield. Storing of paddy also consumes lot of space, time and energy leading to capital lock up. Parboiling and steaming are the two most widely followed paddy processing methods adapted to improve milling and cooking qualities. Studies were undertaken to develop a simple and alternate method to improve the milling yield of the freshly harvested paddy irrespective of their harvesting moisture with minimum change in starch characteristics.

In order to optimize the process variables, Response Surface Methodology (RSM) was used. A second order central composite rotatable design was employed to study the combined effect of soaking temperature (°C) and soaking period (h) on the head rice yield of the freshly harvested paddy (IR-64 and Jyothi). The hardness of the freshly harvested and 3 months old rice was 244.12 N and 410.45 N, respectively. Grains soaked for 7 h at 70°C showed the maximum hardness of 531.49 N. The result obtained also indicated that as the temperature increases above certain temperature, there is a decrease in yield. The HRY of the freshly harvested rice and 3 months old rice was 4.76% and 22.33%, respectively. The maximum HRY of 50% was obtained when paddy was soaked at 70°C for 5 h. The volume expansion of raw rice was 340 ml/100 ml and 360 ml/100 ml, respectively. Among the treatments, rice grains soaked at 70°C for 5 h and 50°C for 5 h showed an expansion of 380 ml/100 ml. A simple soaking and drying method could be used to improve both the milling and cooking quality of freshly harvested paddy.

Improved methods for curing paddy and rice: Freshly harvested produce was stored in different forms viz., paddy, brown rice and milled rice in modified atmospheres like higher RH (75%) and temperature (50°C), higher temperature (50°C) and only RH (75%). It was observed that storing paddy and brown rice at higher temperature improved the head rice yield (63-79%) after 15 days of storage and improvement in cooking characteristics like reduced solid loss and stickiness was noticed. Paddy stored at higher temperature and RH for 15 days showed an improvement in head rice yield (72%) and the cooked rice properties improved appreciably. The cooked rice resembled that of naturally aged rice (i.e., cooked rice was hard and fluffy, with increased volume expansion and reduced solid loss and stickiness). Also, brown rice and milled rice showed improvement after one month. Changes in cooking characteristics were monitored every month for 12 months. It was observed that improvement in cooking

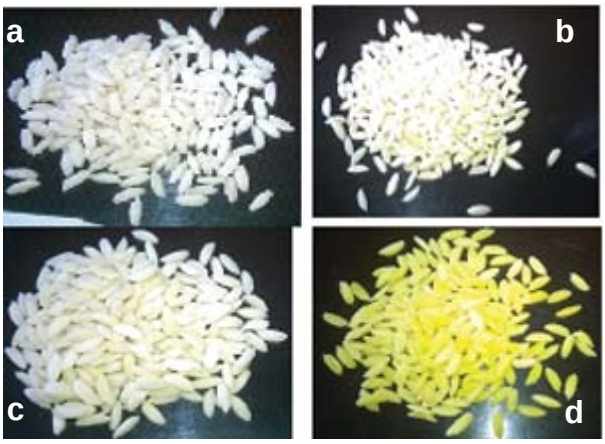
Accelerated aged rice

Naturally aged rice

characteristics such as solid loss, water uptake, and elongation ratio was observed after 10 months of storage, while reduced stickiness was observed only in the case of 12 months of storage under ambient conditions. However, such changes could be observed within 15 days of storage under modified conditions. Rapid Visco Amylograph (RVA) parameters were also monitored and variations were observed with respect to peak viscosity and setback.

Instant products from broken brown rice

Convenience flour for traditional food preparations were developed using dehusked broken red and black rice. Instant products such as string hopper, breakfast cereal and fortified breakfast cereal were developed using red rice convenience flour by cold extrusion, thermal treatments and fortification. The flours and products were analyzed for the content of polyphenol, total flavonoid, anthocyanin, tannin and antioxidant activity as well as nutritional quality.



Dried (a) protein rich rice (b) Fe rich rice (c) spiced rice and (d) carotenoid rich rice

Results showed that convenience flour from red rice retained about 75% total polyphenol, 100% flavonoids, 51% reducing power and 49% scavenging ability and reduced tannin content by 52%. On the other hand, processed black rice flour retained about 100% polyphenols, 94% flavonoids, 75% anthocyanin and 89% scavenging ability. Instant products showed retention of 24-27% total polyphenol content, 18-21% flavonoids, and 13-18% reducing power and reduced the tannin content by 70-80%. The convenience products developed using broken rice has not affected the polyphenol characteristics and antioxidant activity. The products are better compared to refined rice products in terms of phytochemical and nutritional quality.

Fabricated protein rich rice analogue using broken rice

Broken rice was used to prepare restructured rice analogue. A die was fabricated for obtaining the shape of Sona musuri rice. Attempts were made to prepare designed rice using brokens. Quick cooking high protein, high iron, high carotenoid and spiced/flavoured restructured rice were prepared which cooks in about 8-9 min with acceptable sensory attributes. Raw restructured rice is brittle but tough whereas cooked restructured rice was found soft and sticky. Protein content of the protein rich rice is about 12% compared to the normal rice which has only 6.1%. Iron content is about 15 mg% in iron rich rice and about 200 ìg carotenoids per 100 g carotene rich rice. Dried rice was opaque (opacity 99.9%) and creamy white in colour when compared to creamy white translucent normal rice having opacity 97%. Study showed that nutritionally enriched designed rice is suited for the preparation of nutrient dense quick cooking *bisibele bath* or *khichdi* mix.

Cooked (a) protein rich rice (b) Fe rich rice (c) spiced rice and (d) carotenoid rich rice

Ready mix / batter for uniformly textured *idli*

Nine black gram varieties used for the study were subjected to various analyses like amylose and protein contents, pH, functional properties, colour, fermentation capacity etc., before and after different processing steps. T-9 and MDU-1 cultivars showed maximum fermented batter volume after 16 h when fermentation capacity of the black gram varieties alone was determined at 30^{o}C$\pm$1^{o}C. Total quantity of black gram batter after fermentation from these cultivars under standard conditions was also different with maximum volumes for MDU-1, LBG-645, LBG-752 and Vbn-4, which indicate more number of *idli*s from less quantity of black gram.

However, no correlation could be made between batter volume and textural softness of *idli*. The pH of the *idli* batter ranged from 6.5 to 6.8 amongst varieties before fermentation which reduced to 4.8 to 5.6 after fermentation. The functional properties of black gram indicated a water absorption capacity range from 260 - 331 ml/100g. Though the T-9 cultivar had the best foam stability, the *idlis* were slightly hard. In addition, higher initial foam value correlated with softer i*dlis*. The amylose content varied from 17.9-20% in the black gram cultivars while the rice varieties CO-50 and TRY-3 had 26% amylose. The raw rice had higher amylose content (27%) than *idli* rice (25.4%). Similarly, the protein content of rice varieties ranged from 5.5-7.5% while the *idli* rice had ~9.4% protein. The protein content ranged from 25.4-27.6% amongst the black gram varieties.

To prepare nutritious *idli*, quinoa was substituted by rice. Parboiling of quinoa did not yield good texture for *idli*. The volume rise after fermentation was comparable to that of traditional rice *idli* batter. The shear force analysis of quinoa *idli* indicated a value (7.97±0.14 N) very close to that of control rice *idli* (7.71±0.06 N) indicating very smooth texture of *idli*. The main advantage of quinoa *idli* was that it had higher protein content (16.4%) than traditional rice *idli* (11.6%). The raw quinoa had 17.68% protein which reduced to 11.68% after processing.

The black gram, raw quinoa and processed quinoa had amylose contents of 17.54%, 12.75% and 14.85% respectively. The raw quinoa had saponin content of 1.5 g/100g. The raw quinoa had higher polyphenol content (9.73 mg/g) than the processed quinoa (7.29 mg/g).

Traditional *idli* batter, Quinoa *idli* batter before and after fermentation and Quinoa *idli*

Cinnamon as a natural preservative in rolls

Microbiological studies of the control and cinnamon rolls having 2% cinnamon were carried out on 0, 7th and 14th day of storage. The samples were analyzed for microbial safety. All the samples were found to be microbially safe. Cinnamon rolls with 2% of cinnamon bark powder was subjected to flavor profile analysis by extracting the volatile components. The concentrated and recovered flavorant was analyzed by GC and GC-MS analysis and the resultant profile indicated that the *trans*-cinnamaldehyde as the major volatile component which is known to possess preservative and anti-microbial properties. In addition to this major ingredient, the fresh sample (0 day) showed around 20 significant compounds which got degraded/ evaporated during storage at room temperature and after 2 wks. It was also found that some of the oxygenated terpenes were lost as evidenced by the GC-MS analyzed for 7th and 14th day samples. However, the stability of *trans*-cinnamaldehyde was found to be comparatively better and the storage and preservative qualities may be attributed to this major ingredient. Further studies are under progress. The flavor profile of the control and the rolls with 2% cinnamon during different storage periods were characterized. From the PCA plot it is clear that the clusters formed for control and cinnamon rolls, indicated that the volatiles from the cinnamon rolls were distinctly different from that of control samples. The different storage period also affected the volatile profiles of the cinnamon rolls.

Whole wheat flour (*atta*) storage

Lok-1 quality wheat was cleaned. Wheat was then conditioned for the short time conditioning followed by the pre-break dampening to toughen the bran and not to mellow the endosperm. Prepared wheat was roller milled to separate the bran (bran + germ) and endosperms fractions of the wheat grains.The bran fraction was treated with the dry heat, steam and microwave to inactivate the lipase activity. The treated samples were evaluated for the colour and lipase activity.

The results showed that the microwave treatment with 90s has decreased the lipase activity by 92%. Microwave treated bran fraction showed no change in the L, a* and b* colour values compared to control bran fraction. The bran fraction treatment showed that the microwave treatment is effective with less time without affecting the colour. Hence the microwave treatment was used for the further storage study of whole wheat flour (*atta*). The storage studies of *atta* at ambient and elevated temperature are in progress.

Shelf-life extension of bread with natural ingredients

Effect of combination of ingredients namely sugar, cinnamon, raisin and vinegar (SCRV) on the shelf-life of bread was studied. Microbial studies of bread showed that the control bread showed visible mould growth on 3rd day. However, breads with SCRV showed no viable count of mesophilic aerobic bacteria, yeast and moulds on 15th day of storage.

Products from wheat germ

Traditional fermented products like *dosa*, *idli* and vegan curds/yoghurt were developed using wheat germ. In case of *dosa* and *idli*, lentils were replaced with processed wheat germ. Products were evaluated sensorially and the proximate composition, texture was determined. Ready premixes for eggless, sugarless cake/ muffins have also been developed by incorporating optimally dried and powdered wheat germ. Based on wheat germ milk, a process was standardized for the production of a non-dairy vegan whitener. By using the fibre rich by-product generated during the process for preparation of wheat germ milk, an omelette like vegan product was also developed.

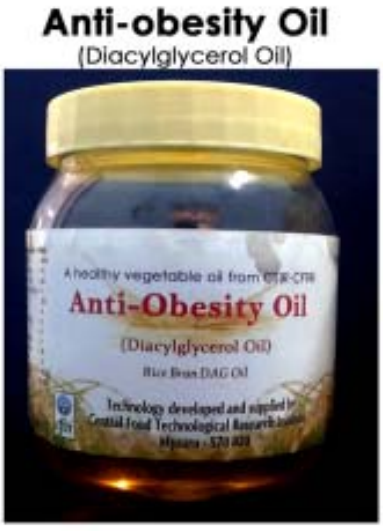
DAG oil

The anti-obesity oil enriched with DAG was produced by enzymatic lipase-mediated transesterification reaction. Diacylglycerols are chemically similar to triglycerides. They contribute to providing energy like conventional vegetable oils but do not get stored as fat in our bodies. The consumption of DAG oil can help to maintain healthy body weight as well as to manage obesity and its complications. The energy value of DAG oil and TAG oil is almost same and there is no significant difference in digestion and absorption rates. However, human body metabolize the DAG oil after absorption differently. The robust technology can be adapted for all edible oil. However, initial trials were carried with sunflower and rice bran oil.

Sunflower DAG oil, rice bran DAG oil, deodorized distillate DAG oils were prepared and packed in two different type of pouches (100 g volume; size15 X 13 cm) such as nylon and aluminium foil based laminates. The pouches were stored at accelerated (38°C at 90 % RH) and normal storage (27°C at 65% RH) conditions and storage studies were performed. The samples were withdrawn twice a week and quality assessment of the products was determined. The moisture pick up increased the FFA content and peroxide value in nylon followed by aluminium foil laminate. The increase in peroxide value was due to a higher level of free fatty acid in the starting material. Hence the package studies need to be repeated with a new preparation. Currently, the technology is available for 10 kg level. The scaling up of the process and enhancement of 1, 3-DAG is in progress.

Arabinoxylan from defatted wheat bran and rice bran

Wheat bran was defatted using hexane. The fat free residue was digested with thermo-stable bacterial alpha amylase for 1 h in boiling water bath followed by glucoamylase digestion for 48 h at 55°C in order to remove the associated starch and acetate buffer soluble polysaccharides. The starch free water unextractable bran (1 g) was further extracted separately with varying ratios of saturated calcium hydroxide in varied range containing 1% (w/v) sodium borohydride for 16 h at room temperature followed by centrifugation and the resultant supernatant was acidified with 50% glacial acetic acid to pH 4.8, concentrated, dialyzed extensively against



A healthy vegetable oil from rice bran enriched with diacylglycerols

water and then lyophilized. The yield of polysaccharides extracted from wheat bran increased with respect to increase in ratios of saturated calcium hydroxide and stirring time. Arabinoxylan isolation from 1 kg wheat bran/ rice bran is in progress.

Utilization of mango peel

Mango peel waste from Alphonso mango cultivar was collected from a mango pulp canning factory. The peels were washed and blanched to inactivate enzymes and also to remove the adhering pulp. The treated peels of mango contained a high moisture content of 83-89%. The peels were shredded and dehydrated using cross flow hot air drier till moisture reached 4-6%. The dehydrated peels were packed and stored for subsequent extraction of pectin.

Pectin extraction studies from mango peel using organic acid

Different organic acid namely tartaric acid, citric acid and acetic acid were used for the extraction of pectin from Alphonso mango peels. At different concentration of these acids from 0.1 and 0.4%, period of extraction, peel to extractant ratio, boiling period and temperature were kept constant. Extraction of pectin at these concentrations affected the yield, methoxyl content, galacturonic acid. Maximum pectin yield could be obtained with extraction by tartaric acid followed by citric acid. Methoxyl content and galacturonic acid were higher in pectin extracted from tartaric acid. Total pectin, ethoxyl content, galacturonic acid increased with increase in concentration of tartaric acid and citric acid. Pectin extraction with tartaric acid and citric acid at 3% level was found to be the maximum. Work on pilot-scale processing and production of pectin from mango peels and use of mango peel powder as a source of gelling agent in the preparation of fruit jams is in progress.

Effect of driers on different cultivars/ accessions of capsicum

Capsicum has been recognized as an excellent source of carotenoids, capsaicin, ascorbic acid and free fatty acids. Capsicum crops were collected under aseptic conditions from the fields of Haveri district of Karnataka for different harvest periods in the months of November, January and April. It was found that in the third crop, aflatoxin B1 and B2 levels were 2.7 and 1.6 µg/kg respectively. No aflatoxin occurrence could be found in fresh capsicum crops of November and January harvest. From the observation it could be deduced that the third crop is susceptible to aflatoxin contamination and the aflatoxin problem can be addressed by reducing the exposure of fresh capsicum fruits and mechanizing the drying process.

Drying conditions leads to a great deal of modifications and can cause quality degradation. In the present study, the effect of various drying methods like LH (low humidity), TD (tray drier) and IR (infrared) dryer were examined on the quality parameters of different hybrid varieties of capsicum. The quality parameters such as moisture, colour/ carotenoids, ascorbic acid, capsaicin and free fatty acids were analyzed by standard methods. The moisture content reduced with increased time interval (82.5 ± 3.5 to 11.5 ± 1.5). IR dyer showed a steep decline in the moisture content as compared to other dryers. The chromatic parameters (L*, a*, b*, C* and H°), and extractable colour were affected by drying temperature, which contributed to the discolouring of chilli during this process. The better retention of colour was observed in LHA drying methods. Higher ascorbic acid content was retained in the LHA drying methods. The unsaturated fatty acids increase by the dryer's treatment. The experiments which were done are limited to temperature difference and a use of single variety. The study has given insights into the effect of drying on various varieties in order to choose the best method for drying.

Value added products from fresh red Byadgi chilli

Sweet chilli sauce

Fresh red chillies (500 g) procured from chilli growers, Dharwad district, Karnataka were cleaned and destalked. 400 g of chillies were deseeded, chopped and grinded with remaining 100 g seeded chillies along with garlic (3 cloves) and vinegar (250 ml). The ground paste was adjusted to pH around 4.0 with vinegar. The paste was boiled on low flame with sugar (645 g) for 30 min until it thickened. The paste was hot filled into sterilized glass bottles and stored in ambient and refrigerated condition away from sunlight.

Hot chilli tomato sauce

Fresh red chillies (500 g) and tomatoes (400 g) procured from local producer were cleaned, destalked, chopped and grinded in mixie with vinegar (100 ml), pepper (15 g) and garlic (1 clove). Onion (1 bulb) was chopped and fried in oil until soft. Paste, salt and sweet chilli sauce (50 ml) was added to onions and boiled until it thickened. Hot filled into sterilized glass bottles and stored in ambient and refrigerated condition away from sunlight.

Tomato chilli sauce

Red chillies (100 g) and tomatoes (500 g) procured from local market were cleaned, destalked, chopped and

ground in a mixie with vinegar (100 ml). Paste was boiled with sugar (100 g) on low flame until it thickened (30 min). Hot filled into sterilized glass bottles and stored in ambient and refrigerated condition away from sunlight.

The processed samples were subjected to microbiological analysis. Also samples were processed in bulk and kept in three storage conditions and evaluated periodically for microbiological safety for 30 days and found to pass the test for commercial sterility. Since the samples had a pH of >4.5 and belonged to the category of low acid foods, they were thermally processed in hermetically sealed containers.

Microwave assisted extraction of capsicum varieties

The ground chilli powder was subjected to particle analyzer followed by microwave assisted extraction method for the extraction of oleoresin. The colour value was estimated by EOA method, and the capsaicin content was quantified. To check the phenolics, TPC (gallic acid) method was used and for ascorbic acid AOAC official method was done. For fatty acid analysis, lipid was extracted and FAME was done to analyse the sample. Taking the quality parameters into account the combination of ratio 1:5 (material: solvent) temperature of 60°C, power of 600 Watts and time 10 min was optimized and tested for different varieties. The above observation was compared with column process of extraction. The particle size ranged from 38-257 microns. The larger ones accounted more than 70%. The yield percent varied from 14.3-16.7% in column process and 15.5-16.9% in the case of microwave mediated extraction. The colour value was high as compared to cold process (8-80%). The capsaicin level was not that adverse (28-80%). Degradation in the level of phenolics (2-19%) were found in each microwave treated varieties. Elevated level of ascorbic acid (1-41%) was found by the treatment.

Dopaminergic neuronal dysfunction in *C. elegans* by curcumin

Parkinson's disease is a familiar neurodegenerative disease characterized by selective death of dopaminergic neurons which leads to cognitive and motor impairment in patients. Due to lack of complete cure, the present therapeutic practices are limited to prescription of dopamine against drugs which turns ineffective in long run. The present study utilized the model system *Caenorhabditis elegans* towards exploring the anti-parkinsonian effects of curcumin using γ cyclodextrin as a drug delivery system for evaluating its neuroprotective activity. Both wild type and transgenic strain expressing green fluorescent protein (GFP) specifically in the dopaminergic neurons [BZ555(Pdat-1 ::GFP)] were treated with known neurotoxin 6-hydroxy dopamine (6-OHDA) and monocrotophos (MCP), a neurotoxic insecticide for the study. The study examined the impact of curcumin on brood size, longevity, egg laying, neurodegeneration of dopaminergic neurons, and locomotion and acetylcholinesterase activity of the nematodes. The study showed that curcumin increased longevity (3 days), marginally extent of egg laying (2%) and brood size (7%), decreased the dopaminergic neurodegeneration (15%) and increased the acetylcholinesterase activity (5-13%) in the worms treated with both OHDA and MCP. Results provide evidence on the potential of curcumin to ameliorate dopaminergic dysfunction in the worms. These findings advocate the use of curcumin as a possible therapeutic intervention against Parkinson's disease.

Radical scavenging activity of coriander (*Coriandrum sativum L.*) foliage

The primary objective was to characterize Indian *Coriandrum sativum* L. foliage (*Vulgare alef* and *Microcarpum* DC varieties) and its radical scavenging activity. Foliage of *Vulgare alef* and *Microcarpum* DC contained ascorbic acid (1.16±0.35 and 1.22±0.54 mg/g), total carotenoids (1.49±0.38 and 3.08±1.2 mg/g), chlorophyll 'a' (8.23±2.4 and 12.18±2.9 mg/g), chlorophyll 'b' (2.74±0.8 and 4.39±1.3 mg/g) and total chlorophyll (10.97±2.6 and 16.57±3.2 mg/g). The polyphenol content was 26.75±1.85 and 30.00±2.64 mg/g in *Vulgare alef* and *Microcarpum* DC, respectively. Ethanol extracts (200 ppm) of *alef* and *Microcarpum* DC showed higher radical scavenging activity of 42.05±2.42% and 62.79±1.36% when compared with 95% butylated hydroxyanisole. The principal component analysis results indicated that e-nose can distinguish the volatiles effectively. Quantitative descriptive sensory analysis showed that *Microcarpum* DC variety is superior to *Vulgare alef* variety. Nearly 90% of the flavour compounds present were identified by GC-MS in both varieties. The principal component identified in both the varieties were decanal (7.645 and 7.74%), decanol<n-> (25.12 and 39.35%), undecanal (1.20 and 1.75%), dodecanal (7.07 and 2.61%), tridecen-1-al<2E> (6.67 and 1.21%), dodecen-1-ol<2E-> (16.68 and 8.05%), 13-tetradecenal (9.53 and 8.60%), tetradecanal (5.61 and 4.35%) and 1-octadecanol (1.25 and 3.67%). Further drying studies on selected coriander foliage and fixation of green colour are in progress.

Extraction of melatonin

The multiplicity of life-rejuvenating effects rendered by serotonin (SER) and melatonin (MEL) has attracted

studies into foods rich in these tryptamines, for which tropical fruits are popular. This study has established for the first time that the banana peel accumulates high levels of SER and MEL, which increase upon ripening in var. *Silk* – the yellow banana of genome type AAB rather than in the popular var. *Cavendish* (AAA).

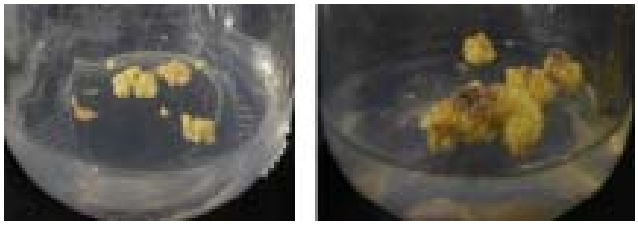
Analyses by two widely used HPLC methods, one for SER quantification and the other for simultaneous estimation (µg/g FW) of SER and MEL, revealed that SER (54 µg) in raw peel of *Cavendish* declined in ripe (39) and over-ripe stages (21.5). The pulp also had significant levels of SER ranging from 33 in raw and 20 in ripe. In *Silk* banana, SER in peel increased from 78 in raw to 111 in over-ripe stage, declining later, whereas pulp had negligible SER throughout. Since the SER content was high in peel, the outer and inner peel from different varieties of ripened banana namely *Nanjangudu rasabale*, *Silk* and *Cavendish* were selected for the analysis. It was found that higher serotonin content was present in *Nanjangudu rasabale* (14.44 mg/100 g) and in outer peel (10.54 mg/100 g), and in inner peel (3.9 mg/100 g). Where as in *Cavendish* (3.7 mg/100 g) and in outer peel (2.93 mg/100 g), and in inner peel (0.94 mg/100g) and it was comparatively low in *Silk* banana (2.7 mg/100 g) and in outer peel (0.36 mg/100 g), and in inner peel (2.3 mg/100 g). The dry peels of *Silk* and *Cavendish* were also analysed and was found to have very low serotonin content 0.1 and 0.5 mg/100 g respectively.

Production of pyrethrins *in vitro*

Best callus growth of pyrethrins, as reported earlier, occurred in MS medium containing 2, 4-D (3 mg/L) and kinetin (1 mg/L). The callus formation and proliferations were standardized in MS medium containing 2, 4-D (3 mg/L) and kinetin (1 mg/L). Further, the additional compounds like adenine sulphate, colchicine and coconut water were used to speed up the proliferation speed.

Among the combinations, MS media supplemented with 24D (2 mg/L) and Kinetin (0.4 mg/L) along with 40 mg/L adenine sulphate showed the best result (100%) when compared to other combinations. MS media fortified with adenine sulphate showed fast callus formation (within 5 days callus formation was noticed) but the MS media devoid of adenine sulphate showed slow callus formation (more than 12 days). The callus formed with the above mentioned media compositions were subjected to pyrethrins analysis.

Well established callus



Based on the above results, combination of colchicine (0.001, 0.01 and 0.05%) and coconut water (5, 10 and 15%) along with 24D (2 mg/L), Kn (0.4 mg/L) and adenine sulphate (40 mg/L) was also tried. In both media, calluses are sustained but mass proliferation was less. In colchicine fortified media, 0.01 and 0.05% concentration showed better results while in coconut water supplemented media with 5% coconut water, media showed good results.

Control of anthracnose in mango

Study to find out effective concentration of four bioactive molecules (cinnamaldehyde, citral, phenyl acetaldehyde and n-nonanal) that controls anthracnose disease (*Colletotrichum gloeosporioides* L. and *C. acutatum* L.) in *Neelum* mangoes in *in vivo* condition was carried out by adopting RSM. Results showed that n-nonanal was the most effective, followed by cinnamaldehyde, with optimum disease spread area (14.2 ± 2 mm^2) for *C. gloeosporioides* L. While phenyl acetaldehyde was found to be the most effective followed by cinnamaldehyde, with optimum disease spread area (10.88 ± 2 mm^2) for *C. acutatum* L. as compared to their respective positive control fruits (treated with 1000 ppm difenoconozole (25% EC) after 12 days of RT storage.

Bioformulations as emulsions for control of anthracnose

Optimization of concentration of suitable wall materials, emulsifiers and bioactive molecules for emulsion preparation at RT (25±2°C) was carried out. Results indicated that gum arabic at 10% and HPMC at 1% were most suitable wall materials for emulsion. Emulsion with 80:20 mixture (Tween-80; Span-80) was the most stable. Results on storage stability of emulsions with 80:20 blend mixture in combination with 1500 ppm bioactive molecule (cinnamaldehyde, citral, n-nonanal

and phenyl acetaldehyde) and with gum arabic at 10% and HPMC at 1% showed their antifungal activity negative against *C. gloeosporioides* L. as compared to the respective controls.

Surface coating emulsions on anthracnose control in mango fruits

Firm and green matured fruits from unsprayed *Raspuri* mangoes were tested with dip solutions of emulsions at 1500 ppm for 20 min from three bioactive molecules (cinnamaldehyde, citral and n-nonanal) when stored at RT (25±2°C). Results revealed that emulsion prepared from n-nonanal at 1500 ppm in combination with 80:20 blend mixture of emulsifiers (Tween-80; Span-80) and HPMC at 1% was found to be most effective surface coating emulsion, with better retention of fruit quality attributes (in terms of PLW%, fruit peel color, fruit spoilage control due to anthracnose).

Extended storage life of tomato

Studies on development of emulsifiable concentrate (EC) bioformulation(s) by using screened three plant bioactive molecules for their synergetic effect by MÉC at 1500 ppm against *Colletotrichum* in tomato were focused. Results showed that among the EC bio formulations, the blend mixture of cinnamaldehyde and nonanal of 75:25 concentration, 80:20 blend mixture (Tween-80; Span-80) emulsifiers and with 1% SDS showed better storage stability (in terms of particle size, surface tension, consistency and creaming properties) when at RT (25-28°C) for 30 days. Further, results on the efficacies of these EC bio formulations when applied as postharvest dip treatment to optimally matured *Madanapalli* tomatoes indicated that 0.1% of cinnamaldehyde+ n-nonanal (75:25) blend mixture aqueous solution with 1% SDS and 1% HPMC for 20 min showed better result when compared with positive control 0.1% difenoconozole (25% EC).

Edible plant mucilages as surface coating agents

The papaya fruits at mature breaker stage and coated at the surface with cactus mucilage showed an extended storage life of ~16 days compared to control at room temperature (~9 days) with normal course of ripening. Pectinolytic and hemicellulase enzymes like polygalacturonase (PG) and xylanase were estimated in the experimental fruits at different stages of ripening. The PG and xylanase activity increased (5.4 to 27.1 μmoles/ml/min and 7.6 to 30.1 μmoles/ml/min, respectively) with the rise in ethylene liberation and a drastic fall was observed after reaching 100% ripening in control fruits. In treated fruits a similar trend (5.4 to 28 μmoles/ml/min and 7.5 to 29.98 μmoles/ml/min respectively) was observed with the extension of time up to 16th day of storage.

To further evaluate the biochemical data, gene expression profiling of PG and xylanase in experimental fruits was carried out. During the ripening of papaya, the activities of cell wall hydrolysing enzymes increased in response to ethylene. In the current study, a coordinated and parallel increase in the enzyme activity and expression levels of PG and xylanase during the ripening of papaya was observed.

Scale up trials (200 kg, 3 trials) was undertaken with the commercial variety of papaya: var. Red Lady to evaluate the response when processed in bulk. The treated and untreated fruits were stored in plastic crates and the trend was similar to that observed in laboratory scale trails. In order to facilitate large scale handling and production of mucilage from cactus cladode, equipment for de-spinning of cactus cladode has been conceptualized and fabrication of the same is in progress.

Natural pyrethrum as food protectants

Bioassay was carried out with pyrethrum (300, 450 and 600 ppm concentration) in combination with deltamethrin/cypermethrin and PBO. The contact toxicity bioassays were performed by following filter paper impregnation method. Pyrethrum was administered in five different doses viz., 0.1, 0.2, 0.4 and 0.6 mg/cm^2 test concentrations. The mortality of the adults was recorded at 12, 24 and 48 h treatment. The % corrected mortality was calculated and subjected to probit analysis for the determination of LC_{50} values. The mortality response of the tested insects showed dose-time dependent response. The combined effect of pyrethrins, pyrethroids and PBO resulted in higher mortality than pyrethrum alone. The insect population of *R. dominica* responded well to all the three tested concentration of pyrethrum extract in combination with deltamethrin and cypermethrin. The obtained LC_{50} concentration in *R. dominica* over 48 h exposure for 600 ppm pyrethrum: cypermethrin combination was estimated as 0.624 mg/cm^2; while for deltamethrin combination a LC_{50} concentration of 0.479 mg/cm^2 was recorded. Pyrethrum-deltamethrin combination was significantly effective to *T. castaneum* when compared to cypermethrin in combination with pyrethrum, while, *S. oryzae* was more susceptible towards cypermethrin compared to deltamethrin.

Natural/ semi-synthetic phytochemicals as grain protectants

The fumigant action of *trans*-anethole against *Sitophilus oryzae* on wheat was evaluated at varying capacities

viz., 0.25, 0.5, 3.0 (glass containers) and 8.0 kg (plastic container). In all the cases the *trans*-anethole test dose was maintained at 1000 ppm level. Mortality (90 to 100) was observed in all the above cases. Oviposition was found nil as revealed by egg plug staining and F1 population was also totally inhibited. This treatment did not affect seed germination –viability. Further *trans*-anethole exhibited inhibitory effects on the developing stages of *S. oryzae.* In similar studies with *C. chinensis* 95-100% mortality was observed at working capacities of 300, 500, 1000 and 4000 g of green gram. Oviposition and F1 population were totally inhibited.

Decontamination strategies for aflatoxin

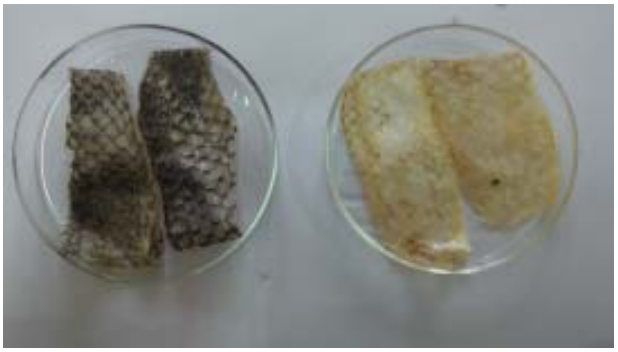
With an objective of looking at the biochemical characterization of the interaction between aflatoxin and the cognate molecules, binding of *Saccharomyces cerevisiae* 101 (live and dead cells) with aflatoxin was carried out to standardize the appropriate concentration of aflatoxin that can be decontaminated by known amount of cells. Aflatoxin was extracted from the media with *Aspergillus flavus.* Extracted toxin was tested for its purity through HPLC and HPTLC systems. The purified toxin was interacted and assessed for binding properties using the *Saccharomyces cerevisiae* (101) and AAV2 cells harvested at 24 h. Both the cells were heat killed and also hexane treated. Efforts to purify aflatoxin from culture fluid using yeast cells were conceived. Results showed that there was 40% binding (recovery). Further experiments to standardize the purification protocol are in progress.

Value added products from fish and fishery by-products

An experiment was conducted to study energy efficient drying methods and the impact of drying, on fish skins, comparing the conventional tray drying with the solar drying technique. After one hour of sun drying, the moisture content was reduced by 75% and by the end of 3 h the moisture content reduced by 90% and further drying was not achieved by extending the drying time. In case of tray drying, after one hour of drying, the moisture content was reduced by 60% and 91% of the moisture was removed by 3 h of drying which reached 95% by the end of 5 h of drying. Even though moisture reduction could be achieved by solar drying, tray drying could efficiently and uniformly dry it within 4 h. Tray drying can be used at any time of the year and at any season. However, solar drying could be employed only during summer during prolonged periods of sunlight. A procedure was standardized to decolourise the fish skins using H_2O_2 treatment and the deodorisation of gelatin was achieved by initial ethanol treatment of fish skins and final hexane treatment of dried gelatin powder. Decolourisation treatment did not affect the quality of the gelatin produced as there was no difference in the SDS-PAGE band pattern of the gelatin from untreated and treated skins. Protocol for preparation of gelatin from fish scale was standardized where, decalcification step was found to be critical. Various functional properties of fish skin gelatins were evaluated under varying pH conditions and their properties were compared with respect to commercially available bovine gelatin. The results indicated that emulsifying capacity, emulsion stability, water holding capacity and fat binding capacity of fish skin gelatin was comparable to that of bovine gelatin.

Biodegradable nanocomposite film from basil

The use of nanocomposites is a well-established approach in enhancing the mechanical and barrier properties of biofilm for food packaging applications. The seed mucilage of *Ocimum basilicum* was employed for the preparation of bio-nanocomposite films in the presence of montmorillonite (MMT) as nanofiller. The films were prepared by solvent-casting method at varied MMT loading (1%, 3%, 5%, 10%, 15% and 20%) and solution pH (3, 5 and 9). The films were characterized



Tilapia skins untreated and
Tilapia skins decolorised

for physical, mechanical, barrier and microstructural properties. XRD analysis was carried out to determine the mode of dispersion of MMT in the biofilm. Maximum film tensile strength was achieved at a lower MMT load of 5%. Water vapour permeability reduced with increase in MMT loading up to 5%, followed by an increase at higher MMT loadings. An effective interaction between MMT and mucilage was observed at pH 9. Film formed at pH 9 showed improved tensile strength of 17.3 ± 0.33 MPa and reduced water vapour permeability (WVP) of 0.21 g.mm.sqm^{-1}.h^{-1}.kPa^{-1}. At the aforementioned WVP, the developed bio-nanocomposite film would be compatible with food products of low and intermediate moisture content. The electron scanning micrograph showed MMT reinforced films as smooth and uniform without defects in comparison with control film without MMT. Further, investigation on the application of basil seed mucilage for edible coating of fruits is under progress. The rheological characterization of basil mucilage solution at varied concentrations revealed pseudoplastic behaviour. Effect of coating on the quality characteristics of tomatoes (moisture content, weight loss, total soluble solids and texture) over the storage period is the scope of future study.

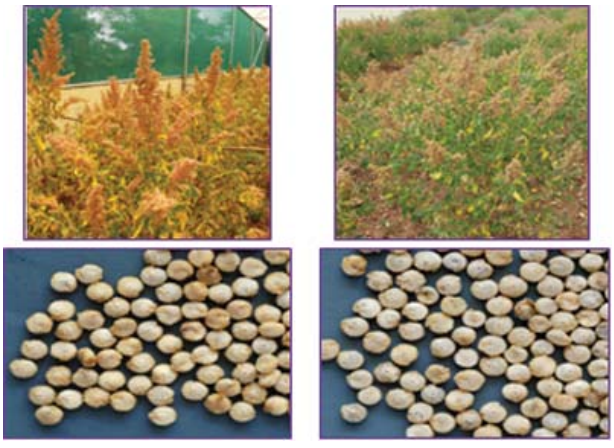
Gluten-free, protein rich grain crops - teff and quinoa

Quinoa (*Chenopodium quinoa*) the protein rich super food pseudo-cereal were subjected to selection for protein-rich and high seed yielding plants. Quinoa population grown from the seeds collected from Anantapur (Andhra Pradesh) farmers were found to be highly variable for both morphology and quality. The variable population were grouped into 9 different morphotype clusters based on plant height, inflorescence shape, colour and other variations. Within each cluster, phenotypically superior plants were selected. A total of 54 superior plants were identified with moderate to high seed yield. Plants with higher seed yield (>85 g/plant) were studied for the protein content that ranged from 11.4 to 16.3%.

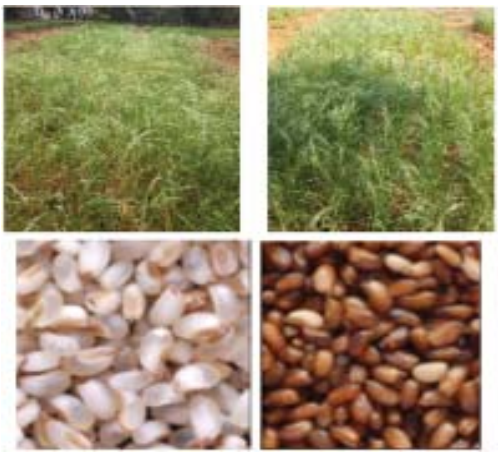
Selections with high protein content and high seed yield were identified and the superior selects were subjected to further evaluation for their homogeneity and protein yield. Two selects with high protein content and high seed yield were identified and these superior selects were subjected to further evaluation. Morphologically uniform protein-rich selects were pooled to derive the homogenous population with desirable qualities.

In order to facilitate wide spread cultivation of this crop, seed packets were distributed free of cost to more than 5350 farmers and other entrepreneurs during various “Programmes” and to the farmers who have visited CFTRI for chia and quinoa seeds from different areas. The brochure on “Quinoa Agro-technology” in English and regional languages (Kannada and Tamil) were also distributed to guide farmers for cultivating this crop.

Teff (*Eragrostis teff*), the super food grain crop with gluten free protein was introduced into India by procuring 18 accessions from United States Department of Agriculture (USDA), USA through National Bureau of Plant Genetic Resources (NBPGR), New Delhi. The accessions were grown in Research farm for acclimatization and quarantine evaluation. Among 18 accessions introduced, one didn’t germinate and the remaining were found to exhibit normal growth and were able to produce seed. The quarantine clearance for the introduced accessions was obtained and seed samples of the 17 accessions were submitted to NBPGR for long term conservation of germplasm lines. Twelve accessions with moderate to high seed yield, identified based on yield trial was grown



Quinoa selections



Teff field view and seeds

in replicated yield trial. Based on replicated yield trial, 2 accessions as T6 - white grain and T15 - brown grain were found to be promising for growth and yield attributes. The two promising accessions will be evaluated in pilot scale trials and agro-technology practices will be standardized.

II. Wellness through food and nutraceuticals (WELFO) *(Sridevi A Singh)*

The principal objective of the project has been to establish possible relevance of traditional dietary strategies to cardiometabolic disease and general health and to use this knowledge to create functional foods. This would incorporate (1) identification of food components of traditional dietary interventions for cardiometabolic diseases (2) extraction of nutraceuticals and bioactive compounds from presumed natural functional foods and screening for efficacy in model systems. Other objectives include the study of microbes as prebiotics for nutritional supplements and selected oligo polysaccharides as prebiotics. Progress of work carried out has been classified under various heads:

Food systems/ products with functional ingredients targeted for lifestyle disorders

Bioprocessing of paddy (medicinal variety of rice) by germination and analysis of bioactive components by HPLC characterization revealed that there are changes in individual polyphenol and oryzanol contents. Wellness flour was prepared by bioprocessing, milling and thermal treatment. The flour was rich in GABA, g-oryzanol and polyphenols and can be used for edible purposes.

There is evidence to show the involvement of AMP - activated protein kinase (AMPK) in altered glucosaminoglycans (GAGs) metabolism during diabetic nephropathy. Screening of putative dietary bioactives which can bind to CBM-KD (Carbohydrate binding motif-Kinase domain) interface of AMPK subunit using *in silico* methods (Docking studies) was carried out. Testing of putative AMPK modulators of dietary origin for their ability to activate AMPK in MDCK (Tubuloepithelial) cell line was carried out with natural bioactive molecules under both normal glucose and high glucose conditions. Zerumbone was able to activate AMPK under high glucose conditions. Zerumbone also increased the phosphorylation of acetyl CoA carboxylase, known AMPK downstream target, which signifies that zerumbone effectively restored the AMPK pathway under high glucose conditions in MDCK cells.

Diet induced obese C57BL/6J mice were successfully obtained by feeding high fat (60% calorie by fat) diet. The mice were treated with obestatin, capsaicin and combination of obestatin + capsaicin. The blood lipid profile after treatment showed reduction in triglycerides and cholesterol was best in the group treated with obestatin + capsaicin than obestatin or capsaicin treated groups. No significant variations were seen in HDL-cholesterol and glucose levels. Estimation of leptin and adiponectin in serum showed decrease in leptin levels were significant in obestatin + capsaicin treated group. No significant change in adiponectin levels were seen in any of the groups. Epididymal fat was significantly reduced in the obestatin, capsaicin and obestatin + capsaicin treated groups and the other visceral and subcutaneous fat pads showed no significant change upon treatment. Significant increase in BAT was observed in the capsaicin and obestatin + capsaicin administered groups. The effect of quinoa saponins on obesity is currently under investigation.

Previously, eight bifidobacteria were isolated and identified from infant faeces. Amongst these, after their characterization, *B. breve* 142 and *B. longum* 815j were considered for product formulation, based on their potential probiotic properties and their inability to produce biogenic amines. Soy yoghurt was prepared using three different combinations of soymilk and skim milk. Faster acidification and texture of the final product after 48 h of fermentation was considered as a criterion for selection of best combination among them. The pH decrease was lowest in combination where 75% soymilk and 25% skim milk was used for both the cultures tested. Among the two cultures selected *B. breve* CFR142 was shown to have fast curdling ability hence it was considered for further optimisation. The 16S gene sequences as well as the *xfp* (fructose 6 phosphoketolase) gene sequences of *B. breve* CFR142 and *B. longum* CFR 815j have been deposited at NCBI under the accession numbers 16S: KU297198 and *xfp*: KU297201 and 16S: KU297199 and *xfp*: KU297200, respectively.

Nutraceuticals and bioactive compounds into functional food ingredients

The carbohydrate digestive profile of South Indian foods comprising of the starch fractions digested at different rates was determined. The foods included the lunch preparations with different vegetable groups and legumes in both native and sprouted form. This is apart from rice items along with different sprouted legumes, lemon rice, rice with rasam, rice with dhal, parboiled rice and other variants. Further, the carbohydrate digestive profile of deep fat fried snacks (bajji, pakoda and bonda), thickness, added vegetables and greens and oil content in dosas, biscuits (commercial) and beverages were tested. The release of rapidly available glucose, slow available glucose, total glucose, total starch, rapidly

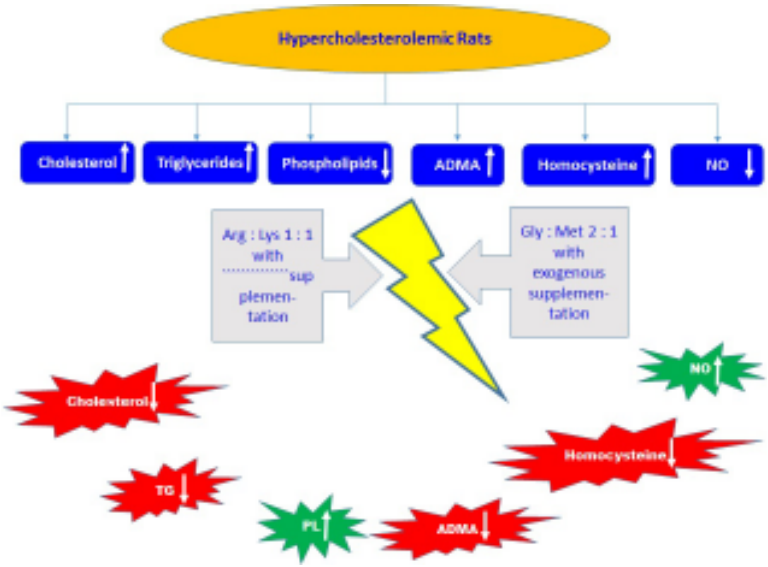
digestible starch, slowly digestible starch and resistant starch pattern in these foods is being compiled to be included in the database.

High arginine along with low lysine, amino acids present in all food proteins, has been reported to be hypocholesterolemic. Altering the lysine:arginine and methionine:glycine ratio in diet has an effect on cholesterol levels. The effect of supplementation of arginine and glycine along with dietary protein on lipid profiles and the levels of biomarkers of cardiovascular diseases was evaluated using male Wistar rat model. Test molecules were administered through oral intubation from fourth week till the end of the study. Rats were sacrificed at the end of the study, organs collected and stored at -80°C till the analysis. Hepatic lipid profiles, plasma lipid profiles, levels of asymmetric dimethylarginine, symmetric dimethylarginine, homocysteine and total nitric oxide were examined. Higher dietary arginine and glycine had a beneficial effect in reduction of triglycerides and cholesterol. Rats fed with high cholesterol showed significant change in lipid profiles. The mRNA expression levels of hypercholesterolemic markers in liver showed hypocholesterolemic evidence after supplementation of diet with high arginine:lysine ratio. Similarly, the hypertensive markers of lungs in hypercholestermia induced hypertension, showed that free aminoacids arginine:lysine has a role in regulation of Renin-Angiotensin System (RAS) and Nitric oxide synthase-dimethylarginine dimethylhydroxylase (NOS-DDAH2) system.

Malted ragi seed coat was explored to be used as a natural, plant based source of calcium and to formulate a ready-to-use calcium rich product. To improve the calcium content as well as the organoleptic characteristics, the finger millet seed coat was blended with amaranth grain fraction and rice bran, and suitably processed so that the particle size was reduced. The processed multi grain seed coat formulation is a ready-to-use product in powder form, which can be used as such, or can be appropriately modified to be used as a spread, or can be incorporated in any traditional or contemporary food products suitably. The formulation contained about 800-900 mg of calcium and 10 mg of iron with 14 g of protein per 100 g.

The glumes (pericarp) from finger millet milling industry is the only by-product. This part of the grain mainly consists of dietary fiber, protein and calcium with hardly any starch content and has not been tapped for its food uses. Efforts were made to process the glumes using various technological processes to isolate crude soluble pentosans which yielded around 5-6% fraction containing ~60% pentosans. Studies are underway to standardize the process and scaling it up.

The effect of EDTA on the bioaccessibility of iron and zinc from germinated, malted and fermented food grains, as well as independent composite meals based on four staple cereals was studied. Addition of EDTA to malted grains brought about a significant increase in the bioaccessibility of iron and zinc. EDTA significantly increased the bioaccessibility of iron from germinated green gram, the percent bioaccessibility of iron increasing from 4% in the absence of EDTA to 35% with the addition of the same. Similarly, the percent bioaccessibility of iron increased from 4% to 29% when EDTA was added to germinated chickpea. EDTA, however, did not have a similar enhancing influence on the bioaccessibility of



zinc from any of the germinated grains examined. Addition of EDTA at molar ratio of iron:EDTA of 1:1.5 to *dosa*, and *idli* batter brought about a 1-fold increase in iron bioaccessibility, which was retained even after cooking the batter. In case of *dhokla* the increase in iron bioaccessibility was 28 fold in batter while it was 4 fold in cooked *dhokla*. Thus, EDTA significantly enhanced the bioaccessibility of iron and zinc from fermented, malted and germinated food grains.

Bioaccessibility of selenium from four cereal-based composite meals was studied. Chickpea, green gram and finger millet were employed to study the effect of germination, and for effect of fermentation, batters used in preparation of *dosa*, *idli* and *dhokla* were used. Soaking the grains in water as a part of germination and fermentation brought about a decrease in selenium content, while its bioaccessibility was not affected. Fermentation resulted in a further decrease in selenium content, the percent decrease ranging from 26 to 47 in the batters. Similar decreases were seen in the bioaccessible selenium content as a result of soaking and fermentation. Cooking of the fermented batters, however, significantly enhanced the bioaccessibility of selenium from *dosa* and *dhokla* by 44 and 71%, respectively. Selenium content of the four meals ranged from 150 to 228.8 ng/g. Bioaccessible selenium was highest in the finger millet-based meal (32.8 ng/g), followed by sorghum, wheat and rice-based meals.

Extraction of identified nutraceuticals and bioactive compounds

Attempts were made to develop iron and carotene rich rice which can be used for nutritional intervention programmes. For developing carotene and iron rich rice, the paddy was soaked with iron salt (sodium iron EDTA) in water and parboiled under open atmosphere. The temperature selected for soaking was such that it softens the bran layer. The parboiled paddy was dried, dehusked and milled to obtain iron rich rice. The polished iron rich rice was allowed to imbibe the carotene, which was dissolved in appropriate solvent. Both raw rice as well as parboiled rice were used for fortification with beta-carotene. The beta-carotene fortified uncooked rice appeared orangish-yellow in colour as compared to control rice samples. A sixty to seventy fold increase in carotene content was observed for the fortified samples as compared to control samples for the uncooked rice. In the cooked rice, a reduction of 50% carotene was observed. Pongal, prepared with fortified rice was found to be acceptable by the panelists. The rice stored in polypropylene material showed mashy texture when compared with the polyethylene terephthalate material rice samples on subsequent storage withdrawals. All the samples had comparable cooked rice aroma and moderate sweet taste. There was no perceptible off odor or off taste in the samples. Bioavailability studies of iron in cooked and uncooked formulations are underway.

Phytonutrient rich jelly was prepared using the technique of frozen reverse spherification. Inside the jelly a small ball rich in phytonutrients was trapped. The prepared jelly was placed in fresh jamun juice, covered and the entire contents were sterilized in boiling water for 15 minutes. The jellies stored at room temperature were microbiologically safe and had acceptable sensory qualities at the end of the storage period of 20 days. The juice of fresh ginger rhizome was added to spinach and mint juice. As the product had unacceptable bitterness, the antidiabetic nutraceutical zerumbone was incorporated into different products. Scale up of process conditions for development of products like sweet potato flakes and snack balls and sweet potato based sauce dip are also underway.

The production of β-galactosidase by *Lactobacillus plantarum* MTCC 2156 (LAB) using whey and compatibility on the growth of the strain in presence of grape seed extract as well as galactooligosaccharides (GOS) were carried out. GOS were characterized by MS and NMR. Oligosaccharides from disaccharide to pentasaccharides were present. GOS effectively inhibited the adherence of enteropathogenic bacterial cultures such as *E. coli* and *B. cereus* to human intestinal epithelial (HEp-2) cell lines but specifically stimulated the growth of probiotic lactic acid bacteria. The *in-vivo* evaluation of GOS supplementation at 10% dietary level to female Wistar rats for four weeks resulted in stimulation of beneficial microbiota such as lactobacilli and bifidobacteria in the gut. GOS supplementation effectively mobilized the calcium from a complex food matrix, finger millet/ ragi flour and enhanced the bioavailability of calcium in experimental female Wistar rats *via* fermentation though gut microbiota. GOS supplementation also resulted in increased production of beneficial organic acids such as lactic, acetic and butyric acids in the gut.

Bioavailability and stability of nutrients/ nutraceuticals

Flax oil was efficiently nanoemulsified by microfluidization technique. Microfluidization parameters influenced the physical stability, whereas, surfactant concentration influenced the oxidative stability of nanoemulsions. Higher physical stability was achieved at high pressure (100 MPa) and number of cycles (4 cycles). Oxidation of nanoemulsions was significantly lower at refrigeration temperature than at oven

temperature. Oxidative stability of 2 and 3% were higher than 1 and 4% surfactant stabilized nanoemulsions.

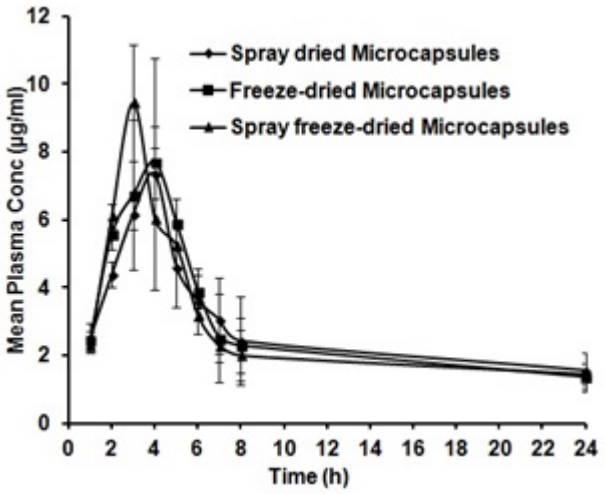
Nano-emulsification of DHA can be used as delivery system to increase the stability. Hence, docosahexaenoic acid (DHA) oil-in-water nanoemulsions were prepared by microfluidization with different emulsifiers of Tween-40 (T-40), sodium caseinate (Na-ca) and soya lecithin (SL). The physiochemical stability of nanoemulsions was investigated under different storage conditions. Less fractionated patterns of crystallization and melting were observed for nanoemulsions than bulk oil. No change in fatty acids profile was observed in nanoemulsions. In addition, the nanoemulsion prepared with T-40 emulsifier yielded lower lipid oxidation than the other emulsifier used emulsion.

Vitamin E is an oily liquid, with poor aqueous solubility and miscibility, which makes poor bioavailability. For any orally administered bioactive compound, bioavailability depends on the dissolution rate in the intestinal lumen and absorption rate across the intestine. Spray freeze-dried and freeze-dried microcapsules showed higher dissolution rate than the spray dried microcapsules. Porous structures formed during the sublimation of ice crystals leads to good dissolution behavior for the freeze-dried and spray freeze-dried microcapsules. Reduced dissolution behavior for the spray dried microcapsules is attributed to the thermal denaturation of whey protein during spray drying. *In vivo* data clearly demonstrates the improvement in VE absorption for the spray freeze-dried microcapsules compared to those of spray dried and freeze dried microcapsules.

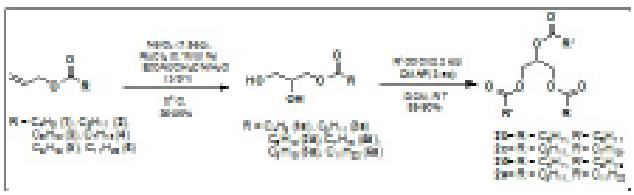
In order to reduce the cost of feed, expensive soya meal was replaced with cheaper rice protein meal (RPM) [obtained by fermentation (P) and enzymatic process (N)] at different levels. The cost of control feed was Rs. 18.17 while by replacing soya meal with rice protein meal to the extent of 90% reduced the cost of feed to Rs. 16.22/kg. Feeding trials with the formulation were carried out using 24 wk old white leghorn birds procured locally and 6 birds each randomly distributed in 7 groups, namely control at 5% RPM (P1 and N1), 10% RPM (P2 and N2) and 15% RPM (P3 and N3) seaweeds. The feed and water was provided *ad libitum.* The results indicated that replacement of soya meal with rice protein meal has not affected the egg production or its quality.

Formulation of functional food products

Tea catechins are valued for their health promoting properties. Tea catechins were isolated as individual catechins (EGCG, EGC, EC, ECG) from green tea and used for the lab scale preparation of complex of micronutrient with iron and boron. Iron complex with catechins were optimized for solvent, temperature, pH



Plasma concentration vs time profiles after oral administration of SD, FD and SFD vitamin E microcapsules in rats



Scheme: Synthesis of MCT

Tea catechins complexed with boron and iron

High fiber buns

and reaction time. The formation of complex was monitored by TLC. Similarly, boron complexes were formed. Both iron and boron catechin complexes are intended to be used as micronutrient fortificants.

Allyl esters prepared in high yields were substrates for Medium Acyl Glycerol (MAG) synthesis. MAG's were synthesized in one step using RuO_4 catalyzed dihydroxylation protocol. 1-hexonoyl glycerol, an intermediate for medium chain triglyceride (MCT) preparation was optimized. This method affords defined fatty acids of medium chain length on MCT's backbone. 2-Nitrophenyl acetic acid was used as a protecting group for the synthesis of 1,2 and 1,3-acylglycerols. 1,2-acylglycerols are prone to undergo fast acyl migration and resulted in the formation of major quantities of 1,3-acylglycerols. The de-protection of 2-nitrophenylacetic acid was de-protected using optimized reaction condition. This group can be used as alternate protecting and de-protecting group in the synthesis of various diacyl- and triacyl glycerols. The work is under progress to develop a new route for the acylglycerols synthesis.

Banana pseudostem (BP) and sugarcane bagasse (SB) were used to improve the fiber content in buns. BR and SB were processed and ground to a fine flour (BR and SB). Blends were prepared using BR at 5%, 10% and 15% by replacing wheat flour (WF). Similar blends were prepared using SB. The buns prepared from a combination of BP (7.5%) and SB (5%) was acceptable based on physical and sensory characteristics. Further to improve the product quality different emulsifiers, hydrocolloids and oxidants were tried. Combination of additives was optimized, wherein the volume and specific volume increased and firmness value decreased. The insoluble dietary fiber in the sample bun increased by 5 times and soluble fibre got doubled when compared to that of control bun. Control and sample buns were stored at ambient conditions in polypropylene pouches. During the 7 day storage period, the moisture content gradually reduced from 28 to 20% and water activity reduced from 0.97 to 0.93, whereas the firmness increased by three times in control and sample buns. These results indicate that fibre rich buns can be prepared from some of the waste/by-products and for enrichment.

Similarly, high fiber millet muffins, using chickpea husk as a source of fiber, were developed. The muffins had 18.95% moisture, 0.86% ash, 10.5% protein, 28% fat and dietary fiber content of 14% as against the values of control muffins (made with wheat flour) having 20.5% moisture, 0.86% ash, 10% protein, 32% fat and dietary fiber content of 3.5%. Incorporation of green gram husk (source of fiber at 5 and 7%), a byproduct of pulse milling industry on the quality of wheat flour muffins were studied. The experiments showed that with the optimum incorporation of 5% green gram husk and a fat reduction of 25% was optimum in wheat flour muffins. Further studies on the use of fat replacers and additives on the quality of muffins is in progress.

Lotus rhizome (LR) was used to replace wheat flour (WF) at 10 %, 15 % and 20 % as a source of phytochemical to enhance the nutritional profile. The blends of WF-LR were used to prepare low sodium soup sticks with various sodium alternatives. Further, test baking of soup sticks is being carried out to optimize the formulation and processing of the product.

Garden cress (Gc) seed can be processed suitably for development of a potential natural source of nutraceuticals. Ready-to-use (RTU) seed flour was prepared using different drying techniques. Processing significantly reduced the insoluble and total dietary fiber content of the flour. The seed coat is a rich source of insoluble dietary fibers. Processing of seed coat reduced insoluble dietary fiber content significantly (12%). Mineral content (iron, zinc, calcium, magnesium, potassium) of seed coat increased significantly due to processing. The seeds were processed to prepare dehulled flour by conditioning the seeds and selectively milling the fractions using a plate mill. The dehulled flour was defatted using n-hexane at room temperature. Osbourne fractionation of the sample revealed the various fractions as follows: Albumin (33%), globulin (31%), prolamin (15%), glutelin-I (12%), glutelin-II (7%) and residue (2%). Thus, albumin (water soluble protein extract) and globulin (dilute saline soluble protein extract) are the major fractions that account for almost 64% of the total extractable protein. The seed protein isolate was prepared by standardizing pH, salt concentration and flour to water ratio. At pH 2, the solubility of protein was 39%, this further decreased between the pH 3 (26.4%) and pH 4 (29.4%). From the standardized conditions (0) M salt concentration, pH 8.5 and flour to water ratio (1:50), protein isolate was prepared. Around 61% of total extractable protein yield was obtained and the protein content of the isolate (through Kjeldahl estimation) was found to be around 88%.

Moisture sorption study for seed based sweet snack was carried out. Sorption study of the product was carried out by exposing the product at different relative humidities (RH) ranging from 11% to 92% at 27ºC. Initial moisture content of the product was 3.5%. Sorption isotherm showed a steep raise after 56% relative

humidity. The corresponding equilibrium moisture content of 5.74% was critical to the product. Moisture tolerance of the product was found to be 2.38%. The shelf life study of the product were carried out under normal (27°C, 65% RH) and accelerated (38°C, 92% RH) storage conditions. Product has a shelf life of 4 months under ambient condition and 30 days under accelerated storage condition.

The effect of monocrotophos (MCP) was studied using *C. elegans* model. Worms (Wild type N2, CB1112 mutant and transgenic BZ555) were maintained in 2% glucose medium for 5 days through development and then treated with MCP (0.75 mM) for 48 h. After the exposure period, dopamine, Dopac and HVA content was quantified in N2 worms by HPLC. Pharyngeal pumping and head thrashing was also quantified. Basal Slowing Response (BSR) was determined in CB1112 mutant strain and N2 worms. Extent of neurodegeneration was also visualized and quantified in BZ555 (transgenic strain). Mitochondrial function (Complex I-III, II-III and SDH) and ADP/ATP ratio were also assessed in the N2 worms exposed to MCP. Pharyngeal pumping rate decreased significantly (36%) in MCP treated worms and further significantly decreased in glucose worms (22%). Further decrease in pharyngeal pumping observed in glucose fed worms treated with MCP (38%). MCP treated worms exhibited a marked reduction in dopamine content (30%), and an increase in Dopac (38%) and HVA (33%) contents. Worms maintained on high glucose and exposed to MCP showed further decrease in dopamine and further increase in Dopac and HVA content. BSR study clearly indicated that CB1112 (tyrosine hydroxylase deficient) worms exposed to MCP and glucose were less affected compared to N2 of the same treatment. Complex I-III and MTT activity were decreased in GF worms exposed to MCP compared to normal control. Visually, a significant neurodegeneration of dopaminergic neurons was evident in worms exposed to MCP while the extent of degeneration was greater in worms maintained in glucose and exposed to MCP. A marked decrease in learning and memory was also evident in worms treated with MCP while these parameters were augmented by glucose. In order to implicate the impact of MCP and Glucose + MCP on mitochondrial function, the effect of MCP and glucose on lifespan in mutant strains (*age-1* (GR1168) and *mev-1* (TK22) in the absence or presence of green coffee extract (GCE) for 24 h was studied. GCE significantly alleviated neurodegeneration, however, it offered greater protection to OHDA (21-32%) induced neuronal defects compared to that of MCP (10-14%). GCE also rescued AChE activity in MCP-treated worms. Significant neuroprotection by GCE was also evident in BZ555 worms exposed to both MCP and OHDA. Dopamine content was increased by 30% in GCE + OHDA and MCP treated worms.

The potential of monocrotophos (MCP), to alter small intestinal structure and function was studied. Further, its potential to exacerbate diabetes induced oxidative stress in intestine was also studied in experimentally induced diabetic rats. MCP significantly increased unit weight of intestine in diabetic rats. MCP alone increased the activities of intestinal brush border disaccharidases in normal rats and further augmented the enzyme activities in diabetic rats. Similar results were found with intestinal alkaline phosphatase activity. In addition, Na+/K+-ATPase activity was found to be aggravated in diabetic rats by MCP treatment. Oxidative stress markers showed similar degree of change in both MCP and diabetic rats while MCP aggravated oxidative stress condition in diabetic rats. Collectively, the findings provide evidence that multiple doses of MCP has the propensity to augment diabetes associated oxidative stress in intestine of rats.

III. Lipidomics Center (LIPIC) *(Malathi Srinivasan)*

Plant lipidome: Three plants, Chia, Portulaca and Ocimum were studied extensively and preliminary studies on a new stearidonic acid rich plant and a laurate rich plant was undertaken during this year.

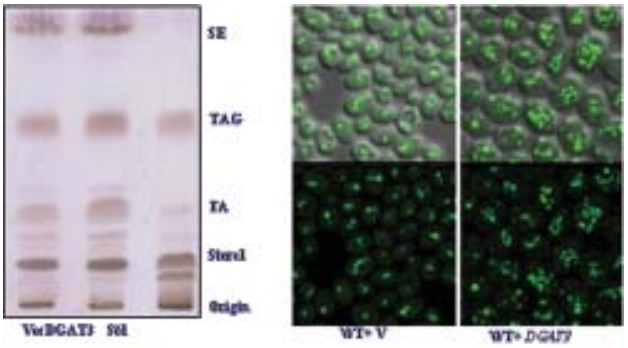
Chia: Several lipid genes that were identified from the transcriptome sequence of Chia in the year 2014 were cloned after codon optimization in a heterologous yeast system. Few genes are being studied in detail, ex. Sh*DGAT2*, Sh*DGAT3*, Sh*OLE1* and Sh*MGAT*. Yeast cells overexpressing these genes are being functionally and biochemically characterized. Data pertaining to overexpression of Chia *DGAT3* (Diacylglycerol Acyltransferase 3) in yeast is presented below:

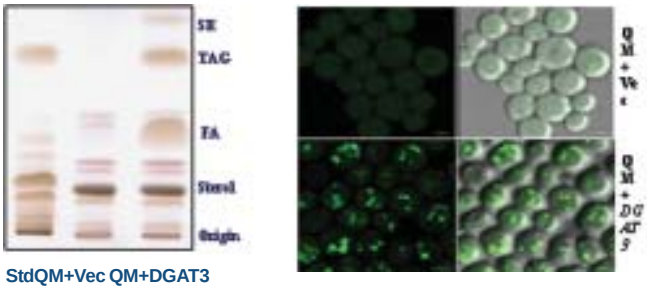
Dgatpin plants catalyses the ultimate step in triglyceride (oil) synthesis. There are many isoforms of this protein. Chia *DGAT* was identified by its transcriptome sequence homology with known plant *DGAT*s and was amplified and confirmed from the seed cDNA. The sequence was codon optimized for cloning into yeast system.

Cells overexpressing Sh*DGAT3* were lysed and subjected to lipid extraction. Yeast lipids were resolved on a neutral lipid solvent system. Cells were also stained with BODIPY and observed under confocal microscope for presence of lipid droplets.

Overexpression of Sh*DGAT3* in yeast wild type BY4741cells resulted in increased triacylglycerol and steryl esters. This was further confirmed by an increase

in number of lipid droplets. Sh*DGAT3* was also overexpressed in a TAG deficient quadruple mutant (QM) that lacks the TAG biosynthetic machinery and it was observed that Sh*DGAT3* could help in the synthesis of TAG in these mutant cells.





StdQM+Vec QM+DGAT3

Similar characterization studies are being carried out with other chia lipid genes. Understanding of the roles played by these genes could help in engineering oil crops to yield more oil.

Portulaca: Lipid content of *Portulaca* leaves showed 25% of more phospholipid compared to spinach. Lipidome of *Portulaca* leaves revealed that alpha linolenic acid is the most abundant fatty acid associated exclusively with phospholipids and galactolipids. Transcriptome analyses of *Portulaca* leaves confirmed there is a high level of expression of desaturases and elongase genes involved in polyunsaturated fatty acid biosynthesis. Similarly, absolute q-RT PCR results also showed the increase in expression level of these genes. Among them, desaturase gene showed highest copy number and expression profile compared to other genes. Lipids were extracted from *Portulaca* leaves. The organic layer was evaporated under vacuum and dissolved in chloroform/methanol (2:1). Separation of lipid classes was performed using a C18-silica column. The isolation of individual components from the different lipid classes was achieved by TLC using appropriate solvents.

Buglossoides arvensis: *Buglossoides arvensis* is the richest natural, non-GMO source of the stearidonic acid (SDA, 18:4) in the plant kingdom. It is a herbaceous, terrestrial, hardy annual plant of Boraginaceae family native to northern temperate regions of Asia and Europe.

Its seeds can be a potential and sustainable dietary source of omega-3 fatty acid - SDA. SDA is known to raise tissue eicosapentaenoic acid (EPA) levels more efficiently than alpha linolenic acid (ALA) seed oils by bypassing the rate limiting step in EPA synthesis.

B. arvensis germplasm was collected from Pampore region of Srinagar, Jammu and Kashmir, India. Seeds were germinated by seed treatments and the plants were acclimatized to local conditions. Oil was extracted from seeds of locally cultivated plants and fatty acids composition was analysed.

With oil content of ~18%, the fatty acids profile analysis revealed SDA (~20%), ALA (~48%) and GLA (4%) to be prominent ones which is on par with the earlier reports. After successful acclimatization to local tropical conditions, work is being carried out towards development of high yielding varieties/lines for its commercial cultivation. Further, studies on the lipid biosynthesis during seed development are also underway.

Ocimum: Bionanocomposite film from the seed mucilage of *Ocimum basilicum* for food packaging application: Food product packaging is an area that aims

B. arvensis at CSIR-CFTRI research farm

Matured seeds

at preserving the quality and extending the shelf-life of food products. Till last decades, man was dependent on petroleum-based packaging material such as plastic, due to their low-cost and easiness of maintenance. Though synthetic polymer packaging is very economical, easy-handling, there are negative effects in spite of their advantages. Biopolymer based packaging is blooming in the recent decades and is important in environmental viewpoint. However, the practical use of the biopolymer packaging material is limited due to their high hydrophilic nature leading to poor barrier and mechanical properties. This can be overcome by the application of nanomaterials to develop biopolymer based packaging material for practical use.

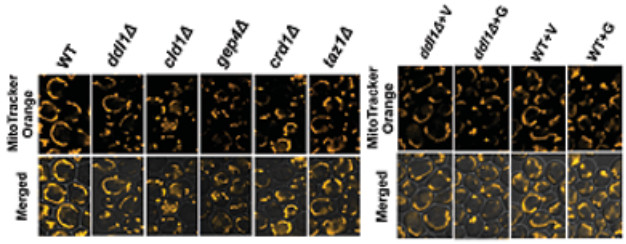
Sweet basil seeds are potential source of mucilage. A preliminary investigation was carried out to develop biopolymer from seed mucilage. After thorough screening of *Ocimum* species and accessions, RR-25 a genotype with high seed mucilage yield was identified as a promising source for isolation of the biopolymer. RR-25 based bionanocomposites incorporated with montmorillonite (MMT) or nanoclay was produced by solvent casting method. The films were prepared under varying pH of the film forming solution and varying MMT load. Characterization of film properties such as mechanical, physical and barrier properties were studied. The results showed an increase in tensile strength up to 5% MMT and in addition decreased with increasing MMT load.

Pisa: transcriptome and metabolome: Pisa (*Actinodaphne hookeri*) plant seeds are known to accumulate high amount of trilaurin in the form of triacylglycerol. Pisa plant is an evergreen tree predominantly found in the Western ghats region of the State of Maharashtra and Karnataka. In this regard, an excursion was undertaken to locate this plant which has unique fatty acid profile. This plant was located and its flower tagged for collection of different stages of developing seed. The tagged immature seeds (flower) were collected at different time point of their development. GC-MS analyses for seed sample were performed to confirm its unique fatty acid profile by converting the extracted lipid into FAMEs. Further RNA was isolated from immature seeds from different stages and converted to cDNA. An illumina based RNA-seq was performed on above samples. Bioinformatics analysis, which involved identification of lipid related genes is underway.

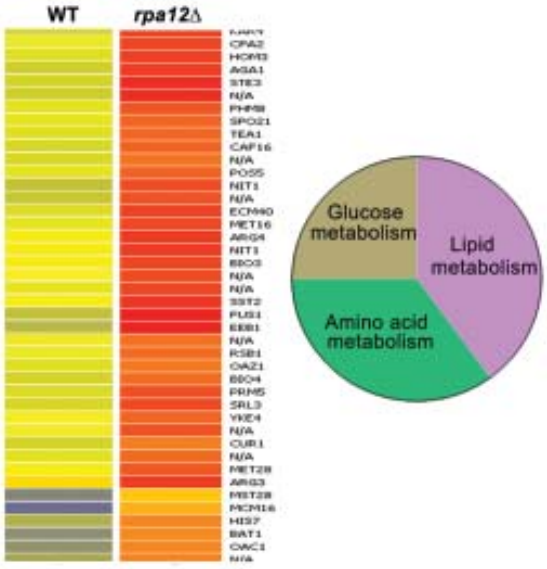
Yeast lipidome: Few yeast transcription factors were identified from the previous studies that could possibly play key regulatory roles in lipid metabolism. Further research on these factors has provided interesting results.

In continuation with the studies on the yeast transcription factor *IME4*, and the gene it regulates, namely, *YOR022C*, it has now been able to postulate that misregulation of a DDHD domain-containing lipase causes mitochondrial dysfunction in yeast. The DDHD domain-containing proteins belong to the intracellular phospholipase A1 (iPLA1) family and have been predicted to be involved in phospholipid metabolism, lipid-trafficking, membrane turnover and signalling. YOR022C

Pisa Flower Immature seeds



Confocal microscopy of cells stained with MitoTracker showing mitochondrial morphology



Heat map of *rpa12Δ* cells showing the expression of different set of genes.Red color shows overexpressed genes. Fold change >1.0, green and yellow colours show under expressed genes. A pie diagram of different metabolic genes that are upregulated in *rpa12Δ* microarray.

is a DDL1 (DDHD domain-containing lipase 1) that hydrolyses CL, phosphatidylethanolamine and phosphatidylglycerol. The data also suggested that the accumulation of monolysocardiolipin is deleterious to the cells. It is shown that AFT1 and AFT2 transcription factors antagonistically regulate the DDL1 gene. This study reveals that the misregulation of DDL1 by AFT1/2 transcription factors alters CL metabolism and causes mitochondrial dysfunction in the cells.

YAP1 transcription factor in phospholipid metabolism: Phospholipids are core components of cell membranes that are highly dynamic in adaptation to stress conditions. H_2O_2 exposure in wild-type yeast cells (BY4741) impairs the transport of acetate and leucine across the plasma membrane. Yap1p activates the transcription of antioxidant genes in response to oxidative stress and has binding sites on phospholipase B genes (*PLB)* promoters. Deletion of *YAP1* causes the down-regulation of *PLBs*, whereas overexpression of *YAP1* increases the levels of these phospholipases. *In vivo* and *in vitro* results showed that Yap1p positively regulates *PLB3* and *ATG15* expression. It was observed that *PLB3* and *ATG15* are responsive to oxidative stress. Collectively, it is evident that Yap1p activates the *PLBs* and regulates membrane remodelling during oxidative stress.

Transcription factor *SPT10* regulates elongated cell morphology and lipid metabolism in *S. cerevisiae.* Here, the relationship between cell morphology and lipid metabolism through Spt10p was investigated. Spt10p controls cell morphology by upregulating the expression of *ELM1* to maintain the normal morphology. Apart from regulating morphology, the same transcription factor down regulates nonpolar lipid biosynthesis by regulating the expression of *DGA1.* In addition, the Spt10p helps in maintaining the structural integrity of cell organelles such as vacuoles, and overexpression of *SPT10* caused a fused vacuolar structure. Furthermore, the Spt10p controls phospholipid metabolism by regulating the expression of *CHO2*.

RNA polymerase I subunit *RPA12* negatively regulates yeast lipid metabolism. The ribosome is a complex of various proteins and different rRNAs. rRNA is mainly synthesized by the RNA polymerase I. A subunit of RNA Pol I, RPA12 negatively regulates yeast cellular metabolism and deletion of *RPA12* leads to an accumulation of triacylglycerol. Microarray and qRT-PCR expression analyses revealed that the expression of genes involved in lipid, glucose and amino acid metabolism are up-regulated in the absence of RPA12. Among the lipid metabolism genes, the expression level of *AYR1* is highly upregulated. The study shows that *RPA12* influences *AYR1* expression levels through the transcription factor, *MSN4.*

Lipids and food: Obesity and thermogenesis: Molecules from food sources that transform white to brown adipose tissue: Diet induced thermogenesis is defined as the increase in metabolic rate due to ingestion of food molecules which generate heat in the body. Based on literature survey, several foods which have been traditionally known to induce thermogenesis were identified and they were screened *in vitro* for the presence of mitochondrial uncouplers. Among the screened molecules, the extracts from two food sources displayed mitochondrial uncoupling activity in *in vitro* oxygen consumption assays and induced the expression of Uncoupling protein 1 (UCP1) in primary adipocytes from mice. The selected food sources from *in vitro* screening results are named as LIPIC-60 and LIPIC 88. Further experiments on C57BL6/J mice for a period of two weeks showed a ten percent decrease in body weight, increase in the mass of brown adipocytes, along with a concurrent increase in the body temperature. There was also an increase in the expression levels of UCP1 protein, which was confirmed through real time PCR and Western blot. Purified LIPIC-60 when subjected to MS studies revealed the molecular weight of the fraction and also based on the fragmentation pattern obtained from MS/MS, the molecular structure was identified. Isomeric structure of the molecule was further confirmed using Nuclear Magnetic Resonance (NMR). RALIG, the characterized molecule of LIPIC-60 purified fraction, too induced a dose dependent increase in the expression of UCP1 in primary brown adipocytes from mice *in vitro.*

IV. Creation of Advanced Research Facility in Molecular Nutrition (Nutri-Arm) *(Balaji Prakash)*

An advanced molecular biology laboratory, including mammalian cell culture and microbial cell culture facility was created as a part of the project. Subsequently, several projects were initiated to examine food based solutions for type II diabetes.

Inhibition of K_{ATP} channel by phytonutrients

Glucose-stimulated insulin secretion (GSIS) is the principle mechanism for secretion of insulin from beta-cells. In this pathway, once glucose is taken by Glut2 receptors of beta-cells, it is metabolized by glycolysis and/or other pathways, which results in an elevated ratio of ATP/ADP, which in turn causes the closure of the K_{ATP} channel mediated by SUR1. Closure of this channel leads to depolarization of membrane potential, which is sensed by VDCC channels resulting in an increase in

the intracellular levels of Ca^{2+} followed by exocytosis of insulin granules.

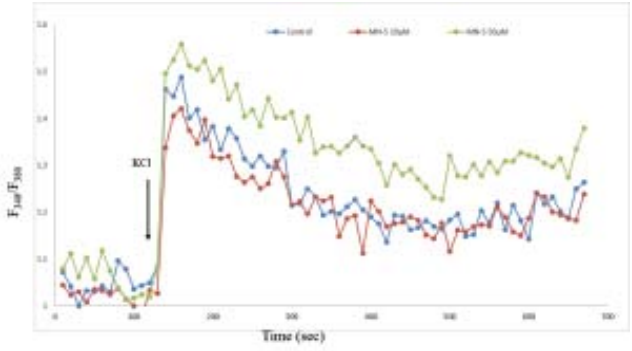
As a part of this project, INS-1 cells were screened with bioactive food molecules in order to evaluate their effect on insulin secretion. The treatment was performed in a dose dependent manner to optimize for the maximum insulin secretion. Based on screening results MN-5, one of the molecules screened, was selected for further studies. MN-5 exhibited glucose dependent insulin secretion also known as glucose stimulated insulin secretion (GSIS). Further studies carried out revealed elevated levels of cAMP as well as intracellular $[Ca^{2+}]_i$ upon treatment of cells with MN-5. In addition, preliminary studies carried out on rubidium efflux assay suggested a reduced amount of rubidium in the incubation buffer of treated cells when compared to control. This indicates the possible inhibition of K_{ATP} channel by MN-5 in pancreatic beta cells.

Activation of peroxisome proliferator-activated receptors-γ by natural ligands

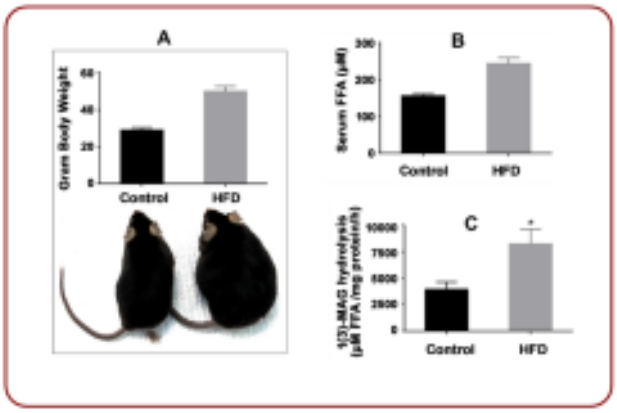
PPARγ has been the focus of intense research during the past decade because ligands for this receptor have emerged as potent insulin sensitizers used in the treatment of type 2 diabetes (T2D). Currently, supplementation of thiazolidinediones (TZDs) are "Gold standards" for the treatment of T2D. The present study focuses on the identification of natural molecules which selectively activates PPARγ to treat T2D. Plant/food sources were identified based on the traditional knowledge as well as human consumption. Further, small molecules were identified based on the *in silico* analysis for PPARγ modulation. Totally 45 identified sources were processed for extractions. The possible PPARγ modulators will be screened by TR-FRET *in vitro* assay. Cell-based assays were performed for the two extracts using 3T3-L1 cells. Diabetic prevalence is high in India due to obesity, which is believed to account for more than 85% of the risk. "Insulin Resistance (IR)" is one of the important pathophysiological factors in initiation as well as the progression of T2D in obese individuals. Controlling increased circulatory FFA level will prevent diabetic prevalence. Preliminary experiments validated the hypothesis and a research proposal with observed data was submitted to DST and was subsequently approved for funding.

Food molecules to modulate bile acid transporters (ASBT)

Bile acid (BA) metabolism plays a major role in regulating blood lipid levels. Since the pathways of lipid and glucose metabolism are linked, hyperglycemia (diabetes) and its complications like dyslipidemia can be addressed by modulation of bile acid (BA) metabolism. Targeting the bile acid metabolism involves diminishing the intestinal reabsorption of bile acids, which triggers the synthesis of bile acids by utilizing the endogenous pool of cholesterol and thus can reduce the blood cholesterol and other lipid levels. Bile acid homeostasis is supported by the enterohepatic recirculation of bile acids through



Effects of MN-5 on the depolarization-induced rise in intracellular calcium in INS-1 cells using the ratiometric fluorescent Ca^{2+} indicator Fura-2AM



High-fat diet-induced obesity enhances the MAGL activity. Mice were divided into two group; the control group was fed with a normal diet and HFD mice (60% energy by fat) were fed with high-fat diet for twelve 12 weeks. (A) The body weight was increased significantly in HFD mice compared to control. (B) Elevated serum FFA content was observed in HFD. (C) Adipocyte MAGL activity. MAG lipase activity was assayed with 50 μM 1(3)-oleoyl-MAG at 37 ºC. The adipocyte cell-free lysate from both control and HFD mice used as enzyme source (50 μg of protein). The released FFA was estimated by sensitive fluorometric method and enzyme activity was calculated. FFA, Free fatty acid; MAG, Monoacylglycerol, MAGL, monoacylglycerol lipase, n=6; * $p < 0.05$

the complex transporter system involved at each junction in the enterocyte and hepatocyte. The ileal apical sodium-dependent bile acid transporter (ASBT) actively pumps bile acids across the enterocyte membrane, from where other transporters shuttle bile acids to the hepatocyte. Thus, recirculation of bile acids can be disrupted at the ileal level by modulating the ASBT.

On the basis of literature, *in silico* analysis and the results obtained from the previous study on mice, an active component of Ashwagandha (*Withania somnifera*) was identified as the potential ASBT modulator, and its ASBT modulating ability, hypolipidemic and hypoglycemic effect was studied in dyslipidemic rats. Dyslipidemia was induced in male Wistar rats by feeding of high fat (HF) diet comprising 35% lard, supplemented with 1% Ashwagandha extract, for a period of two months. Although the Ashwagandha fed group did not display significantly lower animal body weights as compared with that of HF group, the serum cholesterol and triglycerides were reduced by 33% and 37%, respectively. A decrease in circulatory bile acid levels and increase in fecal bile acid levels were exhibited by the Ashwagandha fed animals, while the hepatic bile acid levels did not display significant difference among the groups, therefore, shall be reassessed, in order to be correlated with the reduced HMG-CoA reductase activity in the same group. Glycemic parameters like glucose, glycosylated hemoglobin and protein carbonyls were 13%, 31% and 28% lower than those of HF group. Based on these observations, the future course of work would involve the study of molecular mechanism through expression of the regulatory genes.

Arbinoxylans (AXs) and AX derived oligosaccharides (AXOS) from millets

Alpha-glucosidase is an exo-hydrolase that belongs to glycosyl hydrolase 31 family (EC=3.2.1.20) which cleaves maltose and maltooligosaccharides to liberate glucose. Inhibiting the α-glucosidase is one of the most important targets for regulating the postprandial glucose levels in diabetic patients. Acarbose, miglitol, voglibose are clinically used drugs to inhibit the α-glucosidase. However, these synthetic drugs are known to have some side effects. The aim of the present work was to use arabinoxylans (AX) and AX derived oligosaccharides (AXOS) from different millets to inhibit the human α-glucosidase. Arabinoxylan isolated from the pearl millet bran was subjected to xylanase treatment to generate AXOS, and these were fractionated by using different chromatographic columns. Individual fractions were studied for inhibition of α-glucosidase. Some fractions showed potential inhibition both in *in vitro* assay and cell-based assay. Neutral AXOS from water soluble and alkali soluble polysaccharides showed more inhibition compared to phenolic acid containing AXOS. Crude AXOS prepared from the water-soluble polysaccharides showed potent inhibition than the alkali extractable polysaccharides. One of the AXOS from pearl millet showed the inhibition of glucose uptake by the cells as evidenced by the lactate release assay. These encouraging results suggest the possibility of multiple targets for the AXOS in controlling type-2 diabetes. A detailed study at *in vivo* level using selected AXOS is planned in future. Few fractions of AXOS from pearl millet can be utilized for the development of low GI products and efforts in this direction are also underway.

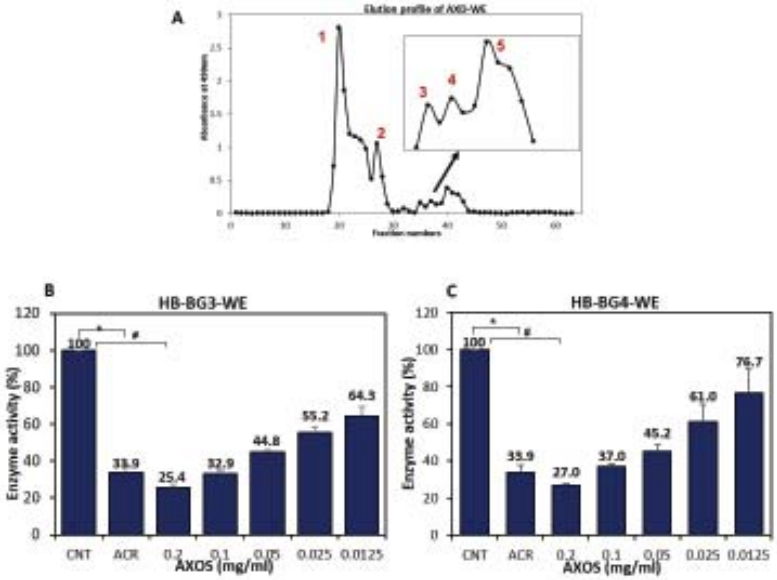


Fig. 1. Alpha-glucosidase inhibition by Biogel eluted AXOS: A. Elution profile of AXOS on Biogel. **B & C.** Alpha-glucosidase enzyme activity in presence or absence of AXOS at different concentrations. Values on top of the bar represents % enzyme activity. * represents p<0.05 and # represents p<0.001

Food based/natural molecules to activate AMPK in type 2 diabetes

AMPK is a master regulator of energy homeostasis, which is highly conserved from yeast to higher mammalian systems. Upon phosphorylation it increases the catabolic processes to generate ATP, inhibits the anabolic processes that require ATP and also brings about â-oxidation and glucose uptake. AMPK is an attractive target for diabetes as most of the drugs prescribed like metformin, sulfonylureas, etc., act either directly or indirectly to activate AMPK. To elucidate AMPK activity *in vitro,* mammalian HepG2 cells were used. The protocol to score phosphorylation activity through western blotting, and an ELISA based assay for AMPK were standardized. *In vitro* scoring of phosphorylation through cell lines were conducted. To evaluate robustness of the assay, 80-90% confluent cells were treated with activators of AMPK: metformin and AICAR which show prominent phosphorylation activity. Subsequently, the cells were treated with varied concentrations of two compounds of interest, which were purified from natural sources and indicated as compound 1 and compound 2. The whole cell lysate after the treatment was subjected to ELISA based assay, which also showed prominent results with regard to AMPK activation in HepG2 cells. Overall these two compounds were found capable of activating AMPK at a lower concentration.

Dipeptidyl peptidase – IV inhibitors of natural origin

Dipeptidyl peptidase – IV (DPP-IV) inhibitors are a class of pharmacotherapeutic agents used for the treatment of type 2 diabetes. These orally available agents exert their beneficial effect on the regulation of hyperglycaemia by enhancing the endogenous concentrations of the active incretin hormones [glucagon-like peptide-1 (GLP-1) and glucose-dependent insulinotropic polypeptide (GIP)]. Previously, the DPP-IV inhibitory activity of phytochemical extracts from certain food sources were reported and compared their inhibitory activity with sitagliptin, a synthetic, commercial DPP-IV inhibitor. Phenolic and alkaloid (trigonelline) extracts of one such source showed strong inhibition towards DPP-IV activity. In addition, multiple antioxidant activities and prevention of structural damage to protein induced by free radicals were also observed with these extracts. In the present study, phytochemical extracts from various cereals and legumes were evaluated for DPP-IV inhibitory activity to prepare a functional food containing major nutrients and bioactive compounds for the control of diabetes.

Phytochemical extracts were prepared from various food grains such as millets, cereals, pseudocereals and legume seeds. These extracts were evaluated for their phenolic contents and composition. Results indicated wide variation in the total phenolic and flavonoid contents in these grains. Compositional analysis and quantification of phenolics by reverse phase - HPLC revealed that ferulic, *p*-coumaric, caffeic, 3,4-dihydroxybenzoic and sinapic acids were the principal phenolic acids found in these food grains.

The phenolic extracts of these grains showed significant differences in inhibition of DPP-IV activity. Strong inhibition with IC values ranging from 45-200 μg/ml, could be achieved with some of the phenolics evaluated. These results provided a scientific rationale for the effective utilization of specific food grains as ingredients for the development of products with health promoting functions and to control hyperglycemia. The enormous potential for industrial utilisation of these under-utilised grains in functional food products may lead to wide consumption of these grains and attract attention to develop methods to optimally process and enrich their biologically active phytochemicals.

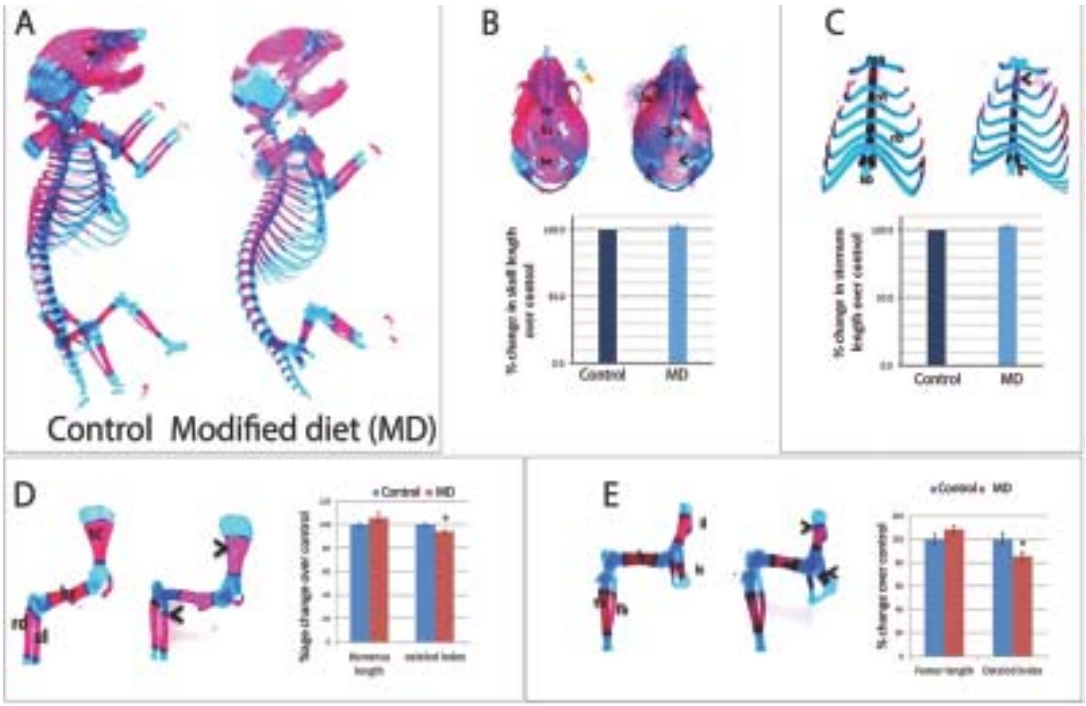
Bioactive cereal protein peptides as inhibitors of Dipeptidyl Petidase 4 (DPP4)

The project aims to generate bioactive peptides from various food grains such as ragi, jower, foxtail millet, chia, quinoa and buckwheat to study their inhibitory effect on DPP4. DPP4 inhibition results in prolonged action of gut hormones like glucagon-like peptide-1 (GLP-1), glucagon-like peptide-2 (GLP-2) and glucose-dependent insulinotropic peptide (GIP) and maintain glucose homeostasis in diabetic condition.

Bioinformatics and *in silico* analysis indicate that several peptides from cereals like wheat, barley, rice and oat contain many potential biological activities including DPP4 inhibition. Work has begun towards extraction of total protein and peptides from several food sources. To test the same for DPP4 inhibition, recombinant expression and purification of DPP4 will be attempted.

Maternal diet in the programming of offspring's adult bone mass

The study deals with the effect of maternal supplementation modified western diet in the development of bone in the offspring. The study was divided into two parts where cell culture based study in MC3t3-E1 cells (pre-osteoblast cell line) was performed to evaluate the cellular effects of western dietary constituents whereas animal study in the offspring's of the western diet fed dams was done to see its physiological effects. The results of the study demonstrated that the constituent of western diet results



Mineralization pattern in the maternal western modified diet (MD) treated new born skeleton (arrow heads indicate decreased mineralized area in MD than control). (A) Whole mount alcian blue/alizarin red staining of the skeleton, (B) skull, (C) sternum, (D) forelimb, and (E) hind limb. (sp-sphenoid, bs-basisphenoid, bo-basioccipital, sc-scapula, hr-humerus, rd-radius, ul-ulna, il-Ilium, is-ischium, fr-femur, tb-tibia, fb-fibula, mn-manubrium, st-sternabra, rb-ribs, xp-xiphoid cartilage) *-P<0.05.micro-computed tomography

in decreased survival, differentiation and mineralisation of osteoblast cells under *in vitro* cell culture conditions. The *in vivo* study investigated the effect of maternal supplementation of western diet on the mineralization pattern of offspring bone at the time of birth. The mice were exposed to western modified diet on the day of detection of pregnancy. Although the over-all body length and the length of several bones such as skull, forelimb, and hind limb between the groups had no significant difference, the osteogenesis index in humerus and femur was significantly reduced in the offspring of modified-fed group. This suggests that there was a delay in ossification in the maternal modified diet fed neonates as compared to control neonates. Moreover, the mineralization zones in bones of skull like sphenoid, basiphenoid and basioccipital were lesser as compared to control. This *in vivo* study complemented cell culture based studies as the decreased mineralisation was a result of reduced osteoblast activity.

Regulatory mechanism of phytonutrients on glucose-induced changes in oxidative stress and redox markers in retinal pigment epithelial (ARPE-19) cells

Diabetic retinopathy (DR), a sight-threatening complication of diabetes, is the major cause of blindness between the age group 20 and 70 years. Under diabetic condition, retina and its capillary cells experience increased oxidative stress due to sustained hyperglycemia which disrupt normal cellular metabolism leading to the development of retinopathy. Since the functional co-ordination between the outer retinal pigment epithelial (RPE) cells and the neighbouring retinal cells are essential for the integrity of the retina, any cellular and metabolic changes in RPE causes retinal dysfunction, which leads to the loss of visual function. This project attempts a phyto-therapeutic approach to address DR, one of the major post-diabetic complications, by targeting retinal pigment epithelial cells.

Pigments (PGs), were isolated and purified from *C. album* by the standardized protocols. The non-cytotoxic concentration of PG-1 in ARPE-19 cells was analysed by WST-1 assay. The results show that PG-1 upto the concentration of 1 μM did not affect the viability of ARPE-19 cells. Next, the effect of glucose at two different concentrations (25 μM and 30 μM) on the level of reactive oxygen species (ROS) and expression of heme oxygenase-1 (HO-1) protein was measured in ARPE-19 cells. Addition of glucose increased the level of ROS in a dose-dependent manner and down-regulated the expression of HO-1 protein. Interestingly, PG-1 at 0.5 μM concentration was found to recover glucose-mediated down-regulation of HO-1 protein.

V. Chemopreventive effects of meat/ fish based ingredients in *in-vivo* and *in-vitro* models *(Bhaskar N)*

Protective effect of squalene was studied against carbon tetrachloride (CCl_4) induced liver fibrosis. Initially a model for chronic liver fibrosis was developed by treating the mice (C57/BL6) with intra peritoneal injections of CCl_4 (0.5 gkg^{-1}) for 4 wks. The liver sections were then formalin fixed and stained with hematoxylene and eosine to check for the development of fibrotic tissue. A significant amount of extracellular matrix was observed which proved the development of fibrotic tissue. On the other hand, CCl_4 treated mice livers exhibited a significant increase in the expression of several liver degenerative and some of the regenerative markers. Further another experiment was set up to check for the protective effect of squalene against CCl_4 induced liver fibrosis.

Squalene was tested for its effect against two glioblastoma and three leukemia cell lines. An apoptosis analysis was conducted where squalene conferred apoptotic death at a concentration of 100 and 500 μM respectively for LN 229 and U87MG cells. On the other hand out of the three leukemia cell lines, K562 and U937 showed apoptotic death at 100 μM and HL 60 were affected at a concentration as low as 50 μM. However no effect on cell cycle analysis of squalene on LN229 was observed.

VI. Bioprospection of plant resources and other natural products (BioprosPR) *(Giridhar P)*

Influence of elicitors salicylic acid (SA) and methyl jasmonate (MJ) on vanillin flavour metabolites production by *in vitro* normal root cultures and callus suspension cultures was investigated. There was significant improvement in the content of 2-hydroxy-4-methoxy benzaldehyde, vanillic acid, ferulic acid in respective cultures, however, the response varies for SA and MJ concentration. Overall the root culture appears to be promising. The possible utilization of flavour rich extracts of *D. hamiltonii* and *H. indicus* were tried to as natural flavour source in making some food formulations followed by sensory studies which supported the acceptability of prepared product. The efficiency of flavour rich aqueous extracts of roots were tested for their cell inhibition potential against prostrate cancer cell lines. Both *D. hamiltonii* and *H. indicus* were found to be good in inhibiting cancer cells growth at 1-2 mg/ml concentration.

VII. Nano-materials: Applications and impact on safety, health and environment (NanoSHE) *(Mukesh Kapoor)*

Biochemical characterization of purified α-galactosidase from *Vigna mungo* was carried out. The enzyme was found optimally active at pH 5 and 55^{0}C. Most of the tested metal ions were found to inhibit the enzyme activity. Ionic surfactants like SDS and CTAB were found to reduce the enzyme activity while, non-ionic surfactants like Tweens stimulated enzyme activity. The K_m and V_{max} of purified α-galactosidase were found to be 0.99 mM and 1.66 mM/min/ml, respectively. Cross-linked enzyme aggregates (CLEAs) of partially purified α-galactosidase from *Vigna mungo* (PP-α-gal-CLEAs) and CLEAs immobilized on magnetic nanoparticles (PP-α-gal-Mag-CLEAs) showed pH optima of 4 and 6, respectively. The pH stability of PP-α-gal-Mag-CLEAs was more than 40% after 18 h of incubation at room temperature in a wide range of pH (3-8). The temperature optima of PP-α-gal-CLEAs and PP-α-gal-Mag-CLEAs was improved by up to 20^{0}C to 70^{0}C and 75^{0}C, respectively when compared to the free enzyme. Preliminary experiments using thin layer chromatography indicated that partially purified α-galactosidase, PP-α-gal-CLEAs, PP-α-gal-Mag-CLEAs, purified α-galactosidase and purified α-galactosidase loaded on to magnetic nanoparticles were found to cleave raffinose family oligosaccharides. Cross-linked enzyme aggregates of recombinant endo-mannanase (ManB-1601-CLEAs) from *Bacillus* sp. CFR-1601 (ManB-1601) was also developed and immobilized on magnetic nanocomposites (ManB-1601-Mag-CLEAs). ManB-1601-CLEAs and ManB-1601-Mag-CLEAs exhibited better activity in presence of metal ions, solvents and surfactants. They also exhibited drastic improvement in pH stability in a wide range of pH (3-10) when compared with the free enzyme. There was a shift in pH optima (pH 6) in case of ManB-1601-Mag-CLEAs. The temperature optima of both ManB-1601-CLEAs and ManB-1601-Mag-CLEAs showed remarkable improvement by up to 15^{0}C in comparison to free enzyme. Thermal inactivation kinetics of ManB-1601-CLEAs and ManB-1601-Mag-CLEAs showed improvement in half-life ($t_{1/2}$) and better values for thermodynamic parameters [deactivation energy (E_d), enthalpy (H) and entropy (S)]. Both ManB-1601-CLEAs and ManB-1601-Mag-CLEAs were found capable of repeated hydrolysis and production of manno-oligosaccharides.

VIII. S&T interventions to combat malnutrition in women and children *(Alok Kumar Srivastava)*

Keeping in view the objective of multi-institutional CSIR network project in developing nutritionally rich food products towards their outreach to combat malnutrition, nutrition dense food products developed by CFTRI were used for 6-months feeding study to identified children of 12 anganvadi centers in Nanjangud taluk, Mysore district. Spirulina chikki, mango bar, energy food, sesame paste, rice-milk mix, high protein rusk and nutri-sprinkle were specially formulated to cater the nutritional needs of malnourished children for specific macro- and micro-nutrients like protein, calcium, iron, zinc, B group vitamins, vitamin A and calories. All above products were analysed for their nutritional composition and microbiological safety. Nutrition intervention study covered around 270 children including severely malnourished children of villages namely, Chamalapura hundi, Heggadahalli and Ramapura.

Members of the project team visited CDPO, Nanjangud and live demonstration was arranged. Also training was imparted to all involved anganvadi workers and supervisors to emphasize on hygiene and sanitary practices during handling, preparation, storage and distribution of foods to ensure food safety. Post training, the 6 months feeding program was initiated starting from 15th February 2016. The above feeding is supervised by the project members during weekly visit to the anganvadi centres. Food products were prepared and distributed to children on fortnightly basis. It is envisaged that as efficacy of nutrition intervention project, basic anthropometric and hematological measurements shall be conducted for all children after 6 months feeding to compare with base-line measurements, already conducted at the start of study.

Chemical Sciences Cluster

IX. Animal and bird feed and probiotic metabolites from fleshings *(Bhaskar N)*

Collagen hydrolysate prepared from raw trimmings was evaluated for their efficacy in comparison with standard protein sources (casein, whey and soy protein) and a nitrogen free diet. Male Wistar rats were fed diets containing different protein sources and their body weight, feed intake and protein intake were monitored. The collagen hydrolysate had the least protein efficiency ratio and was equivalent to a nitrogen free diet.

X. Membrane and Adsorbent Technology Platform for Effective Separation of Gases and Liquids (MATES) *(Subramanian R)*

Membrane desolventizing of hexane-oil miscella was attempted as an alternate energy efficient method for thermal distillation employing both lab-cast (CSIR-MATES) and commercial SRNF membranes. Indigenously developed CSIR membranes performed better (CSIR-M1 and CSIR-M2) and were assessed extensively with due consideration for industrial adoption. The CSIR-M2 membrane exhibited an excellent selectivity (oil rejection >90%) for separating TG from hexane-oil miscella (25% oil) under a wide range of operating conditions in a self-stirred membrane test cell while offering a reasonably good permeate flux (~12 LMH). Further, the membrane sustained its stable performance for more than 50 days in hexane environment. Besides, reproducibility of membrane preparation protocol and the performance of the membranes from two lots were nearly consistent. Holistic analysis showed that the performance of CSIR-M2 membrane was better than the best of the literature reports. Under the plant simulated conditions, the membrane system is expected to recover ~65% of hexane that could be recycled in the extraction plant offering substantial thermal energy savings in the distillation process.

XI. Development of sustainable processes for edible oils with health benefits from traditional and new resources (PEOPLE HOPE) *(Venkateswaran G)*

Polyunsaturated fatty acids (PUFAs) are typical secondary metabolites derived from plants, animals and microbial sources. Studies on PUFAs are considered to be an important aspect both in the views of nutraceuticals and pharmaceutical fields. Omega-3 (ω-3) and omega-6 (ω-6) PUFAs have tremendous potential for use as food additives and pharmaceuticals for a multitude of chronic diseases. A field survey was undertaken for screening and selection of oleaginous fungi in Western Ghat regions of India. Totally 106 soil samples were collected and these were mainly screened for their oleagenicity nature. Six fungal cultures were grossly identified morphologically as *Mucor sp., Rhizopus sp., Rhizomucor sp., Alternaria sp., Cunninghamella sp.* and *Mortierella sp.* and found oleaginous property. These cultures were subjected to screen for PUFA contents and found produced PUFAs with specific reference to GLA and AA by Gas Chromatography (GC) analysis. Further, these cultures

were subjected to various parameters such as media optimization, C:N ratio, different sugars, temperature and pH optimization for maximum lipid and GLA production. This fungal strain was confirmed by 18s rRNA sequencing method for their species identification. The native isolate *Cunninghamella elegans* CFR-C07 (GenBank ANo. KF916583, NCBI) produced maximum biomass of 11.28±1.54 g/L (DW), total lipid yield of 38.52±1.99% at 28ºC, 180 rpm and pH 5.5 for 132 h and the concentration of GLA (Gamma Linolenic Acid; $\Delta^{6,9,12}$ C18:3) was observed as 21.72±0.28% v/w of the total lipid obtained. This strain was further subjected to grow for another 132 h at 20ºC (low temperature) to obtain the maximum yield of GLA. The observation indicated that the native isolate *C. elegans* CFR-C07 produced 11.84±0.35 g/L (DW) biomass, 19.68±0.92% total lipid, 16.62±0.81% v/w GLA and interestingly 1.97±0.07% v/w ALA (Alpha Linolenic Acid; $\Delta^{9,12,15}$ C18:3) also. This was confirmed with GC and GC-MS chromatograms. The growth of this fungus at low temperature (20ºC), altered the biosynthetic pathway and the production of ω-6 and ω-3 fatty acids which includes GLA and ALA. Development of bioprocess in submerged culture of *Cunninghamella elegans* CFR-C07 was carried out in 1000 ml flasks and optimization of extraction process of oil containing GLA from *Cunninghamella elegans* CFR-C07 were also carried out. Oil containing GLA was further purified for oxidation stability and shelf-life for use in food formulation.

XII. Encapsulation of the cell mass of representative microbes to maximize viability and to send to respective laboratories *(Raghavarao KSMS)*

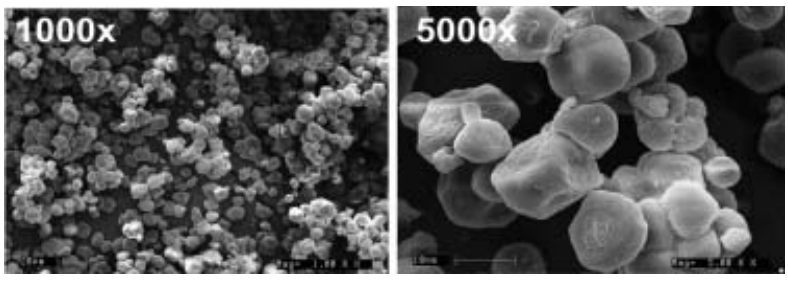
The main emphasis of this research project was to produce encapsulated microbial cells, with high viability by using different drying techniques. Microbial cultures, *Pseudomonas aeruginosa,* from NCL, Pune and *Bacillus* sp. from CLRI, Chennai has ability to degrade phenol and which is known for its environmental versatility was encapsulated with different carrier materials by using spray drying technique. With reference to initial spray drying trials of yeast using different carrier materials, the carrier materials which gave best results (cell survival and powder yield) were used one at a time and in combinations for experiments with different microorganisms. Whey protein, corn starch, and trehalose are used as carrier materials during encapsulation of microbial cells. The encapsulated microbial cells (*Pseudomonas aeruginosa*) powder was analysed for micro structure, particle size, flow properties, moisture content, and water activity. Picture shows SEM analysis of encapsulated *Pseudomonas aeruginosa* with corn starch.

Physical Sciences Cluster

XIII. Measurement Innovation in Science and Technology (MIST) *(Sreenivasa MA)*

Certified Reference Material (CRM) for pesticide (Lindane, Aldrin and Ethyl chlorpyriphos) was developed by spiking pesticides in milk and converting it to powder using spray drier. Control milk powder wherein the pesticides are absent was also prepared along with spiked using the same batch milk. Prepared control and spiked milk powders were analysed for the residue content. The pesticide residue was absent in control milk powder samples. Replicate analyses of the spiked milk powder were carried out and from the obtained results the homogeneity of the samples was evaluated statistically. The stability of the analytes (pesticide residues) in the milk powder (CRM) is also being done periodically.

ILC/PT programme was conducted for pesticide residues in milk powder. A total of 23 laboratories (both accredited and non-accredited) participated in the programme. Samples of control and spiked milk powder were sent to all the 23 laboratories along with a specific deadline for submission of results. Along with samples, result submission format, protocol for handling of samples and participating laboratory information proforma were also sent. About 16 laboratories have submitted the results and statistical evaluation for determining the individual laboratory Z-score is in progress.



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Manjula TC
Maya Prakash
Ravi R
Roopa BS
Shivashankar S
Suresh Kumar G

Animal House & Facility

Muthukumar SP *(Head)*
Aijaz Ahmed
Shinde Vijay Sukdeo

Construction & Civil Maintenance

Arulalan K *(Head)*
Anand Kumar K
Anthony
Chikkaiah C
Ganesha M
Jayaram HC
Mohan Rao P
Prashantha
Suresh Prasad N

Central Instruments Facility & Services

Keshava Prakash MN (*Head)*
Anbalagan K
Asha M
Bavani Eswaran M
Dhaneesh K
Harish Raj V
Judhisti D
Lokesha C
Padmere Mukund Laxman
Ravishankar AC
Sanjailal KP
Srirama R
Umapathi H
Umashanker B
Vatcharavelu K

Computer Centre

Siluvainathan P *(Coordinator)*
Geethesh Menon MV
Jyothi K
Manohar SRM
Shalini M Govinkop
Siva Naga Suresh Purama
Srividhya CS

Design and Fabrication Unit

Nagaraju VD *(Head)*
Bharath
Ezhil Murugan R
Jagannatha MK
Kumar N
Mukunda K
Prakash N
Rajesh M
Ramesh G
Rangadhamaiah
Rangaswamy KP
Shesha Narayana K
Shiva Kumara M
Venkatesha V

Director's S&T Unit

Manilal P

Engeneering & Mechanical Maintenance

Ramesh T *(Head)*
Aravind C
Chandrashekara N
Hemaraju R
Irudayaraj A
Jayakumar B
Jesuraj L
Mahesh D
Manjunatha Rao AR
Narasimha Murthy
Narayanan K
Naveen Kumar C
Parashuram P
Putta Swamy
Siddaiah
Somasundaran CC
Subramani
Suresha H
Vijay Prasad Raju G

Human Resource & Development

Co-ordinators

Shashirekha MN
(M. Sc. Food Technology)

Shylaja M Dharmesh
(Integrated M.Sc. - Ph.D.)

Gangadharappa GH
(ISMT Course)

Sachindra NM
(Ph.D - AcSIR)

Nandini P Shetty
(Ph.D - Universities)

Malathi Srinivasan
(Short Term Courses)

Asha MR
Hanumantha
Karuna Venkataraman
Lakshmi K
Murali Madhav V
Rao PVR
Rekha MN

Library

Ragavan I *(Head)*
Mahadevi
Padmavathi T
Sharma KVSAS
Somashekar KS
Srinivasa Rao N
Suneetha R Bhanderkar

Information & Publicity

Siluvainathan P (*Coordinator)*
Renuka S
Vishnu Kumar M

Planning, Monitoring & Coordination

Siluvainathan P *(Head)*
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Kumar B
Kusuma K
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Masthamma M
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Technology Transfer & Business Development

Sathyendra Rao BV *(Head)*
Dinakar KR
Kalpana SG
Krishna GA
Manjunath N
Pattekhan HH
Raghavendra SV
Udaya Kumara H

Administation

Office of the Administrative Officer

Mallika P Kumar (AO)
Geetha S

Establishment - I

Satheesh Kumar MD*(SO)*
Vijayalakshmi J Rao

Establishment - II

Padmavathi HR *(SO)*
Komala HC
Nataraja C

Establishment - III/IV

Ramachandraiah M *(SO)*
Anupama R
Basavaraju C
Bharathi Murthy P
Preetha K
Rajashekara M

Establishment - V

Sujatha Ravikumar *(SO)*
Asha Dinakar
Basavanna K
Jyothi S
Malini TS
Mamatha
Nagamani S
Padmini M
Ramesh S

Establishment - VI

Krishnamurthy R *(SO)*
Anseem Ahmed
Chanchala Kumari
Nagaraju M
Santhosh G
Savitha K
Usha Kiran KA

Establishment - VII

Satheesh Kumar MD *(SO)*
Maheswara Murthy M
Rajashekar KL
Shivanna K

Establishment - VIII

Satheesh Kumar MD *(SO)*
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Palaniappan V *(CFA)*
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Bhuvaneshwar P
Divya MV
Janaky PI
Mahadev S Khanapuri
Mahesha I
Manikanta Swamy SN
Mohammad Naushad Basha R
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Raghavendra TK
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Ravi VK
Shashikumar P
Vasantha UR

Transport

Gangadharappa KC
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Mohammed Shauib
Nanjunda R
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Stores & Purchase
Thomas T Kuriakose *(CoSP)*
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Abhijna
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Kavyashree L
Lakshmi Nath Thakur
Lawrence A
Prasad T
Ravikumar C
Raviswamy HC
Savitha MP
Shiva Kumar CR
Shobha S
Somaiah PT
Somalatha B

Canteen
Doddaiah
Krishna DR
Mahesh S
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Ramakrishna
Suresh KS
Velu M

IFTTC Guest House
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Vittal Rao

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Security
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