

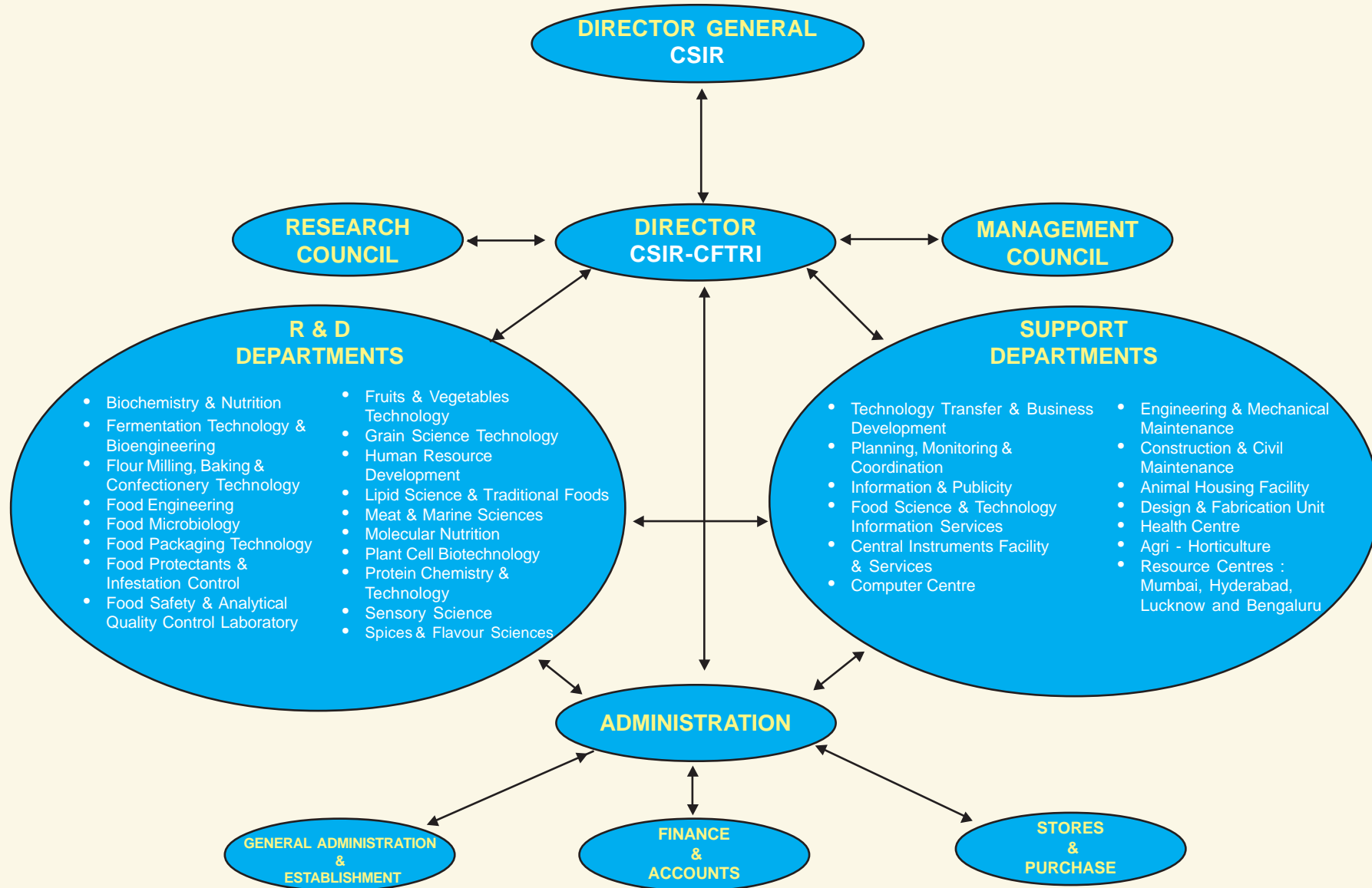


CSIR-CFTRI

PERFORMANCE REPORT 2013-14

**CSIR - Central Food Technological Research Institute
Mysore - 570 020, India**

ORGANISATION CHART OF CSIR-CFTRI



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From Director's Desk

I am extremely delighted to present the Performance report of our Institute for the period 2013-2014. It was another spectacular year for CSIR-CFTRI, in terms of progress in R&D projects, Institute strengthening and publications.



Some of the distinct milestones achieved during this period are the progress made in our XII five year plan projects, viz., AGROPATHY, WELFO, LIPIC and Nutri-ARM, besides the continuous progress made in other in-house projects and externally funded research programs, resulting in an appreciable number of publications.

Several new recruits have joined the Institute this year. I take this opportunity to welcome them to CFTRI and to wish them good luck in all their endeavors, while gently reminding them of the huge responsibility that lies ahead of them. As always, the Institute contributed significantly towards nation development through its acclaimed academic programs, M.Sc. (Food Technology), Certificate course in Milling Technology along with year-long Short Term Courses targeted at the Micro, Small and Medium scale industries. We also inked an academic collaboration with JSS University and Manipal University, for conducting an integrated M.Sc./Ph. D program in the area of molecular nutrition, supported by DBT.

Infrastructural expansion got a boost during this period. Considerable progress was made towards creating the Centers of excellence in Lipidomics and Molecular nutrition. The first high end super resolution gated confocal microscope of the country was procured by us this year. Several 'application specific' equipments were also purchased, to help in seamless research work flow. Few of the existing laboratories were modernized to stay in tune with global standards.

Known for its societal consciousness, Team CFTRI stood up to help the nation in its adversities, by arranging large volumes of nutritious and ready-to-eat food within short notice for the Uttarakhand flood victims. Another notable initiative was making some of our commercially viable technologies available free to entrepreneurs and MSMEs. The Open Day organized in September attracted more than 20,000 visitors, giving them a bird's eye view of the multifarious capabilities of our Institute.

Overall, it was a year of progress. I wish to acknowledge the support provided by CSIR, New Delhi, CFTRI Research Council and Management Council in helping us march towards our Institute's mandate. It is also my duty to thank Team CFTRI for making these achievements possible. Thanks are due to the various funding agencies for their support and trust in our capabilities and performance. With CFTRI raising the bar each year, I look forward to a more productive year!



Prof. Ram Rajasekharan
Director
CSIR-Central Food Technological
Research Institute, Mysore

Date: 26 September 2014

Place: Mysore

Publications

■ Research Papers	180
■ Reviews	17
■ Book Chapters	12

Projects

■ Grant-in-aid	70
■ Consultancy	31
■ Sponsored	38

Industrial Development

■ Patents Filed	3
■ Technologies Transferred	52
■ Short Term Courses Conducted	38
■ New Technologies Released	7

Human Resource Development

■ M.Sc. Students Passed Out	22
■ ISMT Students Passed Out	24
■ Ph.D Degree Awarded	21



Achievements in Brief

1. Research Papers Published

SCI Papers

- 1 Abhijith K.S., Ragavan K.V., Thakur M.S., Gold nanoparticles enhanced chemiluminescence - a novel approach for sensitive determination of aflatoxin-B1, *Anal. Methods*, 2013, **5**, 4838-4845
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Reviews

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2. Patents filed

- A process for the preparation of semi solid palm fat containing high amount of partial glycerides and having emulsifier property
- A process for the preparation of detoxified *Karanja (Pongamia pinnata)* seed meal
- Continuous online round grain separator

3. Processes released for commercial exploitation

Fifty two processes were released for commercial exploitation to 83 parties and forty processes were demonstrated to 60 licensees. Details are given below:

- A device for continuous forming and frying machine for *Boondi*
- Bacon & ham

- Baking powder
- Bottling of sugarcane juice
- Coconut beverage from tender coconut
- Coffee concentrate
- Dehydrated drumstick powder
- Eggless cake premix
- Energy food : New formulation
- Fermented and dehydrated ready mix for *Dosa* batter
- Fortified sugarcane beverage in glass bottles
- Fruit jams & jellies
- Fruit syrups & squashes
- Full fat soya flour: Edible
- Gravy paste for different Indian cuisine
- Honey based bakery products
- Instant gravy mixes dehydrated: *Tandoori* chicken marinating mix
- Instant gravy mixes: Dehydrated - 11 formulations
- Low cost nutrient supplement for malnourished children
- Low fat meat *Kofta*
- Mango pulp: Bulk preservation for RTS beverage
- Meat burger
- Milk chocolate
- Modified atmosphere packaging of minimally processed vegetables
- Moulding machine for besan, soji/rava and similar *Laddus*
- Multigrain fortified snack
- Online fortification of atta (Whole wheat flour)/ *Maida* (Refined wheat flour)
- Pickles & *Chutneys*
- Processed besan (bengal gram flour) for *Sev* and *Boondi*
- Production of atta (whole wheat flour)
- Puffed moth bean based sweet and savoury
- Pulse based *Papads*
- Quick cooking, germinated and dehydrated pulses
- Ready mix: *Idli*
- Ready mix: *Jamun*
- RTS fruit juices & beverages
- Rural based biotechnological production of *Spirulina*
- Sausage preparation chicken

- Sausage preparation: Meat / fish / chicken / pork
- Shelf stable *Biriyani* paste
- Shelf stable *Chapati*
- Shelf stable chicken tit-bits
- Spice oleoresin: Turmeric
- Sugar free cup cake
- Sugarcane de-skinning machine
- Tamarind candy
- Tamarind juice concentrate & powder
- Tamarind powder
- Tomato products
- Tutti fruity – Papaya
- Virgin coconut oil
- Wheat germ stabilization

4. New processes ready for commercial exploitation

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

- Annatto seed separator
- Fruit jam slices
- Shelf-stable convenience mix: A cooking base
- Shelf-stable varieties of curry pastes for vegetarian and non-vegetarian traditional cuisines
- A device for continuous forming and frying of boondi
- Production of turmeric powder from fresh turmeric rhizome
- Low fat expanded green snack using *moringa* leaves

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

Type of project	No. of completed projects	New projects under-taken	Total no. of projects carried out
• Consultancy	23	6	31
• Sponsored	6	17	38
• Grant-in-Aid	11	19	70

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

Academic Programme	Degree/Certificate Awarded
• M.Sc. (Food Technology)	22
• Certificate course in Milling	24
• Short-term courses (38 Nos.)	772

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

- **Presentation of Medals, Scholarships, Awards and Certificates to M.Sc. (Food Technology) and ISMT Students** (July 10, 2013)

In the award function, Sri Umakanth Gupte, VP, MTR Foods, Bangalore distributed meritorious awards, medals, scholarships and certificates to the outgoing students of the M.Sc. and ISMT courses. Prof. Ram Rajasekharan, Director, CSIR-CFTRI presided the function.



Dignitaries of the Awarda function with the outgoing M.Sc. (Food Technology) and ISMT students

- **Hindi Fortnight Celebration** (September 2-16, 2013)

Hindi Fortnight was celebrated at CSIR-CFTRI from 02-09-2013 to 16-09-2013. Prof. Ram Rajasekharan, Director, CSIR-CFTRI inaugurated the function on 2nd September 2013. A variety of competitions in Hindi were conducted for employees, Research Scholars, Project Assistants and students of the Institute during the fortnight. Prizes to winners of the competitions were distributed by the Chief Guest, Dr. Sateesh Pandey, Principal, Dakshina Bharat Hindi Prachar Sabha (DBHPS), Mysore in the valedictory function held on 16th September 2013.



- **CSIR Foundation Day and CSIR-CFTRI Open Day** (September 26-27, 2013)

The Institute organized 'OPEN DAY' during Sept. 26-27, 2013 as part of the CSIR Foundation Day celebrations. Mrs. C. Shikha, Deputy Commissioner, Mysore District graced the occasion as the Chief Guest. A total of 20,000 public visited the campus to understand the R&D activities in the Institute. An exhibition was also arranged for the display of commercial products by CFTRI clients on this occasion. '**Doing Science with a Purpose**' showcased the achievements of CSIR over the past seven decades.



CSIR Foundation Day: Inauguration of the function by Mrs. C Shikha , Deputy Commissioner, Mysore. Prof. Ram Rajasekharan, Director, CSIR-CFTRI is also seen



A view from the Open Day exhibition arranged during CSIR Foundation Day celebrations

Hindi Fortnight celebrations inauguration by Prof. Ram Rajasekharan, Director, CSIR-CFTRI

- **CFTRI Foundation Day** (October 21, 2013)

CFTRI Foundation Day was conducted on Oct. 21, 2013. Dr. B.L. Amla, former Director, CSIR-CFTRI graced the occasion as the Chief Guest and gave away the CFTRI Annual Awards. He also distributed prizes to children who won in competitions held as part of CSIR Foundation Day celebrations. Prof. Ram Rajasekharan, Director, CSIR-CFTRI, presided.



CSIR-CFTRI Foundation Day: Inauguration by Dr. BL Amla, former Director, CSIR-CFTRI. Prof. Ram Rajasekharan, Director, CSIR-CFTRI is also seen



Inauguration of the Cold Storage System by Prof. G. Padmanaban, Chairman, CSIR-CFTRI Research Council

- **Vigilance Awareness Week**

(October 28 - Nov. 2, 2013)

As part of the vigilance awareness celebration, a talk by Shri J.B. Rangaswamy, Deputy Superintendent of Police (Retd.) was arranged in the Institute.



Celebration of Vigilance Awareness week



Release of CSIR-CFTRI Calendar 2014



J.B. Bhat Memorial lecture by Prof. Ram Rajasekharan, Director, CSIR-CFTRI

- **SSBMT Outdoor Zonal Meet** (Nov. 18-21, 2013)

Institute paid host to 45th SSBMT outdoor zonal competitions in which other CSIR laboratories, CSIR-CIMFR (Dhanbad), CSIR-CEERI (Pilani), CSIR-NPL (Delhi), CSIR-IIP (Dehradun), CSIR-NML (Jamshedpur), CSIR-AMPRI (Bhopal), CSIR-CGCRI (Kolkata), CSIR-IITR (Lucknow), CSIR-CBRI (Roorkee) and CSIR-CRRI (New Delhi) were participated.



Valedictory function of SSBMT Outdoor Zonal Meet

- **7th International Food Convention - IFCON 2013** (December 18-21, 2013)

The event was jointly organized by CSIR-CFTRI; Defence Food Research Laboratory (DFRL), Mysore; Association of Food Scientists and Technologists, India (AFSTI) and Ministry of Food Processing Industries, Govt. of India. The symposium deliberated on the theme 'NSURE - Healthy Foods' in which more than 1200 delegates, speakers, students and industrial representatives were participated.



Release of souvenir: from the Inaugural function of IFCON 2013

- **Value Fish 2014** (March 14-15, 2014)

CSIR-CFTRI in association with CIFT, Kochi and National Fisheries Development Board (NFDB), Hyderabad organized the event at Veeraval, Gujarat.



World Environment Day celebrations in the Institute



Prof. Ram Rajasekharan, Director, CSIR-CFTRI addressing the audience in the valedictory session of IFCON 2013

8. Awards and Recognitions

a) Ph.D. Degree awarded

Nithya V (Antibacterial peptides of *Bacillus* species active against food-borne pathogens)

Manjulata Devi S (Molecular genetic studies of pediocin-like bacteriocin in *Pediococcus*, *Lactobacillus* and *Enterococcus* sp.)

Harshavardhan Reddy A (Functional properties of elephant-foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson))

Aruna Gorusupudi (Studies on the bioavailability and biological activity of lutein and its metabolites)

Chandini S Kumar (Membrane processing of black tea extracts)

Raghavendra R Hegdekatte (Studies on modulatory effect of spices and omega-3 fatty acids on eicosanoid metabolism)

Madhu AN (Synergistic effects of selected lactic acid bacteria and fructooligosaccharides in the maintenance of gastrointestinal health)

Latha R (Biochemical and molecular characterization of DDT degrading dehalogenase from *Pseudomonas* spp.)

Vinayaka AC (Studies on bioconjugation of CdTe-quantum dot for monitoring enterotoxin B producing *Staphylococcus aureus*)

Kanchan Singh (Development and comparison of ELISA for environmental contaminants based on natural and synthetic antibodies)

Roopashri AN (Prebiotics-probiotics interaction in selected cereal and legume based foods)

Vijayakumar KR (Functional expression and characterization of lipase from *Oryza sativa*)

Mohammad Imtiyaj Khan (Studies on the pigments from fruits of *Rivina humilis* L: characterization, elicitation, stability and safety)

Sowmya N (Studies on detection of enterotoxigenic staphylococci in food samples by molecular techniques)

Madhusudhan MC (Extraction and purification of selected enzymes using bioprocess integration)

Gururaj HB (Studies on enzymatic regulation and identification of gene leading to vanillyamine biosynthesis in *Capsicum* sp.)

Padma Mallya N (*In vitro* regeneration of *Solanum melongena* L. and genetic transformation towards reduction of enzymatic browning)

Smitha J (Isolation, characterization and mechanism of action of anticancer compounds from selected plant sources)

Suresha BS (Studies on the antidiabetic influence of an aldose reductase inhibitor obtained from fungal fermentation)

Amit Kumar Rai (Biotechnological approaches for recovering lipids from fish processing byproducts and biological activity of recovered lipids)

Rajashankara Murthy HM (Microbial degradation of hexachlorocyclohexane)

Rajashankar BV (Construction of plasmid based molecules for quantification of biotechnological applications)

b) Individual Awards

Award Title	Instituted by	Awardee
Laljee Godhoo Smarak Nidhi Award 2013	Association of Food Scientists and Technologists (India), Mysore	Giridhar P
Dr. PP Kurien Award on Pulse Processing and Utilization	Association of Food Scientists and Technologists (India), Mysore	Sila Bhattacharya
Subhash Bhatnagar Memorial Award	Association of Food Scientists and Technologists (India), Mysore	Narsing Rao G
Engineering Excellence Award - 2013	Public Relationship Society of India (PRSI), Delhi Technological University and Department of Public Enterprises (Government of India)	Sridhar BS
Excellence in Carbohydrate Research Award	Association of Carbohydrate Chemists and Technologists, India ACCT (I)	Muralikrishna G
Young Scientist Award	Association of Food Scientists and Technologists (India), Mysore	Suresh D Sakhare

c) Recongnitions by Academies

Recognition	Instituted by	Awardee
• Fellow	Indian Academy of Science, Bangalore	Raghavarao KSMS
• Fellow	Association of Food Scientists and Technologists, India	Raghavarao KSMS
• Fellow	National Academy of Agricultural Sciences, India	Raghavarao KSMS
• Fellow	Institute of Engineers (India)	Anandharamakrishnan C
• Fellow	Association of Biotechnology & Pharmacy	Prasada Rao UJS
• Fellow	National Academy of Agricultural Sciences, India	Shylaja M Dharmesh

d) Other Recongnitions

Fellowship / Programme	Awardee	Host Institute / Agency
• Member	Bhaskar N	Scientific panel on fish & fishery products, FSSAI
• Member	Lalitha R Gowda	Scientific panel on method of sampling and analysis, FSSAI
• National Consultant	Lalitha R Gowda	UNEP/GEF supported 'Phase II Capacity Building Project on Biosafety' being implemented by the Ministry of Environment & Forests, Government of India
• JC Bose Fellowship	Ram Rajasekharan	Department of Science & Technology
• Member	Ram Rajasekharan	Vision group on Biotechnology, Govt. of Karnataka
• Chairman	Ram Rajasekharan	Task force on "Biotechnological approaches for food and nutritional security", Dept. of Biotechnology, Govt. of India
• Chairman	Ram Rajasekharan	Drink & drinking water sectional committee, BIS
• Chairman	Ram Rajasekharan	Expert committee to suggest parameters for mid day meal scheme, MHRD, Govt. of India
• Member	Ram Rajasekharan	Project approval committee, MFPI, Govt. of India
• Member	Ram Rajasekharan	Review committee on genetic manipulation, Dept. of Biotechnology, Govt. of India
• Member	Sridevi A Singh	Interagency working group 2 on micronutrients coordinated by ICMR
• Member	Sathish HS	Task force of Indian Institute of Packaging, Mumbai
• Member	Prabhasankar P	APEDA Task force, New Delhi
• Certified Food Scientist	Negi PS	International Food Science Certification Commission, USA
• Member	Negi PS	Scientific panel on genetically modified organisms and foods, FSSAI
• Member	Anu Appaiah KA	Scientific panel on pesticide and antibiotic residues, FSSAI
• Member	Srinivas P	Scientific panel on labelling and claims / advertisements FSSAI

e) Other Awards

Recognition	Instituted by	Awardee
• <i>Gandhian Young Technological Innovation (GYTI) Awards-2014</i> for Jaivik Prakash (Biophotonics): A simple tool for detection of hazardous materials and sanitary condition at rural level	Sristi Organization, Indian Institute of Management, Ahmadabad	Mr. Rajeev Ranjan, (Research Fellow)
• Best Paper Award in the Journal of Food Science and Technology - 2013	Association of Food Scientists Science and Technology - 2013	Hameeda Banu N Itagi & Vasudeva Singh

f) Best Research Papers / Posters awards

1. 7th IFCON, CSIR-CFTRI, Mysore, 18-21 December 2013

1 Ramesh Kumar R., Kavya D., Mourya Krishna D., Rajasekharan R., Genetic diversity and trait association for lipid content and composition in basil (<i>Ocimum spp.</i>) (Popular Poster award)	11 Kalpana Devi C., Subramanian R., Vasudeva Singh, Status of protein, starch and dietary fiber in different degree milled rice bran from various rice varieties
2 Amitha V., Shwetha V., Pushpa S Murhy., Roopa B.S., Sathish H.S., Extension of shelf life of <i>Aloo Paratha</i> using hurdle technology	12 Anu Bhushani J., Triroopa Ghosh, Anandharamakrishnan C., Nanoencapsulation of green tea polyphenols by electrospraying
3 Lokesh V., Manjunatha G., Puthusseri B., Neelwarne B., Genetic regulation of banana fruit ripening by non-genetic approach	13 Karthik P., Anandharamakrishnan C., Docosahexaenoic acid (DHA) nanoemulsions: Comparison of different techniques, lipid oxidation and stability
4 Sakhare P.Z., Ashok Kumar C., Ali Muhammed M., Bhaskar N., Utilization of poultry processing by-products : Evaluation of chicken feet as a source of collagen and gelatin	14 Padma Ishwarya S., Anandharamakrishnan C., Spray-freeze-drying technique for soluble coffee production
5 Hema Panwar, Prabhashankar P., Manisha Guha, Development and quality evaluation of protein enriched sorghum pasta	15 Shanthilal J., Suwendu Bhattacharya, Modification of rice flour dough for product development: Rheological and structural features
6 Sathyendra Rao B.V., Srinivas A., Umesha B.A., Arjun S., Faraaz Mohammed, Mohan C.G., Nitish K.J., Pedal operated millet dehuller	16 Tanvi Rao, Nagaraju V.D., Ramalakshmi K., Sridhar B.S., Cryo-assisted spouted bed roasting of coffee beans
7 Raja Rajeswari J., Jayadeep A., A cardio protective component rich food ingredient by drum drying of finger millet seed coat (Best oral presentation)	17 Ram Saran Chaurasiya, Sakhare P.Z., Bhaskar N., Umesh Hebbar H., Efficacy of reverse micellar extracted bromelain in meat tenderization
8 Geetha, Sindhoora S., Vijayanand P., Saritha G Pandit, Utilization of carrot residue for the development of value added products	18 Anupama Rani, Amrutha N., Hrishikesh A., Umesh Hebbar H., Raghavarao K.S.M.S., Ramchandra Gadre, Encapsulating yeast (<i>Saccharomyces cerevisiae</i>) using different carrier materials to enhance its shelf life
9 Math R.G., Nagender A., Sameera N., Satyanarayana A., Studies on microbial destruction by continuous microwave heating system through helical coils (Best oral presentation)	19 Vijayendra S.V.N., Vanajakshi V., Varadaraj M.C., Venkateswaran G., Renu Agrawal, Effect of probiotic cultures on fermentation of <i>Moringa</i> leaves extract
10 Suresh Sakhare, Inamdar A.A., Umapathi H., Prabhashankar P., Rheological characterization of roller milled fenugreek (<i>Trigonella Foenum-graecum</i>) fractions	20 Ranjan K., Sangita S., Simone Guglielmetti, Giovanni Ricci, Vijayendra S.V.N., Varadaraj M.C., Rajani M., Prevalence of probiotic lactobacilli in <i>Dahi</i> prepared at different climatic conditions of Nepal

- 21 Louella C.G., Vrinda R., Prakash M Halami, Characterization, production and application of an acidic lipase from *Enterococcus durans* NCIM 5427
- 22 Mahesh M Patil, Ali Muhammed M., Anu Appaiah K.A., Fatty acid profiling of *Garcinia* species and fermentation studies of *Garcinia xanthochymus* using isolates
- 23 Hema Panwar, Prabhasankar P., Manisha Guha, Development and quality evaluation of protein enriched sorghum pasta
- 8 Hemalatha M.S., Ashwath Kumar K., Jyothilakshmi A., Sindhu Kanya T.C., Venkata Rao S., Development of nutritious food for children to combat nutritional deficiency disorders, 45th Annual National conference of NSI held at NIN, Hyderabad, Nov. 21-22, 2013
- 9 Sakthi Kumaran P., Vijayalakshmi G., Cytoprotective and antioxidant properties of millets and their utilization for synbiotic functional foods, 6th International conference on fermented foods, health status and social well-being (SASNET), Anand Agricultural University, Anand, Gujarat, Dec. 6-7, 2013 (Best oral presentation)

II. Research Papers / Posters awards in other seminars

- 1 Hasitha P., Sunil Kumar R., Aishwaraya S., Chauhan A.S., Rekha M.N., Dharmesh S.M., Anticancer potentials of *Bael* (*Aegle marmelo* Linn.) and *Bael* products, International conference on holistic medicine, Kottayam, Kerala, Sept. 6-8, 2013
- 2 Roopesh S., Purnima Kaul Tiku, 3D computational model of rice bran protease (RBP): First report of a protease with cupin fold, Recent advances in computational drug design (RACDD), Indian Institute of Science (IISc), Bangalore, Sept. 16-17, 2013
- 3 Devi S.M., Selective screening and molecular detection of probiotic lactic acid bacteria from dairy and human sources, 2nd International conference on Probiotics and functional foods, Orlando, USA, Oct. 23-25, 2013
- 4 Math R.G., Nagender A., Sameera N., Satyanarayana A., Evaluation of continuous flow microwave pasteurization/sterilization system for fruit and vegetable juices, National seminar on food processing for sustainable food security and safety, organized by Association of Food Scientists and Technologists (India), Hyderabad Chapter, Hyderabad, India, Oct. 24-25, 2013
- 5 Halami P.M., Protection of bovine neutrophil using neutralising antibodies to recombinant leukotoxin M/F0-PV subunit, Biotechnology for better tomorrow (BTBT) 2013 Conference, Mauritius, Nov. 11-12, 2013
- 6 Kumuda, Sarada R., Evaluation of presence of genes encoding for vitamin B12 dependent enzymes in microalgae, National conference on Frontiers in algology and algal biotechnology, Visva Bharati University, West Bengal, Nov. 15-17, 2013 (Best oral presentation)
- 7 Mahesh M Patil, Anu Appaiah K.A., Fermentation studies of *Garcinia* using isolated strains from traditionally fermented *Garcinia*, Association of Microbiologists of India (AMI-2013, Rohtak, Haryana, Nov. 17-20, 2013
- 10 Ashok Kumar C., Sakhare P.Z., Bhaskar N., Rheological and functional properties of chicken feet gelatine, Emerging food safety risks: Challenges for developing countries, NIFTEM, Kundli, Haryana, Jan. 9-11, 2014
- 11 Shobharani P., Halami P.M., Sachindra N.M., Fermentative recovery of anticoagulant and antioxidant compound from *Sargassum* sp., International conference on Algal biorefinery, IIT, Kharagpur, Jan. 10-12, 2013 (Best Paper)
- 11 Sowmya R., Sachindra N.M., Carotenoid producing flavobacteria from marine environment - Isolation and characterisation, National seminar on therapeutics of marine bioactive compounds, Gandhigram Rural University, Dindigul, Dec. 9-10, 2013 (Best Poster)

g) Editors / Editor-in-Chief / Associate Editors / Advisory Board of reputed journals

- Alternative Respiratory Pathways in Higher Plants (Book) by John Wiley & Sons, UK (Bhagyalakshmi N)
- Journal of Food Science & Technology (Prabhasankar P, Sridevi A Singh, Bhaskar N, Bhagyalakshmi N)
- International Journal of Genuine Traditional Medicine, Assoc. of Humanitas Medicine, Korea (Negi PS)
- ACES (Advances in Chemical Engineering Science), SCIRP (Raghavarao KSMS)
- Journal of Food Biology, Scholar Journals (Raghavarao KSMS)
- Indian Journal of Microbiology, Springer (Venkateswaran G)

- Indian Food Industry, AFSTI (Umesh Hebbar H, Vijayendra SVN, Anu Appaiah KA, Jayadeep A)
- Blue Biotechnology, Nova Publishers, USA (Prabhasankar P)
- Research and Reviews: Journal of Food Science and Technology, STM Journals (Prabhasankar P)
- International Journal of Immunology, Science PG (Prabhasankar P)
- Trends in Carbohydrate Research (e-Journal), ACCTI (Muralikrishna G)
- Egyptian journal of aquatic research, Elsevier, UK (Bhaskar N)

h) Editorial Boards

- Journal of Food Science and Technology, Springer (Anandharamakrishnan C, Madhava Naidu M, Jagan Mohan Rao L)
- Journal of Food Science and Engineering, David Publishing Company, Libertyvilles, USA (Anandharamakrishnan C)
- Journal of Nutrition and Nutritional Epidemiology, Cienza (Anandharamakrishnan C)
- Food Science Journal, Academy Science Society (Anandharamakrishnan C)
- International Journal of Food Science and Technology, Wiley - Blackwell, UK (Jagan Mohan Rao L)
- Recent Patents on Food, Nutrition & Agriculture - Bentham Science Publishers, USA (Jagan Mohan Rao L)
- SOA Journal of Organic and Biomolecular Chemistry, Signpost (Negi PS)
- Biotechnology Advances, Elsevier (Raghavarao KSMS)
- CyTA- Journal of Food, Taylor & Francis (Raghavarao KSMS)
- Journal of Food Engineering, Elsevier (Rastogi N K)
- Journal of Engineering, Hindawi (Rastogi N K)
- The Scientific World Journal, Hindawi (Rastogi N K)
- Research & Reviews: Journal of Food Science & Technology (STM) (Rastogi N K)
- International Journal of Food Science and Nutrition Engineering, Scientific & Academic Publishing Co., USA (Matche RS)
- The International Journal of Agriculture Food Science & Technology, Research India Publications, Delhi (Matche RS)
- International Journal of Knowledge Management and Information Technology, Research India Publications, Delhi (Matche RS)

9. Participation in Exhibitions

- **Vendor Development and Technology Show 2013:** Organized by Peenya Industries Association, Bangalore, Jun. 6-8, 2013
- **9th Food and Technology Expo-2013:** Organized by NNS Media Group, New Delhi, Jul. 26-28, 2013 (Received First Prize)
- **Agri-Tech India - 2013:** Organized by Media Today Pvt. Ltd, Bangalore, Aug. 23-25, 2013
- **Food Pro- 2013:** Organized by CII and supported by Ministry of Food Processing Industries (New Delhi), Chennai, Aug. 30 - Sept. 1, 2013
- **CII - MSME Linkages 2013 - Technology and Supply Chain Development for SMEs: Driving Global Competitiveness:** Ahmedabad, Aug. 30 - Sept. 1, 2013
- **Aahar - The International Food and Hospitality Fair 2013:** Organized by Indian Trade Promotion Organization, New Delhi and supported by Ministry of Food Processing Industries (New Delhi), Bangalore, Sept. 6-8, 2013
- **Agrowon Agri-Expo 2013:** Pune, Nov. 22-26, 2013
- **IFCON-2013:** Organised by CFTRI, DFRL and AFST(I), Mysore, Dec. 18-21, 2013
- **Indian Science Congress:** Organized by Indian Science Congress Association, Jammu, Feb. 3-7, 2014
- **9th Nutra India Summit 2014:** Organized by CSIR, International Society for Nutraceuticals, Nutritionals and Naturals (ISNNaN) and MM Activ SCI-Tech Communications, Bangalore, Mar. 12-14, 2014 (Special Jury Award)

10. Support Department Activities

Library provided access to 4262 journals through CSIR e-journals consortium to the staff and students through National Knowledge Resource Centre (NKRC) network. Also access to citation and full-text databases such as Web of Science, Derwent Innovation Index and Questel Patent Database was facilitated.

The Central Instrument Facility & Services department provided analytical services to R&D departments using sophisticated instruments. New instruments such as Oxygen Meter, Ultracentrifuge, Particle Size/ Shape Analyzer, GC and Confocal Microscope were added to the existing facility. In-house training to research students on operation and sample analysis with various instruments were organized.

Guided tours were conducted by the Information & Publicity department for 120 groups comprising of students, officials, foreigners and entrepreneurs totaling 3600 visitors. Publicity and awareness talks to popularize the CSIR Innovation Awards for school children was also undertaken during this period.

Renovation of mushroom lab, Seminar Hall at Silver Jubilee Block, provision of automatic water pumping

system at M.G Halli campus and interconnection of D.G. power, water lines of the Institute and permanent flood lights were provided for the grounds behind staff canteen (Basketball and Volleyball grounds) was carried out by the Electrical and Mechanical Maintenance department.

Erection of a Poly House and 10,000 lts capacity water tank for research farm at M.G. Halli campus was the highlight of the Construction and Civil Maintenance department.

The Institute mail services were migrated to NIC server. Also access to the Institute network was provided to Resource centres of CFTRI through VPN. More Wi-fi access points were deployed across the campus. Computer centre also supported multi-lingual intranet forum, grammarly software, MIS and number of web-based applications.



Progress Under R&D Projects

VALUE ADDITION TO AGRICULTURAL RESOURCES

Micronization on quality of maize grains

(Umesh Hebbar H)

Effect of infrared (IR) based micronization of whole maize grains (*Nityashree, Arju and Hema*) on product quality which include starch digestibility (RDS%) and enzyme inactivation under varied processing conditions such as temperature and treatment time were studied. A significant increase in RDS content (5-20%) was observed. Processing for more than 2 min resulted in minor fissure development in grains and also a slight change in colour. Hence, further studies were restricted to higher temperature (200°C) and shorter period (< 2 min), followed by holding of grains for 30 sec. Under these conditions, the RDS content increased by 12-15% and complete inactivation of peroxidase enzyme was achieved without significantly affecting other quality attributes (colour/composition) of the grain. At the optimized conditions, micronization reduced lipase activity by 82%.

Non-conventional oilseeds *(Sindhu Kanya TC)*

A cost effective nutrient supplement for animals such as poultry by utilizing non-conventional oilseeds as an alternate source was attempted. A poultry feed formulation was developed by incorporating the detoxified karanja seed meal as a source of protein, and the growth performance and the safety evaluation by feeding broiler chickens at two different levels by replacing soy and maize meal was assessed. Chickens fed with 15% detoxified meal significantly increased their body weights (1024±106g) compared to that of the ones fed on untreated meal (555±48g), however significant ($P>0.05$) difference in growth was observed compared to control group (1995±64g). The feed conversion rate (FCR) seen in group II (2.73) was significantly ($P>0.05$) better when compared to that of untreated group (FCR: 4.1), which was also reasonably comparable with the control group (FCR:2.1). Hematological analysis showed that experimental groups were comparable with standard group whereas significant differences were observed in serum biochemistry and histopathology of organ tissues compared to untreated groups. From the above results, it can be inferred that feeding at the level of 15%

detoxified meal performs the growth of broiler chickens compared to untreated meal.

Small millets *(Sathyendra Rao BV)*

To improve the shelf-life of unpolished and completely polished grains and also the effect of packaging material under ambient conditions, foxtail millet was exposed to moist heat for 5, 15 and 25 min at atmospheric pressure. The heat treated grains were dehulled, polished and stored for 3 months under ambient condition either as unpolished or polished grain in LDPE pouches (200 gauges). Studies indicate that shelf life as well as milling characteristics of foxtail millet grains could be enhanced by exposing the whole foxtail millet to mild heat treatment. This treatment did not change the phenolic acid content but also decreased the cooking time and solid loss in kodo millet grains.

Drum drying of finger millet seed coat, naturally rich in fibre and minerals resulted in an instant food mix with high retention of cardio protective components and properties. Alkaline cooking (nixtamalisation) of foxtail millet resulted in nixtamal with high protein, ash, low fat with lower reduction of antioxidants. The process improves the nutritional value, flavor and aroma of the product. This nixtamal could be used in the preparation of ready-to-eat / ready-to-cook foods. Upon processing, there was an increase in extractable, hydrolysable and total polyphenolic content of steamed kodo millet. Germinated and steamed kodo millet, germinated barnyard millet showed an increase in all polyphenols while in steamed little millet, increase in non-extractable polyphenols was observed. Milling yield and nutrient data obtained on roller milling of foxtail millet, suggests that milling of the husked foxtail millet at 15 to 16% grain moisture content will be optimum. Results indicate the potential of preparation of edible flours from the native millet without the husk contamination.

Biomolecules from agro-processing wastes

(Prasada Rao UJS)

Antioxidant activity studies in germinated green gram seed extracts revealed that whole raw seed showed

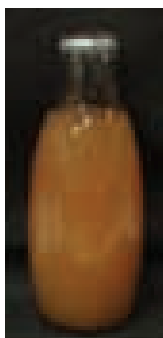
more antioxidant activity compared to that of imbibed as well as germinated seeds. This may be mainly due to the decrease in phenolic acid content during germination. Husk is the major source of phenolic acids and during germination, ferulic acid and synapic acid, which are potent antioxidants, decreased. Husk extracts of ungerminated (raw) seed exhibited inhibition of α -amylase and α -glucosidase activities in a dose dependent manner. However, the percentage of inhibition of α -glucosidase was higher at low concentration (7.5 μ g GAE) compared to α -amylase.

Changes in husk free phenolic acids profile during germination is given below:

Sample	Phenolic acid content (μ g/g)	
	Ferulic acid	Synapic acid
Raw seed husk	110	80
Imbibed seed husk	140	90
5 th day sprout husk	80	60

Beverages from West Indian Cherry (*Malpighia puniceifolia* L) (Revathi Baskaran)

Ready-to-serve beverage and jelly were prepared from the West Indian Cherry (*Malpighia puniceifolia* L) fruit. The fruit has a very high content of ascorbic acid (1000-4600 mg/100g) as compared to other rich sources like aonla (600-700 mg/100g), guava (200-300 mg/100g), citrus (50-100 mg/100g) and jamun (290 mg/100g). It is also a good source of carotenoids, phenolic acids and anthocyanins.



West Indian cherry RTS beverage



West Indian cherry sauce

Nutraceutical products from pumpkin (Vijayanand P)

Four commercial cultivars of pumpkin viz., *Disco*, *Arjun*, *Nati* long and *Nati* round were screened for their physico-chemical compositions. Cultivar, *Nati* endowed with highest carotenoid content was selected for the development of different nutraceutical products. Pumpkin dry powder was obtained by spray drying, drum drying and hot air drying methods and instant beverage mix, pumpkin custard mix were developed.



Pumpkin spray dried powder



Pumpkin RTS beverage



Instant pumpkin custard mix

Specialty products/components from non-conventional grains (Sathyendra Rao BV)

Resistance Starch (RS) was found to be high in pigmented rice (*Jyothi*); phosphorylation increased the RS content both in pigmented as well as non-pigmented variety (IR 64). Cross-linking changed the conformation of starch molecules by making them more compact compared to those of the raw rice flour. Bran from pigmented rice subjected to combination enzyme treatment resulted in 58% increase in soluble polyphenols, 63% increase in free radical scavenging activity and 82% increase in total antioxidant activity.

Foxtail (*Setaria italica*), proso (*Panicum miliaceum*) and barnyard (*Echinochola crus-galli*) millets were subjected to germination, steaming and microwave treatments. Millet phenolic compounds showed concentration dependent inhibition of α -amylase and α -glucosidase. Strong inhibitory activities were observed in phenolic extracts of germinated millets with IC₅₀ values of 8.6-41.8 μ g/ml.

Grain components of pearl millet when soaked in solutions varying in pH showed reduction in antinutrients. Acid soaking and germination reduced the phytic acid considerably while alkali treatment reduced the polyphenols and flavonoids. Organic acid treated endosperm and bran significantly enhanced mineral bioaccessibility when compared to other treatments.

Analysis of cowpea flour subjected to fractionation and sequential separation had varied effects on the nutrient and anti-nutrient contents. The functional properties of the flours showed that chemical composition and functional properties could be manipulated by modifying the distribution of particulate size fractions of the flour.

Fabricated snacks made using dough prepared with different combinations of black gram, amaranth, finger millet and sorghum. Biscuits from buckwheat flour were formulated. Bread has been developed by blending separately the processed pearl millet bran and endosperm with partial replacement (20%) of wheat flour. Maize noodles from nixtamalized flour were prepared.

Measurement of flavour and taste interaction

(*Maya Prakash*)

Basil (*Ocimum sanctum*) and mint (*Mentha spicata*) essential oils were extracted by Cleavenger's method of hydro-distillation. The yield of basil essential oil was 0.7 - 0.8% and for mint was 0.1 - 0.2%. Threshold values for basil aroma and mint aroma using sensory protocols were 0.03% and 0.008% respectively. Essential oils were subjected to sensory odor profiling. The top notes and the base notes were identified and profiled using quantitative descriptive analysis. The sensory profiles for basil and mint odor profile were developed. Ready-to-serve health drink was prepared separately using basil and mint aroma. Sensory flavor profiles were developed for the health drink. The results showed high acceptance score for both the health drinks of basil and mint. The flavor and taste interaction showed that basil flavor intensity increased in the presence of NaCl and mint flavor intensity increased in the presence of sucrose indicating synergistic and antagonistic properties of the flavor compounds.

Analysis were carried out for the mint and basil essential oils to identify the major compounds present. In mint essential oil, 29 compounds were present and major ones are p-Menthane-1,2,3-triol, Caryophyllene and Germacrene-D. In the case of basil essential oils, 23 compounds and major ones are Methyl chavicol, Caryophyllene and Germacrene-D. Anti-oxidant properties of mint and basil essential oils were calculated using radical scavenging method. Results showed an

increasing trend with the increasing level of flavor compounds.

Fruit and vegetable products of Andhra Pradesh

(*Jyothirmayi T, Satyanarayana A*)

Muskmelon products such as fruit rolls, syrup and foam mat dried powder were bright orange in colour, with characteristic flavour and containing considerable amount of vitamin C (21-289 mg/100g), total carotenes (3.4-15.4 mg/100g) and polyphenols (64-197 mg/100g). Foam mat dried powder applied in ice creams at 2 and 3% respectively was found acceptable.

Khatta meetha prepared from karonda by using sugar was more acceptable compared to jaggery, as slight bitterness was observed in the product with jaggery. Khatta meetha had a moisture content of (13.72%), acidity (1.8%), reducing sugars (67.4%) and total sugars (76.2%). Similarly karonda pickle was prepared by grinding part of the pieces (15%) to not only obtain better gravy component along with spice powders and also to impart the required acidity to gravy. Star gooseberry products such as marmalade, jelly and syrup were attractive with good flavour and taste which are rich in vitamin C (13-28 mg/100g) and polyphenols (115-128 mg/100g).

Dehydrated chips from colocasia and yam were prepared by boiling in 0.3 mm thickness slices in 0.25% citric acid, dipping in 0.1% KMS solution and tray drying at 55°C. Both chips possessed high fibre content of 2-4%.

Underutilized fruits and vegetables (Gothwal PP)

Value added products such as pulp, drink with 10% pulp, RTS Beverages/Nectar/Squash and herbal jam with the addition of herbal based nutrients/mixture's of vitamins and minerals were prepared from Jamun (*Syzigium cumunii*), Raspberries (*Rubus rosifolius*) and Kafal (*Myrica nagi*) fruits. The samples were analyzed for its physicochemical studies as well as shelf life. The proximate composition analysis (with the addition of added herbal based nutrients/mixture's of vitamins and minerals) of above products showed significant levels of essential micronutrients and nutrients. Pulp extracted from Jamun, Raspberries and Kafal fruits remains in good condition with respect to aroma and consistency, even after 90 days of storage, except for heat processed pulp, where browning was observed after 105 days of storage. However during prolonged storage, significant reduction of total soluble solids was noticed. The storage studies of above processed products at room temperature, 7°C and 37°C indicated no significant changes with respect to total soluble solids, acidity, total sugar, minerals,

vitamin C, fruit fibres and aroma after six months of storage. The above value added products may be produced on large scale and can be commercialized.

Kokum (*Garcinia indica*) (Badgujar PM)

Kokum rind paste was prepared and stored in the various containers such as Lu Lug cap bottles, standy pouches, pet containers, HDPE bags in frozen condition, screw cap PET container and HDPE can with screw type cap. Shelf life was 12 months in case of Lu Lug cap bottles, standy pouches, PET containers and frozen condition in HDPE bags, whereas it was 3 and 4 months respectively for screw cap PET container and HDPE can with screw type cap. Kokum shred preserves, paste preserve, whole fruit reserve with lye peeling and without lye peeling was also prepared. Kokum based RTS beverage, squash, carrot RTS beverage, Date RTS beverage and carbonated beverage were also prepared. Similarly Kokum bar of various flavours like jeera flavour, fruit and vegetabes, moringa, carrot, guava and okkara bar with sesame seeds and cashew nuts were also made. Solkadhi, a traditional drink consumed as coolant and appetizer in konkan region of Maharashtra, was prepared using the paste on dilution with water.

***Jatropha* seed cake (Somashekar D)**

Solid-state fermentation was carried out for the detoxification of the *Jatropha* seed cake (JSC) using six different fungal cultures. The reduction in the anti-nutritional components such as tannins, phytates, saponins, lectin and protease inhibitor, and phorbol esters on 6th, 9th, and 12th day of fermentation was analyzed. The phorbol ester content in the unfermented JSC was 0.83 mg/g, and the maximum degradation of phorbol esters to the extent of 75% was observed in the case of JSC fermented with *Cunninghamella echinulata* CJS-90. The phytate degradation in the fermented JSC was in the range of 65–96%. There was a gradual reduction of saponin content in the JSC from 6th to 12th day, and the reduction of saponin was in the range of 55–99% after solid-state fermentation. The trypsin inhibitor activity and lectin were 1,680 trypsin inhibitor units (TIU) per gram and 0.32 hemagglutinating unit in the unfermented JSC, respectively. Trypsin inhibitor activity and lectin could not be detected in JSC after 12th day of solid state fermentation. Tannins accounted for 0.53% in unfermented JSC, and there was a marginal increase of tannins after solid-state fermentation. The results indicate that biological detoxification could be a promising method to reduce anti-nutritional compounds and toxins in the JSC.

Bioactives from agri- and marine wastes

(Purnima Kaul Tiku)

Palm kernel and red gram mill waste was used for isolating bioactive ingredients/proteins. A major storage protein, molecular mass of around 200±10 kDa was isolated, purified and characterized from defatted palm oil kernel meal. SDS-PAGE under reducing conditions showed that the protein is made of 3 major subunits suggesting it to be a heterogeneous oligomer. Amino acid sequence of the isolated protein had similarity with the storage protein of palm glutelin (*Elaeis guineensis*). Using PDB hits (Jpred3) the 3D structural analysis of the protein matched with 11S globulin seed storage protein. Signal peptide cleavage site was identified (Signal P-4.). The amino acid profile shows the protein to be rich in arginine (13.3 g%). The sequence of the protein using Phyre 2 Server showed that the protein belongs to cupin family having beta barrel structure. The secondary structure analysis shows the protein to have 16% alpha helix, 32% beta strand and 42% disordered structure. In another study, defatted pigeon pea mill waste by-products were used as a source of protein. The by-products of seed processing from dhal mill include pigeon pea powder, brokens, germ layer and seed coat. The polished powder with brokens (chunl/chunni) comprising of 15% protein was used for the preparation of protein concentrate. The protein concentrate (68%) exhibits antioxidant activity (DPPH free radical scavenging activity, reducing power and metal chelating). *In vitro* digestion of the protein improved solubility and even exhibits antioxidant activity making it advantageous for its use as a functional ingredient.

Shelf-life extension of selected traditional foods

(Jyothirmayi T, Satyanarayana A)

Kajjikayalu, a traditional sweet product of Andhra Pradesh was modified to enrich the protein content from the existing 6.5 to 13.0% by using bengal gram and groundnut mix. Similarly, “*Sunni undalu*” was prepared using roasted black gram dhal powder and roasted finger millet flour (at 10 and 20% levels) to enhance calcium content. The product with roasted finger millet flour incorporated at 10% level scored good over conventional product. Traditional product “*Shankarapali*” was prepared by replacing part of maida with finger millet and soy flour to increase calcium and protein content. The product was prepared by baking to reduce the fat content.

Black grapes (Vijayanand P)

Anthocyanin-rich value added products from black grapes were developed. Ready to serve beverage (RTS)

containing peeled whole grapes showed higher anthocyanin (2.52 mg/100g) content than normal grape beverage (1.52 mg/100g). Anthocyanin content of the products viz. dehydrated black grapes (48.5 mg/100g), grape jam (2.40 mg/100g) and grape candy from peeled grapes (10.3 mg/100g) revealed that these products had substantially higher anthocyanin content. Chemical and sensory quality profiling of the products showed that these products were highly acceptable during 3 months storage at room temperature.

Watermelon (*Vijayanand P*)

Physico-chemical composition of watermelon cultivars viz. dark green and pale green were carried out. Thermal processing of watermelon puree in glass bottles and cans were conducted. Processed products from canned watermelon chunks in syrup (lycopene content 26 µg/100g) and watermelon candy (lycopene content 483 µg/100g) were developed. The products were highly acceptable with respect to sensory qualities up to 90 days at RT.



Watermelon Candy

Seabuckthorn puree (*Chauhan AS*)

Seabuckthorn (SBT) puree (10-40%) was incorporated into semolina to explore the possibility of pasta preparation. Incorporation of 30% SBT puree in semolina resulted in balance between color intensity and acidity of SBT pasta, whereas at concentrations less than 30%, decrease in color intensity in the pasta strands was observed, while, incorporation of higher concentrations of SBT puree resulted in undesired level of acidic products. Concentrations of NaHCO₃ (0.12-0.48) did not reduce acidity in the SBT pasta. The cooking quality of SBT puree pasta was found to be acceptable because of negligible loss after cooking.

Sapota fruit (*Kudachikar VB*)

Studies on optimization of the postharvest treatments, storage conditions, for quality maintenance and extension of storage life of sapota fruits at low temperature (LT) indicated that pretreatment of sapota with 3% CaCl₂ and 4.5% CaCl₂ had better retention of

fruit colour, texture and other quality parameters. The shelf life of treated sapota fruits was extended up to 30 days as against 16 days in untreated control fruits stored at LT. After storage studies, the pulp of fully ripe fruits of these treatments was processed into dehydrated sapota slices. The quality of these dehydrated sapota slices was found excellent in overall quality attributes with shelf stability up to 6 months at RT (22±2°C).

Table grapes (*Kudachikar VB*)

Studies on optimization of concentration of preharvest spray treatments and storage conditions for shelf life extension and postharvest quality maintenance of table grapes (var.Dilkhush) were carried out. Grape berries responded very well to CaCl₂ (3 and 4.5%) and calcium propionate (0.5 and 1%) in terms of retention of fruit colour, texture and other quality parameters, with an effective storage life of 90 days at LT (2±1°C; 90-95% RH) storage conditions as against 60 days in control grapes. Sensory quality of fully ripe berries after 3 days at RT indicated excellent fruit quality compared to control. Grape raisins were developed from fully ripe berries of above pretreatments which were found excellent in overall quality attributes.

Underutilized grains (*Sila Bhattacharya*)

Physical, engineering and functional properties of two varieties each of proso and foxtail millets were studied in whole grain, dehusked grain as well as for the polished grain forms. It was found that variation in the physical and engineering properties between the varieties is marginal whereas, significant variation was observed in the functional properties. Foxtail millets have more water absorption capacity (143 to 168%) compared to that of proso millets (110 to 143%). The morphological and histological studies carried out showed that phytate concentrated mostly in germ (scutellum) and aleurone layers, whereas, polyphenol was concentrated more in germ, cell walls and aleurone layer. Protein concentrated mainly in aleurone and periphery of endosperm, whereas fat was concentrated mostly in aleurone and germ part of the grain. Studies carried out on hydration characteristics of proso millet showed that moisture content increased sharply at the initial stages at all temperatures and a marked increase in moisture content at 85°C for all the fractions. Leaching loss and volume expansion increased with time and temperature and were found to be the maximum at 85°C. The starch characteristics of the millets were studied by sediment volume, swelling power and solubility determination at different temperatures. The sediment volume of proso and foxtail millet was found to be 5.6 and 6.0 ml

respectively, indicating presence of intact (un-disintegrated) starch granules. The swelling power and solubility of both proso and foxtail millets increased with increasing temperature. The water solubility index (WSI) also exhibited the same trend. This may be due to the difference in particle size between the flours and starch characteristics. Mean particle size of proso and foxtail millet flour was 93.3 and 157.3 μm , respectively. These results are useful in developing products such as extruded/ ready-to-eat snacks.

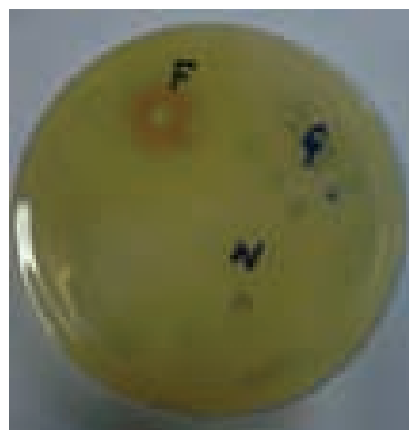
Plant proteins-based staple foods (Prabhasankar P)

Flour obtained from wheat of two different commercial wheat varieties viz. *Triticum durum* and *Triticum aestivum*, was replaced by black gram (*Vigna mungo*) at 30, 40, 50 and 60% proportions for pasta preparation. Proximate studies indicated an increase in ash and protein content while moisture decreased from control with increasing level of incorporation of black gram flours in the blends. Rheological studies such as farinograph water absorption (FWA) showed increase at 71 and 64% for both durum and aestivum blends respectively. With incorporation of black gram, FWA increased in flour blends due to increased protein content. Pasta cooking quality characteristics showed an increase in cooking loss with addition of black gram flour in both species which could be due to dilution of gluten matrix. Sensory, colour, particle size distribution, cooking loss and texture studies favoured 40% replaced blends of both *aestivum* and *durum* and hence 40% replaced wheat flour blends were optimised for pasta preparation. Based on optimized 40% level of blends, two variations of black gram - toasted and untoasted black gram flour were selected for finalization of pasta products. These pasta samples were subjected to biochemical and nutritional evaluations. SDS PAGE showed an increase of protein bands supporting the increase in crude protein value (15%) compared to control (11%). SEM exhibits increase in protein matrix distribution entrapped starch granules. *In vitro* protein digestibility (IVPD) increased from 70% (control) to 89% (40% BG). Mineral content levels of iron and calcium increased relative to control. Sensory analysis showed high consumer acceptance

with the samples. Storage studies and other nutritional parameters such as amino acid analysis and fatty acid profile of optimized pasta samples are in progress.

Papaya seed extract as a preservative (Matche RS)

Papaya seeds were extracted using ethanol and distilled water as extracting solvents in rotavapor at 45°C. Filter papers were soaked in the extract for 6-8 hours and dried under infrared lamps and later in an oven at 40°C for 3-4 hours and its antimicrobial activity was studied. Green beans, fenugreek leaves and litchis were kept on the extract infused filter paper placed inside the polypropylene tray and were wrapped by the linear low density polyethylene cling film and kept at room temperature and at 4°C. Similarly uncoated filter paper was used as control. Samples were analysed every day for physiological, bacterial and fungal growth. Antimicrobial studies on impregnated paper showed an inhibition zone of 10mm for *B. cereus*, 12mm for *S. aureus* and 13mm for *E.coli*. Litchi sourced from the local market and stored at room temperature showed an increase in shelf life from 2 days in control to 5 days in freshness keeper. In the case of green beans and fenugreek leaves the increase was from 3 days to 5 days. At 4°C, the shelf life was increased from 5 days to 9 days. Thus the botanical extract coated material extended the shelf life of fresh produce at room temperature as well as at lower temperature.



Inhibition zone for *S.aureus*, 12mm

HEALTH FOODS & NUTRACEUTICALS

Biomolecules from moringa (*Radha C*)

Protein was extracted from defatted moringa seed flour using response surface methodology (RSM) optimized conditions of solvent to flour ratio, salt concentration and temperature. Improved functional properties of the protein isolate such as oil absorption capacity, foaming capacity and stability, emulsion capacity showed the possibility of incorporating the protein in food systems. Seed flour extracts showed the presence of polyphenols in both free and bound forms with good antioxidant activity. Ten phenolic compounds were identified and quantified. Total dietary fiber in defatted moringa seed flour was estimated to be 33.5% out of which 27% comprised of insoluble dietary fiber. Major sugars identified in non starch polysaccharides were rhamnose, arabinose, xylose and galactose. Xylan type polysaccharides, arabinogalactans and rhamnogalactonurans were also identified. Studies on the anti-hypertensive and hypercholesteromic properties of moringa seeds are under progress.

Prebiotic oligosaccharides (*Prapulla SG*)

α -glucosidase from fungal strains were screened for transglucosylation activity for the production of isomaltooligosaccharides (IMO) from maltose *Aspergillus nidulans*, *Aspergillus japonicas* and *Aspergillus niger* PFS 08 (paddy field soil isolate) were tested positive for α -glucosidase activity among which isolate PFS 08 exhibited higher transglucosylation activity. The process parameters were optimized using Taguchi approach by varying five factors, i.e. reaction pH, temperature, maltose concentration, enzyme units and reaction time, at three levels each and using the orthogonal array) experimental design. Under optimal conditions 298.19 g/L of IMO was produced which corresponds well with the predicted value of 310.71 g/L. The optimized reaction parameters resulted in nearly two times enhancement in IMO production as compared to non-optimized reaction conditions (160 g/L IMO). The product was further characterized by ESI/MS.

α -Galactosidase from fungal and lactic acid bacterial

strains were screened for transgalactosylation of lactose for the production of galactooligosaccharides (GOS). β -galactosidase from *Lactobacillus plantarum* MCC2156, due to its higher transgalactosylation efficacy, was chosen as a source of β -galactosidase for the synthesis of GOS from lactose. Permeabilized *L. plantarum* cells had the highest transgalactosylation activity resulting in 34% (w/w) GOS synthesis from 40% (w/v) lactose at 50 °C over 12 h. HPLC analysis indicated that the GOS were composed of 13% disaccharides (non-lactose), 17% trisaccharides and 4% tetrasaccharides that were further confirmed by ESI-MS. Comparative prebiotic efficacy of GOS and commercial viral GOS using probiotic lactic acid bacteria (LAB) was evaluated. The growth of LAB and short chain fatty acid profile was comparative with that of the commercial GOS.

Novel fibrinolytic enzyme from *Bacillus* sp. (*Prakash M Halami*)

Fibrinolytic protease from *Bacillus circulans* with α -chain specific activity was purified and characterized. The enzyme was partially purified to 2.25 fold with the yield of 17.53% by ammonium sulphate precipitation and Sephadex G-75 chromatography, respectively. The enzyme showed high fibrinolytic activity and cleaved α -chain moiety specifically of human fibrin A α and B β , chains of fibrinogen. Maximum activity was observed at 50°C and pH 7.4. Metal ions like Mg²⁺ and Mn²⁺ were found to enhance the activity of the protease, whereas, PMSF and EDTA inhibited the protease activity, inferring serine protease nature of the enzyme entailing metal ions for its activity. MALDI analysis of two proteases of *B. circulans* CFR11 was carried out and the deduced sequences of enzyme found to be associated with subtilisin type serine proteases.

Anti-diabetic and diuretic banana pseudostem juice (*Aradhya SM*)

Banana pseudostem juice was prepared by crushing the pseudostem. The pseudostem juice was converted to RTS beverage by increasing total soluble solid contents (6-12%) by adding sugar and acidity (0.2-0.3%)

by adding citric acid. The prepared beverages were screened out by testing their sensory quality and overall acceptability. The juice showed attractive creamy white colour with white sediments during storage undisturbed for 1-2 h. The juice was then filled into sterile glass bottles followed by airtight sealing and pasteurization in hot water (85°C) for 15 minutes. Diuretic property of the juice was confirmed by animal model studies.

Banana rhizome (*Aradhya SM*)

Acute and sub acute toxicity studies of banana rhizome powder using animal models revealed that banana rhizome powder is non toxic and fit for consumption.

L- citrulline from cucurbitaceous fruits

(*Vijayalakshmi MR*)

L-Citrulline content in cucurbits like cucumbers, melons and gourds were analysed. Among the screened cucurbits, cucumber, muskmelon and Mangalore cucumber had high concentration of citrulline ranged between 42 to 90 mg/gm (dry wt.).

Raw and ripe papaya powder (*Vijayanand P*)

Physico-chemical composition of raw and ripe papaya revealed that raw papaya fruit is rich in ascorbic acid (86 mg/100g) alone whereas ripe fruit is rich in carotenoids (2699 µg/100g) and ascorbic acid (43 mg/100g). Dehydrated components of raw and ripe papaya viz., peel, pulp and seeds were analyzed for chemical composition and proteolytic enzyme activity. The proteolytic enzyme activity was found to be very high in peel and pulp portion of the raw fruit. Papaya pulp from ripe fruits was used for the development of spray dried powder. Instant papaya beverage mix from papaya powder was developed.

Nutraceutical rich wheat germ oil (*Chetana R, Gopala Krishna AG, Lokesh BR, Nasirullah, Sukumar Debnath, Suresh Kumar G*)

New source of nutraceutical rich oil was explored from wheat bran and wheat germ. Wheat germ oil had six-fold higher carotenoid content than wheat bran oil. Antioxidant activity studies indicated the potential of these oils to be higher than the commercial vegetable oils.

Palm oil industry by-products (*Gopala Krishna AG*)

Nutraceutical enriched palm fat was prepared from crude palm oil and this was used as a nutraceutical source for preparing nutrient rich butter spread.

Crude palm oil fractionation (*Gopala Krishna AG*)

Crude palm oil (CRPO) was dry fractionated at 25°C to find the effect of fractionation on the chemical characteristics and nutraceutical distribution. Crude palm olein (CRPOL, 77%) and crude palm stearin (CRPS, 23%) were obtained and the low melting and high melting crude palm stearin (LMCRPS 14.3% and HMCRRPS 8.7%) were separated by further fractionation of CRPS with acetone. 514.7 mg β -carotene/Kg of CRPO were differently distributed in CRPOL (82.6%), CRPS (16.1%), LMCRPS (12.5%) and HMCRRPS (3.1%) respectively. Distribution of phytosterols in the fraction was 1870.2 mg/Kg, 1996.8 mg/Kg, 1190.9 mg/Kg, 1290.4 mg/Kg and 115.4 mg/Kg respectively for CRPO, CRPOL, CRPS, LMCRPS and HMCRRPS. Total tocopherol composition was 535.5 mg/Kg, 5871.0 mg/Kg, 308.0 mg/Kg, 305.6 mg/Kg and 36.2 mg/Kg respectively for CRPO, CRPOL, CRPS, LMCRPS and HMCRRPS. The results showed that fractionation of CRPO may be helpful in the preparation of nutraceutical rich fractions.

Red palm oil (*Gopala Krishna AG*)

Crude red palm oil (CRPO) of 8.79% FFA was deacidified using enzyme (immobilized *Rhizomucor miehei*), solvent (EtOH) and chemical (aqueous NaOH). Effect of different deacidification methods on neutral oil loss and product yield were evaluated. Quality characteristics viz. free fatty acids (FFA), peroxide value (PV), iodine value (IV), unsaponifiable matter, glyceride composition, fatty acid composition, triglyceride profile, nutraceuticals retention and radical scavenging activity; olein and stearin yield, its fatty acid composition and triacyl glycerol (TAG) profile were analysed. RMRPO showed 100% product yield without neutral oil loss. RMRPO have higher unsaponifiable matter (0.91%), monoglyceride (2.8%) and diglycerides (18.7%) compared to EtOHRPO and NaOHRPO. Fatty acid composition of MAG, DAG and TAG fractions of all samples showed no significant difference among them except DAG fractions of RMRPO. The TAG profile of RMRPO was significantly different from other samples. RMRPO showed retention of nutraceuticals such as carotenoids (94%), phytosterols (57%), total tocopherols (71%), squalene (72%), coenzyme Q₁₀ (99%) and total phenolics (69%) with IC₅₀ value of 19.7 mg of oil/ml. RMRPO showed highest stearin (47.4%) without any loss. Olein fraction of RMCPO is low saturated (41.6%) than other samples (47.2%). The results showed that RM based deacidification can be effectively utilized for the preparation of nutraceutical retained RPO. Further fractionation of RMRPO helps to produce RPO with improved fatty acid composition.

Moringa oleifera seed oils (*Gopala Krishna AG*)

Cold pressed and hexane extracted moringa seed oils (CPMSO and HEMSO) from the Jaffna variety of *M. oleifera* (MSO) were evaluated for its oil quality and antioxidant composition. Physico-chemical characteristics of CPMSO and HEMSO viz. iodine value, saponification value and unsaponifiable matter were found to be 67.8 and 68.5 g I₂ / 100 g oil, 190.4 and 191.2 mg KOH / g oil and 0.59 and 0.65%, respectively. The total tocopherols of CPMSO and HEMSO were found to be 95.5 and 90.2 mg/Kg. The fatty acid composition of CPMSO and HEMSO showed oleic acid as the major fatty acid (78–79%). The oxidative, thermal and frying stabilities of the CPMSO were compared with commercial raw and refined groundnut oil (GNO and RGNO). The CPMSO was found to have adequate thermal stability and better oxidative stability as it showed 79% lesser peroxide formation than GNO. The frying stability of CPMSO was better as it showed lower increase in free fatty acid (28%), peroxide value (10 meq O₂/Kg) and color (25%) than RGNO (48%, 22 meq O₂/kg and 52%, respectively) after frying. Natural antioxidants like tocopherols and phenolics as well as minor compounds such as sterols and carotenoids present in MSO and its radical scavenging activity were measured in comparison to dried coconut kernel (copra) crude oil (CNO), crude sesame oil (SESO), crude niger seed oil (NSO), crude palm oil (CPO), crude rice bran oil (RBO) and commercially refined groundnut oil (GNO). MSO contained 88 ppm of total tocopherols with α -tocopherol (56.2 ppm) being the major tocopherol. MSO also contained 117.9 ppm of total phenolics with gallic acid (48.5 ppm) being the major phenolic. MSO contained fair amounts of sterols (1700.8 ppm) and carotenoids (17.9 ppm). MSO showed an IC₅₀ value of 35.5 mg mL⁻¹. This study indicates that MSO has antioxidant characteristics which are better than CNO and comparable to those of GNO.

Rice bran oil deodistillate (*Gopala Krishna AG*)

Physico-chemical characteristics of rice bran oil deodistillate were evaluated and purified phytosterols having 80-85% purity was obtained from the unsaponifiable matter. PUFA rich fatty acids containing 80-85% of alpha-linolenic acid was obtained from linseed oil. Work on esterification of the phytosterols with the alpha-linolenic is under progress.

Rice bran oil (*Nasirullah, Baby Latha*)

Body weight and diet intake of male wistar rats fed with heated (24h), fried (24h), unprocessed rice bran oil (RBO) and sunflower oil were recorded for 2 months period. Blood profile, lipid peroxidation and histopathology of liver and kidney were studied after sacrificing the

animals. In serum, though the lipid profile (TG, cholesterol, HDL, and VLDL) of different animals did not show significant differences, low density lipoproteins (LDL) and thiobarbituric acid (TBA) reactants were significantly elevated in fried oil (11.7 mg/dL, 2.63 mg/mL) when compared to heated (6.3 mg/dL, 2.40 mg/mL) and unprocessed oil (5.3, 1.85 mg/mL). Increased level of alkaline phosphatase (ALP) in serum and lipid peroxidase in liver was observed both in fried and heated oils but was not apparent in unprocessed oil (463 mU, 66.4U). Examination of histology of liver showed binucleated cells in fried oil fed group and normal cells in all other groups. No such pathological changes in kidneys were observed in all the groups. In fried oil fed group, high levels of LDL and TBA reactants lead to production of oxidized LDL and elevated level of ALP, suggesting abnormal liver functioning. High level of TBA reactants indicating, stress condition in liver lead to ploidy state for hepatic mitogenicity (binucleated cells). Hence it may be concluded that 24 h fried rice bran oil is more toxic than heated oil.

Niger seed oil (*Gopala Krishna AG*)

Bioactives concentrate from niger seed meal/oil was prepared and evaluated for its antioxidant and free radical quenching activity with tenfold effectiveness. Ethanol extracted fat showed 13.9 fold better oxidative stability and a higher radical scavenging activity (IC₅₀ value of 9.2 mg/mL) as compared to hexane extracted fat (IC₅₀ value of 40.3 mg/mL). Lipid classes and subclasses of cold-pressed and solvents (hexane and ethanol) extracted oils from commercially available niger (*Guizotia abyssinica* (L.f.) Cass.) seeds was investigated. The oil yield of niger seeds obtained by cold pressing was 28.3 g/100g while by hexane and ethanol extractions was 38.3 and 29.7 g/100g respectively. The lipid classification of the extracted niger seed oils showed neutral lipids (65.9-95.5%), glycolipids (2.7-24.6%) and phospholipids (1.8-9.5%). The acylglycerol composition of neutral lipids of extracted niger seed oils showed triacylglycerols (76.9-91.6%), diacylglycerols (3.9-7.3%) and monoacylglycerols (0.6-2.5%). The fatty acid composition of tri-, di-, and monoacylglycerols of extracted niger seed oils showed linoleic acid (66.7–71.6%) as the major fatty acid. The triacylglycerol composition of neutral lipids of extracted niger seed oils showed trilinolein (39.2-40.3%) as the major triacylglycerol. The extracted niger seed oils contained 1289.9 - 6215.8 ppm of total phytosterols with α -sitosterol (41.9-43.7%) as the major phytosterol. Acylated steryl glucoside (39.5-52.2%) was the major glycolipid in extracted niger seed oils. Phosphatidylcholine (49.6 and 47.9%) was the major

phospholipid in cold-pressed and hexane-extracted niger seed oils and phosphatidylethanolamine (57.1%) was the major phospholipid in ethanol-extracted niger seed oil. This is probably the first report on the variations in lipid classes and subclasses of Indian niger seed oil as affected by different modes of oil extraction.

Purslane (*Sukumar Debnath*)

Studies on the retention of bioactive molecules and antioxidant activity of purslane during different drying and its rehydration characteristics were undertaken. The total polyunsaturated fatty acids (PUFA) and α -linolenic acid (ALA) were found to be in the range of (47.9-59.9%) and (42.5-50%) respectively, in which highest value of ALA obtained in the vacuum dried sample. No significant ($p > 0.05$) difference in β -carotene observed in the dried purslane using these drying methods. The total polyphenolic content obtained in the range of (188-408 GAE/100g) in which vacuum dried purslane showed maximum retention. The antiradical activity was found in the range of (33.0-88.8 mg/100g) in which vacuum dried purslane retained the highest value. Rehydration ratio was found in the range of 3.2-4.3 and vacuum dried purslane showed maximum rehydration. It could be concluded that vacuum drying of purslane is an effective method for retention of bioactive molecules and good rehydration behaviour of dried purslane. Effect of different cooking methods on the fatty acids profile of purslane was studied. Roasting is the best cooking method among all cooking methods for the retention of PUFA (63.09-68.96). Development of healthy snack foods based on multigrain, oilseeds and purslane were attempted. The use of microwave processing in place of frying resulted in significant ($p < 0.05$) reduction in oil (24.44-8.12%) content, increase in protein (2.19 - 29.36%) and ω -3 fatty acids (2.4 - 35.0%) contents without jeopardizing the sensory quality of the product.

Trans-free margarines/butter spreads (*Jeyarani T*)

Preparation of trans-free margarine using vegetable oils by incorporating various blends of palm oil at 10 to 40% levels into mango kernel fat and margarine was prepared using suitable additives. It was found that the hardness of the blends decreased with increase in palm oil content. When compared with different commercial butter like samples the hardness of the blend containing 30% palm oil was closer to one of the commercial fats. In order to get the natural flavour of butter, 10% butter was added. The hardness of the sample reduced but the flavour and glossiness of the margarine improved. Evaluation of these margarines in a bakery product is in progress.

Prebiotic / low sugar Bombay halwa (*Chetana R*)

Bombay halwa, a traditional sweet was prepared using an alternative sweetener, FOS and an herb *Coleus aromaticus* for improved health benefits. FOS, a non-digestible fructo- oligosaccharide and dietary fibre also acts as a prebiotic by stimulating the growth of 'healthy' bacteria in the colon. The effect of this sugar alternative along with the added herb at 0.5, 1.0, 1 and 1.5% on colour, texture and sensory quality of the products were studied by comparing with Bombay halwa made of sugar. The moisture content of the halwa prepared with various sweeteners ranged between 7.8 to 10.5%, fat from 2.0 to 2.5%. Texture of halwa with sugar and with FOS was determined and the results showed that the product with FOS was more cohesive and acceptable up to two weeks, while that with sugar crystallized gradually and lost the characteristic chewy texture by the end of 10 days. Results showed that the water extract of *Coleus aromaticus* quench the free radicals generated with the addition of Fenton's reagent, and they thereby protect the DNA against oxidative stress-induced damage. In Bombay halwa, addition of the herbal powder (*Coleus aromaticus*) showed DNA protecting activity at higher levels of incorporation i.e., 1.5% level indicating antioxidative property of the herbal powder.

Omega-3 fatty acids (*Lokesh BR*)

Effect of omega-3 PUFA enrichment through emulsions on selected functions of sarcoplasmic reticulum (SR) like membrane fluidity, fatty acid composition, $Ca^{2+}Mg^{2+}$ ATPase activity and calcium transport in rats was studied. Results showed that fluidity of SR membrane increased with increase in docosa hexaenoic acid (DHA) levels in the membrane. The ratio of n-6 to n-3 in SR membranes was lowered when rats were given linseed oil in microemulsion form. The enrichment SR lipids with DHA lowered the Ca^{2+} uptake and $Ca^{2+} Mg^{2+}$ ATP ase activity in rats given LSO in microemulsion form with lipid. Therefore omega-3 PUFA given in microemulsion form beneficially altered functions of heart.

Chicken based functional foods (*Harish Prashant KV, Modi VK, Rathina Raj K, Sachindra NM, Sakhare PZ, Suresh PV*)

Protein isolates prepared from liver of the layer chicken by pH shift method showed better water holding capacity and oil absorption capacity compared to protein isolates from gizzard. Acid solubilized protein isolates exhibited better DPPH scavenging activity than that of alkali solubilized protein isolates. The studies on effect of chitosan coating on the quality and microbiology of table

egg stored at ambient room temperature indicated that three time coating with chitosan of viscosity 2100 mPa.s was more effective in preventing weight loss than with single time coating of chitosan. Chitosan with viscosity of 1224 mPa.s showed higher antimicrobial activity than other chitosans tested and microbiological load and oxidation rate of chitosan supplemented mutton kofta were lower as compared to the control samples. Studies on development of techniques for detection of *Salmonella* in chicken meat resulted in development of PCR conditions for detection of *Salmonella* in inoculated chicken meat samples, but the level of detection was not satisfactory. It is necessary to evaluate the possible presence of PCR inhibitors in the chicken meat, and use of pre-enrichment before enrichment may yield better results and improve the sensitivity of the technique. The PCR conditions were also standardized for detection of *Yersinia enterocolitica*. DNA-based polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) identification system has been adopted to identify the different meat upon storage and cooking. Test for the stability of genomic DNA (TGD) in stored meat samples revealed that samples were amplifiable even after 50-60% degradation of TGD. The amplicon could effectively detect very low levels of adulteration in raw (0.01%) and cooked meat (1%). Testing of adulteration from 3-100% of admixture offers good visualization in 1.7% agarose gel, but visualization of adulteration below 3% was unsatisfactory.

Value added meat and egg products (Modi VK)

Storage stability of developed egg spread (ES) was carried out at ambient temperature ($37\pm 2^\circ\text{C}$) and refrigerated temperature ($4\pm 2^\circ\text{C}$) periodically. The total plate count and *Staphylococcus* was ~ 2.0 log cfu/gm during storage. Yeast and molds, *E coli*, and *Salmonella* were not detected throughout the storage period. The pH (3.4) and water activity (0.91) of the products were low. The protein content of egg spread containing 5, 10 and 15% chicken meat was 12.44 ± 0.77 , 14.31 ± 0.59 and $15.31\pm 0.89\%$ respectively and lipid content was 31.88 ± 1.45 , 32.14 ± 1.87 and $32.74\pm 1.45\%$ respectively. Samples stored at ambient and refrigerated temperature did not show significant changes ($p > 0.05$) in lipid oxidation, whereas, significant changes ($p \leq 0.05$) in viscosity, shear rate and shear stress were recorded. The consumer liked fresh and stored ES containing 10% chicken meat, as indicated by the mean rating of 7.95 of fresh and 7.79 ($p > 0.05$), after 90 days storage under ambient temperature and had 93% of responses in the positive-liking end.

The emulsion properties for egg sausage processing were studied with reference to hunter colour unit, texture

profile analysis, rheological properties, electron micrograph and Fourier transform infrared spectroscopy (FTIR). The rheological study of fresh whole egg sausage emulsion showed shear thinning property with the flow index of $n = 0.28$ with a consistency of $k = 83.312$ Pa/s. The flow index of fresh EAS and EYS was 0.43, and 0.46 respectively. The flow indexes of all the three emulsions are found to be inversely proportional to their consistency. Structural deformation was observed in all the egg sausages under electron microscope. FTIR studies showed that intensity of the protein reduced during storage period. Microbial counts of all types of emulsion were less than 2 log cfu/g during storage. The sausages processed from stored egg sausage emulsion were found acceptable in terms of textural profile analysis and sensory evaluation.

Enhancement of flavonoids synthesis (Bhagyalakshmi N, Giridhar P, Nandini P Shetty, Sarada R)

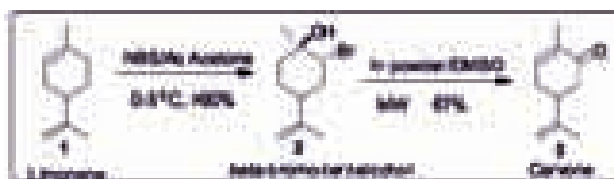
Elicitor treatments both in solid and suspension culture of carrot callus culture were performed and the content of anthocyanin in each treatment was quantified, at various time intervals, using spectrophotometer and HPLC. Primers designed by NCBI primer designing interface were used for analyzing the expression profiles of genes associated with anthocyanin biosynthesis and transport. Analysis of dihydroflavonol 4-reductase (DFR), the key gene for anthocyanin biosynthesis, in control and anthocyanin containing callus revealed that the gene was expressing only in coloured callus and not in control. Expression profile of other anthocyanin biosynthesis genes (CHS, CHI, F3H, DFR, LDOX, and UFGT) and transporters (ABC, MATE, GST) involving in transport of anthocyanin in vacuole is being standardized from callus and suspension culture after elicitor treatment. Enhancement in the level of isoflavone concentration and total isoflavone content of soybean seeds were achieved by using elicitor mediated approach under field conditions. All the abiotic elicitors at different concentrations used in the present study influence the levels of isoflavone and total folate content in soybean seeds. Of the various elicitors used, significant increase in the isoflavone and folates content with optimized levels of salicylic acid was observed. Also response surface methodology was used for soy suspension cultures based isoflavones production.

Bioactive speciality products (Jagan Mohan Rao L, Nagarajan S, Puranaik J, Srinivas P)

Reaction of carvacrol, thymol, perillyl alcohol and menthol with 3,4,6-tri-O-acetyl-D-glucal in the presence of ZnBr_2 in CHCl_3 under microwave irradiation afforded the corresponding α -2,3-unsaturated glucoside acetates

preponderantly in high yields (56-93%). The pure compounds, synthesized on gram scale, were converted to the corresponding glucosides by deacetylation in near quantitative yields. Alternatively, the 2,3-unsaturated glucoside acetates of the phenols and alcohols were hydrogenated followed by deacetylation to afford the corresponding 2,3-dideoxyglucosides. Both the 2,3-unsaturated and 2,3-dideoxy glucosides of the spice constituents viz., carvacrol, thymol, perillyl alcohol and menthol exhibited potent antimicrobial and quorum sensing inhibitory attributes.

A concomitant dehydration-oxidation of β -bromo-tert-alcohol (2) to α,β -unsaturated ketone (3) was reported. The pure β -bromo-tert-alcohol on reaction with DMSO (1 mL) in presence of 0.5 mol equivalent of indium powder afforded an important flavour compound carvone. Microwave irradiation at 70°C and 500 W effects this transformation. The method was demonstrated for synthesis of five more flavour compounds. It is a single step, solvent-less green approach useful for synthesis of flavour chemicals from inexpensive and readily available monoterpene hydrocarbons. Pure flavour compounds were characterized by NMR and MS studies.



Synthesis of carvone, a flavor compound, from limonene

Deodorised turmeric powder (Puranaik J)

A novel process of extraction of turmeric powder that removes the undesirable odour, bitter, fixed oil and resinous constituents of turmeric by retaining the curcuminoids pigments was developed. This novel debittered, deodourised turmeric colourant with 40-47% curcumin and curcuminoids (98.0 – 100% purity) was incorporated in Indian sweets (jilebi) and optimum levels of incorporation were standardized. Sensory evaluation of the jilebi revealed that the product was well accepted at par with the control.

Instant tea concentrates (Borse BB, Jagan Mohan Rao L, Hafiza Khanum)

Tea extracted with boiled water (1:50), filtered (Brix 1) and concentrated in a SEE (Brix 22), mixed with sugar (Brix 700) and filled in plastic screw capped containers. Shelf life studies were carried out for the samples at different temperatures (refrigerated, incubated, RT) and

monitored for physicochemical properties, microbiological status and sensory acceptance for a period of 3 months and the samples were also analysed periodically for antioxidant activity. The samples were found to be microbiologically safe for consumption during storage for a period of four months. All the samples were commercially sterile. Beverages were prepared in bulk and sensorily evaluated at monthly intervals up to four months of storage. Bottled beverage showed a shelf life of four months under ambient storage condition with respect to taste, flavour and overall acceptability.

Health drink from wheat grass (Roopa BS)

Wheat grass drinks modified with flavors of cumin, cardamom, ginger and mango were prepared. Products were profiled using quantitative descriptive analysis and correlated with electronic sensors system. Sensory evaluation results showed that wheat grass drink with cumin flavor was more acceptable with a mean sensory score (11.5) followed by cardamom added wheat grass drink (9.5) and mango flavored drink (9.0). Flavor and taste interaction studies showed that addition of salt enhances the natural sweet taste of wheat grass drink with cumin flavor. The study concludes that the different flavors used in the drink have an antagonistic property, thus reducing the non-desirable grass odour.

Wheat grit based kheer (Asha MR)

Instant mix for preparing wheat grit kheer was developed using wheat grits, green gram dhal, fine wheat sooji, jaggery and other minor ingredients. Kheer prepared using this mix was rated as acceptable in sensory studies. Special features of this instant mix include commercial non-availability of the product in the market, no addition of chemical preservatives, jaggery-based, cost effectiveness and ease of preparation.

Nutri-cereal (Amudha Senthil)

A ready-to-eat value added health food was developed using cereal, pulse, millet and nuts as major ingredients. The nutricereal is jaggery based health food prepared by blending pearl millet and green gram flour at different ratios. The quantity of wheat flour and nuts was kept constant as 20:20 throughout the study. The nutrient composition and the sensory quality of the product were analysed and results showed that 10 to 70% increase of green gram flour in the blend correspondingly increased the protein content of the product from 7.87 to 13.55%.

Sweeteners (Maya Prakash)

Four sweeteners (sucrose 1-64 g%, sucralose 1-8 g%,

aspartame 1-8% g and acesulfame-k 1-8% g) were analyzed using an e-tongue. The PCA plots generated based on the sensory responses indicated that significant differences existed between clusters – formed as a function of sample concentration. Among the four sweeteners, sucrose, sucralose and aspartame, acesulfame-k were different from each other indicating their sweetness perception were different. The distance between the sweeteners clusters indicate the differences with respect to their sweetness perception and taste.

Moringa leaf based products (Akhilendar Naidu K, Anandharamakrishnan C, Iboyaima Singh N, Prabhasankar P, Renu Agrawal, Sathish HS, Sila Bhattacharya, Usha Dharmaraj, Vijayanand P, Manisha Guha, Sasikala VB)

Value added moringa leaves based products with protein, docosahexaenoic acid (DHA), wheat germ oil, probiotics and prebiotics were developed in the form of spray/drum/dried powder with a suitable coating material (whey protein isolate, α -cyclodextrin, maltodextrin, ragi malt and barley malt) so as to suitably incorporate in various food supplements. Various physico-chemical characteristics of the products were evaluated for their quality determination.

Moringa leaf beverage and tablet were also prepared. The prepared RTS beverage showed good appearance with green colour and taste (no bitter or leafy taste), however, on storage colour deterioration was observed. Similarly, effect of replacement of wheat flour with 5, 10 and 15% moringa leaf powder (MLP) on rheological and product quality characteristics of gluten free bakery products was studied. Rheological studies indicated that an incorporation of increasing amount of MLP from 0 to 15% increased water absorption, optimal dough stability, decreased amylograph gelatinization temperature, peak viscosity and alveograph resistance to rupture.

Gluten free cookies (GFC) were prepared using blends of rice flour and MLP with and without exogenous proteins and additives. Product quality and sensory evaluation showed that GFC incorporated with 5% MLP and 7.5% exogenous proteins were acceptable. Wheat germ based product was evaluated for extending their shelf life. Also, developed moringa leaf based ready-to-eat foods like sambhar and curry in retort pouches. Initiated work on making dry moringa leaf briquettes for easy transportation of leaves from the field. Grain based ready-to-prepare food mixes with moringa leaves - *Pesarattu, Pongal, Sambar, Kichdi* were prepared. The taste and colour values of these products varied considerably depending on the processing methods.



moringa based soup mix and low fat green snack were also developed. Moringa leaf water extract based product supplementing with garden cress oil (5 g) (GCO)/ 100 ml of extract and whey protein concentrate (40 g) was prepared by spray drying. Carbohydrate (20.6 mg/g wet wt.), protein (80 mg/g wet wt.) and vitamin B3 (Niacin, 34.4 μ g/g wet wt.) content of the product was estimated.

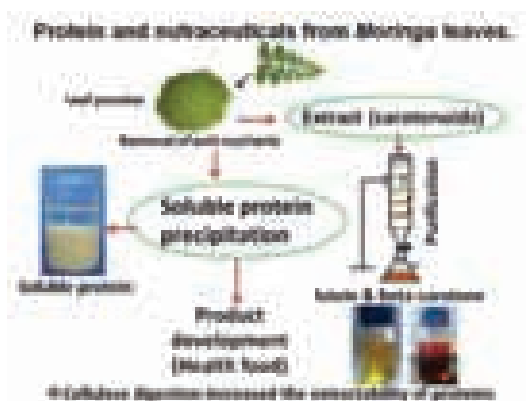
Nutritional profile of moringa leaves

(Bhagyalakshmi N, Baskaran V, Renu Agrawal)

Ascorbic acid, carotenoids, α -tocopherol, total iron, total folate and protein content of the fresh and processed moringa leaves was determined. There was a loss in phyto-constituents levels on drying and storage of leaves. Phyto-constituents and antioxidant activity of the leaves were best preserved by lyophilisation and cabinet tray drying, compared to oven and sun drying methods. Total protein content in the leaves of different age varied between 6 to 11%. The HPLC sugar profile of leaves demonstrated that the level of raffinose was 18.16 mg% and among the disaccharide, the levels (mg%) of maltose, sucrose, glucose and fructose were 80.8 and 22.5 74.9 and 22.5 respectively. The level of anti-nutritional factors (glucosinolates) in processed leaves of different cultivars was lower than the fresh leaves.

Moringa leaf protein (Baskaran V, Govindaraju K)

Moringa leaf protein was separated by alkali solubilisation process by adjusting pH and centrifugation process. The protein precipitate (8-9%) was dissolved in water and its soluble protein content was assayed (4-5 g). Moisture and protein content of the whole leaves ranged as 76.82% and 7.8-8.8%, however the soluble protein content ranged from 3-5% (yield, 23 – 38%) at different pH. The protein solubility in water at various pH was in the range 39-55% with the solubility minimum of 39%. The solubility of proteins in 1M NaCl was 46-63% with the solubility minima of 46.7% at pH 4.0. The study shows that, at isoelectric pH, the solubility of protein is higher.



Moringa leaf protein based health food (Baskaran V, Anandharamakrishnan C)

β-Carotene and lutein (eye protective carotenoids) and soluble protein were prepared from moringa leaves. Ragi and barley malt based nutritious spray dried foods were developed on pilot plant scale with carotenoids and protein. The product was also supplemented with other essential nutrients. The uniqueness of the product is that the protein, carbohydrate, pro-vitamin A and lutein are purely sourced from moringa leaf and ragi flour. The cost of the product is much lower than any commercial formulations.



Protein hydrolysates from moringa leaf (Sindhu Kanya TC)

Preparation of protein hydrolysates from moringa leaf was achieved with controlled hydrolysis. The composite isolates containing around 60% protein were hydrolysed using fungal proteases at alkaline pH 8.0 for a specific time and temperature after standardisation of conditions. Analysis of amino acid composition revealed that all the essential amino acids are present in required amounts. Studies on moringa proteins, revealed isolation of 59.3% of total protein by ammonium precipitation which was easily solubilized in Tris-HCl (pH 8.0). Alcalase treatment showed clear sign of protein degradation, as revealed by SDS-PAGE indicating high

solubility with the formation of short chain peptides. Further, activities of enzymes like α-mannosidase, α-galactosidase, α-glucosidase, and α-glucuronidase were detected in water, NaCl, and Tris/sucrose extract, and are found to be differentially extracted. Formulation of a protein mix with enriched micronutrients and enhanced bioaccessibility were achieved. By activating the native phytase present in the supplementary food mix and incubating the mix at optimum conditions of phytase for a period of 1-3 hours resulted in 7-8 fold increase in bioaccessible iron upto 2 hours and decreased beyond that. Bioaccessibility of zinc was quite higher than iron but yet it was lower in the supplementary food mix.

High protein low calorie butter spread (Radha C)

Health consciousness increased the demand for low calorie and low fat foods. A nutrispread, high in protein and low in fat / calorie with acceptable colour, mouth feel, taste and texture was developed. Sensory analysis showed that the spread was moderately salty with high intensity of desirable fatty, creamy and buttery aroma. The product can go as spread for cookies and bread sandwiches and it was found highly acceptable.

Nutritional information per 100 g

Energy	360 kcal
Protein	25 g
Carbohydrates	20 g
Fat	20 g
Sodium	200 mg

Safety studies in fermented products (Avinash P Sattur)

GRAS cultures procured from IMTECH were grown on underutilized cereals and grains. Amongst them, *Penicillium roquefortii* was successfully grown on kodo millet. The fermented extracts were subjected to a number of enzyme inhibition assays that gave an inhibition of around 55% against advanced glycation end product formation. A proximate and mineral analysis of this fermented fungal material was carried out. HPLC profiling of the metabolites after fermentation and upon *in vitro* digestion was carried out. Two new flavonoid peaks were observed upon fermentation and its purification is in progress. A 14 day single dose acute toxicity study was carried out, which shows the fermented food is safe.

Folates in Arabidopsis (Bhagyalakshmi N)

Studies in coriander revealed that treatment with salicylic acid (SA) enhanced folates, and improved their post-

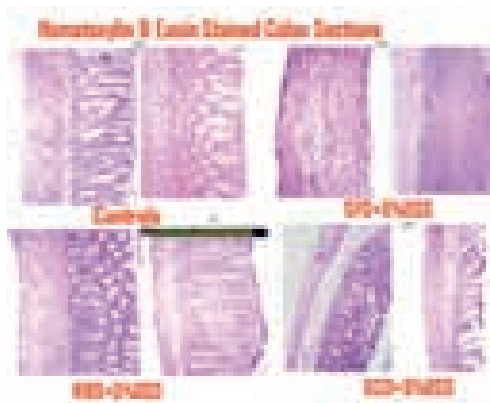
harvest stability as well as bio-accessibility. For obtaining more insights into genes involved in this phenomenon, study was conducted in the model plant – Arabidopsis, where the foliage upon SA (300 µM) treatment showed substantial enhancement of folates and reduction in the levels of reactive oxygen species. Based on the screening of the microarray data of SA treatment in Arabidopsis, expression profiles of 19 genes were analysed by qPCR, which revealed that folate biosynthetic genes were largely down-regulated, whereas folate stabilizing genes were up-regulated, particularly of a putative folate binding protein (At5G27830). This new information on plant folate binding protein may serve as a target for folate metabolic engineering, particularly for the leafy vegetables.

Biosensors for food quality monitoring (Thakur MS)

Isolation and purification of enzyme for biophoton production from firefly and bacterial system was carried out. Further, biochemical aspects of biochemical biophoton production and optimization of conditions were performed. Raising antibodies against selected food borne bacterial toxins (aflatoxin and *Staphylococcus enterotoxin B*), synthesis of quantum dots and gold nanoparticles was done. Development of prototype biosensor based on bioluminescence for assessment of microbial quality and freshness of meat, fish and milk as well as monitoring food hygiene/sanitization was carried out. Further, validations of biosensors results with conventional techniques and monitoring of formaldehyde in processed fish samples were also done.

Garden cress seed oil (Akhilendar Naidu K)

Amelioration of ulcerative colitis using dietary oils and its mechanism of action was studied by inducing ulcerative colitis in rats fed with an iso-caloric diet supplemented with 10% rice bran oil, garden cress oil and sunflower oil for 7 weeks.



Histopathological appearance of colonic tissue in rats. (a) Normal colonic mucosa of control rats stained by

haematoxylin and eosin (H&E) x 40 original magnification. (b) Normal colonic mucosa of SFO fed DSS rats (H&E) x 40, reflects large number of neutrophils infiltration and complete destruction of goblet cells. (c) Colonic mucosa of RBO fed DSS rats (H&E) x 40, shows mild neutrophil infiltration and protected from DSS induced mucosal destruction (d) Colonic mucosa of GCO fed DSS rats, depicts moderate inflammatory cell infiltration and mild destruction of goblet cells.

Rice bran oil and grass cress oil significantly attenuated loss of body weight, shortening of the colon, disease activity index and macroscopic and microscopic colitis scores compared to sun flower oil group. These alterations were associated with a remarkable amelioration of the disruption of the colonic architecture, a significant reduction in the colonic activity, malondialdehyde levels followed by significant restoration of antioxidant enzymes and glutathione reductase levels in the colon. Moreover, rice bran oil and grass cress oil suppressed Dextran Sodium Sulphate induced colitis generation of inflammatory mediators such as NO, Leukotriene B4 and pro-inflammatory cytokine TNF- α in rats. Fatty acid profiles of serum and mucosa reflected the incorporation of fatty acids of fed dietary oils. Results suggest that supplementation of rice bran oil and grass cress oil may exert favorable effects in modulating inflammatory mediators like TNF- α , LTB4 and oxidative stress in experimentally induced ulcerative colitis.

Health foods from coconut (Gopalakrishna AG)

Storage study on health food developed based on coconut water solids, coconut meat, coconut cake and coconut cake testa powder were completed and found to have a minimum of 6 months shelf-life under room temperature / humidity conditions (27°C/65% RH).

Nutritional composition of raw and cooked copra was tested which includes moisture, fat, ash, crude fiber, protein, carbohydrates and minerals. Potassium was found to be more among all the minerals. Phenolic compounds present in brown skin of mature coconut from virgin coconut oil industry and copra cake from coconut oil industry which is considered as waste/by-products of the industry may be useful for preparation of health food.

Bacillus Sp. as probiotic (Shobha Rani P)

Several *Bacillus* cultures were isolated from raw milk and soil samples and investigated for their probiotic effect. Functional properties including antimicrobial, antioxidant and enzymatic studies were carried out in selected cultures. Potent cultures were identified as *B. megaterium*, *B. flexus*, *B. licheniformis* and *B. subtilis*

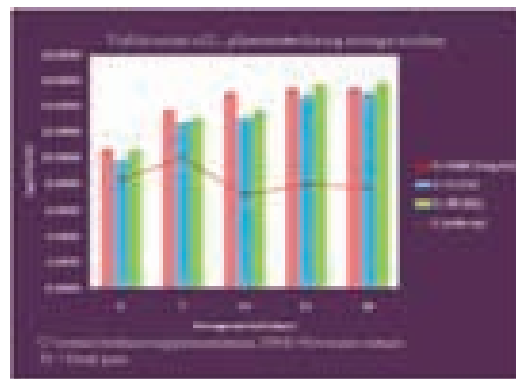
through biochemical characterization, 16S rDNA sequencing and FAME analysis. Antimicrobial compound was partially purified by ammonium sulphate saturation and ion exchange chromatography. It was active under wide range of pH (2-10) and was stable even at a temperature of 90°C. Selected cultures were also studied for cholesterol lowering effect by co-precipitation with bile, cholesterol oxidase and cholesterol assimilation method. CDM4-3c (*B. flexus*1) implicated cholesterol oxidase (2.5 U) for cholesterol reduction, whereas, CDM3-1 (*B. flexus*2) underwent co-precipitation in the presence of bile. Csm1-1a (*B. licheniformis*) showed maximum (42%) reduction of cholesterol.

Hypo immunogenic wheat based food products (Prabhasankar P)

Commercially available wheat milled samples such as *T. aestivum* atta (whole wheat flour), *T. aestivum* maida (refined wheat flour) *T. aestivum* sooji, *T. durum* semolina and *T. diccicum* semolina were studied for its properties with the aim of developing a cost effective modified gluten product for the patients suffering from celiac disease. Proximate analysis showed that protein ranged from 9.5% to 13%. The samples were subjected to enzymatic modification under controlled conditions. Further confirmation of protein hydrolysis was performed by SDS PAGE. Immunological studies using Dot blot and Western blot confirmed the reduction in allergenicity using anti-gliadin antibodies and anti-rabbit IgG-Horse radish peroxidase (HRP) conjugate. Enzyme linked immunosorbent assay (ELISA) further confirmed the results quantitatively. Reduction in gliadin immunogenicity of *Atta* was highest (77%) and that of maida (refined wheat flour) was lowest (35%). Rheological analysis of unmodified and modified flours showed that the dough development time and stability time to breakdown decreased with enzyme treatment.

Probiotic Lactic Acid Bacteria in gut (Praveena Bhatt Mudliar)

Polyphenol rich fractions of selected plants were isolated and their total polyphenolic content was determined. Leaves of *Plectranthus amboinicus* and flowers of *Peltophorum pterocarpum* were found to have a high total polyphenol content (313.6 mg GAE/g and 222 mg GAE/g respectively) among the samples tested. Further, the influence of the leaves of *Plectranthus amboinicus* on the growth and viability of probiotic strain of *Lactobacillus plantarum* was studied. Results showed that the hot water extract (HWE; 1 mg/ml) and fresh juice (1% and 5%) of the leaves used as supplement in fermented milk, efficiently increased the growth (1-2 fold) compared to control without supplementation and



viability of the bacterium. The viability of the bacteria was maintained more than 10^9 cfu/ml throughout the storage period of 28 days in comparison to control without the supplement where the count of bacteria decreased steadily during storage.

Exopolysaccharides from indigenous fermented foods (Prapulla SG)

Indigenous fermented foods like fermented milk, fish, rice, and *dhokla*, *dosa*, and *jalebi* batter and a few North Eastern fermented foods like *gundruk*, *sinki* and mustard were screened for the lactic acid bacteria. Isolated bacterial colonies from plates were further cultured to obtain pure isolates and were investigated for basic characteristics of lactic acid bacteria like gram reaction, catalase production and spore formation. Extracellular polymeric sugars (EPS) produced by gram positive, catalase negative isolates were evaluated on ruthenium red MRS agar. EPS producing isolates appear as translucent mucoid colonies on ruthenium red agar plate and were further evaluated for fermentative production of EPS. Quantitative analysis of the EPS produced in modified MRS broth [glucose replaced with sucrose (10% w/v)], and simplified synthetic medium was carried out by phenol-sulfuric acid assay for total carbohydrates. Probiotic properties *viz.* acid tolerance, bile tolerance, bile salt hydrolysis, antibiotic susceptibility test, surface hydrophobicity and auto-aggregation of the high EPS producing isolates were further studied.

Chicken liver hydrolysates (Bhaskar N)

Chicken liver hydrolysates (CLH), prepared by both fermentative and enzymatic hydrolysis, were found to exhibit anti-oxidative and anti-bacterial properties. This may be due to the low molecular weight peptides formed during the hydrolysis and more so in case of fermentative hydrolysis wherein bacteriocins also aid in anti-bacterial properties. The CLH prepared in both methods had iron content (mg per 100g) ranging from 16.1 to 17.1, indicating their potential as materials with available iron for preparation of iron rich products/formulations.

INNOVATIVE FOOD PROCESSING

Microwave preservation (Math RG)

Fruit pulps and juices from non-acidic and acidic fruits and vegetables were blended at various proportions and processed through continuous-flow microwave heating 2kW system, using specially designed helical-spherical applicator. The effects of microwave heating at 4.73 W/g with flow of 250 ml/min on juices viz., physical-chemical properties, nutritional characteristics, engineering properties and kinetic data of microbial destruction (D , k , Z and F_0 values) and enzyme inactivation were evaluated and studied during the storage. Storage at the end of one year period showed that all blends were found to have no significant variation compared with fresh juices. Three specially designed glass helical coil applicators were introduced to study the effects of microwave radiation on microorganisms. Energy absorption rate increased with respect to increase in diameter of the coil and with lesser velocity. Destruction rate was directly proportional to power and temperature. It was found that when velocity increases destruction rate decreases. Based on the results, continuous microwave pasteurization (45 l/hr)/sterilization (30 l/hr) was developed. Specific energy consumption was 0.160 KW-hr/kg and energy cost for 1 kg of blend juice processing was Rs.1.12 (INR) compared to the conventional cost approx. Rs. 4.9 (1kWh=Rs. 7.00 (INR)). Energy saved during microwave heating is ~ 337% and processing time was reduced about 3 times compared to conventional, indicating increase in the production of processed juice.

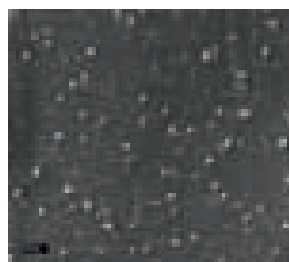
Fish processing equipment (Bhaskar N)

A SS based fish-meat bone separator (FMBS) was designed and developed for small scale fish processing industries to increase the efficiency of production and solve labour-intensive problems. Process yield using dressed fish was in the range of 55-75% and 35-50% for whole fish weigh basis, with minimal loss of meat. Capacity of the FMBS was up to 70 kg/h for meat which was recovered for first pass of sample at a constant speed (25 rpm) of motor and tension on the conveyor belt. The quality parameters resulted for bone content

with very negligible content of bone on first pass ranged from 0.1 to 0.2% based on the fish species and the data resulted in proximate composition showed no significant change in the quality profile of minced meat. The fish filleting machine conceptualized, design provided and fabricated.

Food packaging applications (Keshava Murthy PS)

Pectin/silver nano composite films were prepared by simple and direct method using pectin and silver nitrate by reducing different concentration of silver nitrate (2-10%) and pectin. SEM data showed tetragonal silver nanoparticle formation in the surface morphology of nano composite films which were further characterized to establish the mechanical and barrier properties. In the case of mechanical strength, 2-10% silver nitrate addition did not show any significant increase in tensile strength (TS) but oxygen transmission rate (OTR) and water vapour transmission rate (WVTR) has changed significantly at 2% and 4% addition of silver nitrate concentrations respectively. Antibacterial properties showed clear inhibition zones for nanocomposite films compared to plane pectin films against three different bacterial cultures viz. *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. The green synthesized nanocomposite films prepared can be used in development of active packaging systems.



Silver nano composite film



Plain pectin nano composite film

Sodium carboxymethyl cellulose/polyvinyl alcohol casted blended films were cross-linked with gamma irradiation (4, 6 & 8 kGy) and later by incorporation of chemical cross-linking agent to improve its mechanical and barrier properties. The structural characterization indicated that irradiated sample was more homogeneous

than control and Fourier transformation infra red (FTIR) spectra showed that possibly there was interaction between two molecules. Cross-linking resulted in 180% increase in tensile strength, 1260% increase in tear strength and 500% increase in elongation. Oxygen transmission rate was increased by about 270% in 8 kGy irradiated films. These cross-linked films can be used for several food packaging applications

Antibacterial studies showed effective inhibition zones around nanocomposite films compared to plane pectin films against foodborne pathogens viz. *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

Microwave cooking and mineral bioaccessibility (Kalpana Platel)

Representative staple cereals and pulses were subjected to microwave cooking and the cooked samples were used for determination of mineral bioaccessibility. Bioaccessibility of copper were increased by 18.5%, 38.6%, 51.72% and 36.5% in wheat, rice, finger millet and maize, respectively. In cereals, bioaccessibility of manganese were decreased by 80.6% in rice and 70.6% in wheat. Bioaccessibility of chromium increased by 10% and 43% in finger millet and maize respectively whereas it decreased by 14.3% and 29% in rice and sorghum respectively. A significant increase in bioaccessibility of copper from pulses was observed, the increase ranging from 12.5% in decorticated green gram to 64.3% in whole green gram. Contrary to this, there was a decrease in the bioaccessibility of copper from black gram (20.5%) and rajmah (33.3%). A significant decrease in the bioaccessibility of manganese was observed from almost all the pulses, the percent decrease ranging from 29.1 (rajmah) to 62.7 (black gram). Decrease in bioaccessibility in chromium was very significant; decrease ranging from 10% in black gram to 66% was observed in all the pulses, in decorticated green gram.

Enrichment of wheat milled, bakery, pasta and traditional products (Prabhasankar P, Sai Manohar R, Venkateswara Rao G)

Formulation and processing conditions for the preparation of samosa, *Cucuma amada* powder incorporated aromatic rhizome soup sticks, sugar free kesari bath and fiber enriched bars were standardized. Low GI noodles prepared using 7.5% dried guar/cluster bean powder and 20% rajmah (*Cicer arietinum*) resulted in significant decrease in available starch and increase in slowly digestible starch. Influence of processing conditions like roasting time, discs gap settings in different types of mills like chakki, pin, plate, roller and hammer on the quality characteristics of *atta* were studied. Conditions for roller milling of fenugreek were

standardized. The fractions rich in fiber were identified. Addition of 10% fiber rich fractions was found to be optimum in bread making. Studies were carried out to utilise processed mango pulp, dry fruits in biscuits, cookies and muffins. A formulation for the pizza base having 5% more protein than the control with the use of whey proteins was standardized.

Fabricated foods (Bhattacharya S)

Gel characterization and rheological status of hydrocolloid based gels were investigated using gellan, agar and their combinations. These gels are sensitive to strain rate and the extent of applied strain. Nutritious gels were prepared using gellan gum as the gelling agent along with mango pulp, sugar and ferrous sulphate.

Micro structural observation of turmeric powder subjected to agglomeration process at different moisture contents (10-28%) and steaming times (0-60 min) showed spheroids and ellipsoids of different sizes ranging between 50 and 160 μm and shapes varying from spheroid to elongated ellipsoids. Image analysis infers that the size related parameters increase with an increase in moisture content/steaming time. A four-layered artificial neural network having a structure of 2-10-8-4 was developed to predict the agglomeration process of turmeric powder.

Paani poory sheeting and cutting machine (Nagaraju VD)

Employing traditional methods of poory making and existing equipment, experiments were carried out to standardize the process of making poories. Based on the above data, a conceptual design was made and detailed design drawings were prepared to develop a prototype machine with three stages of unit operations, namely extrusion, multiples of compression and finally cutting of round and hexagonal discs. Prototype working model was fabricated and the unit is being fine tuned for optimizing the performance. The machine will be tested for its endurance and commercialization.

Ultrasound aided concentration of fruit juices (Rastogi NK)

Supported liquid membranes (SLM) was used for recovering organic acids, as it potentially offers high flux, selective separation, low energy consumption, simplicity of operation and regeneration. The SLM used in the present work uses a porous membrane support (PTFE membrane) impregnated with organic solvent (toluene) in which the complexing carrier (Aliquat 336) was dissolved. This membrane separates the feed and strip phases (solution of $\text{Na}_2\text{CO}_3/\text{NaHCO}_3$). The citric acid was selectively extracted from aqueous and real

solutions such as citrus fruit juices such as sweet lime, lemon, and orange. Extractions were carried out with $\text{Na}_2\text{CO}_3/\text{NaHCO}_3$ and distilled water as strip solutions and ~100% and 33% citric acid extraction, were achieved in 5.5 h.

Ultrasound was shown to increase the transmembrane flux by reducing the concentration polarization associated with forward osmosis concentration process. The effect was notable when the osmotic solution was towards the support layer of the membrane, where in, the concentration polarization was usually higher. The effect of ultrasound on flux was more pronounced when the feed solution had less content of pectin. The application of ultrasound to sweet lime juice resulted in higher flux from 5.58 to 6.95 $\text{Lm}^{-2}\text{h}^{-1}$ resulting in faster concentration of the juice compared to the normal forward osmosis process.

Cryo pulverization and spouted bed roasting of coffee beans (Sridhar BS)

An optimised roasting method of coffee beans according to the type of coffee being roasted and without burning the beans and compromising the flavor of the beverage was developed. Green coffee beans (peaberry) roasted in an indigenously designed spouted bed roaster followed by quenching with liquid nitrogen and ground in cryogrinder and hammer mill was found to have more concentration of caffeine and lesser concentration of chlorogenic acid and volatile compounds than the conventional drum roasting. The rate of color change and color degradation pattern was observed to be linear and more than the conventional drum roasting. 15 flavor compounds were identified in the coffee extracts from the present study leading to retention of flavor compounds, such as the furans and thiols. The major compounds were 1-propen-2-acetate, 3-furanmethanol and furan, 2 [methylthio] methyl. A mathematical model, taking into account heat and mass transfer at the surface and inside of the beans, was proposed considering material balance, air heat balance and heat balance to validate the model. The proposed roasting method will be very useful for coffee processing in order to produce high quality coffee beans and increase its economic value.

Shelf life of popular snacks (Indiramma AR)

Tengolalu and *Shankarpouli*, the traditional popular snacks were prepared using different frying media like refined sunflower oil, groundnut oil, palm oil and coconut oil with an objective to determine the best frying medium to obtain snacks of good quality and longer shelf life. Different aspects of packaging materials and the influence of vacuum and different gases such as carbon

dioxide and nitrogen on improving shelf life were also studied. It was observed that frying media and available oxygen were the determining factors for shelf life. The shelf life of both the products fried in sunflower oil, groundnut oil, palm oil and coconut oil is in the ratio 1:2:5 :>6 respectively and nitrogen packing increases the shelf life by 3 times under identical conditions.

LPG based liquid food pasteurization system (Satish HS)

LPG based liquid food pasteurization for direct and indirect heating was designed. In the case of direct system, the product tube will be in contact with the flame and fouling problem was observed. The fouling was controlled with inclusion of clean-in-place (CIP) in the design thereby the cooling water flows into the system before the product flow is completed in the run. This system was tested for milk and various fruit juices like lemon, orange, mango and tomato for pasteurization with temperature varying from 65-85°C with a maximum flow rate of 6 l/min. The temperature of the product is controlled by adjusting the product flow and the fuel flow. An indirect system was also designed wherein the product tube will be either in steam or water medium.

To complete the pasteurization system sans electricity, an LPG based heat sealer was also designed and fabricated. The performance evaluation of the sealer for various thermo plastics are being carried out.

Evaluation of botanicals for insecticidal potential (Sumitra Devi S)

Plant materials viz., flax seed, kachur rhizomes, jamun seeds and jamun seed coat powders were subjected to sequential extraction i.e., Hexane -> chloroform -> methanol -> water and these extracts were evaluated for their insecticidal potential against *S. oryzae*. Bioassay results of each of the above extracts at 500 ppm and 1000 ppm against *S. oryzae* on wheat revealed that hexane extracts were highly efficient in bringing about mortality of *S. oryzae*. The order of their efficiency was kachur > flax seed > jamun seed coat > jamun seed with 78.33, 53.33, 47.0, and 15.0% mortality respectively. With chloroform extracts, jamun seed coat exhibited 45% insect mortality. Similar trend was observed with the influence of these extracts on F_1 progeny. The order of their efficiency in reducing the F_1 number was kachur > flax seed > jamun seed coat > jamun seed.

Microwave processing of vegetables and spices (Umesh Hebbar H)

Under optimized processing conditions, application of microwave blanching on red bell pepper slices resulted

in high level of retention of ascorbic acid (92.3%) and β -carotene (79.5%) while completely inactivating peroxidase and polyphenoloxidase enzymes to the desired level. In another work, effect of infrared (IR) radiation on sterilization of black pepper at different processing temperatures was studied. Processing at higher temperatures was found to be not only effective in achieving complete elimination of coliforms, *Salmonella*, *Shigella* and *E. coli* but also total aerobic mesophiles and total yeast and molds to the desired level. Volatile oil retention of seeds was found to be more than 100% because of the increased extractability. Piperine and resin content remained unchanged in seeds sterilized at lower temperatures. Microwave sterilization of black pepper up to 7 min was found to be ineffective in eliminating the microbial load to the desired level. Radio-frequency was found to be effective in eliminating the microbial load to the desired level when moisture content in feed was enhanced.

Biofunctional applications of marine carotenoids (Baskaran V)

Studies on improvement of stability and biological availability of the light and heat sensitive bioactive carotenoid fucoxanthin (FUCO) was made by encapsulating FUCO in chitosan (CS) - sodium tripolyphosphate (TPP) - glycolipid (GL) nanogels, prepared by ionic gelation method. Scanning electron microscope and dynamic light scattering examination revealed smooth and spherical nanogels with size range of 300-600 nm in weight ratios of CS: TPP (2.5:1), CS: GL (1:0.5). The zeta potential of CS-NGs with FUCO + GL (+30 to 50 mV) was more stable than with no glycolipid (+15 mV). Fourier transform infrared spectroscopy studies showed an extensive hydrogen bonding interaction between the FUCO and CS. FUCO is distributed in a disordered state in CS-NGs as revealed by X-ray diffraction. Encapsulation efficiency, loading capacity and the yield of nanogels were 90%, 85% and 70% respectively. Concentration dependent FUCO release from CS-NGs demonstrated initially a rapid burst release following the zero order kinetics (till 10 h) followed by sustained release over 24 h. Stability studies illustrated that glycolipid offers enhanced FUCO stability in CS-NGs. The bioavailability of FUCO *in vitro* from CS-NGs with GL was higher compared to with no GL.

Biochemical characterisation of nutraceuticals from oilseeds and cereals (Sridevi A Singh, Jyothi Lakshmi A)

Rice bran (RB) arginine peptide fractions were checked for hypotensive effect by post-oral administration in DOCA induced hypertensive rats. The fractions increased cyclic

GMP levels and the nitric oxide levels in plasma and kidney and remarkably regulated hypertension.

Saponins were extracted from germinated soyabean. By mass spectrometric analysis saponins of group A - Aa, Ab, Ae and Af and group B - Bb (I), Bc (II) and Bb' (III) were separated.

Different modes of thermal treatment and exposure to UV rays were tried for removal of glucosinolates in mustard seeds. Roasting at 95-105°C for 15 min was found effective in reducing glucosinolates.

Natural black colour was extracted from sesame hulls (142.6 mg/g) and brown colour from mustard hulls (54.5 mg/g). Based on chemical tests, UV- visible absorption spectra and FTIR spectroscopy of these pigments were identified to be 'melanin' like.

The two major globulins of soyabean, glycinin and conglycinin were separated in presence of sodium bisulphite, a reductant which yielded 16% glycinin and 13.4% conglycinin.

Oilseed flours were fortified with different ratio of iron:zinc, zinc reduced bioaccessibility of iron and vice-versa. Addition of amino acids - histidine, cysteine, methionine and glycine counteracted the inhibitory effect of comineral fortification.

Endo-mannanase from *Bacillus* sp. CFR1601 was enriched using aqueous two phase system with 70% recovery with 12.32-fold purification. The purified endo-mannanase had a molecular weight of ~ 46.0 kDa and was a member of glycosyl hydrolase family 26. The endo-mannanase gene from *Bacillus* sp. CFR1601 was heterologously expressed in *E. coli* BL21 (DE3) and recombinant enzyme was purified in single step to apparent homogeneity.

Nanoencapsulation of polyphenols for food supplement (Anandharamakrishnan C)

Application of nanoencapsulation to improve the stability and bioavailability of green tea polyphenols was attempted. Green tea polyphenols rich extract obtained by microwave assisted extraction of green tea leaves at a temperature of 80°C for 10 minutes was freeze dried and combined with zein, a protein based biopolymer obtained from corn. The morphology of nanoencapsulated green tea polyphenols revealed that the electrosprayed particles had diameters ranging from 100 nm to 300 nm. Fourier Transform Infra Red spectrum of pure zein powder showed two intense bands at 1661.4 cm⁻¹ and 1532.5 cm⁻¹ corresponding to the amide I and II of zein. The appearance of these bands for the encapsulated samples suggests the absence of chemical reaction

between zein and the green tea polyphenols during encapsulation. Nanoencapsulates had diameters ranging from 100 nm to 300 nm. The encapsulation efficiency was above 75% for all the samples and nanoencapsulated sample with core:wall ratio (1:3), exhibited highest DPPH radical scavenging ability. These nanoencapsulates can be used as a functional food ingredient or as additives in food packaging materials.

Protein-rich pasta from sorghum

An innovative approach to improve the shelf-life of sorghum flour by subjecting it to infrared heating was made. Infrared heating conditions such as, time and temperature of sorghum flour were optimized using central composite rotatable design. As a result, a flour with low free fatty acid content (0.03%), lipase activity (15 $\mu\text{eq.mg/h}$), and peak viscosity value (294 BU) were achieved. In another study, protein rich sorghum pasta was prepared by blending sorghum flour separately with soya protein concentrate (SPC) and Bengal gram flour along with guar gum and antioxidant BHA. This sorghum pasta prepared showed better sensory acceptability and contained 8% moisture, 13% protein, 5.6% fat and 0.6% ash. Cooking quality of the pasta revealed that sorghum pasta with different blends exhibited more cooking loss (6-14%) than that of durum wheat (control) pasta (5%).

Bioactive flavourants (Nagarajan S)

Isolation of potential biomolecules from garlic and its application to food systems with suitable delivery mechanism was studied. Fresh garlic was subjected to drying with a microwave system under various power levels. The results showed that the cloves of garlic are partially retaining the colour and volatiles. The volatile oils from the dried and fresh garlic was extracted and subjected to GC followed by GC-MS analysis, which showed at least 60 components. The crushed garlic was subjected to solvent extraction and further isolation and evaluation of activity studies are under progress.

Multi-spouted bed roaster for roasting makhana seeds (Sridhar BS)

Design of multi-spouted bed roasting for makhana seeds and development of certain value added products from makhana was taken up. Initially, physical data and correlation equations that predict physical properties as a function of moisture content was generated in order to utilize in the design of the equipment and processing of such type of products. It was found that the test weight, bulk density, porosity, angle of repose and coefficient of friction of makhana varied quadratically with moisture content. The average diameter varied between 16.4 mm to 11.2 mm with sphericity ranging between 0.54 mm to 0.87 mm. The terminal velocity and drag coefficient at

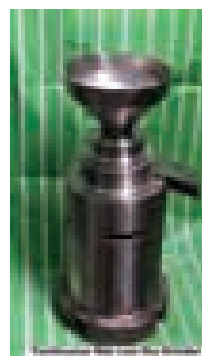
8% moisture content (dry basis) varied between 5.18 to 7.20 m/s and 0.72 to 1.85, respectively. The preliminary design for the mechanical system of multispouted processing of makhana based on this was initiated. Preparation of detailed design and drawings of prototype multi-spouted bed roaster for makhana is in progress.

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

Ultrasound assisted ozonator consisting of an ozone generator and reaction chamber equipped with ultrasonic probe for the processing of liquid foods was developed. Challenge tests were performed in sterilized sugarcane juice containing *E. coli* ATCC 25922 by subjecting it to ultrasound treatments individually. These treatments resulted in more than 5-log reduction of *E. coli* ATCC 25922. The individual effect of ozone and ultrasound treatments on natural contaminants of fresh sugarcane juice resulted in more than 3-log reduction. However, simultaneous treatment of ozone and ultrasound resulted not only in 4.3-log reduction of natural contaminants but also more than 90% reduction in the activities of polyphenoloxidase and peroxidase.

Continuous wet cum dry grinder for grinding waxy rice (Venkatesh Murthy K)

A continuous wet cum dry grinder with a capacity of 3-5 kg/h for grinding waxy rice was attempted. Three variants of grinders was designed and fabricated; hand operated table top grinder, motorized table top grinder and pilot scale grinder. The grinder was designed based on a set of carborundum wheel for grinding with an operating speed of around 3000 RPM and having a four stage gear train to generate 4500 RPM. A standard gear box with a gear ratio of 75:1 was selected assuming an input rotational speed of 45 RPM (hand rotational speed). Hand operated machine has an input torque of 2 kg-m. Output torque of the hand operated gear head was around 10 kg-m. Power requirement for the motorized grinder was estimated to be around 100 W and induction motor of 180 W was chosen for the motorized grinder. Detailed engineering drawings were prepared for both hand operated as well as for motorized variant.



LONG TERM STRATEGIC RESEARCH

Anti-cholelithogenic influence of dietary tender cluster beans (*Srinivasan K*)

Effect of a combination of tender cluster beans (*Cyamopsis tetragonoloba*) and garlic (*Allium sativum*) was evaluated by inducing lithogenesis in mice by feeding 0.5% cholesterol diet (HCD). Tender cluster beans (CB) (10%) and garlic (1%) were included individually and in combination along with high cholesterol diet. CB, garlic and their combination reduced cholesterol gallstones formation by 44, 25 and 56%, respectively, which was attendant with reduced cholesterol by 23-48%, 16-24%, and 24-58% in bile, serum, and liver respectively. Biliary cholesterol saturation index and their related biochemical indices viz. cholesterol/phospholipid ratio in serum and liver, lipid peroxides were found to be significantly higher due to these dietary interventions, the combination producing higher effects as compared to individual effects. Thus, the antilithogenic influence of dietary CB and garlic resulting from decreased cholesterol hypersecretion into bile and hence the cholesterol saturation index and the related biochemical indices were higher with the combination of CB and garlic compared to individual effects.

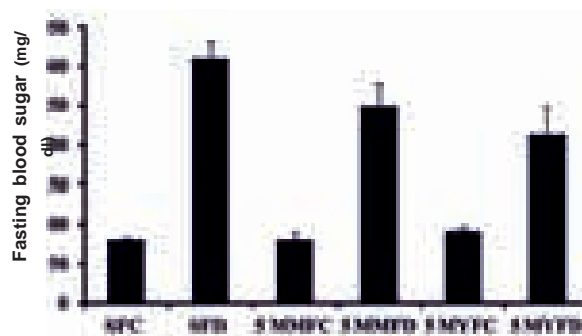
Attenuation of cholesterol gallstones by dietary tender cluster bean (*Srinivasan K*)

Effect of dietary tender cluster beans (CB) individually and also in combination with garlic were studied with respect to dissolution of pre-established cholesterol gallstones (CGS) in mice. CGS were induced by feeding a high (0.5%) cholesterol diet (HCD) for 10 weeks. CB (10% freeze-dried powder) and garlic (1% freeze-dried powder) were included individually and in combination in the basal diet of gallstone-induced animals for a subsequent period of 5 and 10 weeks. CB, garlic and their combination reduced the pre-established CGS by 61, 50 and 72%, respectively, in 10 weeks. This was accompanied by a reduction in cholesterol saturation index to 0.749, 0.903 and 0.648 from 1.86 in HCD group. This was supported by a beneficial modulation of altered ratios of cholesterol: bile acid and cholesterol: phospholipid ratios in the bile as a result of these dietary

interventions. Basal control diet after CGS induction in mice caused only a moderate 27% regression of CGS, in 10 weeks. Acceleration of the regression of CGS in animals confirms the health beneficial antilithogenic influence of dietary CB previously observed in terms of reducing the incidence of CGS during experimental induction.

Attenuation of diabetes (*Salimath PV*)

Experiments on streptozoin-induced diabetic rats fed with mature and young leaves of mulberry revealed that it had a beneficial effect on basic parameters such as blood glucose, kidney index and glomerular filtration rate. Diabetic animals exhibited a significant increase of more than 2-folds in blood glucose levels compared to control animals. The increase was significantly ameliorated by 19% and 31% respectively, on feeding mulberry mature and young leaves. Levels of glycosaminoglycans, a key component of kidney extracellular matrix, found reduced in diabetic rats, was restored in rats fed with mulberry leaves.



Effect of feeding mulberry leaves on blood glucose levels. SFC: Control; SFD: Diabetic; 5MMFC: Mature mulberry leaves control animals; 5MYFC: 5MMFD: Mature mulberry leaves Diabetic animals; Young mulberry leaves fed Control animals; 5MYFD: Young mulberry leaves fed Diabetic animals

Hypolipidemic influence of dietary fenugreek seeds and garlic (*Salimath PV*)

Hypocholesterolemic and antioxidant influences of dietary fenugreek seeds (*Trigonella foenum-graecum*), garlic (*Allium sativum*), and their combination included in a high cholesterol diet (HCD) for 8 weeks were

evaluated in Wistar rats. Dietary fenugreek, garlic or their combination significantly countered hypercholesterolemia, the effect being higher by the combination. LDL-cholesterol was particularly countered, while HDL-cholesterol was restored. Compromised cholesterol, phospholipid ratio and atherogenicity index were reversed by these dietary interventions, the effect being higher by fenugreek-garlic combination. Hepatic cholesterol was lowered by dietary fenugreek, garlic or their combination. Cholesterol content and cholesterol: phospholipid ratio in the heart was also beneficially modulated by dietary fenugreek and garlic, with higher benefit from the combination. Increased lipid peroxides was effectively countered by dietary fenugreek, garlic, and fenugreek+garlic, which was accompanied by restoration of vitamin E in liver and heart and the effect being highest with fenugreek+garlic. Undesirable activity of glutathione peroxidase in serum, liver and heart and that of catalase in serum was effectively restored by these dietary interventions indicating that dietary fenugreek and garlic may have higher cardio protective influence when consumed together, and this may be critical to derive maximum nutraceutical benefit from these two spice ingredients.

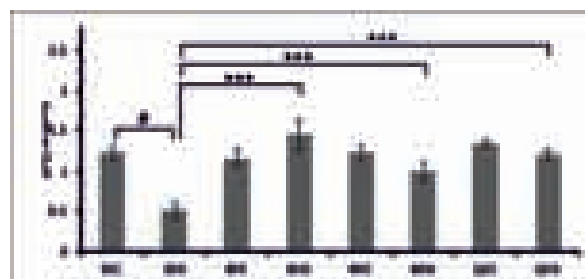
Metabolism of lutein in mice (*Baskaran V*)

Metabolism of lutein in plasma, liver, intestine and eyes of mice after repeated dose of lutein dispersed in olive oil were characterized by HPLC and LC-MS. The fragmented lutein found in plasma and liver were found to be oxygenated products, apocarotenals and epoxides of lutein, which indicates that lutein is involved in the chain-breaking reaction by peroxy radical or quenching of the singlet oxygen. In case of intestine, demethylated and dehydration products of lutein were characterized, indicating that dehydroxylation and demethylation take place which may be due to alkaline pH in intestinal lumen. Further, in eyes, lutein fragments were detected indicating that lutein may offer protection against endogenous pro-oxidants produced by UV- and sunlight in the eye, by undergoing breakage, demethylation and oxidation reactions. This clearly postulate that lutein play an important role in protecting the eye by scavenging pro-oxidants from visible and UV-irradiation, that results in formation of these oxidative metabolites.

Influence of dietary components on insulin signalling (*Salimath PV*)

Role of dietary components such as quercetin, naringenin and berberine on insulin signaling components in the brain was studied by analysing various

components of neuronal insulin receptor substrate – phosphatidylinositol-3-kinase (IRS – PI3K) pathway and glucose transporters (GLUTs) by Western Blot analysis. Results clearly indicate the impact of diabetes in altering the insulin receptor substrate in brain and beneficial effects of dietary components which cross the blood-brain barrier.



SFC, BFC, NFC, QFC- Control animals starch, berberine, Naringenin and quercetin, respectively. SFD, BFD, NFD and QFD, Corresponding diabetic animals

Studies on the role of diet-induced hypercholesterolemia on glycosaminoglycans (GAGs) revealed fine structural changes in GAGs especially with respect to disaccharide composition and molecular weight changes. This impinged on the ability of erythrocytes from control and hypercholesterolemic rats to bind to laminin, fibronectin and type IV collagen. The binding was significantly abrogated on digesting the GAG chains implicating it as one of the molecules required for cytoadherence.

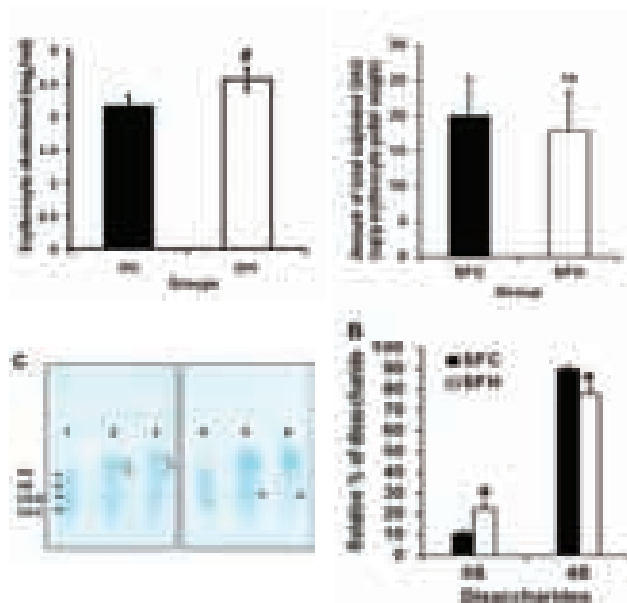


Fig: Effect of diet induced hypercholesterolemia on erythrocyte cholesterol and glycosaminoglycans. Values are depicted as Mean \pm SD of two independent experiments carried out on two pools from each experiment. # $p < 0.001$, † $p < 0.01$ and ns (non-significant)

Immunomodulatory activity of arabinoxylans (Muralikrishna G)

Mitogenic activity of purified arabinoxylans, a potent natural immunomodulator, antimicrobial and prebiotic against splenocytes was carried out by MTT assay and their capacity to activate macrophages was performed by quantifying the release of nitric oxide (NO) from murine peritoneal exudate cells (PECs). *In vitro* fermentation experiments were conducted by incorporating purified polysaccharides concentration into fermentation medium and inoculating with five different species of *Lactobacillus* such as *L. casei*, *L. fermentum*, *L. plantarum*, *L. acidophilus* and *L. brevis* for 24, 48 and 72h at 37°C. The increase in O.D at 600nm and decrease in pH was compared against respective controls. Purified arabinoxylans (BE, KE1 and KE2) significantly stimulated proliferation of murine splenocytes and also elevated the level of NO production by peritoneal exudate cells. The growth of all *Lactobacillus* species was maximum at 48h among which *L. brevis* showed the highest as compared to the rest.

Attenuation of acrylamide-induced impairment (Muralidhara, Akhilendar Naidu K)

Evaluation of gestational parameters on inulin supplemented pregnant wistar rats indicated that inulin treatment diminished ACR-induced anxiety-like behaviour. It was found that reduction in fetal/placental weights due to ACR treatment was marginally restored in rats supplemented with inulin.

Analysis of biochemical markers revealed that ACR-induced oxidative stress in maternal brain regions was significantly attenuated with inulin supplements, and a similar effect was evident in developing fetal brain, significantly the elevated levels of protein carbonyls in fetal brain were completely normalized with inulin supplements. Specifically, inulin treatment significantly diminished the ACR-induced depletion in fetal/maternal brain (cortex/striatal) dopamine levels. Furthermore, inulin effectively diminished ACR-induced elevation in fetal brain acetylcholinesterase activity. Inulin supplementation was also able to confer significant protection against decreased mitochondrial redox state (MTT reduction) in fetal brain, suggesting its ability to mitigate mitochondrial dysfunction. In a satellite study, inulin supplements provided to untreated rats resulted in a significant increase in caecum weight and bifido/lactobacilli counts.

Vitamin C ester-ascorbyl stearate (Akhilendar Naidu K)

Molecular mechanism underlying anti-proliferative, apoptotic inducing property of ascorbyl stearate in human

cervical carcinoma cells were studied using human cervical carcinoma cell line (HeLa). HeLa cells grown in modified eagle's medium (MEM) containing 10% fetal calf serum at 37°C in CO₂ incubator were treated with different concentrations of ascorbic acid and ascorbyl stearate and cell growth was measured by MTT assay after 24 and 48 h. Ascorbyl stearate inhibited the proliferation of HeLa cells in dose dependent manner. IC₅₀ values for 24 h and 48 h were found to be 190 μ M and 123 μ M respectively. Fluorescence microscopy showed significant number of apoptotic bodies with blebbing of plasma membrane and condensation of chromatin after propidium staining in Ascorbyl stearate treated HeLa cells. Studies on the bioavailability of ascorbyl stearate in HeLa cells revealed that ascorbyl stearate penetrate through the cell membrane and part of it hydrolyzed to ascorbyl radical by esterases in HeLa cells. The effect of different concentrations of ascorbyl stearate (50-200 μ M) on the expression of caspases -3, 9 was also studied by western blot in HeLa cells. Ascorbyl stearate dose dependently inhibited expression of caspase-3 and caspases-9 indicating that apoptosis is induced through cytochrome c and caspases pathway.



Control HeLa cells stearate
(123 μ M)

HeLa cells showing apoptosis
on ascorbyl treatment 48 h

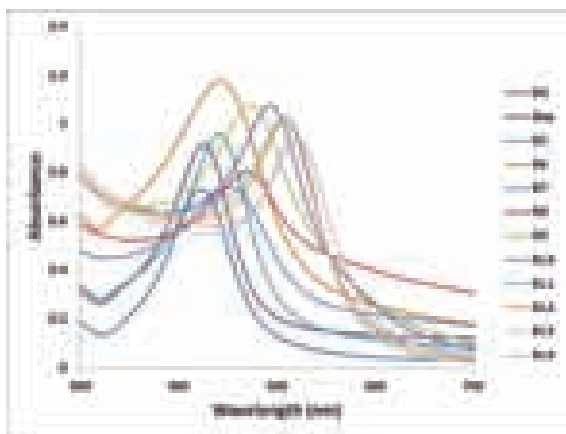
Turmeric pectic polysaccharide

(Shylaja M Dharmesh)

Effect of sheep red blood cell (SRBC) (Inflammant) and cyclophosphamide (Immunosuppressor) on ulcerations revealed that it enhances the ulcer index. Anti-inflammatory cytokine IL10 was reduced significantly suggesting the cause of aggravation of ulcers. Treatment with dietary pectic polysaccharide (DPP) enhanced the levels of cytokine IL10 *in vivo* suggesting the immunomodulatory potential of turmeric pectic polysaccharide. The enhanced IL10 is known to augment the ulcer healing ability; which was studied in our model by histopathological analysis of both stomach and the spleen. Data revealed altered architecture and alteration in production of periodic-acid schiff stain (PAS) positive substances during ulceration, which was modulated effectively by turmeric pectic polysaccharide. Changes observed in the spleen including red/white pulp changes and capsule fibrosis, were normalized upon treatment.

Aptamer based biosensor (Thakur MS)

Bimetallic alloy nanoparticles were synthesized using noble metal salts. Nanoparticles with surface performance resonance (SPR) peak around 510 nm were used for aptamer based colorimetric sensor for vitamin B12. Detection of vitamin B12 was carried out using modified aptamer specific to vitamin B12 and gold nanoparticle (GNP). Detection is based on the change in colloidal state of GNPs solution based on the presence or absence of target molecule aided by salt induced non-crosslinking aggregation mechanism. The GNPs sol displayed red colour in the absence of vitamin B12 whereas, the colour changes to purple in the presence of vitamin B12. With the optimized parameters, limit of detection for vitamin B12 was found to be 0.1 µg/mL. The IgY antibodies from chicken against bisphenol-A and isolated using sodium sulphate precipitation. Titre value of the antibodies was found to be in micrograms, which is less sensitive for the detection of bisphenol-A.



Absorption spectra showing the surface plasmon resonance peak of gold silver alloy nanoparticles

Chemical diversity by OSMAC (One Strain ± Many Compounds) (Avinash P Sattur)

Analysis of selected fungal crude extract was done using HPLC separation technique to identify and isolate novel inhibitors against alpha glucosidase enzyme. Purification of the active fraction was carried out by preparative HPLC and other conventional methods. Structure elucidation of the active ingredient is in progress. This is the first time that this technique has been attempted to discover (many) new molecules with multiple bioactivities, in a single culture

Microbial L-asparaginase (Manonmani HK)

Bacterial isolates maintained in lab were cultured on nutrient agar slants for 48 hours under aerobic conditions at 37°C. The cell pellets from harvested medium were re-suspended in minimal medium and were induced with

the addition of L-asparagine (2 mM) for 30 hours. Out of 40 bacterial soil isolates screened for asparaginase production, 12 organisms showed asparaginase production. The organisms were further screened for intracellular and extracellular enzyme production

Genomic DNA was isolated from these isolates and primers were designed for the asparaginase sequences available in NCBI database using primer designing software Gradient PCR experiment was performed using ASN primers at temperatures between 50 °C and 70°C. The PCR tubes were kept at 8 different temperatures. The number of cycles used for amplification was 30. The optimized temperature, time and the genomic DNA from the selected organism T9 were used for large scale amplification. The large scale amplification products of *asn* gene were pooled separately and preparatory electrophoresed on agarose gel. The purified PCR product of *asn* gene were ligated to pTZ57R/T vector and cloned in to *E. coli* DH5α. The cloned plasmid isolated was sent for sequencing. Purified PCR product was ligated of to linearized pET101 directional vector using "PET101 Directional TOPO kit". The PCR product was transformed into Competent Cells of *E. coli* BL 21. The transformants were selected on luria antibiotic agar. The selected clone tested for protein expression. The clone chosen was grown on 10L fermentor. The cells were harvested from fermenter grown cells, enzyme isolated from cells by sonication, purified by Ni-NTA column and characterized. The purified enzyme was studied for antiproliferative activity on ehrlich ascites carcinoma (EAC) cell lines where apoptosis was found to be brought out in enzyme treated cells. The enzyme was also tried on mice induced with EAC. The development of EAC was stopped in L-Asn treated animals and no observable toxicity was present.

Secondary metabolites from *Penicillium* sp. (Ramaswamy K)

29 *Penicillium* sp. isolated from different food samples using potato dextrose agar (PDA) medium and purified on the above media were subjected for secondary metabolite production using 100 mL of antibiotic test broth (ATB) on a rotary shaker for 15 days in shake flasks at 120 rpm per minute. After 15 days of incubation, broth and mycelia was separated by filtration and the filtrate was extracted with equal volume of ethyl acetate. Further, the extract was concentrated by reducing the volume in flash evaporator.

The crude extract was tested for antibacterial activity and found that all metabolites have shown antibacterial activity. Based on these results, further work such as TLC, column chromatography was carried out to

separate the possible components present in each of the metabolite.

Insecticidal effect of wheat flour fortified with saponin (Krishnaiah HE)

Wheat flour mixed with saponin in different ratios were tested for the effect against *T. castaneum* and it was found that 5% level saponin affects the development of *Tribolium* species. The development was delayed by one month with the inhibition of 50% population. Similar experiments to be planned against *C. cephalonica* and *E. cautella* later.

Methyl derivatives and its insecticidal activity (Akmal Pasha)

4-Chloro-3-methyl phenol (0.03 M) and 4-chloro-3,5-dimethyl phenol (0.03 M) were separately dissolved in 100 mL acetone. Anhydrous potassium carbonate (10.0 g) was added to the mixture followed by O,O-diethyl chlorothiophosphate (0.03 M). The mixture was refluxed for 3. The product was analyzed by TLC using 15% diethyl ether in petroleum ether (60-80°C) and the plate was visualized under UV light at 254 nm. The product showed as spot at Rf 0.51 while the unreacted starting materials showed at different Rf 4-chloro-3-methyl phenol at 0.17 and O,O-diethyl chlorothiophosphate at 0.67. The mixture was passed through basic alumina using acetone as eluent to remove the impurities. Acetone was evaporated off to obtain the product. The resulting derivatives was O-(4-chloro-3-methylphenyl) O,O-diethyl phosphorothioate and O-(4-chloro-3,5-dimethylphenyl) O,O-diethyl phosphorothioate respectively.

Ethyl derivatives and its insecticidal activity (Akmal Pasha)

4-Chloro-3-methyl phenol (0.03 M) and 4-Chloro-3,5-dimethyl phenol (0.03 M) was dissolved separately in 100 mL acetone. Anhydrous potassium carbonate (10.0 g) was added to the mixture followed by O,O-dimethyl chlorothiophosphate (0.03 M). The mixture was refluxed for 3 hours. The product was analyzed by TLC using 15% diethyl ether in petroleum ether (60-80°C) and the plate was visualized under UV light at 254 nm. The product showed as spot at Rf 0.436 while the unreacted starting material showed at different Rf 4-chloro-3-methyl phenol at 0.17. The mixture was passed through basic alumina using acetone as eluent to remove the impurities. Acetone was evaporated off to obtain the product. The structure was characterized by NMR. The resultant derivatives were O-(4-chloro-3-methylphenyl) O,O-dimethyl phosphorothioate and O-(4-chloro-3,5-dimethylphenyl) O,O-dimethyl phosphorothioate

respectively.

Antifungal activity was tested from 4-chloro-3,5-xyleneol and p-chloro meta cresol (both are starting materials) along with their derivatives were tested against some plant pathogenic fungi such as *A. niger*, *Fusarium*, *Alternaria*, *Rhizoctonia* and *Botritis* sp. using agar-well method. The results demonstrate that neither the starting materials nor their derivatives mentioned above have shown fungicidal activity.

Toxicity of PH₃ + N₂ mixture on storage pests (Manivannan S)

Efficacy of phosphine + nitrogen mixtures on the mortality of adults of *S. oryzae* and *T. castaneum* revealed that, phosphine + 30% inert gas mixture proved effective in insect control compared to control in both the insect species, *T. castaneum* and *S. oryzae*. At 0.14 mgL⁻¹ concentration, 100% mortality in the adults of *S. oryzae* was observed over 56 h exposure to phosphine + 30% N₂ mixture. Adults of *S. oryzae* when exposed to three sub-lethal concentrations LC₁₀, LC₁₆ and LC₅₀ showed delayed mortality in the treated insects. Similar results with increasing mortality was also observed when the adults of *T. castaneum* were exposed to phosphine + 30% N₂ mixture over 48 and 72 h of exposure. However, unlike *S. oryzae*, delayed mortality was not noticed in *T. castaneum* adults exposed to sub-lethal doses. The treatment of mixed age cultures of *R. dominica* to different concentrations of phosphine/CO₂ combination showed significant reduction in the LC₅₀ concentration compared to the control involving phosphine. The results revealed that better synergistic action of PH₃ + CO₂ may be obtained, if 30% CO₂ levels are maintained.

Sub-lethal effect of pesticides on intestinal enzymes (Rajini PS)

Effect of oral administration of monocrotophos (MCP) and chlorpyrifos (CPF) in rats and its effect on brush border enzymes and redox state markers of small intestine were studied. Biochemical studies were carried out in jejunum of small intestine. Monocrotophos treatment reduced acetylcholinesterase (AChE) activity by 40% whereas an increase in the activity of brush border disaccharidases like sucrase, maltase, lactase and trehalase besides, alkaline phosphatase (ALP) activity was observed (50%). Catalase (CAT) showed reduced activity (36%) and superoxidase dismutase (SOD) recorded no change. Lipid peroxidation (LPO) was increased (29%) and reduced glutathione (GSH) level was decreased (31%). Similarly chlorpyrifos administration resulted in an increase in sucrase (25%) and maltase (35%) and LPO activity (25%) and decrease

in CAT activity (20%). Of the two insecticides selected for the study, MCP was found to have more impact on intestinal enzymes. These results clearly establish the propensity of organophosphorus insecticides to induce alterations in brush border and antioxidant enzymes of small intestine which may lead to intestinal dysfunctions.

Monocrotophos on the neurobehaviour

(Shahin Jafrin Ali)

Monocrotophos (MCP) was initially screened for its ability to cause any neurobehavioral deficits and alterations in Swiss albino mice (5 wks, 25-30 g) with repeated doses of MCP at 0.3 and 0.6 mg/kg b.w/d (1/20 and 1/40 of the established LD50 :12 mg/kg b.w) for 7 and 30 d. Mice treated with MPTP (1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) for 7 days. were analyzed for neurobehavioral deficits through cataleptic scoring and dopamine content, histological examinations, immunohistochemical localization of the tyrosine hydroxylase (TH) and markers of oxidative stress such as extent of lipid peroxidation, generation of reactive oxygen species and the reduced to oxidized glutathione ratios. Mice administered with MCP alone revealed a significant ($P < 0.05$) decrease in the dopamine content at both 7 and 30 days and a significant ($P < 0.05$) decrease in neurobehavioral deficits. Interestingly, when MCP administration was for 7 days to MPTP treated mice, a further significant decrease in both dopamine content and neurobehavioral deficits was evident. The extent of reactive oxygen species and lipid peroxidation, markedly increased, while the ratio of reduced to oxidized glutathione levels were significantly decreased ($P < 0.05$) in the treated mice compared to the control. A marked decrease in the number of TH⁺ve cells and histopathological alterations were evident in striatum of mice treated with higher doses of MCP. These changes were comparable to that seen in mice treated with MPTP and post-administered lower doses of MCP.

High throughput analytical methods for food quality and safety (Asha Martin, Nanishankar VH, Pasanna Vasu)

An LC-MS/MS analytical method for the analysis of tetracyclines using ionic liquids aqueous two-phase system (IL-ATPS) was developed. Sample preparation for LC-MS/MS was optimised using IL-ATPS consisting of 1-butyl-3-methyl-imidazolium tetrafluoroborate ([Bmim]BF₄) with ammonium sulfate and sodium citrate. Good phase separation was achieved at ammonium sulfate concentration of 42% or more, at pH 4.5. sodium citrate at concentration more than 36% at pH 5.6 also showed good phase separation. The LC-MS/MS method showed good linearity in the range of 10 – 80 ppb ($r^2 >$

0.99). The method was validated using spiked honey samples, and showed good recovery.

A synthetic protocol was optimised for the preparation of Maillard reaction conjugates; amadori ketoses *N*-(1-deoxy-D-fructosyl) amino acid (amino acid = L-ornithine and L-citrulline). ZnCl₂ mediated practical protocol for the synthesis of Amadori ketoses was developed which avoids protection and deprotection steps as well as chromatographic separations.

A modification of a standard method for the detection of adulteration (up to 5%) in ghee based sweets was optimised by comparison of triacylglycerols (TAG) and sterol composition. By using this method, 7 out of 8 ghee-based Indian sweets were found to be adulterated with non-milk fat.

To study the quality and safety attributes of wheat grains of diverse agro-climatic conditions, eight samples of wheat obtained from different zones of the country were analyzed for aflatoxins. Aflatoxins (B1, B2, G1 and G2) in all the 8 wheat samples were found to be below detectable limits (BDL of 20 ppb). Furthermore, deoxynevalenol (DON) were not detected in any of the above 8 wheat samples tested, as analyzed by TLC. No *Fusarium graminearum* isolates that produced DON were detected in any of the wheat kernels. The presence of toxic metals consisting of lead (Pb), mercury (Hg), cadmium (Cd) and arsenic (As), were not detected in the five ragi and five wheat samples analyzed by ICP-AES techniques.

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

Theobromine synthase gene promoter deletion fragments were amplified using designed primers and cloned into pORE-R4 binary reporter vector at *HindIII/SacI* sites upstream of small modified green fluorescent protein gene (*smgfp*). For construction of promoter invert repeat constructs, different locations of promoter were amplified as sense and antisense fragments. The sense fragments were cloned in *KpnI/XhoI* site of pHannibalsiRNA vector and antisense was cloned in *BamHI/ClaI* of the resulting clones. Regular maintenance of coffee plants and somatic embryos in tissue culture and *Arabidopsis thaliana* in green house has been followed up.

De-phytization of oil cake rich animal feed (Mukesh Kapoor)

Soil samples were collected from different agricultural fields located nearby Mysore city and was used for isolating wild-type bacterial isolates by standard microbiological techniques. A total of 106 bacterial isolates were obtained, purified and subsequently

analysed for phytase (neutral/alkaline) production qualitatively and quantitatively. Results obtained indicated that 23 bacterial isolates were able to produce neutral/alkaline phytase qualitatively and quantitatively under solid state fermentation conditions.

Biosensors (Thakur MS)

Aptamers conjugated to gold nanoparticles were used for the detection of food toxins namely ochrotoxin and aflatoxin (Kd=nM). Detection was based on aggregation of gold nanoparticle (GNP/AuNP) which is specifically induced by detachment of the ochrotoxin and aflatoxin binding DNA aptamer from the surface of AuNPs as a result of the aptamer target interaction, leading to a colour change. Another approach involving conjugation of aptamer with fluorophore and quencher was used for the detection of the toxins. This was based on change in relative fluorescence upon binding of analyte to aptamer.

Probiotics for antigen delivery (Rajagopal K)

Antigen hTNF- α has been successfully expressed in HT-29 cancer cell line and isolated novel bacteria *Enterococcus*, *Bifidobacterium* and *Lactobacillus* from infant faecal material. It is proposed to understand the affinity of different probiotic microbes for cancer cell line cloning, expression of CD (Cytosine Deaminase), NTR (Nitro Reductase) and hTNF (human Tumor Necrosis Factor-alpha) in *E. coli* and *Lactobacillus*.

Biotransformation of caffeine (Thakur MS)

Naturally available caffeine in coffee pulp and tea leaves was biotransformed to obtain valuable product theophylline for which ten fungal strains were isolated from coffee plantation area. Among the strains identified, *Fusarium solani* showed maximum biotransformation of about 34.92 mg/l in caffeine sucrose liquid medium. After optimization of physical parameters like pH, temperature, inoculum size and allopurinol concentration, there was 2.5 fold increase in product yield i.e., 90 mg/l. The biotransformed theophylline was checked for its anti-proliferative activity in B16F10 melanoma cells and it was found to be concentration dependant. The IC₅₀ value was found to be 7.2 mM for apoptosis.

Management of coffee pulp effluents

(Anu Appaiah K)

Coffee pulp effluents were treated with a consortium of four isolates (*Pichia kudriavzevii* (3 nos.) and *Candida tropicalis*) for a period of 60 days. After the treatment the odor production was almost non-existent and clarity

of the effluents had improved. The initial range of COD was from maximum 16003 mg/L to 11233 mg/L, which was reduced to 2123.5 mg/L minimum compared to uncontrolled lagoons being 18919 mg/L.

Biofunctional applications of carotenoids

(Baskaran V)

A comparative study on the protective effect of astaxanthin and fucoxanthin against lutein in lutein deficient rats fed on β -carotene, astaxanthin, fucoxanthin and lutein rats revealed suppressed lipid peroxidation and reduced SOD activity in plasma and liver, while the catalase, glutathione reductase and glutathione increased in plasma and liver. Fatty acid profile showed a significant decrease in saturated fatty acids and an increase in unsaturated fatty acids compared to the control group. These results indicate that astaxanthin and fucoxanthin are potent antioxidants similar to lutein.

Genetic diversity of lactic acid bacteria

(Prakash M Halami)

Lactobacillus plantarum, *Lb. fermentum*, *Lb. salivarius*, *Lb. viridescens*, *Lb. delburkii*/ *Lb. leichmannii* were isolated from 8 sinki samples and *Lb. plantarum*, *Lb. fermentum* and a new species of *Lb. xylosus* from Khalpi, North East fermented products, and identified based on morphological, physiological and biochemical tests. Internal Transcribed Spacer (ITS) region of representative LAB was evaluated and the species specific primers were designed using the 16S, 23S rRNA (ITS) region. The ITS sequence of such species was extracted by analyzing ribosomal locus from whole genome sequences using NCBI. A 16S-23S rDNA ITS region amplification size of different LAB was *Lb. plantarum* (647 bps), *Lb. acidophilus* (663 bps), *Lb. brevis* and *Pediococcus pentosaceus* (630 bps), *Lb. delbrueckii* subsp. *bulgaricus* (670 bps), *Lb. fermentum* (605 bps), *Lb. salivarius* (634 bps), *Lc. lactis* subsp. *lactis* (516 bps), *Lb. casei* 434 bps), *Leu. mesenteroides* (588 bps) and *Leu. citreum* (591 bps). Further, *Leuconostoc fallax* species specific primer was designed with an amplicon size of 1386 bps for 16S rRNA gene and 669 bps for RecN protein gene. These primers are used for characterization of the isolates and classified by RFLP pattern analysis.

Bench-scale prototype reactor extraction system

(Sarada R)

Seventeen microalgal strains were evaluated with 20% v/v CO₂ and *Chlorococcum* sp., *Scenedesmus dimorphus*, *Chlorella* sp. *Desmodesmus opoliensis* and *Coelastrum astroideum* exhibited higher CO₂ fixation rates up to 0.210 g CO₂/g biomass/day. Total chlorophyll

and carotenoid content increased with CO₂ supplementation, however the response was species specific. Effect of bicarbonate supplementation on the growth of four strains *Chlorococcum* sp., *Scenedesmus dimorphus*, *Kirchneriella contorta* and *Desmodesmus opoliensis* were studied and it was found that bicarbonate levels above 40mM were growth inhibitory. Evaluation of the selected culture of *Scenedesmus* in CO₂ sparged raceway pond of 50 L volume indicated enhancement in biomass content upto 15%. The *Scenedesmus* sp. has been acclimatized and scaled up in outdoor open raceway ponds at 1000L. Harvesting of the biomass using different coagulants was studied and chitosan is found to be effective in harvesting of algal biomass.

***In vitro* propagation protocols (Giridhar P)**

A tissue culture method for the production of ascorbic acid was standardized in roots of *Hibiscus cannabinus* by screening different media + growth regulator combinations *in vitro*. A food formulation rich in pigment extracts was developed using extract of *Basella rubra* fruit which is a rich source of betalains, where achieving pigment stability in the product is a great challenge.

Neuroprotective effects of saffron (Muralidhara)

Efficacy of saffron bioactive crocin to attenuate rotenone induced neurotoxicity in *Drosophila* model was studied in a 5 day co-exposure paradigm. All the tested concentrations of crocin i.e., 10, 25 and 50 µM significantly protected against rotenone induced mortality (64-83%), locomotor phenotype (28-38%) and oxidative stress. The levels of oxidative stress markers (ROS, NO, HP) which were increased significantly by rotenone treatment were decreased significantly by crocin supplementation. The defense mechanisms like reduced glutathione and total thiols levels were elevated significantly, in flies co-exposed to rotenone and crocin. Even the endogenous levels of oxidative stress markers were reduced, and antioxidant enzymes (CAT and SOD) were increased in crocin *per se* effect studies.

Antibiotic resistance in lactic acid bacteria (Prakash M Halami)

Lactic acid bacteria isolated from meat and poultry products were analyzed for prevalence of vancomycin resistance. Presence of tetracycline and erythromycin resistant gene on transposon-Tn916 was detected by PCR method. Prevalence of aminoglycoside resistant bifunctional gene *aac(6')Ie-aph(2'')Ia* encoding AAC(6')-APH(2''), 6'-N-acetyltransferase and 2'' O phosphotransferase responsible for enzymatic modification of aminoglycosides was evaluated in LAB isolated from poultry and meat origin. Presence of the

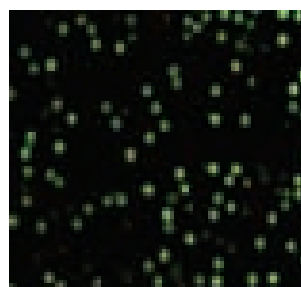
aminoglycoside resistant bifunctional gene *aac(6')Ie-aph(2'')Ia* among LAB from poultry and meat products was investigated. A low level resistance to gentamicin and kanamycin among 38% of the isolates with MIC value of ≤ 64 µg ml⁻¹ and moderate MIC values was observed for most of the cultures. Among the tested cultures, 22 LAB isolates showed high level gentamicin resistance and the presence of the *aac(6')Ie-aph(2'')Ia* gene. Results indicated that the native isolates of *Enterococcus cecorum*140a, *Enterococcus avium*CS31+ and *Lactobacillus plantarum* S9 were found to possess bifunctional gene.

Rapid detection of probiotic bacteria (Prakash M Halami)

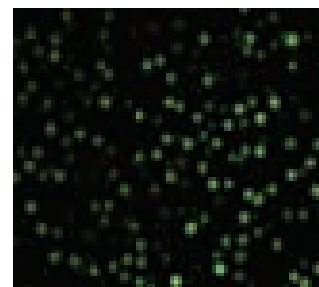
Lactobacilli isolated from human and dairy sources were characterized for their potential probiotic properties including acid and bile tolerance, GIT survival, adhesion and functional properties including antimicrobial activity and bile salt hydrolase activity. Further probiotic functional properties were evaluated using probiotic marker genes. Bioinformatics tools were employed to study allelic variation in adhesion genes, especially mucin binding genes and fibronectin binding protein. An assay for the evaluation of probiotics functionality using probiotic marker genes was developed. The potential cultures isolated from human source and dairy products were rapidly characterized and differentiated by RFLP, ITS, 8 RAPD, (GTG)₅ and subsequently by 16S rDNA sequence homology. The allelic variation was evaluated by using nucleotide sequence data of mucin binding protein (*mub*) and fibronectin binding protein (*fbp*) through bioinformatics tools. Probiotic binding domains responsible for the adhesion of probiotic bacteria to the intestinal epithelial layer were identified.

Glycosaminoglycans in macrophages (Nandini CD)

Glycosaminoglycans isolated from peritoneal macrophages of hypercholesterolemic and hypercholesterolemic/diabetic rats revealed the presence of exclusively low molecular weight heparansulfate.



CD11b staining of macrophages



Anti-heparan sulphate staining of macrophages

LPS-activated macrophages from hypercholesterolemic rats were able to show increased adhesion to the extracellular matrix components such as laminin, fibronectin and type IV collagen which was significantly attenuated on treatment with heparinase, an enzyme which digests heparansulfate. These results indicated that heparansulfate class of molecules might be responsible for adhesion of macrophages to various components.

Avian single chain antibody technique

(Manonmani HK)

Avian antibodies against organochlorine pesticide endosulphan were generated and a competitive immunoassay was developed. Endosulphan concentrations from 1000 ng to 1 ng were tested to obtain the minimum and maximum detectable concentrations. Competitive ELISA was performed and the colour development was studied by p-NPP method. The signal developed was inversely proportional to the amount of analyte present. Endosulphan levels of upto 1 ng could be detected by this method. Effect of matrix on the detection of the pesticide was also carried out. Among the cooked samples tested, the recovery was around 89% and 81% of alpha and beta endosulphan respectively. Vegetables like coriander and tomato showed the maximum matrix effect with a recovery of 56% of alpha endosulphan.

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

Four week old C57BL/6J male mice (80 nos.) were fed with high fat diet for 19 weeks to induce obesity. After the induction period obestatin and Nt8U were injected intraperitoneally for a period of 8 days and their effect on food intake and gain in body weight was monitored. Despite no significant differences in food intake, gain in body weight was stalled.

Characterisation of lactic acid bacteria strains

(Bhaskar N)

The lactic acid bacteria (LAB) strains isolated from fermented freshwater fish were screened for their antimicrobial activity and evaluated for their susceptibility under varied pH, temperature and salt concentrations. Among all the isolates, the strains HAT6 (halo-alkali tolerant) from fermented tilapia has been identified as extracellular lipase secreting halo alkali tolerant bacterium, and HAT6 was identified as non-virulent (non-pathogenic) strain of *Staphylococcus* as revealed by biochemical tests. Stability of halo-tolerant lipase under different physico-chemical conditions indicated that lipase secreted by HAT6 was stable at 2M NaCl, active over the pH range of 6 to 10 and stable between 30 and 40°C.

PROGRESS UNDER XII PLAN PROJECTS

Biological Science Cluster

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

Post-harvest and food technology processes

Breakage and cooking quality of rice are major concerns of the rice milling industry. Three freshly harvested paddy cultivars (*IR-64*, *Jyothi* and *Sona masuri*) were tested for their milling and cooking characteristics. It was observed that the breakage was very high during both dehusking and polishing. By enhancing the grain moisture and drying under controlled conditions, breakage could be reduced with significant increase in the head rice yield (70 to 85%). Cooking characteristics of the fresh rice improved – indicated by reduction in stickiness and increase in hardness of the cooked rice. Gel texture of the untreated and processed rice also varied similar to cooked rice texture. α -Amylase activity in the freshly harvested rice cultivars ranged between 0.014 and 0.024 maltose units/mg flour and it increased during the second month and ranged between 0.054 and 0.074 m units/mg flour, the activity was similar in all the 3 cultivars during third month (0.045 to 0.048 μ /mg flour) when stored in room temperature.

Brown rice flour possesses excellent nutraceutical properties which can prevent life style disorders. Physical, functional and product qualities of head and broken brown rice flours obtained from different milling methods was studied. Differences were observed in the physical, functional and product forming quality of flours from broken/ whole brown rice and commercial traditional food flour. A ready mix for instant *idiappam* mix was developed.

Attempt was made to prepare structured rice using broken rice. Cooked fabricated rice was found to have 86% starch digestibility, cooking time of about 5 min with acceptable sensory attributes.

Process conditions are being optimised on stabilising the high lipase fraction (rich in bran and germ) before

re-blending it with low lipase fraction (endosperm) for improving the storage of whole wheat flour. Use of lemon grass (LG) and spices (clove and cinnamon-CC) as anti-mould and antioxidants has resulted in sensorily acceptable muffins. Increase in the shelf life of *parotta* from 2-3 days to 7 days without affecting the overall quality of the product was achieved by the addition of natural preservative.

Mango peel, solid waste produced from a mango canning unit was dried after a suitable pre-treatment. Dried mango peel yielded a good pectin quality and enhanced total free radical scavenging activity. Pectin extraction studies of mango peel were carried out using acid and salts at different conditions. Development of mango peel as a gelling agent and studies on characterization of peel carbohydrates and pectin from mango peel by different extraction conditions are in progress.

A process for the preparation of zerumbone (sesquiterpene), a highly value added compound with medicinal benefits was developed. The extraction process involves size reduction of zerumbet ginger rhizomes (grown in North East and Southern parts of India), crushing, de-starching, and isolation of volatile oil and crystallization. Authenticity of the compound was established by structural elucidation and purity.

Aflatoxin contamination is a major bottleneck in the export of red chilli. A hygienic process was therefore optimized for the dehydration of chilli (*Byadgi* fresh red chilli). Washed fruits subjected to air drying for removal of surface moisture were further dried by a microwave drier at 800~1500 W of power for about 2-5 min followed by 6-10 min cooling to reduce the moisture from 80% to 8-10%. Dried chilli was either packed in gunny bags or subjected to hammer mill for size reduction/powdering and passed through 25-40 mesh to get fine powder. The dried chilli having good aroma and natural red colour contains 225~250 ASTA colour units with 0.5-1.0% pungency. The dried red capsicum has a shelf life of more than 3 months at $37\pm 2^\circ\text{C}$ in metalized polyester pouches. The dried red chilli/powder was found to be free from yeasts, molds, aerobic mesophilic spore

forming bacteria, non-spore forming mesophilic aerobic bacteria and coliforms.

A study on the suitability of infrared (IR) radiation for enzyme inactivation and drying with respect to bitter melon (*Momordica charantia* L) was taken up. Enzyme inactivation with IR required 8 min, compared to 2/3 min for water and steam blanching, respectively. IR enzyme inactivation resulted in higher ascorbic acid (93.9%) and chlorophyll (72.4%) contents. Water blanched and IR-hot air dried bitter melon retained nearly 64% of *charantin*. Browning index, an indicator of product discoloration was higher in water blanched slices. The study indicated that IR blanching followed by low humidity air or hybrid drying involving IR could be explored as an alternative to conventional water blanching and hot air drying to reduce drying time and improve product quality.

Chapatis prepared using standard ingredients and method of preparation packed in fours, hermetically sealed in PET/PP pouches were subjected to pasteurization in a steam-air retort and later cooled. Heat penetration studies showed that P_{90} of 10 min has been delivered with a process time of 15 min at 95°C. Microbiological analysis has shown that yeast and molds were completely absent in both 3 and 8°C pasteurized samples. TPC were well within the limits in pasteurized samples which were stored at 3 and 8°C. The chapatis which were stored at ambient condition were spoiled by yeast and mold after storage of one month. The sensory studies revealed that the pasteurized chapatis stored at 3 and 8°C showed good overall acceptability till the end of 10th week. Ambient samples were not sensorily acceptable from the 3rd week onwards. From this study, it can be concluded that pasteurization in combination with packaging and refrigeration could extend the shelf life of chapatis up to 10 weeks.

Control of ripening / senescence

For post-harvest treatment of banana, a typical climacteric fruit, chemical treatments for genetic control by up/down-regulation of genes involved in ripening are being developed. Various growth regulators (gibberellic acid, auxin, cytokinin, abscisic acid) and signalling compounds, (salicylic acid, methyl jasmonate and nitric oxide) were screened for their ethylene inhibitory effects of overall ripening delaying effect. Expression patterns of genes involved in diverse class of biochemical and physiological functions like cell wall hydrolysis (polygalacturonase, pectate lyase, pectin methyl esterase, α -galacturonase, expansins and chitinase), carbohydrate metabolism (sucrose synthase, sucrose phosphate synthase, α -amylase, β -amylase), ethylene

pathway (1-aminocyclopropane-1-carboxylic acid synthase, 1-aminocyclopropane-1-carboxylic acid oxidase), ethylene signal perception and transduction (CTR1, ERS-1, ERS-2, EIL-1, EIL-2, EIL-3, EIL-4, MADS-1, MADS-2, MADS-4 and MADS-6), senescence (catalase, peroxidase, SOD, PAL) was studied. The effect of individual growth regulator / signalling compound on the expression pattern of individual class of genes was evaluated. Based on genetic expression data, various formulations of these phytohormones and signalling compounds with and without chitosan were developed and were analysed for their efficiency to delay fruit ripening.

Papaya fruits harvested at mature unripe and breaker stages were given dip treatment (30 s) in the mucilage emulsion which was extracted from Cladode (modified stem) of *Opuntia dillenii* and stored at RT. Changes in texture and colour indicated delay in ripening at both the stages.

Mature tomato fruits harvested at breaker stage were dipped in emulsions of eugenol (400 ppm). Initial lagging in ripening was seen up to 3 days. Recovery in ripening was observed after day 3, may be due to regeneration of new ethylene receptors. Repeated application of eugenol on 4th and 6th day resulted in delayed ripening to the extent of 28% and 24% respectively. Fruits treated with ethrel were used as positive control.

Biopolymers for food preservation

About 20 essential oils were screened for insecticidal activity and tested against the rice weevil, *Sitophilus oryzae* and the activity was found to be dose dependent. However, higher insecticidal activity was observed in 50 and 100 μ L concentrations. The highest activity was found with lavender, cumin, ajowan, clove, pacholi, oregano, rosemary, pepper mint and caraway oils. The activity was 100% with these oils within 24h exposure.

Extracts with different solvents of ten cultures of *Actinomycetes* isolated from soil were evaluated at 1000 ppm for their insecticidal potential against *S. oryzae*. Ethyl acetate extract of DTS-6 showed promising insecticidal activity by exhibiting 90% mortality of *S. oryzae*. DTS-6 was grown in 10L fermenters. Ethyl acetate extract of mycelia evaporated and resuspended in DMSO was fractionated under preparative HPLC using C18 column and acetonitrile: water (1:1). Among the two fractions obtained, P2 was found to be more effective than P1. Total mortality of insects was observed by 7 days. F1 population was totally inhibited. Contact studies carried out with the two extracts at

concentrations of 0.5, 1.0, 1.5, 2.0 and 2.5 $\mu\text{l}/\text{cm}^2$ revealed that 100% mortality was achieved by 24 h at 2.0 $\mu\text{l}/\text{cm}^2$.

Effect of carvacrol and thymol were studied on the growth inhibition of the mycotoxigenic fungi by *in vitro* methods specifically on spore germination, growth inhibition, MIC, MFC. Carvacrol and thymol were found to be effective on *A. flavus* and *A. ochraceus* at 50 μM , 60 μM and 50 μM , 75 μM respectively. Inhibitory studies were also performed on the dried chilli. These were found to be effective on mycotoxigenic fungi at 100 μM in the chilli substrate.

Ten identified aromatic compounds as well as ten essential oils were tested for their antifungal activity against two spp. of *Collectotrichum*, identified as the cause for Anthracnose, a serious post-harvest disease in mango. Citral, nonalal and phenyl acetaldehyde showed total inhibition of the pathogen.

Aflatoxins are known to be decontaminated through the mediation of yeast and lactic acid bacteria. Comparison was made between aflatoxin binding of yeast cell (*Saccharomyces cerevisiae 101*) and pure glucan of barley. It was observed that yeast cells except AAV2 had high binding potential to aflatoxin. Both *Saccharomyces* strains (AAV2 and 101) and non *Saccharomyces* strains (*Candida* and *Hanseniospora*) were subjected to fluorescence microscopy, to assess the binding patterns.

Studies on extracting gelatine from fish skins was taken up in order to add value to skin and bones. Treatment of skin with organic acids yielded lesser gelatine compared to mineral acids. Gelatine yield was high with dry skins than the wet skins. Process conditions were optimised by fractional factorial design for extraction of gelatine from fish (*tilapia*) skin considering normality of acid, acid pre-treatment time, extraction temperature and extraction time as variables.

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

The major nutritional deficiency/ over nutrition encountered in India are iron deficiency anemia, zinc, vitamin A and iodine deficiencies along with obesity associated pathologies causing mental retardation and birth defects including alterations in the architecture and functioning of vital tissues and organ systems leading to loss of mental, bone, immune, gut, cardiac health as well as several metabolic disruptions. Changes due to technology development, modern lifestyles and newer arenas in food warrant the deciphering of prevailing

micronutrient deficiencies in addition to the counter problem - overweight/obesity and related pathologies. Both nutrient deficiencies and overweight problems result in negative effects on GDP and tremendous amount of precious resources are spent on health care. The great biodiversity of India offers opportunities to identify and select biomolecules for promoting health and wellness and produce them on a sustainable basis. The research approach envisages dietary interventions in the regulation of physiological activities and encompasses wide array of sources including spices, fruits, vegetables and major staple ingredients. The impact of nutrition on health and disease needs to be understood at the molecular and genetic level for developing scientifically validated food products. Thus, the principle aim and objective is to establish possible relevance of traditional dietary strategies to cardiometabolic disease and general health and to use this knowledge to create functional foods. The project will culminate in the development of micronutrient fortified foods, specialty foods like low GI foods and functional foods with positive cardiometabolic effects after studying mechanism of actions employing strategically developed bio-markers based *in vitro* cell culture and *in vivo* models. The work carried out under the objectives of the project is given below:

Food systems / products with functional ingredients targeted for lifestyle disorders

Obesity is one of the factors that is known to lead to metabolic syndrome and lifestyle disorders like diabetes and cardiovascular disease. Several low calorie products and bioactive ingredients were identified for developing anti-obesity foods, low calorie foods and low glycemic index foods.

Grapefruit and hibiscus are known for their anti-obesity properties. The effect of various abiotic elicitors like salicylic acid and temperature on increasing contents of major phytochemicals like phenolic acids and anthocyanins were successful. Identification of the anthocyanins and their ability to inhibit pancreatic lipase activity are being carried out.

Blood and serum from weaned rats fed with 0 - 10% levels of ghee and vanaspathi, were analysed for cholesterol, fatty acids and lipid peroxidation. Liver, heart and adipose tissues were analysed for biochemical and gene expression studies. Initial results indicate that the total cholesterol and LDL cholesterol decreased in ghee fed animals, while HDL cholesterol increased by 40%. The results were contrasting in case of vanaspathi fed animals wherein the total cholesterol and LDL cholesterol increased by 15% and 31%, respectively.

The LDL/ HDL ratio decreased by 33% in animals fed with ghee, while an increase of 16% was observed in animals fed with vanaspathi.

Nt8U a synthetic peptide, which resembles obestatin, has anti-obesity activity in mouse model. To study the existence of any possible synergistic effect of Nt8U along with capsaicin, tea saponin and soy isoflavones, NMR studies were conducted to understand interaction between these components. The components did not interact with the synthetic peptide.

Initiation and progression of diabetic nephropathy (DN) involves defects in carbohydrate, protein and fat metabolism. Activated protein kinase modulator (AMPK) is an evolutionary conserved serine threonine kinase, which plays an important role in energy homeostasis. The role of AMPK in DN was investigated by natural compounds that could bind to it. Hesperidin and coumesterol showed highest binding energy towards 3 binding sites in AMPK alpha subunit, two binding sites in AMPK β and one binding site in γ subunit. Effect of these polyphenols on AMPK activity *in vitro* and *in vivo* are under progress.

A database on carbohydrate digestive profile of Indian foods is being created and a select group of typical Indian foods from various regions are being studied for rapidly digestible starch, slowly digestible starch, total starch and resistant starch. Different cereal bases in combination with pulses and spices influence the carbohydrate digestive profile.

Functional food ingredients

Many micronutrients, nutraceuticals and bioactives are generally unstable, not bioavailable or have a negative impact on the sensory quality of food. High protein ingredients or metal chelating ingredients find applications in nutrition for the preparation of specialty foods. Some of the bioactive derivatives may be more potent than the parent compound. It is important to transform the select nutraceuticals into functional food ingredients so that they have a positive impact on the health of the consumer.

Seed coat or bran of different cereals are discarded due to the high amounts of insoluble fiber present in them. Attempts were made for the recovery of bioactive fractions and ingredients from the seed coats of ragi and rice bran. Native and malted finger millet grains were fractionated to obtain seed coat and endosperm fractions and isolation of water soluble arabinoxylans from the fractions are underway.

Bioactives from tea, and ginger were extracted both by

conventional extraction and microwave extraction, analysed and thus derivatives prepared. Green tea catechins (20-30%, w/w basis) were isolated by hot water extraction from tea brew and catechins isolated by extraction with various solvents. "Zerumbone", chemically sesquiterpene, from *Zingiber aromaticum* or *zerumbet*, is reported to be protective against cancer and human immunodeficiency virus (HIV). Zerumbone oxime was prepared by reacting with hydroxyl amine in methanol. It was esterified with set of fatty acids (both saturated and un-saturated) by using a dehydrating agent. The protocol of oxime esterification was simplified and developed as general experimental protocol. The set of carboxylic acids used are long chain fatty acids such as butyric, hexanoic, octanoic, decanoic, dodecanoic and palmitic acid, and unsaturated fatty acids like linoleic and oleic acids. The yields obtained were in the range of 78–91%.

Phenolic components of ginger (*Zingiber officinale* Roscoe) viz. [6]-gingerol, [6]-shogaol and zingerone exhibit quorum sensing inhibitory activity (QSI) against *Chromobacterium violaceum* and *Pseudomonas aeruginosa*. [6]-Azashogaol, a new derivative of [6]-shogaol has been synthesized by Beckmann rearrangement of its oxime. This compound show better QSI activity against *P. aeruginosa*. The inhibitory activity of all the compounds was studied by zoneinhibition, pyocyanin assay and extraction of violacein from *Chromobacterium violaceum*. All the compounds displayed good inhibition at 500 ppm.

Extraction of nutraceuticals and bioactive compounds

Garden cress seeds are rich sources of polyphenols. The polyphenols were extracted under optimal conditions of solvent, time, temperature. The phenolic extract showed inhibitory activity against trypsin, alpha amylase and alpha glucosidase activities with IC_{50} values of 9.2, 2.3 and 12 μ g/ mL, respectively.

Different pigmented rice were studied for the distribution of polyphenols. Black rice had higher anthocyanin content and lower proanthocyanidin contents. Whole rice of pigmented varieties have a higher ferric reducing activity compared to the white variety. Human LDL oxidation inhibition activity was also higher in pigmented rice samples.

Patients with atherosclerosis, hypertension and hypercholesterolemia have elevated asymmetrical dimethylarginine (ADMA), symmetrical dimethylarginine levels (SDMA). A method for the simultaneous measurement of various cardiometabolic disorder

markers, homocysteine, arginine, homoarginine, ADMA, SDMA and homocystine in plasma was standardized. Proteins and peptides containing higher arginine are known for their cardioprotective effects. Screening of sesame, groundnut, moringa and flax seeds proteins for production and characterization of protein hydrolysates with higher Arg: Lys ratio using commercial proteases and gastrointestinal enzymes was carried out. Among these, moringa seed protein has shown a high Arg: Lys ratio compared to other proteins. Further characterization is in progress.

The effect of monocrotophos (MCP) on physiological / behavioural and biochemical responses in *C. elegans* that were maintained on high glucose diet was studied. The worms were exposed through development to high glucose diet (GF, 2%) and then treated with sublethal concentrations of MCP (0.5, 0.75, 1.5 mM). The behavioural responses in terms of locomotion, physiological responses in terms of egg laying, brood size, lifespan; morphological alterations; and biochemical responses including glucose content were measured. The worms exposed from egg stage through development to high glucose diet showed enhanced toxic outcome of MCP in terms of physiological, behavioural and biochemical responses. The studies showed that *C. elegans* is a good model to understand glucose-OPI interactive neurotoxicity since all the responses could be followed at ease in this organism and the outcome could be well extrapolated to those that one would expect in higher animals.

Improved bioavailability and stability of nutrients/nutraceuticals through processing and delivery systems

Delivery of the select nutraceuticals is critical as the shelf-life, bioavailability and sensory quality of food are affected by higher concentrations of these molecules. Delivery systems are crucial to stabilize the biomolecule during processing and shelf-life, prevent cross - reactions with other components in the food matrix, increase bioavailability without adversely affecting the sensory quality of the product. Processing operations, nanoemulsions, coating and other techniques were used to increase the bioavailability and stability of nutrients/nutraceuticals.

Finger millet (*Eleusine coracana*) and pearl millet (*Pennisetum glaucum*) were evaluated for total phenolic and flavonoid contents as well as their bioaccessibility. Total polyphenols of native finger millet was 10.2 mg/g which reduced by 50% after sprouting or pressure cooking. About 12-19% reduction was seen after open-pan boiling. Phenolic acids generally increased during

sprouting and roasting of the grain. Concentration of salicylic acid was particularly increased upon sprouting. Pressure cooking, open-pan boiling and microwave heating reduced the bioaccessible polyphenol content by 30-35%. There was a 67% increase of bioaccessible phenolics as a result of sprouting. Bioaccessible gentisic and syringic acids increased by >100% after sprouting. Sprouted, pressure-cooked and microwave heated samples showed significantly lesser bioaccessible flavonoid content. Concentration of sinapic acid (501 µg/g) was highest among the identified phenolic acids of pearl millet, followed by salicylic acid (182 µg/g). There was a 20% increase in the bioaccessible polyphenols including flavonoids, after sprouting of pearl millet.

Stability of bioactive compounds like docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA) and alpha-tocopherol during processing, storage and distribution can be achieved through nanotechnology. Absorption level of nutraceuticals can be increased as nanocarrier which allows these bioactive compounds to enter the bloodstream from the gut more easily. Droplet size distribution of nanoemulsions was in the range of 0.2-20 nm and morphology revealed a very fine and uniform globular droplets. FTIR spectra confirmed the presence of DHA in the emulsion. Thus, the prepared DHA nanoemulsion can be used for food and pharmaceutical application to improve the bioavailability of DHA.

Tea catechins extracted by supercritical CO₂ were encapsulated at a concentration of 0.1% (w/w) in lipid based nanoemulsion delivery systems using sunflower oil and palm oil with the combination of hydrophilic and hydrophobic emulsifiers. The nano emulsions were characterized for their physicochemical properties such as mean emulsion size, creaming index, pH, conductivity, refractive index, colour, peroxide value and physical stability under accelerated storage conditions. The presence of catechin components in the encapsulated matrix was confirmed by conducting different chemical assays (total polyphenol content, total flavonoid content and FRAP). The oxidation of nanoemulsions was successfully arrested by the catechins in all the formulations. Sunflower oil based nanoemulsion resulted in the best physically and chemically stable form with no significant variation in mean droplet diameter, conductivity, refractive index, pH and creaming index up to 14 days and temperatures up to 37°C.

Formulation of functional food products

Chickpea flour is a known low glycemic index (GI) ingredient. This was incorporated in noodles, and *chapathi* to obtain lower GI products. Nearly 50%

substitution of wheat flour with chickpea flour was successful, after optimization, with additives to improve the product quality. Addition of guar gum improved noodle quality in terms of cooking loss and *in vitro* starch digestibility. In case of *chapathi*, more than 15% addition of chickpea flour decreased the sensory quality of the product. Chickpea flour, psyllium husk and fenugreek were used to improve the nutritional characteristics of North Indian *parotta*. The dough rheology changed significantly in the various blends and addition of chickpea flour at 20 – 25% level, marginally decreased the overall quality score. The protein and fiber contents in the *parottas* with chickpea, psyllium husk and fenugreek were increased by 1.2 and 1.8 times, respectively.

Puffed whole Bengal gram was coated with whey protein concentrate, gum arabic and sugar powder to prepare a sweet ready-to-eat snack. The product possesses good binding ability and could be a carrier for macronutrients and micronutrients. Improvements in product characteristics and modelling of the coating process are in progress.

Microbes as prebiotics for nutritional supplements and selected oligo-, polysaccharides as prebiotics

Efforts have been made to utilize whey as an economical source of lactose for the fermentative production of beta-galactosidase using *L. plantarum* MTCC2156 (KoA1), a potent probiotic and further the production of galactooligosaccharides (GOS) using *L. plantarum* beta-galactosidase. Results indicated that the induction of beta-galactosidase was highest when whey medium was supplemented with galactose (0.2%). Kinetics of growth of *L. plantarum*, beta-galactosidase production and lactose consumption in the whey media are under progress. GSE contains about 97.86% total polyphenols with 98% DPPH scavenging activity. The growth pattern of the selected strain was almost the same under controlled conditions (MRS media) and in the presence of GOS, GSE individually or a combination. This suggests that further product formulations can be developed using a combination of GSE, GOS and *L. plantarum* with improved functional properties.

Isolation of bifidobacteria from infant faecal and human breast milk were initiated. Forty five isolates were subjected to bifidobacterial genus-specific PCR. Of the isolates tested for the highly specific primers for the bifidobacterial fructose 6 phosphoketolase (*Xfp*) encoding gene, six were found positive. Seven species of *Lactobacillus* and two species of *Bifidobacteria* were screened for extracellular amylase activity and intracellular alpha glucosidase activity grown on resistant starch as substrate. Amongst these *Lactobacillus*

fermentum showed an enzyme activity of about 50 U (U = nanomoles/ml/minute). *Lactobacillus fermentum* showed optimum growth at 14-16 h. Media for the growth of *Lactobacillus fermentum* for enzyme production was standardized.

III. Lipidomics centre (LIPIC) (Ram Rajasekharan, Malathi Srinivasan, Ramesh Kumar R, Sridhar RV, Sunny Rupwate)

Facility Creation

The primary objective of the XII Plan project Lipidomic Centre (LIPIC) is to create a state-of-the-art lipid research facility in the country. Towards this, construction of the new facility in Bangalore is under progress. The centre also procured a high end Leica gated Super resolution microscope (STED), first of its kind in the country, to facilitate super resolution live cell imaging.

Apart from this, in terms of research, progress has been made in studies pertaining to yeast and plant lipidomes.

Plant lipidome

Ocimum: Basil germplasm lines belonging to three species i.e. *O. tenuiflorum* (OT), *O. basilicum* (OB) and *O. gratissimum* (OG) were investigated for genetic parameters, correlation and diversity for seed oil content and composition.

Studies on genetic divergence among the 3 species for seed lipid content and composition, grouped the basil accessions into two broad clusters - A and B. This grouping was found to be fitting with the two botanical sections of *Ocimum viz.*, *Basilicum* (Cluster-A, OB) and *Sanctum* (Cluster-B, OT and OG). Our studies revealed that *Basilicum* and *Sanctum* sections were divergent for the seed lipid and its composition corroborating the taxonomical classification. The distinct grouping has raised the need to identify the potential species capable of yielding higher α -linolenic acid (ALA), the health beneficial omega-3 fatty acid.

ALA was found to be the predominant fatty acid (46.35%) in all the three species followed by linoleic acid (LA) (24.59%), oleic acid (OA) (12.45%), palmitic acid (PA) (8.89%) and stearic acid (SA) (4.05%). The ALA content in OB (54.40%) was significantly higher than OT (43.52%) and OG (47.22%). This observation is supporting our genetic diversity studies that botanical sections *Basilicum* and *Sanctum* differs significantly for seed lipid composition. The saturated fatty acid contents of OT (PA – 9.64% and SA – 4.54%) were significantly higher than OG and OB.

The mean seed oil content of the basil accessions was found to be 14.31% ranging from 9.51% to 20.65%. Among the three species, OB with higher amount of the predominant fatty acid (ALA) also had higher seed oil content (16.09%). Also the seed yield/ plant of OB (29.14 gm) was found to be significantly higher than OG (25.42 gm) and OT (7.94 gm). Among the three species investigated, OB was found to be promising with higher ALA, seed oil and seed yield that can serve as reliable source for health beneficial omega-3 fatty acids.

Determination of genetic parameters for oil content and five major fatty acids showed that PA and OA showed low heritability estimates (0.4473 and 0.5906) coupled with low genetic advance (23.03% and 17.29%), indicating that selection for these fatty acids in basil population may not lead to genetic improvement due to poor genetic gain. The remaining three fatty acids viz., SA, LA and ALA showed high heritability estimates (0.8309, 0.8037 and 0.8632) coupled with moderately high genetic advance (43.06%, 29.24% and 30.85%) indicating that these traits are reliable and selection for these fatty acids may be rewarding. Similarly, selection may be effective for oil content with high heritability (0.7914) and moderate genetic advance (24.06%).

Correlation estimates showed that the association of predominant fatty acid, ALA was significantly positive with oil content (0.5436) and seed yield (0.6390). Oil content (0.5436) and seed yield (0.6390) were found to be positively associated with each other (0.4655). The correlation of ALA, oil content and seed yield was found to be negative with the remaining four fatty acids. The positive correlation of the ALA with oil content and seed yield implies that genetic improvement for the omega-3 fatty acid can be attained through indirect selection *via* oil content and seed yield that are relatively easier and rapid to screen.

Chia: Genetic improvement of Chia (*Salvia hispanica*)

The first ever transcriptome data for chia is now available with the Lipidomic centre, facilitating mining of the chia seed transcriptome across its various developing stages. RNA of the seeds from 5 different development stages (3, 7, 14, 21, and 28 DAF (days after flowering)) was isolated and sequenced using an Illumina platform. This data has been deposited at NCBI (PRJNA196477).

It was observed that of all the KOG categories, the chia seed transcriptome constituted mainly of the "metabolism" category and in that, of carbohydrate and lipid metabolisms. So far, no SSR (short sequence repeats) markers are available in Chia. From this study, we have been able to identify ~ 5600 SSRs that can

immensely aid in crop improvement program.

Experiments were also conducted to develop a photo-insensitive variety of chia through chemical mutagenesis. Seeds were subjected to ethyl methane sulfonate treatment at different concentrations and the mutant plants are under field trial.



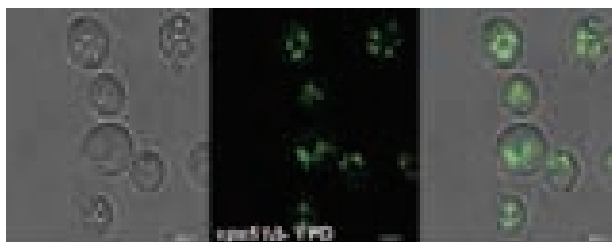
High yielding seed varieties of Chia

Biochemical studies of two lipid enzymes identified from the chia transcriptome: Two important lipid metabolic enzymes, namely, Monoacylglycerol Acyltransferase (MGAT) and Oleosin (OLE) identified from the chia transcriptome data, based on their homology with other oil seed crop genomes were isolated and successfully cloned in a pYES2 vector for expression in yeast. Site directed mutagenesis to mutate the HX4D catalytic domain yielded mutants, which when assayed along with the MAGAT and OLE proteins provide information about the acyltransferase activity and the substrate preferences of these enzymes.

Localization of both proteins within the yeast cell was studied using immuno fluorescence techniques. Lipid profiles of the yeast cells expressing the two proteins were also analysed by thin layer chromatography with further confirmation of lipid droplets by imaging under a microscope using a Bodipy stain.

Yeast lipidome

Transcriptional regulation of yeast lipid metabolism: Studies to ascertain the transcriptional regulation of yeast lipid metabolism provided clues on the regulation by transcriptional factors *FKH1*, *PHO4* and *IME4* of the genes, *LPP1*, *PHM8* and a yet-to-be characterized putative gene, respectively. This has been confirmed by EMSA and over expression and deletion studies. Over expression of some genes resulting in a changed morphology, wherein, the single cell yeast develops a



structure called pseudohyphae has been of importance as it may throw light into the understanding of the pathogenicity seen in some fungal systems like *Candida*.

Genome wide screening of yeast deletion mutants for lipid droplets using Confocal Microscopy: More than 100 deletion strains of the budding yeast, *Saccharomyces cerevisiae* were grown under rich and minimal media until stationary phase, to study the pattern of lipid droplet formation within the cells. Variations were observed between strains and also between media types, pertaining to number and size of lipid droplets.

IV. Creation of advanced research facility in molecular nutrition (Nutri-Arm) (Baskaran V)

Anti-inflammatory property of lutein and its metabolites against LPS induced inflammation in rats

Lutein can be oxidized to a number of compounds by chemical transformations, because of the reactivity of conjugated double bonds to active oxygen species and biological functions of lutein metabolites have not been fully understood. Thus, objective was to study the anti-inflammatory properties of oxidative metabolites of lutein against LPS induced inflammation in rats. In the present study, we appraised and compared the antioxidant and anti-inflammatory efficacy of the lutein oxidative degradation derivatives mediated through UV-irradiation over lutein in counteracting the oxidative stress and inflammation induced by lipopolysaccharide (LPS) in rats. UV-oxidised metabolites were obtained *in vitro* were characterized by HPLC and LC-MS as M1 (m/z 122.5), M2 (m/z 300), M3 (m/z 285) and M4 (zeaxanthin m/z 568), respectively. Rats received intubation of lutein (200µM) and metabolites (200µM) in GNO for 15 days and GNO alone was considered as control. At the end of 15 days, all the groups received LPS (1 mg/kg BW) and control received saline by intravenous injection. Induction of inflammation by LPS significantly increased the productions of nitric oxide (NO), prostaglandin E₂ (PGE₂), and pro-inflammatory cytokines like tumor necrosis factor-α (TNF-α), and interleukins-6 (IL-6). M1, M2 and M3, oxidative derivatives of lutein ameliorates acute inflammation by inhibiting the production of NO, malondialdehyde (MDA), PGE₂, TNF-α, and IL-6 cytokines more efficiently than lutein in rats. These data strongly suggest that lutein oxidative derivatives may mediate some of the antioxidant functions of lutein in cells by increasing the antioxidant enzymes activities and thus decreasing the inflammatory cytokines and eicosanoids.

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

Squalene, one of the important marine biofunctional material, was evaluated for its effect in reducing the virulence of *Staphylococcus aureus*. The reduction in virulence was assayed by determining the effect of squalene in inhibiting the biosynthesis of staphyloxanthin (a golden color carotenoid which contributes to the virulence factor), thereby establishing the potential of squalene as a potential *in-vivo* anti-bacterial therapeutic agent. Inhibitory effect of squalene was studied (by spotting culture on Tryptic Soya Agar containing squalene as supplement). The presence of pigment was analyzed visually and by spectral profiling. Further these cultures were tested for susceptibility to oxidants like H₂O₂ and the resistance to innate immune clearance was tested using whole blood killing assay. The pathogenicity was assayed by hemolysis method. Cultures grown with and without the supplement of squalene produce white and yellow colonies respectively. The spectral profiling pigmented bacterial colonies indicated a pigment with three absorption peaks at 440, 462 and 491 nm; and, this pigment which was absent in non-pigmented colonies. Considering the susceptibility to oxidant, the non-pigmented forms were killed more efficiently by H₂O₂ and whole blood. The results concluded that squalene effectively renders *S. aureus* avirulent. Staphyloxanthin promotes resistance to ROS mediated host neutrophil-based killing. As the early enzymatic steps in staphyloxanthin production resemble those for cholesterol biosynthesis, squalene having its structure similar to 4,4'-diaponeurosporene (intermediate in staphyloxanthin biosynthesis) might act as a structural analogue inhibiting staphyloxanthin thereby rendering the organism avirulent.

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

Methods for efficient *in vitro* rooting of *Decalepis hamiltonii* under altered nitrate stress was developed. Callus suspensions cultures were established on medium with 2,4-D (2 mg/l) and kinetin (0.5 mg/l). Biotransformation studies using callus suspension cultures were studied. Maximum content of vanillin accumulation was on 4th day after adding precursor (1 mM ferulic acid, 4.6 fold i.e. 0.51 mg/g dry weight). Ferulic acid at 1 mM in callus medium supported maximum accumulation of 2-hydroxy-4-methoxybenzaldehyde (2 H4MB) by 6th day (40 fold i.e.

0.4 mg/g dry weight). Similarly, 2 H4MB was found maximum in spent culture media of cell suspension on 2nd day at 1mM ferulic acid treatment (55 fold i.e. 0.55 mg/l), followed by vanillic acid (5.4fold i.e. 29.74mg/l). Major phenolics and flavonoids were identified from different parts of tuberous roots of both *Hemidesmus indicus* and *D. hamiltonii*.

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

In submerged fermentation only 3 isolates (3 MR, 4 MR and 7 MR) were found to produce up to 0.8 IU/100ml of α -galactosidase quantitatively. Bacterial isolate 3 MR was biochemical characterized and showed blue colonies on 5-bromo-4-chloro-3-indoxyl- α -D-galactopyranoside. We have found that how development of false positive reaction in qualitative assay of α -galactosidase could be solved. Through time course studies, it was found that enzyme production (0.8 IU/100 ml) occur only for short duration in early log phase and declines sharply afterwards. Increasing the concentration of nitrogen in media results in up to 75.0% improvement (1.4 IU/100 ml) in enzyme yield. We have synthesized chitosan and BSA loaded magnetically active nanoparticles by using chemical co-precipitation method using $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and $\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$. Bacterial isolate 3 MR was identified using standard techniques and protocols mentioned in Bergey's manual of systematic bacteriology and 16S rRNA gene sequence. The nucleotide BLAST similarity search and phylogenetic analysis revealed that bacterial isolate 3 MR was closely related to the genus *Enterococcus* [*Enterococcus ratti* (NR041933.1), *Enterococcus faecium* LMG11423(NR042054.1), *Enterococcus faecium* (NR102790.1)]. Partial purification of indigenous α -galactosidase from the seeds of *Vigna mungo* using ammonium sulphate precipitation (0-75%) indicated good recovery (47.18%) and purification fold (2.32). The partially purified *Vigna mungo* α -galactosidase was found to be optimally active at 55°C. Preliminary studies on partitioning of *Vigna mungo* α -galactosidase using aqueous two phase system (ATPS) indicated partitioning of enzyme towards polymer rich top phase.

VIII. S&T interventions to combat malnutrition in women and children (Gupta PK)

The nutritional status of pre-school children is critical for growth and development of the country. Protein-energy malnutrition (PEM) is a prominent nutritional problem in the country which leads to physical and mental retardation and under development of children. The

solution to this problem could be achieved through proper use of inexpensive traditional cereal-legume-based diets within the economic reach of poor families.

The project was undertaken along with other labs viz. NBRI, IHBT, NEIST, CIMAP and NIIST. Accordingly, activities were initiated for implementation and development of nutritious product targeted to preschool children suffering from malnutrition in the Mysore District, Karnataka. Similarly, food products developed by CFTRI viz. *rice milk mix*, *high protein rusk*, *energy food*, *nutri chikki with spirulina*, *nutri sprinkle*, *sesame paste*, *spirulina cereal bar* or *spirulina cereal choco bar* were selected to provide macro and micro nutrients to the target population. These food products will be integrated with the schedule of feeding through Anganawadis.

In order to impart training, the institute organized a two days training program for the representatives from Department of Child & Women Development, Government of Karnataka. Also CFTRI scientists participated in meeting with National Coordinator of the project and state officials of Karnataka for devising schedule of feeding and assessment of nutritional status.

Chemical Sciences Cluster

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

The lactic acid bacterial (LAB) cultures isolated from tannery fleshings, fish waste and poultry by-products were assayed for their anti-bacterial activity against 19 spoilage bacteria of leather and leather based products. The cultures were shown to inhibit all the spoilage bacteria, especially pseudomonas.

X. Membrane and adsorbent technology platform for effective separation of gases and liquids (MATES) (Subramanian R)

Partial refining of vegetable oils, solvent recovery and separation of value added products using solvent resistant polymeric membranes (SRNF & SRUF)

CFTRI's work component mainly focuses on evaluation of solvent resistant nanofiltration and ultrafiltration membranes for select processes with emphasis on extraction and purification involving organic solvents. Lab-cast (CSMCRI) and commercial membranes were evaluated for their possible application in desolventizing and degumming steps in vegetable oil processing in terms of solvent stability (hexane), productivity and selectivity.

The major focus of the project during this period was towards hexane cycling in the oil extraction process. In the first instance, pure hexane flux was measured which indicated that four of the five commercial membranes displayed a reasonable flux (>10 LMH) while the flux of lab-cast membranes ranged between 30 and 700 LMH. Only one of the membranes tested, exhibited a selectivity of >3 between triglycerides and hexane, however hexane-oil miscella flux of this commercial membrane was unacceptably low (<1 LMH). Feedback is being sent to collaborating laboratory requesting for redefined approach in developing appropriate membranes for the desolventizing application.

All the commercial membranes displayed good selectivity for separation of phospholipid (PL), but none of the new generation membranes matched the performance of NTGS series membranes (flux >20 LMH; R_o >90%) reported in our earlier studies. Five out of 7 lab-cast membranes displayed good selectivity (R_o ~80%) and atleast four of these membranes exhibited reasonable miscella flux (>10 LMH). The solvent stability of these membranes is being assessed in terms of changes in the microstructure with hexane exposure.

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

Out of 106 soil samples collected from the Western Ghats regions covering Kerala, Karnataka and Tamil Nadu, 50 cultures were qualitatively classified as oleaginous fungi using Sudan Black B and Nile red staining. These 50 cultures were thoroughly investigated for its PUFAs content with specific reference to GLA. Six strains, CFR – G1, G2, G3, G4, G5 and G6 produced 16-18% of GLA in their total lipid. Media optimization reveals that these fungi grow well in synthetic medium producing maximum biomass and lipid content. All the six strains are being confirmed by 18s rRNA sequencing method for their species identification. Out of these six strains, CFR-G3 *Cunninghamella elegans* (Acc. No. KF916583) yielded maximum biomass, total lipid and GLA content.

XII. Encapsulated microorganisms for environmental protection (EMEP) (Raghavarao KSMS)

Use of different carrier materials and their combination in spray drying of yeast cells resulted in better powder

yield and cell viability. A cell viability of 81.6% and powder yield of 70% was observed when only 1% sodium alginate was used as carrier material. Phase contrast microscopy of the spray dried powders showed almost no contamination. SEM images of the spray dried samples indicated good degree of encapsulation. The particle size of spray dried samples varied according to the carrier material employed. The powder in which 1% sodium alginate (w/v) was used as carrier material, the particle size (volume-80%) was around 17.04 μm . Granulation and drying of yeast cells employing LTLH and tray drying at low temperatures (40 & 50°C) exhibited more than 90% cell viability. SSF of yeast cells followed by drying after addition of carrier material was performed. The plating of dried SSF bran was found to exhibit contamination even at 20% inoculum (w/w) however, the degree of contamination was found to be reduced.

Information Sciences Cluster

XIII. CSIR knowledge gateway & open source private cloud infrastructure (KNOWGATE)
(Ragavan I)

CSIR-CFTRI is involved as one of the participating laboratory of the project aimed at providing virtualised shared computing resources by enhancing the computing power for data intensive research and hosting of knowledge management applications and services; training, consultancy services and technical support to participating Knowledge Resource Centres (KRCs) by providing low cost open source software; provision of aggregated online public access catalogue (OPAC) of all CSIR KRCs by optimal utilisation and sharing of information resources, standardised open sources solution across CSIR; multidimensional analysis system for analysing research and technology data.

A total of 34959 records comprising of books, bound volumes, theses and dissertation were created and migrated to the library management software KOHA installed on the KNOWGATE server. The data has been provided to CSIR-NISCAIR, New Delhi, and the records have been made accessible at <http://library.cftri.com>

Physical Sciences Cluster

XIV. Measurement innovation in science and technology (MIST) (Sreenivasa MA)

CRM for pesticide in vegetable oil: Refined vegetable oil (15L) was procured and screened for pesticide residues. After confirming the absence of pesticide

residues in the oil, antioxidants (BHA and BJHT) were added to it to increase the shelf-life of oil. After thoroughly homogenizing, half the portion of the oil was transferred to 30ml vials and labelled as control and, remaining half was spiked with Methyl parathion and alfa-Endosulfan pesticides at 1.0 and 0.5ppm levels respectively. Spiked oil was mixed thoroughly and homogenized using high pressure homogenizer. Spiked oil was transferred to 30ml vials and homogeneity of the spiked sample was confirmed by analyzing about 10 randomly selected vials and subjecting the data to statistical analysis.

Sample vials of both control and spiked oil samples were dispatched to 29 laboratories for performing the pesticide residue analysis and participation in proficiency test. Results were subjected to statistical evaluation and the z-scores of the participated laboratories were intimated

to individual laboratories. Also shelf life studies of the pesticide residue content in the spiked samples is being monitored.

CRM for pesticides of milk powder: A bench scale preparation of milk powder with pesticide was prepared to study the degradation, recovery and achievable homogeneity of pesticides in the prepared milk powder. For this purpose, 5 L of milk was procured and screened for pesticide residues. Out of this, about 2.5L milk was spray dried and subjected to further analysis as control sample. Remaining 2.5L milk was spiked with Methyl chloropyriphos and Lindane pesticide at 1.0ppm and 0.5ppm levels to represent organochlorine and organophosphorus pesticides. Spiked milk was homogenized and spray dried. Spray dried control milk powder is being analyzed for its homogeneity.



Societal Programmes

CSIR-CFTRI responds to the Uttarakhand Flood Tragedy

The CSIR-Central Food Technological Research Institute, Mysore, has made available more than 8 tonnes of shelf-stable and nutritious food materials for distribution among the victims of the Uttarakhand floods. It may be recalled that in the past too CSIR-CFTRI similarly responded to natural calamities such as the earthquake in Gujarat or the Tsunami in the eastern coast.

As soon the dimensions of the tragedy were known, the Director met the senior staff of the Institute on 20th June 2013 to draw strategies for action. A menu was prepared considering the nature and extent of tragedy and the relief operations needed in the context. Survival rations in the form of tasty, long shelf foods such as high protein rusks and canned bisibele bhath (spicy sambar rice), quick preparation foods like Imli Poha, energy food and chapatis to cater to immediate hunger were included in the menu. While it was decided to prepare the long shelf foods such as high protein rusk, canned bisibelebhath and imli poha in the Institute itself, the energy food and chapatis were sourced from CFTRI licensees nearer to Uttarakhand.

M/s JVS Foods Ltd., Jaipur was approached for help in production of Energy Food, they readily agreed to send three tonnes of energy food directly to Dehradun, free of cost. The chapatis were made at a utility centre that

had CFTRI designed chapati machines in New Delhi. Three senior scientists left for Dehradun and Delhi to coordinate operations there.

The manufacturing which began on 27th morning made ready 3 tonnes of food by the evening and the same was despatched to Bangalore. The National carrier offered free logistic support between Bangalore and Delhi, reducing the transit time. In about 36 hours, the Institute produced more than 12,000 cans of Bisibele bhath that had more than 3 month shelf life, 5000 packets of rusk that had proteins 1.5 times more than the normal rusk, 12000 packets of Imli Poha which could be reconstituted with just water in about 15 minutes.

The first consignment of foods reached CSIR-Indian Institute of Petroleum, Dehradun on 28.6.2013 and the second consignment on 30.6.2013. More than eight tonnes of food were made available by the Institute for the relief operations. The distribution was undertaken under the supervision of CSIR-Indian Institute of Petroleum, along with the Uttarakhand government and several non-governmental organizations.

Applauding the efforts of the staff in planning such quick relief plan, Prof. Ram Rajasekharan, Director, CSIR-CFTRI, called for setting up of a more efficient and permanent Disaster Response System at the Institute to respond in double quick time during such eventualities. "The system will be put in place soon and will include stocking of ready-to-eat foods prepared and packed at the Institute," he said.



Packing of imli Poha under progress



A view of pilot plant where canned Bisibele Bhath was prepared



A view of food packets despatched to Uttarakhand



Prof. Ram Rajasekharan lends a hand to upload a relief packet (in the Centre)

Free Technologies

A few of the selected technologies developed at CSIR-CFTRI were offered free in terms of technology dossiers that can be downloaded from the Institute website for the manufacture of such products to generate employment, entrepreneurship, effective utilization of raw material. The technologies include: Amla Candy, Composite Ragi Bread, Curing and Polishing –Turmeric, Dosa Batter in Retail Packs, Idli Batter in Retail Packs, Fruit Spread, Ginger Dehydration, Green Chilli Sauce and Protein Enriched Buns. More than 1000 downloads of technical dossier have been recorded so far.



Technology download - A screen view

Awareness Programme for School Children

CFTRI conducted a summer school programme for high school students of Mysore district during April 15-16, 2013. A total of 20 students from various Government schools participated in the programme. The programme was initiated to inculcate and simulate young minds towards science. Also as a part of the National Nutrition Week, an awareness programme was conducted on September 13, 2014 at Government high school, Thandavapura, Mysore. Audio and video presentations on scientific innovation, nutrition awareness, health and hygiene were the highlights of the programme.



CSIR 800 Activities

Under CSIR-800 initiatives, large number of awareness programs for the benefit of farmers were held at different locations of Karnataka. These include interactive programs arranged at Haradanahalli, Kollegal, Chamarajanagar, Gundulpet, Udupi, Mala, Jadkal, Kolar and Shimoga. Demonstrations were also held at CFTRI on technologies such as virgin coconut oil, energy food, turmeric processing and processing of fruits and vegetables. An MoU was signed for the transfer of turmeric processing and maize processing with various farmers clusters.



Demonstration of turmeric processing under progress



Energy food process demonstration for farmers group in the Institute

Participants of the Summer School with Prof. Ram Rajasekharan, Director, CSIR-CFTRI and faculty of the programme

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