

CSIR - CFTRI REPORT PERFORMANCE 2021-2022

CSIR-Central Food Technological Research Institute

(A constituent laboratory of Council of Scientific & Industrial Research)

Mysuru - 570 020, India

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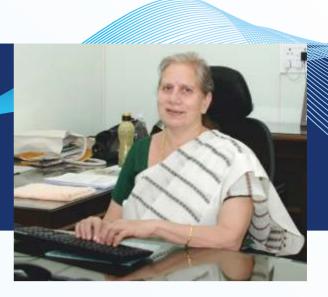
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Management Council / Research Council



From Director's Desk&



It is my privilege and pleasure to present Annual Report of the Institute for the year 2021-22.

The year 2021-22 has witnessed several innovations and initiatives in the programmes and activities of the Institute. The report provides detailed information about various programmes and activities of the Institute undertaken during the year under report, however I have tried to outline here some of the major initiatives and highlights of the Institute.

The Institute takes pride in its research agenda that includes CSIR Mission projects such as ATLAS, Floriculture Mission, Immunity Mission projects which has shown considerable progress in terms of product development. Extraction of arabinoxylan from wheat bran, export protocol for fresh pineapples and extended shelf-life of minimally processed fruits under the FTC category has shown promising results for commercialization of the products.

During the year, 96 Grant-in-Aid projects from various external funding agencies and 51 industry projects were undertaken. A steady rise in the average impact factor has shown the standard of publications that have been published by the Institute in peer reviewed journals. The Institute has also fared well in terms of technology transfer, patents and HRD activities. About 33 students were awarded doctorate degrees from Mysore University & AcSIR.

Skill development, Farmer-centric and Incubation centre activities has advanced our efforts towards entrepreneurial activities. Establishment of Common Incubation centres under the PMFME scheme for setting up of processing lines for banana-based products, minimally processed fruits & vegetables and coffee based on ODOP theme has been initiated.

Overall, the year was very productive for the Institute with tremendous progress in all fronts while aligning with National Missions and Mandate of the Institute. I wish to express my sincere gratitude to DG-CSIR, Research Council and Management Council for being the beacon in guiding us in our efforts to achieving our targets and milestones. It is my privilege to thank the funding agencies, Government departments and all other stakeholders for their belief and confidence in us towards meeting the objectives under each of the schemes/projects.

Finally, `Team CFTRI' has been pivotal in driving this journey. I thank them for working relentlessly and building a strong value-based organisation.

I look forward for all the guidance and suggestions from the stakeholder's towards steering the Institute to greater heights.

Date: Feb. 02, 2023

(Sd/-) Sridevi Annapurna Singh

Achievements at a Glance

	Publications	Research Papers Reviews Book Chapters	126 11 34
Project	Projects	Grant-in-aid Consultancy Sponsored	96 18 33
	Industrial Development	Patents Filed Patents Granted Technologies Transferred New Technologies Developed	3 5 85 7
	Human Resource Development	M.Sc. (Food Technology) Certificate Course in Flour Milling Ph.Ds Awarded Skill Development Programmes	30 27 33 1687



Achievements in Brief



1. Research Publications

SCI Publications

- Abdul Majid, Lakshmikanth M., Lokanath N.K., Poornima Priyadarshini C.G., Generation, characterization and molecular binding mechanism of novel dipeptidyl peptidase-4 inhibitory peptides from Sorghum bicolor seed protein, Food Chem., 2022, 369, 13088
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- 14. Basista Rabina S., Prakash M. Halami, Jyoti Prakash T., Novel pathways in bacteriocin synthesis by lactic acid bacteria with special reference to ethnic fermented foods, *Food Sci. and Biotechnol.*, 2022, 31(1), 1-16
- 15. Bhavjot Kaur, Yahya M., Natesh J., Dhanamjai Penta, Syed Musthapa M., Identification of hub genes associated with EMT-induced chemoresistance in breast cancer using integrated bioinformatics analysis, Gene, 2022, 809, 146016
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2. Patents Filed / Granted in India

Filed

- A device useful for washing fruits and vegetable at domestic scale
- A supplementary formulation for cancer therapy and method for the preparation thereof
- A device for continuous cooking and discharging of cooked rice and other similar kind of products

Granted

- A process for the preparation of detoxified
 Simarouba glauca oilseed meal
- A process for the preparation of protein isolate from defatted Moringa seed meal flour
- An improved process for the preparation of Zerumbone crystals from shampoo ginger (Zingiber zerumbet)
- A process for the preparation of spiced tea concentrate and products thereof
- Antimicrobial peptide and its use thereof



Patent Licensed

- A process for the preparation of Bacillus Antimicrobial Peptide (BAMP) useful for food industry
 - 3. Processes / Technologies transferred for commercial exploitation

The following eighty five processes were released to 139 parties.

- Annatto dye
- Bio preservation of RTE sugarcane chunks
- Chicken pickle
- Chicken wafers
- Chikki with moringa
- Coffee concentrate
- Coffee flakes based mouth freshener
- Coffee leaf brew mix
- Continuous idli making unit
- Deep fat fried and flavoured cashew kernels
- Dehydrated whole lime
- Dehydration egg cubes
- Desiccated coconut
- Dolymix a ready to use mix for soft and enhanced number of Idlys
- Egg loaf
- Egg wafers
- Eggless cake premix



Coffee leaf brew mix

- Fermented and dehydrated ready mixes for dosa batter
- Fish pickle
- Fish wafer
- Fortified mango bar
- Fruit syrups and squashes
- Ginger beverage
- Herbal fogging disinfectants for mist sanitizer system
- High protein biscuits
- High protein rusk
- Improved process for preservation of neera
- Instant coffee cubes
- Instant millet halva mix and multimillet semolina
- Instant mushroom soup mix
- Instant products from moringa leaves
- Instant millet upma mix and multimillet semolina
- Layered parotta (South Indian)
- Making superior quality of white pepper
- Malted weaning food
- Meat pickle
- Modified atmosphere packaging of minimally processed vegetables
- Moulding machine for besan, soji/rava and similar laddus
- Mustard / rapeseed integrated processing



Deep fat fried and flavoured cashew kernels



- Mutton pickle
- Neera concentrate
- Nutra chikki with added spirulina
- Nutri fruit bars with immune boosters
- Online fortification of atta/maida
- Osmo-air dried fruits (Amla, Jackfruit, Pineaple & Mango)
- Paan flavoured water
- Pasta: Chocolate, multigrain, legume based
- Pickles and chutneys preparation
- Plant growth promoter: containing ntriacontanol
- Potato flour
- Potato wafers/chips
- Prawn pickle
- Prawn wafer
- Preparation of beverage mix from malted ragi
- Preparation of ready-to-cook multigrain whole mix for drink/porridge
- Preparation of shelf stable biriyani paste
- Preparation of shelf stable roti from non wheat cereal and millet
- Process for flavour essence from *Decalepis*
- Process for instant tomato crush, tomato rasam mix and tomato rice bath mix
- Process for the preparation of gluten free bakery products



Beverage mix from malted ragi

- Processed besan (Bengal gram flour) for sev and boondi preparation
- Pulse based papads
- Quick cooking, germinated and dehydrated pulses
- Ragi based papads
- Raw banana powder
- Ready mix: Pakoda
- Roasted and flavoured cashew kernels
- RTE Convenience food Khakra
- RTE Shelf stable egg crunchy bites
- RTS Fruit juice and beverages
- Shelf stable chapati
- Shelf stable chicken biriyani
- Shelf stable chicken tit-bits
- Shelf stable jowar flour
- Shelf stable kabab mix with chicken meat
- Spirulina choco bar and spirulina cereal bar
- Spray dried refined papain
- Sugar free biscuits
- Sugar free cake rusk
- Sugar free cup cake
- Sugarcane juice spread
- Tamarind candy
- Tamarind juice concentrate & powder
- Tomato products
- Water soluble turmeric colourant (odourless)



Ragi papad



4. New Processes / Technologies Developed

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

- Buckwheat noodles (soba) / pasta
- Gluten free biscuit
- Gluten free cookie cake
- Coffee leaves brew mix
- Multigrain nutri cookies
- Chikki with moringa
- High performance advanced oxidation process for STP's greywater and industrial wastewaters (food and non-food)

5. Consultancy/Sponsored/ Grant-in-Aid/Technical Service/ Collaborative Projects

SI. No.	Type of project	No. of projects as on 31.3.2022	No. of projects completed during 2021-22	No. of new projects initiated during 2021-22
1.	Sponsored Consultancy Grant-in-Aid Technical Service Collaborative Projects	21	12	24
2.		13	5	2
3.		70	26	12
4.		22	2	8
5.		12	5	4

6. M.Sc. / ISMT / Skill Development Programmes

SI. No.	Academic Programmes	Degree / Certificate Awarded
1.	M.Sc. (Food Technology)	30
2.	Certificate Course in Milling	27
3.	Skill Development Programmes	1687



Gluten free biscuit



Buckwheat noodles



Buckwheat pasta

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

Covid-19 Webinar (April 16, 2021)

Webinar on "Covid-19 Appropriate Behaviour and Vaccination Strategies (Kannada)" was held. The event was inaugurated by Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI. Dr. P.V. Ravindra, CSIR-CFTRI Covid Testing centre, spoke on CSIR - Sero Survey & SARS Cov2



genomics. Dr. Mudassir Azeez Khan, Head, Dept. of Community Medicine, MMC&RI delivered a talk on "Vaccination options and realising the herd immunity". Dr. Kala R. Swamy, Chief Medical Officer, CSIR-CFTRI spoke on "Covid-19: Clinical perspectives of Covid-19 positive patients".



National Technology Day (May 11, 2021)

National Technology Day 2021 was held at CSIR-CFTRI on 11th May, 2021 in the virtual mode. The Chief Guest, Dr. V. Prakash, Former Director, CSIR-CFTRI delivered National Technology Day Lecture on "Food Science for Food Technology". Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided over the function. Dr. Rajesh Matche, Head, TTBD gave an overview of the technologies licensed to parties in 2020-21.



Virtual National Symposium on the eve of Late Shri P.V. Surya Prakash Rao Birth Centenary Celebrations (June 21, 2021)

One day virtual national symposium commemorating the Birth Centenary of Late Shri PV Surva Prakasa Rao was organised on Food and Nutrition Security - Role of Small and Medium Food Processing Industries on 21st June 2021. Chief Guest Dr. V. Prakash, Former Director, CSIR-CFTRI, Mysuru, delivered the keynote address titled "India's SMEs in Food Sector - A role Model of Global Leadership". Dr. B. Sesikeran, Former Director, ICMR-NIN, Hyderabad and Dr. C. Anandharamakrishnan. Director, IIFPT, Thanjavur were the Guests of Honour. The lectures on "Nutrition and nutraceuticals for boosting immunity" and "Opportunities and technologies for small and micro food processing industries" were delivered by the Guests of Honour respectively.



Pravasi Bharathiya Academic and Scientific Sampark (PRABHAS) (Aug 13, 2021 to Sept 07, 2021)

CSIR-CFTRI scientists participated as subject experts in the National outreach program for school children in association with PRABHASS, CSIR-ISTADS and NCERT, New Delhi. The program was entitled "How human we are? Our microbiome, Nutrition and long-term health". The program was conducted in five sessions between August 13, 2021 to 7th September, 2021 and talks were telecast live on PM-e-vidya channel of Doordarshan, New Delhi and also streamed live on NCERT YouTube, CSIR Facebook, YouTube and Twitter handles.

Digital Signature & Public Key Infrastructure Awareness Workshop (Aug 31, 2021)

A workshop was held in which Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI, and Dr. S.D. Sudarshan, Executive Director, C-DAC were present. Staff from C-DAC gave lectures on Digital Signature & Public Key infrastructure, Esign: online Digital Signing Service and Demo of Digital signing. About 50 staff participated in the workshop.



Hindi Fortnight Celebration (Sept 1-14, 2021)

Hindi Fortnight was celebrated at CSIR-CFTRI from 01.09.2021 to 14.09.2021. Due to COVID-19 pandemic various competitions in Hindi were conducted through online mode for the employees and research students of the

Institute during the fortnight. Prizes were distributed to the winners of competitions by Dr. Sridevi Annapurna Singh, Director & Chairman, OLIC, Shri DJN Prasad, Controller of Administration and Smt. Mangala S., Administrative Officer during the valedictory function held on 28th September 2021.



Dr. Sridevi A Singh, Director & Chairman of OLIC with prize winners of Incentive Scheme during valedictory function

CSIR Foundation Day Celebrations (Sep 26, 2021)

The Chief Guest, Dr. Nagahanumaiah, Director, Central Manufacturing Technology Institute (CMTI), Bengaluru delivered the CSIR Foundation Day lecture on "4Ps: Challenges in Inclusive Innovation Process". Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided.





World Food Day 2021 (Oct 16, 2021)

World Food Day was organised through Webex platform on October 16, 2021 with the Theme – "Our actions are our future - better production, better nutrition, a better environment and a better life". Dr. R. Hemalatha, Director, ICMR-NIN, Hyderabad was Chief Guest of the function and stressed on the importance of nutrition. Dr. Mohan Kanda, Former Chief Secretary, Govt. of Andhra Pradesh, the Guest of Honour delivered a lecture on Agriculture and Productivity.

• CSIR-CFTRI Foundation Day (Oct 21, 2021)

CSIR-CFTRI Foundation Day and 'Stakeholders Connect' was organized. Prof. G. Hemanth Kumar, VC, University of Mysore, delivered the Foundation day lecture, and Dr. Tanweer Alam, Director, IIP-Mumbai, was the Guest of Honour. The occasion was presided over by Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI. A Stakeholders Connect programme was also organized in which developments in the areas of coffee products, probiotics and banana products were presented and 13 companies participated.



Ambedkar Birth Anniversary (Oct 22, 2021)

130th Birth Anniversary of Bharath Ratna Dr. B.R. Ambedkar was celebrated in the Institute.

• Vigilance Awareness Week (Oct 26 - Nov 1, 2021)

As part of the Vigilance Awareness Week, Dr. Manjunatha A. Kanamadi, Sr. Divisional Commercial Manager, South Western Railways, Mysuru, delivered the talk on "Independent India at 75: Self Reliance with Integrity". Director, CSIR-CFTRI presided and prizes were distributed to the winners of various competitions.

International conference on Gut Brain-Health: Connections (Oct 28-29, 2021)

An international conference on "Gut-Brain-Health: Connections" was jointly organised by CSIR-CFTRI and the Karnataka State Open University on Oct 28-29, 2021. The conference was inaugurated at the Cheluvamba Hall, CSIR-CFTRI in the august presence of Prof. S. Vidyashankar, Vice-Chancellor, KSOU, Dr. Sridevi Annapurna Singh, Director CFTRI, Dr. Prakash M Halami, Chief Scientist & Head, MFT Dept., CSIR-CFTRI, Dr. Niranjan





Raj S., Director, CIQA-KSOU, Dr. Panduranga Narasimha Rao, Science Coordinator, KSOU. Dr. Arun Sharma, Founder and Director (IMANAH), International Institute of Mahayoga and Natural Hygiene, USA and Prof. Srinivas Arka, Founder-Centre for Conscious Awareness (CCA), United Kingdom Arka Dhama Ayurveda delivered the keynote addresses.

Kannada Rajyotsava (Nov 1, 2021)

The Kannada Rajyotsava was celebrated and Shri. R. Dhruvanarayan, Ex Member of Parliament, addressed the staff and students. Director, CSIR-CFTRI presided over the function.



Inauguration of "We-Mill" Plant (Nov 21, 2021)

'We-Mill' plant, a social enterprise project to empower rural women through a sustainable



livelihood model was inaugurated at Bilikere Village, Mysuru, with the technical support for Ragi-based products from CSIR-CFTRI.

Workshop on Antimicrobial Resistance in Food Chain (Nov 25-26, 2021)

Two days National workshop on 'Antimicrobial resistance in food chain' organised by CSIR-CFTRI under the sponsorship of Department of Health Research, Indian Council of Medical Research (ICMR), New Delhi was held on Nov 25-26, 2021. Experiments such as, antimicrobial susceptibility testing, screening of antimicrobial resistant bacteria, MIC determination, PCR of antibiotic resistance genes, evaluation of mechanism of antibiotic resistance by phenotype expression, conjugation experiment, heteroresistance, gene expression studies etc. were dealt in the workshop. In addition, demonstration on simpler AMR evaluation in bacteria, antimicrobial residue analysis was also organized. The workshop enlightened the fact that the antimicrobial resistance in food chain is a serious concern since, Tylosin, Auoparcin, and Colistin are the antibiotics used in live stock farms as an additive to the livestock feed to promote growth of chicken, pig and cattle. A total 35 participants registered for the event.





Training programme on ragi and value added products (Dec. 6-10, 2021)

Training programme on ragi and value added products from ragi was conducted for Women SHG supported by WASAN and District Mineral Foundation, Keonjhar under Odisha Millet Mission.



Kerry Scholarship Scheme (Dec 16, 2021)

A scholarship scheme for M.Sc. (Food Technology) programme was launched in association with Kerry Ingredients India Pvt. Ltd., Bangalore under a CSR programme for a period of 3 years. Scholarships were awarded to M.Sc. Food Technology students of fresh batch who excelled in the entrance exams conducted for admission.



• Seminar on "Struggle for Swatantrata and the Science" (Jan 20, 2022)

On January 20, 2022, Shri. Jayant Sahasrabudhe, National Organizing Secretary, Vijnana Bharati, delivered the lecture on "Struggle for Swatantrata and the Science"

The Story of Infant Food Formulation (Amul) from Buffalo Milk (Feb 7, 2022)

The webinar was inaugurated by Dr. Shekhar C. Mande, DG, CSIR. The panelists included Dr. V. Prakash, Former Director, CSIR-CFTRI, Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI, Dr. B.M. Vyas, Ex-MD, Amul Dairy, and Commodore Amit Rastogi (Retd.), CMD, NRDC. The event was organized under the banner of "Success stories of CSIR" in commemoration of 80 years of CSIR's existence.



• Science Festival (Feb 22, 2022)

Vijnan Sarvatra Pujyate' inaugural function was held at CSIR-CFTRI on Feb 22, 2022. The event was inaugurated by Prof. S.K. Brahmachari, former DG-CSIR and Dr. Sridevi Annapurna Singh, Director CSIR-CFTRI presided. The valedictory function was held on Feb 28, 2022



and prizes/awards were distributed to school children who participated in various competitions as part of the festival.



National Science Day (Feb 28, 2022)

National Science Day was celebrated on Feb 28, 2022 at CSIR-CFTRI. Prof. P. Balaram, former Director, IISc, Bengaluru delivered the lecture, "G.N. Ramachandran and the Birth of Molecular Biophysics in India: Reflections on a Centenary". Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI welcomed the audience.



International Women's Day (Mar 10, 2022)

International Women's Day was celebrated in which Dr. Villoo M. Patel, Founder and Chairperson, Avesthagen Limited, Bengaluru was the Chief Guest. Mrs. Marthamma Mary, a woman auto driver of Mysuru City was felicitated

on the occasion. Dr. Sridevi Annapurna Singh, rendered presidential remarks. Mrs. K. Kusuma, PMC Department was honoured for her achievements in the State level para swimming competition, where she won one gold and two silver medals.



• National Workshop (Mar 24-25, 2022)

A two day National workshop on "Bifidobacterial Probiotics: Supplementation through Fermented Food" sponsored by the Probiotic Association of India (PAI) was organized. Dr. Shrilakshmi Desiraju, Probiotic IP Advisor, TENSHI Life Science, Bengaluru was the Chief Guest, Dr. Prakash M Halami, Chief Scientist, CSIR-CFTRI briefed about the workshop and Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided.





8. Azadi Ka Amrit Mahotsav Webinar Series

- As part of the Azadi ka Amrit Mahotsav, a webinar on "Millet Processing & Value Addition Avenues" was conducted on Sep 7, 2021 and inaugurated by Dr. Shekar C. Mande, Director General, CSIR, New Delhi. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided. Dr. Geethavani Rayasam, Senior Principal Scientist, CSIR Hqrs gave opening remarks and scientists from CSIR-CFTRI and ICAR Institutes delivered lectures.
- Awebinar on "Innovations and Advancements in Food Protection and Grain Storage" was conducted on January 5, 2022.
- Webinar on "Balanced Nutrition through Microbial Food Additives" was conducted on January 10, 2022. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided over the session. Dr. Prakash M. Halami, Chief Scientist, CSIR-CFTRI

Azadi Ka Amrit Mahotsav Celebrations webinar was inaugurated by Dr. Shekar C Mande, DG, CSIR, New Delhi. Dr. Sridevi A Singh, Director, CSIR-CFTRI presided

- rendered opening remarks and faculties from CSIR-CFTRI and universities delivered lectures.
- World Pulses Day was held at CSIR-CFTRI on Feb 10, 2022. Dr. Sridevi Annapurna Singh, Director CSIR-CFTRI delivered the inaugural address on the occasion. Sri A. Srinivas, Chief Scientist, CSIR-CFTRI and Sri M. Arjunan, Technical Advisor, Jeyyam Global Foods, Salem delivered expert lectures.
- Webinar on "Challenges in Food Safety and Quality Assurance" was held at CSIR-CFTRI on March 30, 2022. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI gave initial remarks. Dr. Chindi Vasudevappa, Vice Chancellor, NIFTEM was Guest of Honour. Dr. N. Bhaskar, Advisor, FSSAI, Dr. Pramod Siwach, Asst. Director, EIC, Dr. P. Nisha, Principal Scientist, CSIR-NIIST, Mr. Shrinivasa Joshi, President, AOAC, Dr. A.K. Srivatsava, Chief Scientist, CSIR-CFTRI delivered lectures on the occasion.



Webinar inauguration by dignitaries



9. MoU(s) Signed

- Khadi and Village Industries
 Commission (KVIC), Mumbai
- ICAR-Indian Institute of Millets Research (ICAR-IIMR), Hyderabad
- Spirulina Foundation, Tumkuru
- Ozone Research & Applications (I) Pvt. Ltd. (ORAIPL), Nagpur
- Indian Institute of Management Nagpur Foundation for Entrepreneurship Development (InFED, IIMN), Nagpur
- Ministry of Rural Development (MoRD), New Delhi
- Createcomm Tech Pvt. Ltd., Gurugram
- Prakhoj Private Limited, Bengaluru
- Indian Institute of Packaging, Mumbai
- Establishment of CIC under PMFME scheme at Basti
- Establishment of CIC under PMFME scheme at Bareilly
- Establishment of CIC under PMFME scheme at Gorakhpur
- Establishment of CIC under PMFME scheme at Ayodhya
- Establishment of CIC under PMFME scheme at Aligarh

Signing of MoU between CSIR-CFTRI and National Sugar Institute (NSI), Kanpur

- Establishment of CIC under PMFME scheme at Lucknow
- Establishment of CIC under PMFME scheme at Meerut
- Establishment of CIC under PMFME scheme at Varanasi
- Establishment of CIC under PMFME scheme at Agra
- Establishment of CIC under PMFME scheme at Jhansi
- Karnataka Agriculture Produce Processing & Export Council (KAPPEC), Bengaluru
- National Sugar Institute (NSI), Kanpur
- SLN Coffee Pvt. Ltd., Kushalnagar, Kodagu
- UPL Limited, Mumbai
- Prayoga Institute of Education Research, Bengaluru
- Coffee Board, Bangalore
- Raghunathpur Sub-Divisional Office, Purulia, WB
- North East Centre for Technology Application & Reach (NECTAR), New Delhi and Technology Information, Forecasting & Assessment Council (TIFAC), New Delhi
- Mahatma Gandhi University, Kottayam, Kerala



Signing of MoU between CSIR-CFTRI and Prayoga Institute of Education Research, Bengaluru



10. Awards and Recognitions

Ph.D. Degree awarded

a) University of Mysore

Name of the Student	Title of the Thesis	Guide
Mohammad Hassan Kamani	Application of grain protein resources in texturized products	Dr. Meera MS
Bhavya ML	Light based processing of cut fruit, leafy greens & fruit juices for microbial load reduction	Dr. Umesh Hebbar H
Praneeth Juvvi	Extraction of protein and PUFA rich oil from an oil seed/cake employing three phase partitioning	Dr. Sukumar Debnath
Lalitha	Molecular and anti-glycemic properties of globulins from horsegram	Dr. Sridevi A Singh
Pradeep PM	Phenolic antioxidants in little millet (<i>Panicum</i> sumatrense): Evaluation of their modulatory effects on hyperglycemia and its related complications	Dr. Sreerama YN
Gyanendra Kumar JP	Studies on major indolamines and N-acetylserotonin O-methyltransferase of soybean	Dr. Giridhar P

b) AcSIR

Name of the Student	Title of the Thesis	Guide
NalawadeSagar Arjun	Electromagnetic radiation based hybrid drying of vegetable and herb: Process efficiency and product quality evaluation	Dr. Umesh Hebbar H
Sandopu Sravan Kumar	Isolation and characterization of potential nutraceutical compounds from fruits of Basella rubra L. for value addition	Dr. Giridhar P
Shewale Sandhya Rustumrao	Integrated electromagnetic radiation treatment and low humidity air drying of apple and rosemary for improving product quality	Dr. Umesh Hebbar H



Name of the Student	Title of the Thesis	Guide
Sandeep Kumar	Functional expression of α-glucosidase towards production of isomaltooligosaccharides	Dr. Sarma MVRK
 Varkekar Namrata Jagdeo 	Processing of <i>Parkia biglandulosa</i> W. & A. for traditional food formulations of Manipur: Evaluation of nutritional quality and storage stability	Dr. Iboyaima Singh Ng.
Dongala Venkataramanamma	Studies on effect of pomegranate peel extract on polyamine metabolism in acrylamide induced cytotoxicity	Dr. Singh RP
Dileep SA	A molecular understanding of human sucrase enzyme with sugarcane sucrase inhibitor	Dr. Usharani D Prof. Ram Rajasekharan (Co-guide)
Om Prakash	Characterization of Kainth (<i>Pyrus pashia</i> Buchham ex. D. Don) fruit for biofunctional property and its value addition	Dr. Kudachikar VB Mr. Chauhan AS (Co-guide)
Theresa Shalini RM	Functional expression and characterization of wax synthase from sunflower (Helianthus annuus)	Dr. Asha Martin
Suchitra Pradhan	Understanding the mechanism of chromosome condensation by SMC proteins in <i>Mycobacterium smegmatis</i>	Dr. Ravi Kumar
Govindaraj Ellur	Effects of maternal high protein diet in the programming of adult bone mass of the offspring	Dr. Kunal Sharan
Anitha RE	Lactucaxanthin mediated modulation of oxidative stress & retinal angiogenesis in hyperglycemia induced ARPE-19 cell line and rat models	Dr. Baskaran V
Abignan Gurukar MS	Modulation of PPARγ by mulberry leaf bioactives and its implications on chondroitin sulphate/dermatan sulphate in kidney of diabetic rats	Dr. Nandini CD
Monali Mukherjee	Studies on biosensing of mycotoxins using oligonucleotide aptamers	Dr. Praveena B Mudliar



Name of the Student	Title of the Thesis	Guide
Mahendra VP	Effect of dietary molecules in glucose- stimulated insulin secretion from pancreatic β-cells and their effect on insulin aggregation	Dr. Ravi Kumar
Janhavi P	Studies on the sour mangosteen (Garcinia xanthochymus) bioactives and their modulatory effects in diet induced hyperglycemic mice model	Dr. Muthukumar SP Dr. Ravindra PV (Co-guide)
Arpitha HS	A molecular mechanistic approach on the protective role of lutein against hyperglycemia-mediated oxidative stress in retinal pigment epithelial (RPE) cells	Dr. Ganesan P Dr. Kunal Sharan (Co-guide)
Sowmya Shree G	Studies on the molecular mechanism underlying the inhibitory potential of lutein on adipocyte differentiation <i>in vitro</i> and <i>in vivo</i>	Dr. Ganesan P Dr. Baskaran V (Co-guide)
Nimisha Sarah Mathew	Evaluation of <i>in-vitro</i> and <i>in-vivo</i> anti-proliferative potential of <i>Ensete</i> superbum Roxb. Cheesman (Wild banana)	Dr. Negi PS
Nikhita R	Biochemical and functional properties of chicken blood and plasma protein isolates	Dr. Sachindra NM
Latha M	Functional characterization of plant acyl-hydrolases and its significance in oil accumulation	Dr. Vijayaraj P
Chegu Krishnamurthi Madhubalaji	Studies on microalgae-bacterial association for biomass production, metabolites and their bioavailability	Dr. Sandeep N Mudliar Dr. Sarada R (Co-guide)
Vinayashree S	Biochemical and functional characterization of proteins from pumpkin seeds (<i>Cucurbita</i> sp.) and its implications to cancer and diabetes	Dr. Prasanna Vasu
Vallamkondu Manasa	Isolation and characterization of fixed oil from selected spices and its role in addressing lipid metabolism-related disorders	Dr. Ajay W Tumaney
Deependra Rajoriya	Infrared assisted refractance window drying of fruits-apple and banana	Dr. Umesh Hebbar H



Name of the Student	Title of the Thesis	Guide
Bhatt Kavya Shridhar	Characterization of quercetin glycoside from leaves of <i>Trigonella foenum-graecum</i> L. for its anti-inflammatory property <i>in vitro</i> and <i>in vivo</i>	Dr. Umesh Hebbar H

c) Other Universities

Name of the Student	Title of the Thesis	Name of the University
Sridhar Rachakonda	Facile synthetic strategies for quinoziline, triazole, indole and imadazopyridine derivatives	KLU, Vijayawada

d) Individual Awards

Award Title	Instituted by	Awardee
Prof. Carl Hoseney Award	AFST(I), Mysuru	Dr. Aashitosh A Inamdar
Subhash Bhatnagar Memorial Award - 2020	AFST(I), Mysuru	Mr. Shivakumara M
Fellow	AFST(I), Mysuru	Dr. Giridhar P
Prof. V. Puri Commemorative Medal	Indian Botanical Society	Dr. Giridhar P
• Fellow	Biotech Research Society of India (FBRS-2021)	Dr.Prakash M Halami
• Fellow	National Environmental Science Academy (2022)	Dr.Prakash M Halami



Mr. Shivakumara M., Senior Technician, Dept. of Food Engineering, receiving the Subhash Bhatnagar Memorial Award -2020 instituted by AFST(I), Mysore



f) Other Recognitions

Awardee	Member / Panel Expert & Host Institution	
Dr. Sridevi Annapurna Singh	Taskforce Chair on Standards Committee for Indian Mithai and Namkeen	
	Chairperson, Expert Committee, FSSAI	
	BIS Chair on FAD14 on Water	
	Governing Council Member for National Agri Biotechnology Institute, Mohali (DBT) - 2017 till date	
	Governing Council Member for CIAB, Mohali (DBT) - 2021 till date	
	Member, Technical Expert Committee on Public Health and Nutrition, DBT, Govt. of India (2017 - till date)	
Dr. Prakash M Halami	Convener cum Member, Drinking water and carbonated beverages sub committee of Bureau of Indian Standards, 2021	
Dr. Madan Kumar P	Advisory committee Member and Examiner for Diploma course in Food Safety Management, Sri Sankara Arts and Science College, Kanchipuram (TN)	
Dr. Madhava Naidu M	Executive Councillor for Indian Society for Spices, ICAR-IISR, Calicut	
	Advisory Committee Member, Department of Postgraduate studies in Botany, Sharnbasava University, Gulbarga	
	Technical Committee Member (PMFME), Technical Committee on Food Products under the MoFPI's Production Linked Incentive Scheme for Food Processing Industries (PLISFPI)	
	Member, Coffee Board, Ministry of Commerce, Bangalore Head of ISO delegates (India), BIS, New Delhi, FAD-9, Spices and Condiments	
Dr. Pushpa S Murthy	Member of Advisory Board, Siddaganga Institute of Technology, 2020-2025, Under Graduate course, Biotechnology	
	Member BIS-India, Stimulant Foods Sectional Committee, FAD 6 of BIS under the Food and Agriculture Division Council.	



Awardee	Member / Panel Expert & Host Institution
Dr. Gothwal PP	 Executive Member, State Level Empowered Committee for appraisal of Milk/Dairy Processing Industry, Govt. of Uttar Pradesh Member, Task Force Committee, MSME, Kanpur for National Award to the progressive entrepreneurs of Uttar Pradesh Executive Member, Vigyan Bharthy, New Delhi
Dr. Nandini CD	 Member, Fixed Dose combination related to vitamins and minerals, Central Drug Standard Control Organisation, New Delhi External Member, BOS, Faculty of Community Science, Tamil Nadu Agricultural University, Coimbatore
Dr. Jayadeep A	 Member, BIS, Panel on Specifications for Fortified Rice Kernels, FAD 16/Panel 7 Member, "White Paper on Millets – A Policy Note on Mainstreaming Millets for Nutrition Security", ICAR- IIMR, Hyderabad
• Dr. Negi PS	 Convener, Fruits, Vegetables and Allied Products Sectional Committee (FAD 10/ Panel IV) of Bureau of Indian Standards Expert Member, Technical Advisory Committee (TAC) of Technology Development and Utilization Programme for Women (TDUPW) of Department of Scientific and Industrial Research Member, Scientific Panel for Fruits and Vegetables and their Products (including dried fruits and nuts) of FSSAI Expert committee member, MoFPI to review curriculum and course content under the capacity building component of PMFME scheme Expert Member, Appraisal committee (Fruits and Vegetables Processing), MoFPI to review the proposals received from States / UTs for Common Incubation Centre establishment under PMFME scheme



Awardee	Member / Panel Expert & Host Institution
Dr. Vijayanand P	Member, APEDA expert panel on Fruits and Vegetables; Expert Member, BIS panel FAD 10 (Fruits, Vegetables, and Allied Products Sectional Committee)
	Expert Member, Karnataka State Mango Development Centre, Govt. of Karnataka
Dr. Kudachikar VB	Expert Member, Techno Financial Expert Committee (TFEC) of Indo-US Pace Setter Fund Programme under MNRE, GOI, and US embassy
	Expert Panel Member, FAD-10 / Panel 5 Sectional Committee of National Standard Organisation-BIS, New Delhi
Dr. Prasanna Vasu	Principal Member, Sectional Committee of Test methods for food products (FAD-28) of the Food and Agriculture Division of Bureau of Indian Standards (BIS)
	Member - Convener, Sectional Committee of Alcoholic Drinks (FAD-29) of the Food and Agriculture Division of Bureau of Indian Standards (BIS)
	Alternative Member, Chemical Hazards Sectional Committee of Chemical Science Division of the Bureau of India Standards
Dr. Asha Martin	Member, Scientific panel on Sweets, confectionery, sweeteners, sugar and honey (FSSAI)
	 Principal Member, Technical Committee on Food biotechnology Sectional Committee (FAD-23) of the Food and Agriculture Division of Bureau of Indian Standards (BIS)
	Member, Board of Studies for Food Sciences and Nutrition, University of Mysore
	Expert Member, Project review and steering group (PRSG) for Ministry of Electronics and Information Technology
Dr. Usharani D	Research Council Member, ICAR-IINRG
	Principal Member, Technical Committee on Chemical Hazards Sectional Committee of Chemical Science Division of Bureau of India Standards (CHD 06)



Awardee	Member / Panel Expert & Host Institution
	 Alternative Member, Technical Committee on Oils Seeds and Oils of Bureau of India Standards (FAD13) Alternative Member, Technical Committee on Test methods for Food Products of Bureau of Indian Standards (FAD 28)
Dr. Vanajakshi V	Alternate Member, Drinks & Drinking Water Section Committee, Bureau of India Standards (FAD14)
Dr. Vivek Babu CS	Member, Board of Studies (BOS) for Molecular biology and Cell biology course, Department of Life Sciences, Parul Institute of Applied Sciences, Parul University, Waghodia, Vadodara, Gujarat
	 Member, Board of Studies (BOS) for Department of Biotechnology, R.V. College of Engineering, Bengaluru, Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi
Dr. Umesh Hebbar H	Member, Food and Agriculture Division Council (FADC), BIS, FADC, New Delhi
	Member, BOS, Food Science and Technology (PG), University of Mysore, Mysuru
	Member, BOS, Food Technology, Bannari Amman Institute of Technology, Tamil Nadu
Dr. Usha Dharmaraj	 Member, 42nd Session of Codex Committee on Nutrition and food for special dietary uses constituted by FSSAI, New Delhi Member, Task force on nutrition and health benefits of millets constituted by Ministry of Agriculture and Farmers Welfare, Government of India
	Member, Task force on Processing and value addition and recipe development from millets constituted by Ministry of Agriculture and Farmers Welfare, Government of India
Dr. Ajay W Tumaney	 Member, FAD 13 BIS Member of FAD 15 BIS Member, Expert Panel on Oils and Fats, FSSAI



Awardee	Member / Panel Expert & Host Institution
Dr. Muthukumar SP	 Member, FAD 13 BIS Member of FAD 15 BIS Member, Expert Panel on Oils and Fats, FSSAI
Dr. Syed Musthapa M	 Panel Expert, Research Advisory Board (RAB), JSS Medical College, JSS AHER, Mysore Member, BOS in Biochemistry, Islamiah College, Periyar University, Tamil Nadu Member, BOS in Biochemistry, Vivekananda College of Arts and Sciences for Women, Periyar University, Tamil Nadu
Dr. Harish Prashanth KV	 Research Advisory Member, MIMS, Mandya under the Department of Health Research and Family welfare, Government of India and Department of Medical Education, Government of Karnataka Member, Research Advisory Committee (RAC), Adichunchangiri University, B.G. Nagar, Karnataka Advisory Panel Member, Advanced Noble Synergies Private limited, Mysuru; Scientific Advisor, for company "ICurry", Vijayawada, Andhra Pradesh
Dr. Prabhasankar P	 Member, BOS, Home Science, Sri Padmavathi Mahila Visvavidyalayam (SPMVV), Tirupati Academic Council Member, Faculty of Food Technology, University of Mysore Member, Ready to Eat Foods and Specialized Products Sectional Committee, FAD 24 (Food and Agriculture Department, Bureau of Indian Standards) Member, 42nd Session of the Codex Committee on Nutrition and Foods for Special Dietary Uses (CCNFSDU42) Member, Nodal Scientist for the Nutritional Security under Agriculture and Nutritional Biotech (ANB) Theme (CSIR) Member Expert, TIFAC-NEST



Awardee	Member / Panel Expert & Host Institution
Siva Naga Suresh PSanjailal KPSudhakar Sanaboyina	Director General, CSIR has appreciated the support extended by CSIR-CFTRI in conducting the Limited Departmental Competitive Examination-2021 (LDCE-2021), pre-examination work such as software design & managing data received through online application mode.

d) Individual Awards

Award Title	Instituted by	Awardee
IASLIC - Ranganathan Best Article Award	Indian Association of Special Libraries and Information Centres, Kolkata	Dr. Padmavathi T
 Augmenting Writing Skills for Articulating Research (AWSAR 2021) 	DST, Govt. of India	Trishitman Das, SRF, FE Dept. (Guide: Dr. Rastogi NK)

g) Best Research Papers / Posters Awards

28th ICFoST 2021 - Emerging and Adoptable Technologies for Sustainable Agro-Food Industries and Economy (EAT-SAFE), January 20-22, 2022, Hotel Rama International, Aurangabad, Maharashtra

- Sravan Kumar S., Manasa V., Ajay W.
 Tumaney, Bettadaiah B.K., Sachin R.C.,
 Giridhar P., Basella rubra Linn Seed oil
 A novel source of squalene and nutraceuticals
- Tiwari S., Shende D., Manilal V., Sarada R., Chauhan V.S., Effect of sodium azide on cell viability, photosystem II and astaxanthin accumulation in Haematococcus pluvialis.
- Sridhar R., Narsing Rao G., Sulochanamma
 G., Prabhakara Rao P.G., Nagender A.,

Madhusudan D., Srinivasulu K., Jyothirmayi T., Sathiya Mala K., Nutritional evaluation of vegetable snack bar

- Vallamkondu Manasa, Ajay W. Tumaney, Spice fixed oils: A good source of antidyslipidemic activity as confirmed by in vitro and in vivo studies
- Pramod Kumar P., Harish Prashanth K.V., Chitosan derivatives ameliorate neuronal and behavioral defects in rotenone induced *Drosophila melanogaster* model of Parkinson's disease
- Neethu E. John, Sharneeta S., Suresh Sakhare, Usha Dharmaraj, Ragi laddu mix
 An ideal snack product for ICDS programs
- Priyanka Rose Mary, Monica P., Mukesh Kapoor, Insights into β-mannooligosaccharide uptake and metabolism



in *Bifidobacterium adolescentis* (DSMZ 20083)

- Shubhashini, Neelam Prabha, Monica P., Sachin Rama Chaudhari, Mukesh Kapoor, Short-chain β-manno-oligosaccharides from copra meal: Structural characterization, prebiotic potential and anti-glycation activity
- Yadav D., Negi P.S., Bioconversion of ergosterol into vitamin D₂ in the UV irradiated mushrooms
- Rakshitha J., Iboyaima Singh., Gopika S.
 Pillai., Bhumika V., Babylatha R., Use of black rice in traditional sweets
- Pavan Kumar P., Muthu Kumar S.P., Jyothi Lakshmi A., Crosstalk between IgA and gut microbiota in protein energy malnutrition induced rats influences antioxidant activity and its state of immunity

Two days International conference on gutbrain health connection, Oct 28 – 29, 2021, CSIR-CFTRI (Hybrid mode)

- Saarika P.K., Mahejibin Khan, Screening identification and characterization of ferulic acid esterase producing microorganism from cow dung samples
- Kusuma N.P., Rwivoo Baruah, Halami P.M., Characterization of EPS gene cluster from Bifidobacterium breve NCIM 5671
- Ashwini M., Mousumi Ray, Sumana K., Halami P.M., Gene expression of lactic acid bacteria isolated from food samples against macrolide - lincosamidestreptogramin antibiotics
- Prathiksha U.B., Ashwini Manjunath,
 Mousumi Ray, Halami P.M., Conjugal

transfer of vancomycin resistance in lactic acid bacteria

National E-Seminar on Holistic Nutrition for a Healthy Nation, September 23-24, 2021, organised by Bhavans Vivekanadanda College, Secunderabad and University College for Women, Koti, Hyderabad

- Pratyusha D., Jyothirmayi T., Development of tailor made nutritive multigrain extruded product and multipurpose foods
- Sweta Snigdha Mishra, Jyothirmayi T., Development of foxtail millet based extruded product with cumin spice coating

Best Research Papers / Posters Awards in Other Seminars

- Sruthi P., Naidu M.M., Utilization of cashew nut testa as a promising source of phenolics compounds: Extraction, separation and its in-vitro biological activities, PLACROSYM XXIV, organized by Spices Board, Kochi, Dec 14-16, 2021
- Rajlakshmi, Anbarasu K., Milk derived exosomes mediated delivery of glaucarubinone – emphasis towards the targeted drug therapy for breast cancer, 8th International Symposium on Current Trends in Drug Discovery Research at CSIR-CDRI, Lucknow, Mar 12-14, 2022
- Pavan Kumar P., Muthukumar S.P., Jyothi Lakshmi A., Evaluation of milk protein hydrolysates in protein energy malnutrition induced rats: Deciphering its state of immunity and antioxidant activity, 4th ICFN Conference, Singapore, Sept. 23-24, 2021





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

Name	Role	Journal / Publisher
Dr. Negi PS	Chief Editor	Indian Food Industry, AFST(I), Mysore
	Associate Editor	BMC Complementary Medicine and Therapies, BMC, Part of Springer Nature, New York, USA
	Associate Editor	International Journal of Genuine Traditional Medicine, Association of Humanitas Medicine, Seoul, Republic of Korea
Dr. Prabhasankar P	Associate Editor	Journal of Food Measurement and Characterization, Springer
	Editor	Blue Biotechnology, Nova Publishers, USA
	Editor	Research and Reviews: Journal of Food Science and Technology, STM Journals, Noida, U.P.
Dr. Harish Prashanth KV	Editor	Research and Reviews: Journal of Food Science and Technology, STM Journals, Noida, U.P.
Dr. Mukesh Kapoor	Editor	Research and Reviews: Journal of Food Science and Technology, STM Journals, Noida, U.P.
Dr. Aashitosh A Inamdar	Editor	Journal of Food Science and Technology, Springer
Dr. Navin K Rastogi	Associate Editor	Journal of Food Process Engineering, John Wiley, USA
	Executive Editor	International Journal of Membrane Sci. Technol., Cosmos



I) Member of Editorial and Advisory Boards

Name	Journal / Publisher
Dr. Sridevi Annapurna Singh	ACS Food Science and Technology, American Chemical Society
Dr. Muthukumar SP	 Frontiers in Nutrition, Frontiers Media, Switzerland Frontiers in Sustainable Food Systems, Frontiers Media, Switzerland Journal of Laboratory Animal Science, Laboratory Animal Scientists' Association, India
Dr. Syed Musthapa M	Non-coding RNA research, KeAi
Dr. Navin K Rastogi	 Journal of Engineering, Hindawi The Scientific World Journal, Hindawi Journal of Membrane Science & Technology, Omics Journal of Food Research and Technology, Jakraya
Dr. Sudheer Kumar Y	 International Journal of Nutrition and Food Sciences, Science publishing group, USA
Dr. Negi PS	 Journal of Food Science, IFT, Chicago, USA Signpost Open Access Journal of Organic and Biomolecular Chemistry, Research Signpost, Thiruvananthapuram, India
Mr. Matche RS	 International Journal of Food Science and Nutrition Engineering, Scientific & Academic Publishing Co. Rosemead, CA, 91731, USA International Journal of Agriculture Food Science & Technology (IJAFST), Research India Publications, Delhi International Journal of Knowledge Management and Information Technology (IJKMIT), Research India Publications, Delhi Indian Journal of Nutrition, Open Science Publications, Hyderabad

11. Participation in Exhibitions

- Food & Drink Processing Expo:
 Organised by HITEX & Synergy Exposures
 & Events Pvt Ltd. at Hitex Exhibition Center,
 Hyderabad, Sept 2-4, 2021
- Food Expo 2021: Organised by Indian Industry Association, Lucknow at Indian Industry Association Bhawan, Lucknow, Oct 20, 2021
- Virtual Expo on India Food & Nutrition Innovation Summit: Organized by Federation of Indian Chambers of Commerce and Industry (FICCI), supported by the Ministry of Food Processing Industries (MoFPI), Oct 27 - 28, 2021
- India International Science Festival (IISF 2021): Organised by Ministry of Science & Technology and Ministry of Earth Sciences in association with Vijnana Bharati (VIBHA), Goa, Dec 10-13, 2021



Technology Awareness Workshop on Digital Revolution in Dairy & Food Technologies at Jaipur



CSIR Technologies Demonstration Pavillion (75th Foundation Day Celebrations of CSIR)

- Brain-Storming Conclave and Techno fair for Atmanirbhar North East through S
 T Interventions: Organised by Cotton University, Guwahati, Assam, Dec 21-22, 2021
- CSIR Technologies Demonstration Pavillion (75th Foundation Day Celebrations): Organised by CSIR at CSIR-NPL, New Delhi, Jan 4-6, 2022
- Pre-Event on Agri-Tech and Food Tech of 3rd Edition of Tech Bharat-2022: Organised by IMS Foundation & Laghu Udyog Bharati, Karnataka at VTU Campus, Belgaum, Jan. 5, 2022
- Science Week & Azadi Ka Amrit Mahotsav
 Exhibition: Organised by ICMR-NIN at ICMR-NIN, Hyderabad, Feb 22-28, 2022
- Technology Awareness Workshop on Digital Revolution in Dairy & Food Technologies: Organised by CSIR-CEERI at CSIR-CEERI, Jaipur, March 29, 2022



Brain-Storming Conclave and Techno fair for Atmanirbhar North East through S & T Interventions, Guwahati, Assam



India International Science Festival (IISF 2021)



12. Visit of International Delegation to Institute

- Denmark delegation visited CSIR-CFTRI on November 10, 2021 as part of Indo-Danish Food Coalition for ensuring safe, wholesome & hygienic food sustainability. The team consisted of Ms. Anandita Prakash, Embassy of Denmark-India, Mr. Tobias Hansen, Confederation of Danish Industries & Mr. Tom Sebastian, Program Director at NORDIN, Asia House and interacted with scientists on R&D.
- Prof. K. Sandeep Prabhu, Professor of Immunology and Molecular Toxicology and Head, Department of Veterinary and



Denmark delegation with Director, CSIR-CFTRI



Prof. K. Sandeep Prabhu delivering invited talk at CSIR-CFTRI

- Biomedical Sciences, The Pennsylvania State University, USA visited CSIR-CFTRI on March 16, 2022 and delivered a talk entitled "Trace element selenium and its anti-inflammatory and anti-cancer effects".
- Dr. Kerry Cooper, Assistant Professor, University of Arizona, USA visited CSIR-CFTRI on March 22, 2022 for interaction with various R&D scientists and also to know about CSIR-CFTRI technologies.

13. Support Department Activities

Central Instruments Facility and Services houses Sophisticated Analytical Instruments and provides analytical services to staff and students of the Institute.

Information Services: The Library has an extensive collection of print and electronic resources viz., books/e-Books, Hindi books, reference materials, current periodicals, standards, dissertations, theses and databases which are of immense help to scientists, researchers and industries. The library has been serving the R&D community through information services, enabling them to keep track of the technological advances worldwide. The Library has access to global information through several databases, e-Journals through CSIR Network (NKRC) of Libraries in the field of Food Science and allied areas. The total print collection of the FOSTIS/Library exceeds more than 2 lakh volumes. The Institutional Repository holds over 10,000+ research articles that have been published by CSIR-CFTRI since 1949.

Jocietal Programmes



I. Outreach Activities

a) COVID-19 testing & related activities

CSIR-CFTRI COVID-19 Testing Centre was operational since Aug. 10, 2020 and it was one of the top most among other CSIR labs involved in testing with over 7 lakh samples as on Mar 31, 2022. To support the COVID testing facility, M/s BRBNMPL (RBI), Mysuru had provided some funding for equipment (ELISA microplate reader and -80°C freezer) and consumables through their CSR Scheme. The Institute coordinated with District Administration and State Government for funding and supply of RT-PCR machines, biosafety cabinets, -20°C freezer, automated RNA extractors and for constant supply of major and minor consumables and kits (RNA extraction and RT-PCR) for processing of samples. The samples were collected in coordination with District Administration from Government hospitals and other testing facilities created to control the pandemic. Initially the testing centre processed the samples of Mysuru city only, but eventually it covered the entire Mysuru district. The processing rate went upto 1100 samples/day during 2021-22. All the samples were processed and the results were uploaded within 24 hours.

The staff of the testing center received the appreciation and corona warrior recognition award from Medical Lab Technologist Association, Bengaluru and Microbiologists Society of India for the efficiency, coordination and contribution in fighting the pandemic. The centre also participated in the validation of dry swab technique for COVID testing developed by the CSIR-CCMB, Hyderabad. The COVID testing team conducted several camps for

sample collection. Five vaccination camps were organised in CSIR-CFTRI campus for the benefit of students, staff and their families. The team also coordinated three camps for Sero-surveillance as part of Pan-CSIR phenome India sero surveillance longitudinal study along with CSIR-IGIB, Delhi.

b) COVID survey at CSIR-CFTRI - A survey on changes in food consumption habits and nutritional / health status of staff & students of CSIR-CFTRI during COVID-19 pandemic

Most of the people in India faced lots of challenges in many aspects whether economical, food habits, psychological etc. during the pandemic. Elders, diabetic, hypertensive, cardiac patients and people suffering with other critical illness were at high rick of COVID infection. To understand the scenario, a survey was conducted among the staff and students with proper questionnaire to understand the impact of COVID on individuals. The survey revealed about the increase in weight gain and psychological depression among most of the participants during the lock down and peak of the pandemic. Also, the survey revealed about the drastic change in the food habits during this period in comparison with pre-COVID period. The data collected through this survey will be useful in the future for suggesting how to manage and mitigate the problems during such unforeseen situations.

c) Training Programme for Farmers on processing of groundnut

A training programme was organized on processing of groundnuts for the benefit of farmers from Yadgiri district, Karnataka. Yadgiri



district is recognized by the Central Government for the 'Groundnut' crop, under the 'One District-One Crop' scheme so that the farmers growing groundnut can be provided with the facility under the cluster development scheme. Incidentally, this program was organized on 'Farmer's Day', that is, on December 23, 2021 in the Institute. Necessary briefing about the technologies suitable for these farmers were given. Some equipment and technologies were demonstrated during this training session. Problems related to the farmers regarding the groundnut crop, preservation of the harvest, processing, commercial aspects were noted for providing time bound solutions. Though the programme was primarily attended by the Yadgiri district farmers, a few farmers from Mandya district, prospective MSME industrialists and members of the 'Vision Karnataka Foundation' also attended the programme.

II. Skill Development Programmes

a) Skill Development Programs under CSIR Integrated Skill Initiatives

CSIR-CFTRI has conducted several Skill Development Programmes (SDPs) during 2021-22. Due to the pandemic situation, Institute focused more on online workshops/ programs. Nearly 600 participants attended the SDPs conducted by the Institute this year representing 25 States/UTs of India. Details of the programs are as follows:

 Online Course cum Training: An Overview of Food Processing Machineries & Unit Operations (Aug 17-18, 2021)

Two-day webinar was organized under CSIR Integrated Skill Initiative for the benefit of MSMEs & Startups working in the area of food processing with the involvement of experts involved in various engineering operations and machinery development. The program was inaugurated by Smt. R Vinothpriva, IAS, Director. MSME, Dept. of Industries & Commerce, Karnataka. Director, CSIR-CFTRI and 11 other senior & experienced faculty from the Institute delivered lectures in this webinar. Topics such as Challenges for MSMEs in Food Processing, Unit Operations in Food Processing, Primary & Secondary Grain Processing, Machineries for Roasting, Drying, Frying, Packaging & Labelling and Processing of Fruits & Vegetables were covered. Machinery layouts for MSMEs, Standards, Regulatory Requirements & Energy Auditing were also presented during the webinar. A total of 191 participants participated in this webinar.

2. Workshop on "Innovative & Healthy Snacks" (Sept 28-29, 2021)

The program was organized for the benefit of Startups/SMEs/Entrepreneurs working in the area of food processing. The webinar focussed on aspects for establishing sustainable business model towards functional and health promoting snacks in meeting the increasing demand along with changing life styles. The topics covered were Novel & Healthy Food Products including Speciality Foods, Healthy Bakery & Confectionary Products, Sensory & Consumer Acceptance Studies, Snacks Based on Fruits & Vegetables, Opportunities for MSMEs & Startups with respect to Indian Snack Industry, Nutritional Labelling & Regulatory requirements. The program was



inaugurated by Dr. RK Sinha, Head, CSIR-Human Resource Development Centre, Ghaziabad. The speakers included senior faculty from the Institute (12 nos.) and also from industries. The program was attended by 77 participants.

3. Virtual Training Programme on "Sustainable Rural Food Processing Enterprises for Livelihood generation" (Nov 18, 2021)

The program was targeted for Self-Help Groups (SHGs) registered under State/National Rural Livelihoods Mission (SRLM / NRLM) and rural entrepreneurs. Experienced faculty from the Institute (8 nos.) and an external speaker delivered lectures in this program which was inaugurated by Mrs. Chayaa Nanjappa, Founder & Managing Director, Nectar Fresh Pvt. Ltd., Mysuru. 37 participants attended the webinar which covered topics such as processing of locally grown agri-commodities, ingredients and formulations for variety of papads, murukku and vermicelli, nutritional aspects, FSSAI standards etc.

4. Skill Development Programme on "Baking Technology" with NSDC certification (Nov15,2021to Dec10,2021)

A 4-week Skill Development Programme on "Baking Technology" catering to the needs of fast-growing baking industry was conducted as per the National Skill Development Corporation (NSDC) guidelines. The programme was inaugurated by Director, CSIR-CFTRI and expert scientists from the Institute provided hands-on training on choice of quality ingredients, product development, quality criteria etc. Insights on packaging aspects, FSSAI guidelines,

nutritional profiling, health and hygiene control were also provided. Topics covered were wheat milling, flour constituents, flour quality, dough rheology, leavening agents, bread, biscuit and cake making, traditional products etc. Craft baking was demonstrated by the experts from local bakery. To provide insight into commercial baking, visit to industry was arranged for the participants. Apart from certificates of the Institute, NSDC certificates were provided to the successful 18 participants who attended the program.

5. Online Workshop on Intellectual Property with Emphasis on Food Processing (Jan 19, 2022)

This workshop focused on Intellectual Property Rights in food processing through different case studies and explored the opportunities in the innovation driven industry where IPR skills are most essential. Five leading IPR experts of the country and two experienced professionals on patent law have shared their experience with the participants in this programme. Topics like Filing IPR, Patent Search Database, Impact of Innovation & IP in India, Commercialization of IP, Biodiversity Act with focus on Food processing etc. were covered. A total of 49 participants attended in this online workshop.

6. Online workshop on 3Ps of Food Industry: Processing, Preservation & Packaging (Mar 3-4, 2022)

Institute conducted a two day programme under the CSIR Integrated Skill Initiative for the benefit of Entrepreneurs / Startups working in the area of food processing. Thirteen speakers consisting of senior faculties within the Institute, food safety officials and faculty from

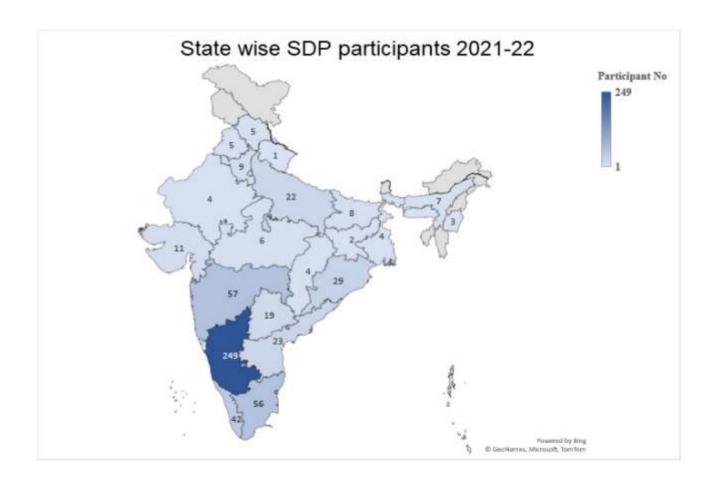


DFRL, Mysuru have delivered lectures in this workshop. Several topics related to Food Processing, Preservation & Packaging were covered. Latest technologies available in the market were explained for the benefit of 175 participants registered for the workshop.

7. Online Workshop on Bakery Units for Urban & Rural Markets: Bringing Sustainability (Mar 29, 2022)

Bakery products have become popular in India and is evidenced by a two-fold increase in production during last five years. To capture the rising market, the budding entrepreneurs/micro-entrepreneurs/startups and SHGs needed

essential skills to sustain in the market and to meet the growing needs of the consumers. CSIR-CFTRI thus organised a webinar focusing on the raw material selection, arts & science of making different bakery products, packaging and food laws and newer trends in the bakery industry. The program was an ideal opportunity to those who have small bakery units in the rural and urban settings. Experiences were shared with the participants by the senior faculty members of the Institute and invited dignitaries from KVIC, MoFPI & MSMEs. Topics related to funding opportunities were also highlighted. A total of 47 participants attended in this online workshop.





b) Farmer's Training Programme under PMFME

The primary objective of PMFME scheme, introduced by Government of India and financially supported by both Central and State governments, was to enhance the competitiveness of micro-enterprises in the food processing industry and promote formalization of this sector. Besides supporting individuals, it also supports Farmer Producer Organizations (FPOs), Self Help Groups (SHGs) and Producers Cooperatives and their entire value chain.

One of the major components of the scheme is skill development through training and this has been carried out at different levels in order to ultimately train the beneficiaries of this scheme. The training of Master Trainers is the first level of training wherein Master Trainers from all the States and Union Territories are trained by the National Institutes/experts in the field. CSIR-CFTRI conducted All India Master Trainers Training Programme on "Grain Processing". The 4-day training programme was conducted during August 3-6, 2021. 12 participants from different States/Union Territories attended this training programme. The technical sessions and demo/self-learning sessions were conducted by the experts from the Institute. Interactive sessions were arranged after each class and participants actively took part in these interactive sessions.

CSIR-CFTRI also conducted three online training programmes on Entrepreneurship Development (EDP) for District Resource persons (DRPs) from Karnataka State. 53 participants from different districts attended the first training programme held on June 22-24,

2021. The second batch was scheduled during December 21-23, 2021 and a total of 129 participants from different districts attended the training programme. The third batch of training was held during March 2-4, 2022, which was attended by 98 participants from the state of Karnataka.

CSIR-CFTRI in association with KAPPEC, Bengaluru conducted beneficiary training programme on ODOP - "Guava processing" for farmers/beneficiaries of Koppala district, Karnataka. The training programme was conducted in offline mode for 5 days at Government Horticulture Training Centre-Munirabad, Koppala. A total of 39 participants attended the training programme. The training included domain skills (Introduction to PMFME scheme, Plant layout and maintenance, Equipment and specifications of machineries in Guava processing, Guava value addition, Packaging of fruits and vegetable products and Food safety regulations & certification).

CSIR-CFTRI has actively supported PMFME awareness programmes organized by KAPPEC, Bangaluru in both offline and online modes. CSIR-CFTRI participated in 7 training programmes (Coconut processing, Coffee processing, Turmeric processing, Jaggery making), organized at different districts of Karnataka, namely, Hassan, Kodagu, Chamarajanagara, Tumkuru, Ramanagara and Belagavi. Around 200 farmers/ beneficiaries/ FPOs attended each of these awareness programmes. The Institute also actively participated in Awareness Programme conducted by MIDC, Nasik for farmers from Maharashtra. Training mainly focused on processing & value addition, plant & machinery and maintenance of plant layout etc.



c) Establishment of Common Incubation Centres

Work on setting up of Common Incubation Centre under PMFME scheme was taken up at CSIR-CFTRI, Mysuru. The project funded by Ministry of Food Processing Industries, Government of India has been initiated to set up the following processing lines

- Processing line for banana-based products
- Minimally processed fruits and vegetables line
- Coffee based product line

The processing lines were selected based on One District One Product theme adopted by the scheme for promotion of industries in each district. Banana and coffee processing lines have been chosen considering the fact that Mysuru and Coorg have banana and coffee, as ODOP products, respectively.

Building renovation work has been completed and process of procuring equipment lines is in progress. On completion, this facility will be extended to entrepreneurs to carry out commercial production as per the terms and conditions laid down by the funding agency.

d) Farmer Centric Activities / APEDA Programme

Under the farmer centric activities, ten workshops cum training programs were conducted during 2021-22. A total of 285 farmers benefitted from these courses. Out of these, five courses for the farmers of Maharashtra were conducted through online mode. The other five courses were conducted offline at their respective places. About 50 farmers

mostly women participated in the hands-on training programme on food processing at MM Hills, Karnataka. The training programmes sponsored by APEDA were conducted at four cities of the North-East States viz. Dimapur (Nagaland), Shillong (Meghalaya), Agartala (Tripura) and Gangtok (Sikkim). A total of 150 farmers, SHGs, entrepreneurs from NE participated in these APEDA sponsored programmes.

The Farmer Centric Training Programmes conducted are as follows:

- Cashew Nut processing: Quality, value addition and marketing held on August 11-13, 2021 sponsored by Rajapur cashew cluster, Ratnagiri, Maharashtra (20 participants)
- Grape processing: Quality, value addition and marketing held on August 25-27, 2021 sponsored by Vinita Raisin cluster, Niphad, Nashik, Maharastra (15 participants)
- Rice processing and marketing held on August 30–September 01, 2021 sponsored by Rice cluster-ANDAD Agro foundation, Shahapur, Dist-Thane, Maharastra (20 participants)
- Grape processing: Quality, value addition
 marketing held on Oct 27-29, 2021



Hands-on training programme at MM Hills



- sponsored by M/s MMB Raisin & Fruit Cluster Association, Nashik (15 participants)
- Value addition to fruits, vegetables & spice processing at Dimapur, Nagaland held on Nov 15-19, 2021 sponsored by APEDA, Guwahati (35 participants)
- Value addition to fruits, vegetables & spice processing at Shillong, Meghalaya held on Nov 22-26, 2021 sponsored by APEDA, Guwahati (35 participants)
- Processing fruits, Veg. and Spices held on Dec 28-30, 2021 sponsored by M/s, Akola Wala Food Processing Association, Mumbai, Maharashtra (15 participants)
- Food Processing held on Mar 8, 2022 sponsored by MM Hills (50 participants)
- Value addition to fruits, vegetables & spice



APEDA sponsored training programme at Dimapur (Nagaland)



APEDA sponsored training programme at Gangtok

- processing at Agartala, Tripura held on Mar 14-18, 2022 sponsored by APEDA, Guwahati (40 participants)
- Value addition to fruits, vegetables & spice processing at Gangtok, Sikkim held on Mar 21-25, 2022 (40 participants)

e) Training to Women SHGs

Training programme was held in the Institute on ragi and value-added products from ragi was conducted during Dec 6-8, 2021 for women SHG supported by WASSAN and District Mineral Foundation, Keonjhar under Odisha Millet Mission. Demonstration of degluming, destoning and roasting of ragi and different ragi processing methods were explained in detail. Fifteen participants attended the workshop.

f) Training Program to Women SHG identified by GRAAM

Onsite training program was conducted for the technologies transferred to women SHG identified by GRAAM at Bilikere village, Mysuru,. Scientific and technical assistance for machinery specifications and product protocol were provided. The products viz. ragi mudde mix and malted weaning foods were





launched on March 15, 2022. These products were successfully commercialized in the market including the online platform.



g) Training programme on chilli processing and value addition exclusively for chilli processing cluster, Maharashtra, Jan 05-07, 2022

About 16 participants which include, young IT professionals/start-ups, progressive spice growers/farmers, entrepreneurs and other stake holders from various districts attended the program. Expert faculty from the institute shared their experience and explained the potential of the spice industries. The training programme consisted of classroom sessions followed by the demonstration as given below:

 Processing of fresh chilli fruits (blanching, colour fixing, drying, and packing)



- Chilli sauce (red chilli: hot/tomato/sweet)
- Preparation of hygienic spice powders
- Encapsulation of spice oils and oleoresins

The participants had a first-hand experience about the pilot plant facilities available at CSIR-CFTRI. The demonstrations were useful for the potential entrepreneurs, start-ups, farmers and the research students. A visit to industry (M/s. Poustik Agro Food Products, Hebbal Industrial area, Mysore) was arranged to know the commercial aspects of chilli processing.

h) Capacity building training programme on rice processing and products for Shahpur cluster, Thane, Maharashtra

CSIR-CFTRI organized a farmer-centric online training program for Shahpur rice cluster, Thane, Maharashtra on "Rice Processing and Products" from Aug 30, 2021 to Sept 01, 2021.

i) Training programme on fruits & vegetables

CSIR-CFTRI conducted a "Quality Control cum Hands on Training Programme on fruits & vegetables processing" for students from RBVRR, Womens College, Hyderabad which was sponsored by RBVRR Womens College, Narayanguda, Hyderabad. This program was held on Aug 23-25, 2021 with 26 participants.

j) Training programme on millet processing

Hands on training programme on millet processing for woman participants from ALEI, Hyderabad sponsored by ALEI was conducted on Aug 23-25, 2021. Demonstrations on millet



cakes, millet bar, biscuits, popped millets, millet based fryums, ragi vermicelli, millet porridge, soup mix, extruded millet snack with spice, chocolate and honey jaggery coatings were held which had 12 participants.

III. Entrepreneur Development Programmes (EDPs) Conducted:

 EDP cum Skill Development Program on Food Processing (June 28, 2021)

Thirty prospective participants under NAHEP-Centre for Advanced Agriculture Science & Technology project funded by ICAR at CSA University of Agriculture and Technology, Kanpur participated in EDP cum Skill Development Program on Food Processing.

 EDP/Skill Development Programme about CFTRI technologies for the prospective women entrepreneurs (July 29, 2021)

Thirty-five women entrepreneurs who were interested to set up food and agro based units participated in this programme sponsored by VIBHA (Vigyan Bharthy), Lucknow at CFTRI RC Lucknow.

 EDP cum Skill Development Program on Food Processing for the prospective women entrepreneurs (Sept 27-28. 2021)

Forty women entrepreneurs from various Self Help Groups (SHGs) working in Uttar Pradesh under Women's Empowerment Program of NABARD participated. This training programme was conducted at CFTRI Resource Centre, Lucknow.

 Training cum demonstration programme for the students, faculty and leading entreprenuers (Oct 27, 2021)

Thirty-two participants consisting of students, faculty and leading entreprenuers from Chaudhary Charan Singh University, Meerut participated. This training programme was conducted at CFTRI Resource Centre, Lucknow.

 Online lecture series on food processing and preservation (July 14-16, 2021)

Twelve online lecture series on Food Processing and Preservation to EDP Participants sponsored by MANAGE, Hyderabad was conducted.

IV. JIGYASA 2021-22

Student-Scientist Connect Program

As a part of JIGYASA Student-Scientist connect programme, students of Jawahar Navodaya Vidyalaya, Mysuru visited the institute on Nov 22, 2021 in which 30 students and 5 teachers participated. Visit to various R&D laboratories of the Institute, interaction with scientists and research scholars were arranged.





• Quiz for school students at CSIR-CFTRI

Three quiz programs were held for VIII and IX standard students of Kendriya Vidyalaya, Mysuru, Hassan, Mandya, Chamarajanagara, BRBNMPL, Kodagu and students of Jawahar Navodaya Vidyalaya, Mysuru, Chamarajanagara, Hassan and Mandya. The students got the opportunity to visit the facilities of CSIR-CFTRI and interact with the scientists. Quiz programmes conducted under JIGYASA are:

 A preliminary online and offline quiz was conducted for KV Students on Dec 21, 2021 & Mar 21, 2022 respectively with the participation of 75 students and 12 teachers



- An offline quiz for JNV students was conducted on Mar 03, 2022 with 24 students and 05 teachers
- Visit of Jigyasa team to GHS, Kumbarakoppalu and Marballi Mysuru

CSIR-CFTRI along with Agastya International Foundation visited Govt. High School, Kumbarakoppalu and Marballi, Mysuru on 28th Feb and 18th March 2022 respectively and organised demonstration cum hands on experience for detection of starch in foods and food adulteration tests using the kit developed by CSIR-CFTRI. About 300 students and 20 teachers participated in the program.



Progress Under R&P Projects



ENGINEERING SCIENCES

Processing spices, gums and juices by alternate technology (Rastogi NK)

Curcumin-removed-turmeric-oleoresin (CRTO) is an underutilised by-product of the turmeric industry. Organic-Solvent-Nanofiltration (OSN) technique was proposed for the concentration of volatile oil and bioactive turmerones. The solvent selection with model non-volatile solutes revealed that hexane and ethyl acetate are promising solvents. Processing of the model volatile solute with a suitable membrane revealed that the OSN technique could improve the aromatic-turmerone content. In extracted CRTO-oil processing, the less hydrophobic solvent-resistant-nanofiltration membrane exhibited the highest selectivity for volatiles increasing from 82.7% to 95.7% in the ethyl acetate phase. Correspondingly, the aromaticturmerone content and total turmerones increased from 16.3% to 20.6% and 54.8% to 69.5%, respectively. The oil flux increased by nearly ten-fold with the same membrane while processing in the ethyl acetate phase compared to undiluted oil. The results demonstrated that membrane-solvent interaction is critical in OSN processing, and solvent dilution significantly impacts the productivity and turmerone content of the processed oil.

Nanofiltration membranes for the processing of vegetable oils (Rastogi NK)

The chemical pre-treatment was attempted at miscella strength (25%) and the efficiency of

pretreatment was evaluated in terms of phosphorus reduction in treated oil. As optimised by response surface methodology, alkali based chemical pre-treatment (4 mg/g-oil NaOH concentration, 1200 rpm, 30 min) resulted in reduction of colour (50-60%), phosphorus (>92%) and FFA (≤0.25%), while leading to higher oil recovery (~97%). Membrane and chemical pre-treatment methods had comparable oil recovery and reduced phosphorus content below 30 ppm. The treated miscella was subjected to 2-stage membrane desolventisation for solvent recovery, which resulted in <1% oil concentration in the solvent.

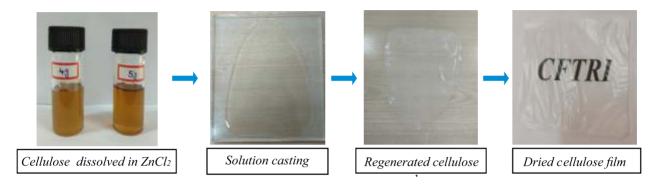
Regenerated cellulose films using zinc chloride molten salt hydrate (Jeevan Prasad Reddy)

A facile method was developed to prepare transparent cellulose film. Regenerated cellulose films were prepared by dissolving microcrystalline cellulose (MCC) in molten zinc chloride salt hydrate solvent. The effect of MCC content (4 g and 5 g) on the structural, mechanical and morphological properties of films were studied using FT-IR, XRD, SEM and optical microscope. The maximum tensile strength for regenerated cellulose film is 32.2 MPa for the 5 g MCC content. Structural analysis from FT-IR and XRD studies revealed that the regenerated films possess cellulose II structure. The microscope images show the homogeneous and uniform surface of the



regenerated films. The water absorption studies confirmed that the regenerated cellulose film has the ability to absorb 58% by its weight of water. Regenerated cellulose film

prepared by this method has good mechanical and water absorption capacity and has the potential to be used as a moisture-absorbing material in food packaging.



Preparation of regenerated cellulose film



TECHNOLOGY DEVELOPMENT

Immune boosting wheat based food formulations (Prabhasankar P)

Immune-boosting wheat based foods are needed to improve the immunity of the targeted population and provide a prophylactic measure to combat various pandemic diseases. Bread is one of the staple foods, widely accepted and consumed, and is a prime mode to impart any functional attributes. In this regard, a combination of immune-boosting ingredients has been tried and tested, imparting immunity. The histopathology assays showed that the developed product had a similar effect as the standard antiimmunomodulatory drug. The study helped to understand the effect of immune boosting ingredients based formulation and wheat germ as an ingredient that has an immunomodulatory effect in the final product formulation and does not lose its efficacy even in the developed product. The Immune Boosting Ingredient (IBI) mix powder and immune boosting bread showed high activity of immunomodulatory effect by inhibiting the responses and resisting the humoral trigger of Sheep Red Blood Cells (SRBCs). The histopathology assays showed that the developed product had a similar effect as the standard anti-immunomodulatory drug. The findings imply that the developed immune boosting bread has significant anti-inflammatory properties, perhaps enhancing the immunological response to inflammation.

Millet based gluten-free bread

(Prabhasankar P)

Celiac disease is an auto-immune disorder that

causes chronic inflammation in small intestine triggered by ingestion of wheat gluten and related proteins also from rye, barley and triticale. The only safe and effective treatment for celiac patients is strict lifetime adherence to gluten free diet. Millets are gluten free and low glycemic in nature. Physical, functional, pasting and nutritional composition of selected millets and its flours were evaluated. Foxtail millet bread was optimized using addition of enzymes which help in increasing the gas holding capacity in dough and also helps in network formation. Optimized foxtail millet bread has higher volume (345 cc) and specific volume (2.09 cm³/g) than control bread (308 cc. 1.69 cm³/g). Textural studies showed that optimized bread has lower hardness (50.53 N) than control bread (87.01 N). Microstructure studies revealed that enzyme addition causes uniform distribution of protein and starch similar to wheat bread. Sensory studies showed that optimized foxtail bread was acceptable with good colour, shape and uniform cell distribution than foxtail control. Proso millet bread was optimized using hydrocolloids. It helps in increasing the loaf volume and specific volume of optimized one compared to proso control. Hardness of optimized bread (109.78 N) is significantly lower than that of control (54.19 N). Microstructure studies shows that better network formation in optimized bread helps in holding gas produced during fermentation. Complete barnyard millet bread was optimized using extraneous protein and starch addition. The optimized bread has lower bake loss (%) and higher load and specific volume than control. Addition of



protein source helps in maintaining the structure of bread. Optimization and storage studies of millet based gluten free bread premixes were also completed.

Synbiotic beverage for healthy aging (Negi PS)

Food products with live microorganisms have been receiving a great attention due to their proven health benefits. The synbiotic beverage was designed considering the growing demand for non-dairy probiotic beverages. Earlier studies showed suitability of pineapple juice with Lactobacillus rhamnosus the probiotic strain, and inulin as prebiotics for synbiotic beverage development and showed the cell count of more than 6 log CFU/ml, as well as maintained nutritional and nutraceutical properties at the end of 2 months storage. The synbiotic beverage was subjected to GC-MS analysis to determine SCFA content and the acetic acid and hexanoic acid content were found to be 22.5 mM and 1.1 mM, respectively. The synbiotic beverage also retained 4 log CFU at the end of in vitro gastric tolerance assay.

Industrial scale cold plasma unit for decontamination of fruits and vegetables (Negi PS)

The escalating demand for food production also has led to increased use of pesticides, and presence of hazardous chemical residues on the surface of various fruits and vegetables are widely reported. It is also reported that around 48 million cases of food related diseases occur per year due to infectious microorganisms, and many among them are attributed to the consumption of fresh fruits and vegetables. A number of contaminant (pesticide and

microbes) removal techniques and processes are available in the scientific world, however, the information is scarce on cold plasma. An industrial scale cold plasma unit (100 kg/h) was fabricated. Treatment of tomatoes at 25 KV for 5 minutes showed a significant log reductions as compared to untreated tomatoes.

Target specific grain-based products (Sreerama YN)

Distribution of soluble and bound phenolics in whole and milled fractions of Browntop millet and their inhibitory effects on starch hydrolyzing enzyme activities: Regulation of postprandial hyperglycaemia is critical for the treatment of diabetes. Alpha amylase and glucosidase are the two key enzymes involved in dietary starch hydrolysis and glucose absorption. Inhibition of these enzymes could prevent diabetic complications. Browntop millet (Urochloa ramose L.) is a minor millet and is a rich source of bioactive phytochemicals. Phenolic contents, antioxidant properties and inhibitory effects on α-amylase and α-glucosidase were comparatively evaluated. Hull and bran fractions recorded more than 85% of total phenolic and flavonoid contents compared to other fractions. Gallic, caffeic and coumaric acids were predominant phenolic acids and daidzein, naringenin and kaempferol were major flavonoids detected in both soluble and bound fractions of whole-grain and milled fractions. It also inhibited α -amylase and α -glucosidase in a dose-dependent manner with IC₅₀ values 19.8-178.5 μ g/ml and 26-82.7 μ g/ml, respectively. Thus, Browntop millet and its milled fractions may serve as potential ingredients in functional foods.



Among pulses, green gram is one of the rich sources of calcium apart from protein and other nutrients, which is removed during the process of milling and hence, the by-product is a potential source of valuable food ingredient which needs to be explored. Green gram milled by-product was obtained from a pulse processing unit and fractionated. It was observed that the mineral content especially calcium varied among the fractions with the aspirated fraction having the major calcium content (949 mg/100 g). However, the bioaccessible calcium (40.4 mg/100 g) was the highest in the +18 fraction. This fraction also had the highest protein content (28 mg/100 g) with an in vitro protein digestibility of 58%.

Functional foods for phenylketonurics and gastritis (Shruti Pandey)

Phenylketonurics (PKU) is an in born error of amino acid metabolism and there are less food choices for phenylketonurics. Thus, the aim was to develop flour with low phenylalanine (Phe) content which can be used to prepare products. The sample A was formulated using

corn starch, potato starch and gelatin, in a ratio of 1:1:0.22:0.004. Premix, (nutrient mix) was added at 0.02% level, for sample A. For sample B, corn starch, potato starch, gelatin, carboxy methyl cellulose (CMC) were added in a ratio of 1:1:0.22:0.022:0.004. In sample A and B, 210-213 mg of Phe/100 g, was reported which is well within the permissible limit for Phe intake is 295-1200 mg/day intake for an adult. The shelf life of the samples developed was 2 months. The sensory score for biscuits developed from flour sample B were higher as compared to sample A. However, both the types of biscuits were acceptable.

Millet value chain for export markets (Jayadeep A)

Development of phyto-nutrient rich instant millet mixes and traditional convenient millets based instant mixes were carried out. Two varieties namely normal and spirulina fortified Multi Millet Mix (MMM) for gluten free beverage was developed. It is 60% millets, gluten free, rich in phytonutrients, ready-to-cook and can be used for beverage or porridge.



Normal and Spirulina fortified Multi Millet Mix for gluten-free beverage



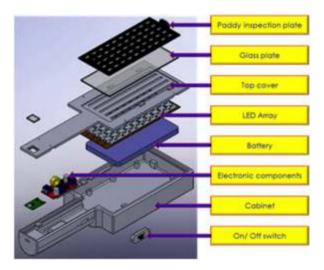
Cowpea tofu as functional food (Mohan Kumari HP)

Cowpea tofu was prepared with different types of coagulants and concentrations. Prepared cowpea tofu was analyzed for shelf life and consumer acceptability. The shelf life study of pasteurized (tofu and milk) and unpasteurized (tofu) samples were carried out for 28 days under refrigerated conditions. There was no growth of aerobic colonies, yeast and mould, and coliform in pasteurized samples stored up to 28 days. Consumer acceptability of cowpea tofu was performed on four different types of coagulants (CaSO₄, CaCl₂, MgCl₂ and citric acid) for parameters like appearance, hardness/texture, taste and overall consumer acceptability. The report revealed that cowpea tofu prepared with the addition of CaSO₄ with vanilla flavour was accepted by most consumers.

Gadgets for grains (Srinivas A)

Paddy crack detector: The device is aimed at non-destructively determining the number of paddy grains which have internal cracks. This device uses bright LED light source (white colour) powered by a rechargeable battery connected to charging circuit and on/off switch. Thus, this device is portable and can be used in the field also. The first prototype was designed, fabricated and tested. It was possible to check 25 paddy grains at a time. This unit was upgraded to another version wherein 50 grains can be checked at a time. The unit was tested for performance and found to be working satisfactorily.

Coefficient of friction meter: The device is aimed at determining the coefficient of friction of grains against different surfaces. The first prototype was fabricated. The grains under test are placed on the load cell and initial weight of the grains is recorded by the system. The grains are spread over the plate and start button is pressed. The plate is hinged at the centre and the linear actuator starts pushing the plate at one end. The chute near the lower end diverts the grains to the pan which is placed on the load cell. Once the grains have fallen down, the linear actuator is stopped. An ultrasonic sensor with receptor determines the height of the plate. Then, the microprocessor calculates the coefficient of friction and displays the same on the TFT display unit. The unit was tested for performance.



Exploded view of paddy crack detector

Ragi based nutritious foods for community feeding (Usha Dharmaraj)

The main objective of the project was to develop products based on ragi suitable to use in take-home-ration scheme of Odisha



Government. Ragi laddu mix and the ingredients were optimized based on the Government norms to maintain the cost factor of the final product. Hence, the main challenge of the project was to prepare a nutritious product based on ragi which shows desirable sensory properties yet low in cost and needs low investment in machinery. Thus, roasting was chosen as the main processing step. However. roasting does not lead to complete gelatinization, a good number of trials were undertaken to optimize the roasting process in order to attain maximum gelatinization of the product. Accordingly, a ready mix, suitable to prepare laddu was prepared and its nutritional parameters, functional properties, sensory characteristics and shelf-life studies were undertaken. The product was successfully implemented in aspiring districts of Odisha State at pilot level, which helped more than 2 lakh beneficiaries. Single laddu weighing about 20 g each provided 2.18 g protein, 3.34 g fat, 15 g starch with 92 Kcal of energy and 33 mg of calcium. The product exhibited 5 months shelf-life. A ready-to-eat chatuua based on ragi was also developed under the project which provided 12.5 g of protein, 4.5 g of fat, 279 mg calcium, 2.4 mg zinc, 2.12 mg iron and 326 Kcal of energy per 100 g of the sample. As part of the project, one training program for the SHG members (14 No.) from Keonjhar district was arranged. The training program was for 3 days covering the basic aspects of ragi processing and also the process for preparation of ragi laddu mix. Two technologies namely, malted weaning food and ragi papad were also transferred to the

identified SHG from the same district. The demonstration for the technologies was also successfully conducted.

Millets and pseudocereals for preparation of nutritionally enriched products (Usha Dharmaraj)

The process parameters for fractionation of little millet were optimized and three edible fractions from the millet were prepared. The milling yield, optimum moisture content of the grains before milling etc. were standardized. The fractions were evaluated for nutrient contents and functional properties. Grain amaranth was milled following the known protocol to prepare a fiber, protein and mineral rich fraction. This fraction was evaluated for incorporation in maize flour to prepare the flakes. The optimum level of amaranth fraction tobe incorporated is at 30% and the final product contained 13.32 g protein and 22 g of dietary fiber. The shelf-life studies and sensory evaluation of the product were also completed. The product exhibited 3 months shelf life. Amaranth fraction was also incorporated with wheat to prepare protein and mineral rich pasta. It was observed that the amaranth fraction can be incorporated up to 25% level to prepare pasta of desirable sensory attributes. The physico-chemical analysis of the product such as nutrient composition, cooking time, cooking loss, water absorption capacity etc. were studied. Little millet polished to different levels was subjected to extrusion cooking. Optimization of process parameters and evaluation of the physico-chemical characteristics of the extrudates are being carried out.



Empowering ragi and other small millet growers of Odisha State (Usha Dharmaraj)

The main objectives of the project were to develop ragi based products suitable for incorporation in take-home-ration and to conduct training programs on millet processing. A ready-to-eat ragi based chattua was prepared without milk powder as an ingredient since, incorporation of milk powder increased the final cost of the product. The nutritional, functional, sensory and shelf life studies of the product were evaluated. A ready-to-cook ragi chatuua was also developed and the nutrient analysis for the same is being carried out. Apart from these, ragi semolina, ragi semolina based idli mix, ragi semolina based upma mix, ragi semolina based kesaribath mix, ragi based instant dosa mix, ragi based instant halwa mix and ragi based kichadi mix have been formulated and studies are underway.

Bio-functional meat and egg based snacks and beverages (Suresh PV)

Development of egg chips: The study investigated the development and characterization of chips from whole chicken egg, egg white, and egg yolk. Studied different ingredients formulation using liquid eggs and binders (corn, potato, tapioca, jackfruits, and their combination) for the preparation of egg chips. In general, egg

white chips exhibited the highest breaking/ fracture force and stiffness, followed by whole egg and yolk chips, irrespective of starches incorporated. Furthermore, tapioca starch followed by potato starch enhanced the hardness and crispiness of all egg chips. Whole egg chips incorporated with potato starch showed the best overall acceptance by the panelists. However, egg white and yolk chips incorporated with tapioca+potato starch had higher overall acceptance by panelists. All egg chips presented the moisture, protein, fat, ash and carbohydrate content in the range of 1.43-2.46%, 7.40-10.85%, 20.52-44.95%, 2.18-3.37%, and 39.40-67.44%, respectively. Overall, whole egg chips and egg white and volk chips could be prepared with optimized binders.

Duck egg white hydrolysate powders for snack/beverage products: Duck eggs are a rich source of protein for developing nutritional snack and beverage product. The study investigated the development and characterization of protein hydrolysate powder from duck egg white. The hydrolysate was prepared by digesting duck egg white using Flavourzyme® at the hydrolysis conditions of 19 h and enzyme/substrate ratio of 350 unit enzyme/100 ml of duck egg white. Antioxidant capacity of the hydrolysate was measured by %ABTS radical scavenging activity. The



Whole egg white chips



Egg yolk chips



Egg white chips



hydrolysate was dried by freeze and spray drying methods. Duck egg hydrolysate freezing temperature and glass-transition temperature were noted using a differential scanning calorimeter. Results of these studies suggested that the duck white hydrolysate and duck egg white hydrolysate powders prepared could be exploited for the production of nutritional snack/beverage products for the management of current malnutrition scenario of the nation. Development of nutritional snack/beverage products using the duck egg white hydrolysate powder is under progress.

Egg and meat based value added products using REPFED technology (Sathish HS)

Chicken tidbits and chicken manchurian are two popular snack items in India and presently these products are not available in RTE form with extended shelf life of 10 and 60 days. This project aims to develop products packed in retort pouches and storing at refrigerated conditions for extended shelf-life. Microbiological

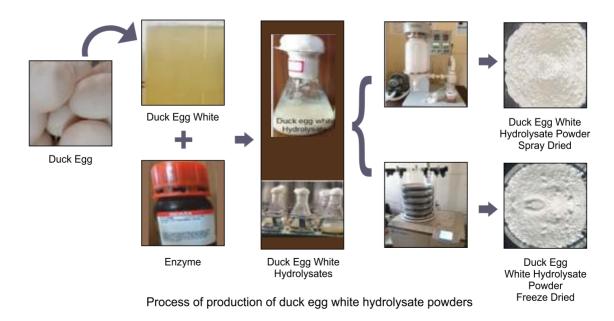
studies were conducted on samples prior to heat processing and immediately after heat processing to ascertain the reduction in microbial count. Results indicated that, all the microbial counts were well within the limits and no pathogenic bacteria were detected. Hence,





Chicken manchurian and chicken tidbits packed in pouches

the products were microbiologically safe at the end of 10th day and 60th day. Sensory studies were also carried out on chicken products in pouches stored under refrigerated conditions. The overall rating was about 6.5 to 7 and products were highly acceptable. There were no significant changes in the colour and aroma of the products.





Biomolecules from spices and plantation crops for the prevention and control of COVID-19 (Nagarajan S)

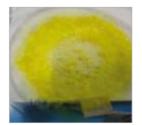
It was proposed to evaluate efficacy of some of the biomolecules from spices/ plantation crops for prevention and control of COVID-19 with a functional food approach. Under this context pure compounds viz., garcinol, cyanidin-3glucoside, cyanidin-3-sambubioside from kokum, thymoquinone from black cumin were isolated. In addition, dithymoguinone was synthesised from thymoquinone by photodimerization. The cytotoxicity levels of the isolated compounds were evaluated (MTT assay) with IC₅₀ values (0.4 µg to 5.5 µg) and optimised. Preliminary evaluation studies on the ACE-2 receptors showed inhibition with the concentrations of 0.1 µg to 5.5 µg levels. Further, the optimization of bioactive potential of the isolated compounds for their antiviral properties by in vitro methods along with inhibition studies of ACE-2 and M-protease which can be used for the preparation of formulation with the bioactive molecule(s) for the control of COVID-19 were conducted.



Black cumin







Thymoquinone Crystals

Ayurvedic food formulation and assessment for immunomodulatory effect (Madan Kumar P)

The study was aimed to evaluate the antiinflammatory and immunomodulatory effects of the ayurvedic formulation using in vitro and in vivo models. The anti-inflammatory potential of ayurvedic formulation was tested in 3T3-L1 cells that are challenged with lipopolysaccharides (LPS). The immunomodulatory effect of the ayurvedic formulation was studied in cyclophosphamide-induced Wistar rats. The phenolic, flavonoid and antioxidant content was found markedly high in the ayurvedic formulation. In LPS-stimulated 3T3-L1 cells, the protein levels of TNF-α and IL-6 were significantly upregulated compared to the untreated cells. While pre-treatment of ayurvedic formulation markedly downregulated the pro-inflammatory markers. Ayurvedic formulation showed immune modulating and anti-inflammatory effects in cyclophosphamideinduced rats in compliance with all the regulatory requirements. The administration of ayurvedic formulation to female Wistar rats did not cause any mortality and biochemical changes between the groups. Overall, the ayurvedic formulation used in this study exhibited potent anti-inflammatory and immune modulating effects.

Functional validation of COVID-19 Main Protease (Mpro) inhibitors (Vijayaraj P)

The protease, particularly COVID-19 main protease (Mpro) activity, is vital for the self-replication of the viral RNA. Hence, Mpro is an attractive drug target due to its essential role in processing the polyproteins translated from the



viral RNA. The study aimed aty identification and functional validation of neutraceuticals molecules for the Mpro inhibition. The inhibitory potential of the neutraceutical molecules was validated by enzyme assay using fluorescentbased enzyme assay in various physiological conditions to monitor the stability of the compounds. Interestingly, the maximum inhibitory activity was observed with a range of dietary molecules. The study provides experimental evidence for the potent Mpro inhibitor molecules, which are part of our Indian diet. These results help to formulate personalized food to combat COVID-19. Further, the empirical evidence will pave the way for further in vivo validations.

Immunity-boosting shelf-stable probiotic curd enriched with *Bifidobacteria* (*Prakash M Halami*)

Evaluation of probiotic functionalities of novel probiotic formulation (combi curd) in animal model was studied using SRBC-induced humoral immunity and PHAP-induced cell mediated immunity. Probiotic combi curd formulation shows that the viability of all the probiotic cultures is maintained in sufficient level to explore its probiotic attributes with good curdling properties. Combi curd imparts health benefits that vary among the three strains used in the product. Probiotic combi curd is effective in increasing level of anti-oxidant enzymes with the low haemagglutination titre. This also resulted in poor infiltration of neutrophils in different organs with normal DLC count in SRBC group. In PHAP group, it shows better stair climbing ability and decreased paw thickness. Combi curd was observed to lower the level of lactate dehydrogenase and CRP protein. These results clearly indicate the health benefits of two probiotic cultures in preclinical trials.

Spirulina arthrospira and D. hamiltonii as prophylactic and ameliorative nutraceutical adjuvant to COVID-19 virus therapy (Giridhar P)

Revalidation of the antioxidant potential (FRAP) of the prepared blend (*Decalepis* and *Spriulina*) was performed and the results were found to be on par with the preliminary data. Cytotoxic effect of *Spirulina* and *D.hamiltoni* in macrophage cell lines were analyzed. The results indicated that *D. hamiltonii* extracts showed immunomodulatory properties in *in vitro* (cell line) model.

Silkworm pupae products for human and animal consumption and composting (Sachindra NM & Shinde Vijay S)

The development of a process for utilization of spent and fresh pupae for the production of animal feed and human food is undertaken to valorize the by-products of the sericulture industry. Silkworm pupae are a rich source of proteins (59.39%), lipids (29.15%), and other bioactive compounds. Hence, it is essential to utilize the pupae efficiently for the production of



Different products developed using Silkworm pupae



value-added products on a commercial basis. Multiple products such as pasta, cookies, beverages and mayonnaise incorporated with dried silkworm pupae (*Bombxy mori*) powder (SWP) as an ingredient are being developed. Incorporation/substitution of SWP in the traditional ingredients at different levels (5, 10 and 15%) in the products has been undertaken and 10% w/w incorporation of pupa powder is seen to be sensorially acceptable. Also, evaluation of spent silkworm pupae as an ingredient in poultry feed - meat in broilers and egg production in layers is underway.

High protein food formulations with improved digestibility (Jyothi Lakshmi A)

The raw and germinated soya flakes were prepared which contained 41-42% protein and 20-25% fat. The soya dhal was flaked after suitable hydrothermal treatments to obtain soya dhal flakes, the nutritional value of the flakes increased marginally due to loss of moisture and the anti-nutritional factors. The flakes were coated with suitable flavouring agents like spices, sugar and chocolate. The energy provided by roasted soya bean and soya-flakes were 464.19 and 479.83 Kcal respectively. Sensory scores increased on flaking and the chocolate coated flakes received higher scores than the plain flakes.

'Protein water' was prepared using soya protein hydrolysate in RO water at different concentrations ranging from 0.5-1.5%. Solubility, turbidity tests and sensory analysis were done to optimize the protein content. Microbial load pertaining to the long-term storage at 4°C and at room temperature was evaluated. The turbidity measurements and sensory studies indicated the acceptability of

the water at 0.5% level. The microbial analysis of fresh, carbonated samples stored at room temperature and 4°C were evaluated. Samples stored at 4°C was safe till six months. Consumption of 1 L of this protein water would meet around 10-15% of RDA for adults.

A wheat based complementary food mix was formulated with enhanced bioaccessibility of iron and zinc. The product contained 17 g protein, 11.9% fat, 433 Kcal, 12 mg iron and 6 mg zinc per 100 g of dry mix. The bioaccessibility of iron and zinc with all the selected fortificants and promoters was found to be 26% and 30% respectively in the final product. The product had a PDCAAS of 0.9 for children. The enhanced bioaccessibility of iron and zinc was validated in corresponding mineral deficiencies induced rat models. The complementary food was fed to the deficient and normal rats and their efficacy in alleviating the deficiencies was evaluated. The feed intake and growth of the deficient rats improved, though not to the level of normal rats. Serum levels of iron and zinc of the deficient rats fed with the complementary food reached that of normal rats. The oxidative stress markers of the complementary food fed rats were in the normal range. This confirms that the enhanced bioaccessible iron and zinc of the complementary food was bioavailable and was efficacious in reverting the induced deficiencies.

Probiotic lactobacilli involved in β-mannooligosaccharides catabolism (Mukesh Kapoor)

Thermal decomposition studies of the purified CM-β-MOS (DP 2, 3 and 4) showed mass loss at high temperatures (135.8°C to 600°C). DP2,



DP3 and DP4 CM-β-MOS were adjudged as un-substituted Manß-4Man. Manß-4Manß-4Man and Manβ-4Manβ-4Manβ-4Man. respectively, using NMR (¹H and ¹³C) studies. Acetate was the predominant short-chain fatty acid produced by Lactobacillus sp. RT-PCR studies of *L. plantarum* WCFS1 fed with CM-β-MOS showed up-regulation (up to 6.7-fold) of the cellobiose utilization operon (pts23C and pbq6) and oligo-sucrose utilization loci (pts1BCA and agl2). Biochemical (free amino groups, carbonyl and fructosamine content), fluorescence (AGEs-specific and intrinsic) and molecular docking studies suggested the antiglycation potential of CM-β-MOS. Co-culture studies of generalist β-mannan degrader Bacteroides ovatus with probiotic B. adolescentis and Lactobacillus plantarum WCFS-1 were carried out on varied galactomanan substrates. B. ovatus grew well on polysaccharide substrates (0.5 % w/v) like guar gum, fenugreek gum, and locust bean gum and afterwards this conditioned media was used to grow probiotic B. adolescentis and L. plantarum WCFS-1. Both probiotic strains grew appreciably by attaining high log CFU/ml in the respective conditioned media. Further, bi- and tri-cultures of B. ovatus with probiotic B. adolescentis and L. plantarum WCFS-1 were also carried out to understand their feeding abilities, resource sharing and short chain fatty acid production.

Galactomanno-oligosaccharides as potential therapy for inflammatory bowel disease (Mukesh Kapoor)

Purified ManB-1601 hydrolysed guar gum and generated DP2 and DP3 and other low molecular weight GG-β-MOS (12.5% w/w). At

the end of the treatment, colitis control group registered a sharp decrease in body weight $(13.97 \pm 2.84\%)$ and decrease in food consumption (52.42 ± 1.70%) but marginally increased water consumption $(24.59 \pm 10.36\%)$. GG-β-MOS treatment group showed marginal increase in food consumption (up to 27.1 ± 8.7 p<0.0001), up to 1% increase in body weight and rise in water consumption (up to 29.11 ± 4.44 p<0.01). FOS group also showed increase in food consumption (35.72 ± 19.05 p<0.0001), 2.7% decrease in body weight and rise in water consumption (32.21 ± 5.28 p<0.01). DSS induced colitis led to shortening of colon length (4.58 cm \pm 0.27cm p<0.0001) when compared with normal group (6.54 cm ± 0.11 cm). Supplementation of GG-β-MOS and FOS in the diets prevented shortening of colon length (up to 6.5 ± 0.25 cm p < 0.0001). In the DSS induced colitis control group, decrease in weight, diarrhoea and rectal bleeding were observed during the course of treatment. GG-B-MOS administered mice had normal faeces and did not exhibit any diarrhoea or bloody stools till 6th day of treatment. However, from 7th day onwards, loose stools and mild rectal bleeding was observed. FOS treated group also exhibited loose stools and rectal bleeding from 7th day onwards. The DAI scores reduced in both GG- β -MOS (0.47 \pm 0.25) and FOS (0.39 ± 0.12) treatment groups.

Protein beverage for the diabetic population (Sachin M Eligar)

Pearl millet bran arabinoxylan oligosaccharides (AXOS) showed promising antiglycation effect and inhibition of protein aggregation *in vitro*. Further, sugar beet pulp (SBP), an agro-



industrial by-product rich in polyphenols was subjected to alkaline extraction and the extract showed potent activation of AMPK in high alucose-induced HepG2 cells. Hence, AXOS and SBP extracts were tested in vivo using a high-fat diet-induced diabetic mice model using C57BL/6 mice to control hyperglycemia and manage diabetic complications. Results revealed a significant reduction in hyperglycemia compared to diabetic control. The body weights of the animals in the treated group were reduced to normal weight after 8 wks of treatment. The increased oxidative stress, altered lipid profile, liver function and renal function were reversed due to AXOS and SBP extract treatment. The results are comparable with the positive drug, and these molecules have the potential to be used as nutraceuticals in supplementary foods. The processes for the extraction of AXOS and SBP extract were carried out at a lab scale and the process is scalable. Development of protein beverage and nutritional evaluation is under progress.

Mitochondrial fusion associated with mitophagy and exosomes (Anbarasu K)

Mitochondria (mt) are the major source and target of ROS including superoxide, byproduct of the electron transport activity, which can elicit apoptosis or mitophagy depending critically on the signaling balance. The SH3GL2 overexpressing cells produced large amount of superoxides as demonstrated by MitoSOX Red staining and exhibited increased mt fusion network compared to the control cells. Release of CYTC from mt to the cytoplasm is the central step in triggering mt apoptosis. Enhanced CYTC expression was observed in the

cytoplasm compared to mt in all the SH3GL2 over expressing cells. Accompanied with these molecular and mt associated changes, reduced proliferation, invasion and anchorage independent growth of the SH3GL2 over expressing breast cancer cells was also observed. These observations suggest for a functional link between SH3GL2 and mt reprogramming leading to apoptotic induction in the breast cancer cells.

Regulation of cytochrome p450 fatty acid monooxygenases by nutraceuticals (Mahesha G)

The project is an attempt to connect three distinct areas of biomedical research involving cytochrome p450 fatty acid monooxygenase, peroxisome proliferator-activated receptor and nutraceuticals. The objective is to see the role played by cytochrome P450 fatty acid monooxygenase in diabetes and its complications modulated by nutraceuticals via PPAR's. Nutraceuticals belonging to the flavonoid, guinone and phenol class of molecules were docked on to the crystal structure of PPARy (PDB ID-2 prg) using the Glide from Schrodinger and Autodock Vina software to see if they interact with the protein. 550 Flavonoids, 328 phenols and 89 quinone small molecules were used to see if they bind human PPARy ligand binding domain by molecular docking and molecular dynamics simulation studies. Based on the docking score, nutraceuticals which showed good ADMET properties were subjected to molecular dynamics simulation studies using GROMACS 5.1.4 package of molecular dynamics by using CHARMM 36 force field for



protein as well as protein-ligand complexes to identify potent nutraceuticals. Also, the role of eriocitrin and its metabolites in binding to PPARy were analyzed by docking, molecular dynamics and ADMET studies. Flavonoids had a range of binding energy from -14.583 to -10.169 kcal mol⁻¹. Phenols had a range of binding energy from -15.106 to -10.418 kcal mol⁻¹. Quinones had a range of binding energy from -11.913 to -10.488 kcal mol⁻¹. The 2D interactions of the screened ligands as well as a reference compound, pioglitazone in the active sites of receptor were visualized by using Glide software. The interaction of flavonoids was also followed under dynamic conditions using molecular dynamics simulation approach. Vicenin 3 was found to be better than pioglitazone, a well-known agonist of the protein in binding to PPARy.

Mulberry sericin powder for nutraceutical applications (Sridevi Annapurna Singh)

Sericin is gaining popularity due to its biomedical and biotechnological applications as well as due to its excellent water solubility and biocompatibility. The high serine content attributes towards high water holding capacity, making sericin ideal protein for food applications. Therefore, considering the value that sericin can bring to the silk production industry, sericin extraction and application as a smart protein remains inevitable in near future. Proximate analysis and amino acid profile revealed that sericin consists of ~91% protein rich in serine (~28%), aspartic acid (~18%), threonine (~9%), glutamic acid (~5%), and tyrosine (~4.7%). The water holding and oil holding capacity of sericin was found to be 3.8 ml/g and 1.7 ml/g,

respectively. Further, the foaming capacity, foam stability and emulsion stability was found to be 14%, 28.57% and 8.33% respectively. Process optimization for utilizing sericin for food and nutraceutical applications are under progress.

Value added products from coffee leaves (Pushpa S Murthy)

The efficiency of different drying methods and drying kinetics was assessed and its effect on the phytochemicals, volatiles and antioxidant potential from Coffea robusta leaves was analysed. Further, the effect of different steeping methods in the development of a coffee leaf beverage was explored. Chlorogenic acid was the major biomolecule accompanied by p-coumaric acid, quercetin, rutin, caffeine, trigonelline, and theophylline relating to its high antioxidant activity by ABTS and FRAP assays. Methyl salicylate imparts wintergreen warm-spicy aroma followed by 2, 4-decadienal in the dried coffee leaf powder. Hot infusions (HI) proclaimed significant extraction yield (47.7±0.23%), pH (6.54±0.03), total polyphenols (89.93±2.25 mg CGAE/g), CGA (33.01±0.47 mg/g) and caffeine (5.2±0.15 mg/g). HI has a better steeping process which was established by the quantitative descriptive sensory analysis with HI having an overall balanced sensory profile. Thus, the study provides insights on the valorization of coffee leaves and its approach in designing a nutraceutical or functional beverage.

Nutraceutical food products by incorporating nanoencapsulated curcumin (*Pooja J Rao*)

Bioavailability and anti-inflammatory activity of native and nanoencapsulated curcumin was

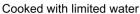


checked in vivo. The nanoencapsulated curcumin and the native curcumin were incorporated in the Indian Basmati rice and cookies. The results showed that the physical properties of native curcumin (0.092 mmol) and nanoencapsulated curcumin (0.069 mmol) incorporated rice (cooked) were at par with the plain cooked Basmati rice. The protein content of nanoencapsulated basmati rice was higher than native curcumin rice and plain basmati rice. There was no significant difference in TPC of nanoencapsulated curcumin incorporated and plain basmati rice, however, the native curcumin rice contained less TPC. The radicalscavenging activity of nanoencapsulated curcumin incorporated rice was higher than plain and native curcumin incorporated Basmati rice. The curcumin retention was more in nanoencapsulated curcumin rice than the native curcumin incorporated rice. The radicalscavenging activity of cookies with nanoencapsulated curcumin was higher than the cookies with native curcumin and untreated cookies.



Rice treated with nanoencapsulated curcumin







Cooked with excess water

NMR methods for qualitative and quantitative analysis of curcuminoids (Sachin R Chaudhari)

Existence of β-diketone form of curcuminoids is revealed by NMR spectroscopy. Detail molecular structure of demethoxycurcumin (DMC) and bisdemethoxycurcumin (BDMC) has been investigated by extracting and purifying curcuminoids (CC) from natural source in consideration of potential mechanisms for its specific biological activities. DMC and BDMC are having a similar structure to that of curcumin (CUR), however, their existence may be in β-diketone or keto-enol form. However, the structure and dynamics of CUR, DMC and BDMC that exist in tautomeric stability in solution state is less explored compared to CC. The results justified that CC has nearly 3% of βdiketone tautomer in dimethylsulfoxide solvent at 298 K. Further, results revealed that βdiketone form was favoured in alkaline pH condition whereas acidic and neutral pH conditions favour keto-enol tautomer. However, at higher temperatures, equilibrium shift towards β-diketone tautomer.

Sensory lexicon for selected coconut based products (Asha MR)

Development of a sensory lexicon for coconutbased products was undertaken. Commercial samples comprising selected coconut-based products were procured from two different local supermarkets and some samples of coconut oil were obtained from a retail dealer. Some samples were developed in the food processing laboratory of the Institute. A trained panel consisting of 7 members generated about 550 sensory descriptors for 27 categories of



coconut-based products, covering 48 samples, using "Free Choice Profiling" method (Descriptive Analysis). Sensory descriptor generation was conducted under white fluorescent light, with the booth area maintained at temperature 22±2°C and RH 50±5%. Sample was presented in transparent glass containers/white porcelain plates coded with 3digit random numbers, to the panelists, with a glass of warm water and a nearly bland biscuit for palate cleansing. After collection of descriptors, they were categorized under separate heads such as colour and appearance, texture, aroma, taste and mouth feel. Under each of these heads, the relevant descriptor was given a definition easily understandable to common man, with examples wherever possible, so that each sensory attribute was accompanied by statements of experiences of the known, to facilitate understanding the unknown. In the next step, the specific terminology was connected with the characteristic chemical compound, using GC-olfactometry and Solid Phase Micro Extraction (SPME) techniques for some compounds and reference from literature for some other aroma attributes. The outcome of the study was a Sensory Lexicon comprising about 170 sensory descriptors (comprehensive) with definitions (examples where relevant) for coconut-based products.

Milk or legume protein-based nutritional supplementation in infants (*Sridevi Annapurna Singh*)

The main objective of the project was to develop a supplementary food which is microbially safe and sensorily acceptable, as per the ingredient composition suggested by the sponsor.

Accordingly, the sweetener component such as sugar or jaggery, type of the oil namely sunflower or rice bran oil were standardized based on the sensory and microbial evaluation. The process parameters for preparation of the supplementary food was standardized such that the final product was microbially safe to be consumed by the target population. The supplementary food was evaluated for its nutritional parameters including minerals and selected vitamins and shelf life. The product exhibited almost 6 months shelf life when packed in Aluminium foil pouches. Shelf-life studies were carried out in two different packaging materials namely Al foil and CPP pouches and in both cases it was found that the product was acceptable till 6 months. The samples were prepared every fortnight once as per the requirement of the sponsor, and were sent to Chitradurga district for field trials. Total 13 batches of the products were prepared starting from July 2021 to February 2022, amounting to 455.63 kg of product in 9,905 unit packs. Each unit pack contained 46 g of the food and 7 such units were packed into a weekly bulk packet. The microbial load of the samples was estimated for all the 13 batches and its was observed that the microbial level was within the limits as per BIS specifications. The field trails were successful and the product was well accepted by the children of age group 6 months to 2-3 years.

Coconut flour in improving functional, rheological and nutritional properties of wheat dough (Roopa BS)

Coconut flour is a by-product from coconut oil industries used for better value addition and is a good source of dietary fiber and protein. To



obtain consumer acceptable dough-based products, the dough formulation with nonwheat flours implies technological challenges. To improve rheological and functional properties with good visco-elastic dough, it is very essential to have whole wheat flour (WWF) and coconut flour with high dietary fiber and good quality protein. The study was carried out to understand composite flour dough rheology and acceptable textural properties of chapathi. Optimal water quantity is a critical point to be considered when formulating dough with mixtures of wheat and coconut flour. The fundamental stress relaxation study at different composite flour ratio (20-35%), moisture (47-59%) and strain (25-50%) were selected to study and analyse the effect on rheological behaviour of dough. The initial and residual forces are increased with coconut flour and strains. The percent relaxation values are also increased with increasing coconut flour in composite flour stating that the required elasticity of dough at high coconut flour ratio is possible even at low level of WWF. With increase in moisture content of composite flour, dough decreases the initial, residual force and % relaxation. Contents of fiber, carbohydrates and protein of coconut flour are responsible for the structure of dough. However, upon adding above 35% of coconut flour, the hardness of dough was higher than that of whole wheat flour dough. However, fat content of the coconut flour has a major role as a lubricant and as such led to reduction in the hardness and toughness of dough.

Tender coconut water from shell to gel (Roopa BS)

Tender coconut water (TCW) is well known throughout the world as a dehydrating agent because of its balanced source of electrolyte (Na, K, Cl, & Ca), sugars, B vitamins, phenolics and bioactives. As TCW is susceptible to oxidation, several preservation techniques were attempted to preserve/ enhance natural organoleptic and nutritional properties. A novel solution is conceptualized with an objective of enriching the nutritional and sensory profiling of TCW by freeze concentrating technology. From organoleptic studies, the desirable sensory properties of TCW were transparent color and appearance, liquefied body, pleasant aroma with mild acidic note, optimum sour and sweet taste perception with astringent mouthfeel. Most importantly, the consumer behaviour or perception feeling for TCW is by the attribute pleasantness or freshness. Electrolytes of TCW were concentrated by using freeze drying technique by varying variables such as time, temperature, TCW volume, surface area, pre-treatment of TCW and °Brix. Results show the enhancement of total soluble sugars from 4.0 to 67.0°Brix without significant change in pH. There were marginal changes in colour, polyphenol oxidases and peroxidases. Similarly, minerals such as sodium, calcium, magnesium, potassium, phosphorus, iron and zinc contents increased significantly. The variables like time, °Brix and surface area during freeze concentration were the important factors.



Reactor for processing coconut based beverages (Sudheer Kumar Y)

The main goal of the project was to assess, improve and maximize the safety and quality (sensory) of UV-processed tender coconut water (TCW). A UV-C collimated beam reactor has been designed and evaluated for microbial inactivation in TCW for dose determination. A continuous UV-C reactor has been developed for the non-thermal processing of TCW. Initial experiments were carried out to optimize the reactor for dose validation and determine the inactivation kinetics of E. coli, L. monocytogenes and S. enterica in TCW. UV-C dose of 200-250 mJ/cm² proved to be ideal for the inactivation of microbes in TCW. Physico-chemical characteristics showed no variations in the UV-C treated coconut water. Moreover, the mineral content levels have been elevated in UV-C treated when compared to untreated TCW. The studies showed that the shelf-life of tender coconut water is 30 days at refrigerated conditions. There were no major changes in the sensory quality of UV-treated TCW when compared to untreated TCW. During storage, untreated coconut water samples have been spoiled within 24 h at room temperature and 48 h in refrigerated condition. The microbial analysis suggests that UV-treated TCW samples were safe for consumption up to 30 days at all temperature conditions.

Coconut-based products for sustenance in sports (Chetana R)

Spicy spread: A spicy fat spread was prepared using blends of Virgin coconut oil (VCO) and trans free fat (TFF). The stability of the product

is up to 6 months at 25°C and more than 6 months at refrigerated temperature.

Coconut spread: A fibery coconut spread was prepared from a blend of *trans*-free fat and virgin coconut oil in the ratio of 50:50 along with coconut fibre, whey powder, emulsifiers and flavours such as garlic, pineapple, chilli etc.

Beverage mix and chew: Concentration of mature coconut water (MCWC) by thin film evaporator and product development using MCWC as the base was carried out to make a beverage mix and a confectionery chew. MCW contains comparable amounts of sodium, calcium and magnesium, with the right amount of glucose very similar to that of ORS. Hence, MCW was used to formulate a natural ergogenic drink. VCO based spreads and MCWC was fed to rats to evaluate their exercisefatigue properties (Forced swimming test). Blood glucose, creatinine and urea clearance improved with supplementation of VCO based spread. MDA levels decreased and secretion of liver enzymes including ALP, SGPT and SGOT were also ameliorated. Results indicated increased insulin sensitivity, reduced



Spicy spread



MCWC chew



MCWC beverage mix



Fibery coconut spread



free radicals. Lipid peroxidation was lowered in the treated groups (VCO based spread) due to increased activity of antioxidant enzymes. Blood lactate levels were lowered in rat after swimming (15% weight).

Anthocyanin and polyphenol content of selected black and brown rice (Amudha Senthil)

The study aimed to determine the anthocyanin and polyphenol content of black and brown rice variety. Two types of black rice [Chakhao Poireiton, (Manipur) and Karupu kavuni (Tamil Nadu)] and one brown rice (Mapillai Samba, TN) were analysed for anthocyanin and polyphenol content. The total anthocyanin and polyphenol contents were determined by pH differential method and Folin-Ciocalteu reagent. The study revealed that among pigmented rice varieties Chakhao was found to have the highest anthocyanin (230 mg/100 g) and total phenol contents (216 mg GAE/100 g) followed by Mapillai samba and Karupu Kavuni.

Mango kernel fat for preparation of crunchy snack food (*Jeyarani T*)

Mango kernel fat (MKF) obtained from waste products of mango processing industries is hard at ambient conditions, rich in saturated fat, and thus was evaluated for its use in preparation of a traditional crunchy snack food. Physico-chemical characteristics of commercial MKF showed that the values were within the range specified by FSSAI. The fat was blended with hydrogenated fat at different levels and snack food was prepared using a standard recipe. The product was evaluated for moisture

(2.4%), fat (25.5%), protein (7.1%), colour, texture, sensory profile and fatty acid composition. Sensory characteristics were comparable with the product prepared using hydrogenated fat. With increase in the level of MKF, there was an increase in stearic acid and decrease in palmitic acid content. Based on moisture sorption isotherm studies, a shelf life of 56 days at ambient condition and 18 days for accelerated condition was predicted. This study indicated the potential for utilization of MKF for preparation of crunchy snack food with healthier fatty acid

Fruit pulps/peels and vegetable based snack bars (*Jyothirmayi T*)

Fresh Coccinia was purchased from local market, washed and dried in solar drier. The dried powder was incorporated in the preparation of biscuits (5, 10%) and ice cream (2.5 and 5%).

Dehydration of raw banana: Trials on microwave dehydration of raw banana was carried out by boiling water blanching in 1% salt, 0.25% citric acid and cooling in 2000 ppm potassium metabisulphite solution. Microwave drying of raw banana yielded good coloured product. Application of raw banana flour in biscuits was undertaken, however the acceptability of biscuits was poor. Further trials are under progress.

Vegetable snack bars: The standardized vegetable based snack bar was prepared using jaggery, dried carrot and beetroot shreds (20%), puffed amaranth (5%), roasted groundnut (5%), dark chocolate (5%) and vanilla essence. Proximate composition of the snack



bar indicated moisture 5.86%, ash 2.87%, protein 6.0%, crude fat 1.90%, crude fibre 2.5%, dietary fibre 6.17%, anthocyanins (22.34 mg/100 g) and β - carotene (20.46 mg/100 g). The vegetable bar was acceptable with a storage period of six months.

Shelf life extension of millets (*Jyothirmayi T*)

Trials were conducted by exposing millet grains of foxtail, bajra and pearl millet to solar radiation, heating in a cabinet tray dryer, roasting at 100-120°C for 5-6 min and microwave heating to reduce the infestation. Among the treatments, roasting was found to be most successful in reduction and minimising the infestation by pests followed by microwave treatment at 4 watts/g level. Extruded RTE snacks using foxtail millet alone and in combination with proso and green gram flours were prepared by extrusion using a single screw extruder at 140-170°C. The dried product was coated with spices for consumption as a snack product. The extruded products with spice coating showed good storage stability and was good even after 4 months in MPE pouches with nitrogen flush, whereas control sample without coating was stable up to 9 -12 months.

Farm based S&T interventions in the aspirational district of Nabarangpur, Odisha (*Jyothirmayi T*)

Technologies/processes developed by the Institute were selectedfor licensing to the beneficiaries of Nabarangpur district to set up food processing units based on the requirements listed by a farmer producer group. The detailed Project Report (DPRs) of the

selected technologies (tomato products, fruit jams and jellies preparation, pickles and chutneys, fruit syrups and squashes, tutty fruity, potato wafers /chips, RTS fruit juices and beverages, low fat flaked spicy maize/ corn snacks, protein rich ragi vermicelli) have been provided to the Project Director, DRDA, Nabarangpur. Demonstration of processes for selected licensees was taken up.

Pre & Post harvest treatment protocol for mango varieties of North India (Gothwal PP)

Experiments were conducted to study the post harvest treatment of mango fruits cv. Amarpali and Chausa for the extension of shelf life under two storage conditions (cold store and ambient condition). The fruits were harvested at defined physiological maturity stage from wellmanaged mango orchard in Malihabad. The fruits were washed and subjected to 6 treatments with different combinations such as dipping in hot water at 55°C for 40 min, dipping in 1000 ppm sodium benzoate (1 g per litre water) at 55°C for 40 min, dipping in 1000 ppm potassium metabisulphite (1 g per litre water) at 55°C for 40 min, dipping in acetic acid (1 ml per litre water) at 55°C for 40 min, dipping in sodium bicarbonate 1000 ppm (1 g per litre water) at 55°C for 40 min, control (washing in tap water). The fruits of various treatments were loosely packed in CFB boxes and were kept under ambient (37 ± 2°C; 55–65% RH) and cold (12 \pm 2°C; 80-85% RH) conditions. The physiological and biochemical parameters were measured regularly till the end of the study period. The total soluble solids (TSS), reducing sugar, total sugar and total carotenoids reported increasing trend whereas



total acidity, ascorbic acid and physiological loss in weight (PLW) were found linearly decreasing during the ripening. The treatments retarded the physico-chemical changes feasible for manifestation of ripening quality features and certainly helped considerably in delaying the ripening. This has profoundly notified the extended storage life of Amarpali and Chausa mangoes. The observations on physico-chemical changes and sensorial quality parameters were used as ripening and shelf life monitoring indices. Therefore, using the application of combined treatment with different chemicals of mango at 12°C is a feasible technology for maintaining quality and prolonged storage life in order to expand marketability and export options. Products prepared from ripened mangoes (after completion of study of shelf life extension) were good.

Skill development program in aspirational districts of Uttar Pradesh (Gothwal PP)

A bilingual training manual (English and Hindi) regarding production of fruits and vegetables, cereals and pulses and other agro crops grown in the region was prepared. The manual also included preparation, preservation and management of the food and agro based value added products. The training manual will be distributed among women trainees selected in Balrampur, Bahraich, Shravasti and Siddharthanagar districts of Uttar Pradesh. Further, a survey in the above districts was carried out for finalizing food and agro based raw

materials availability and training schedules. Women entrepreneurs were selected with the help of leading NGOs as well as through state government officials for training programs at Siddharthnagar and Balrampur districts.

Lactoferrin and plant ferritin based dietary supplements (*Arun Kumar V*)

The goal of the proposed project is to develop a sustainable solution for dietary iron fortification to reduce the prevalence of iron deficiency anemia by increasing bioavailability. Lactoferrin and ferritin were quantified from WPI and SPI and further enriched using the filtration method. The enriched fractions were analyzed for their iron content. Additionally, iron saturation in native, apo, and hololactoferrin was performed based on total iron content by atomic absorption spectroscopy and the protein content was determined by the Dumas method. The value of 2 mol of iron/ 1 mol of lactoferrin was considered as 100% saturation. Holo, native, and apo-lactoferrin showed 98, 96, and 94% of protein, 1395, 181 and 12 µg/g lactoferrin, and 99.7, 12.9 and 0.9% iron saturation respectively. The effect of holoferritin and lactoferrin on iron bioavailability was assessed by incubating Caco-2 cells with digested protein solutions containing bound iron. Both ferritin and lactoferrin digests increased iron-induced ferritin formation in Caco-2 cells by approximately 40% and 220% respectively compared to control.

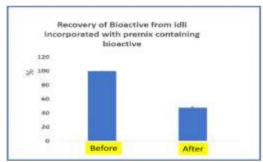


TRANSLATIONAL RESEARCH

Health food formulations (Nandini CD)

Premix formulation has been developed which can be used in traditional foods to enable better glucose disposal. For the bioactives to work, it should survive the processing condition. Premix was used in traditional food formulation such as idli and the stability of the bioactive after cooking was determined. Bioactive to the tune of 50% was retained after processing.





Idli incorporated with premix containing bioactive from wild ginger

Functional food product for diabetics that can modulate PPARy (Nandini CD)

Selective PPARy modulators (SPARMS) are being extensively developed in recent years to circumvent the problem associated with full agonists. Some of the bioactives from plants can act as SPARMS. Bioactives were isolated using a green solvent and attempts are being

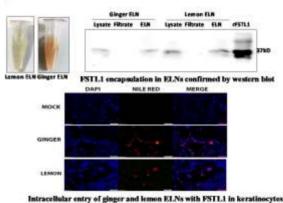
made to microencapsulate it to increase its stability as well as enable its usage in various food products.

Valorization of byproducts from fish industry (Nandini CD)

India ranks as the second-largest fish producer in the world and generates a huge amount of fish processing waste/discard from the inland sector, and adds significant pollution to environment. Fish wastes can be valorized to produce various biomolecules. One such biomolecule is the glycosaminoglycans (GAGs) which are used as a nutraceutical, cosmeceutical and has various other biomedical applications. A process has been developed to isolate it using green solvents. Biomolecule could be isolated five times more using green solvents than by conventional protocol.

Nanovesicles for treating chronic ulcers (Gopinath M)

Chronic foot ulcer is one of leading cause of lower extremities amputations in 25% of diabetic ulcer patients. Follistatin like-1



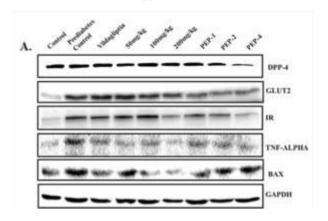


(FSTL1) is a novel protein which aids in skin cell migration in acute wound healing and is absent in diabetic ulcers. Though, FSTL1 application may rescue healing in chronic ulcers, its low half-life (<3h) and the protease rich environment precludes its delivery in chronic ulcers. Exosome-like nanovesicles (ELNs) are intrinsic vesicles isolated from edible plants with nanocarrier potential. The feasibility and efficacy of FSTL1 encapsulated in ELNs for chronic ulcer application are being evaluated. FSTL1 protein has been successfully encapsulated in lemon and ginger derived nanoparticles and their intracellular delivery has been confirmed *in vitro*.

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

Low molecular weight bioactive peptides from Sorghum bicolor seed proteins were generated and assessed for DPP-4 inhibition by in vitro enzyme assays and Caco-2 monolayer model for the intestine. Few of the bioactive peptides (PEP1, 2 and 4) inhibited DPP-4 activity via a mixed-type inhibition. A high sucrose-induced prediabetes model was developed to validate the in vitro results. Insulin sensitivity was improved as indicated by OGTT, ITT and HOMA-IR with the treatment of sorghum protein hydrolysate (SPH) and peptides. The results suggested that all the peptides showed promising results by downregulating DPP-4, and diabetes-related markers TNF-α, IR, BAX, and GLUT-2 in hepatocytes. SPH and peptides treatment showed evidence of ameliorating diabetesassociated damages (fibrosis and inflammation) and lipid accumulation in the liver and heart.

The peptides and SPH also showed significant influence on the diabetes related CVD by downregulating the protein expression levels of inflammatory marker (iNOS and TNF- α), apoptotic marker (BAX) and BNP of cardiac tissue. In addition, the peptides and SPH also improved the bone quality of prediabetes rat when observed using bone microCT. Taken together, the sorghum hydrolysates and derived DPP-4 inhibitory peptides may be a promising source for nutraceutical and pharmaceutical application for the management of prediabetes and type 2 diabetes.

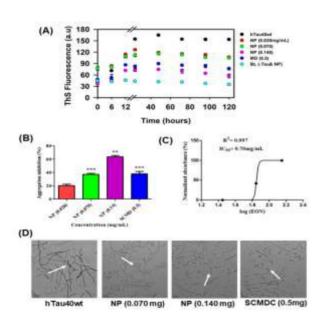


Western blot analysis of DPP-4, GLUT-2, insulin receptor (IR), TNF- α , and BAX of rats fed with normal diet (control), high sucrose diet (Prediabetes), Positive control (vildagliptin), Prediabetes groups treated with SPH with varying concentrations of 50 mg/kg, 100 mg/kg, 200 mg/kg and peptides PEP1 (2.5 mg/kg), PEP2 (2.5 mg/kg) and PEP4 (1 mg/kg). GAPDH is used as a loading control.

Nanoencapsulated Eugenol (NE) (Poornima Priyadarshini CG)

Alzheimer's is a progressive neurodegenerative disorder and pathological hallmarks of Alzheimer's Disease (AD) include abnormal deposition of extracellular Amyloid- β (A β) and intracellular Tau aggregates. However, during AD, Tau undergoes hyperphosphorylation and

self-aggregation leading to aberrant accumulation of neurofibrillary tangles (NFTs). Eugenol is a potential bioactive compound present in essential oils of Syzygium aromaticaum and has shown to exert the positive effect on memory, neurogenes is and neuronal differentiation. Thus, in the present work, the efficiency of eugenol (EO) and eugenol nanoparticles (EON) in the inhibition of Tau aggregation via in vitro, in silico, and in vivo analysis was assessed. The fluorescence and circular dichroism spectroscopy was used to understand the effect of EON in inhibiting Tau aggregation in vitro and the effect was concentration dependent. In silico experiments evaluated the possible interaction between eugenol and Tau amino acid residues that are involved in Tau β-sheets conformation



Tau aggregation inhibition by EON. A) ThS fluorescence for aggregation kinetics. B) The ThS percent inhibition of Tau aggregation at different concentrations of EO. C) The IC5 $_{\circ}$ value for full-length Tau aggregation inhibition, which was found to be 0.070 mg/mL of EO. D) Tau aggregation inhibition visualized by TEM

and found that the interaction was predominantly via hydrophobic residues. Restoration of survivability and cognition deficits was observed in the transgenic *Drosophila* model treated with eugenol nanoparticles. The study suggested that EON decreases Tau-mediated pathology by inhibiting its aggregation, phosphorylation, and physiological/behavioural characteristics of *Drosophila*. Thus, eugenol nanoparticles can be explored as a promising molecule in the management of AD.

Pro-inflammatory dietary factors (AGEs) in age-related diseases (Singh RP)

Accumulation of AGEs leading to cellular oxidative damage and tissue injury is known to cause cellular dysfunction and senescence both in vitro and in vivo. Prolonged and chronic exposure to AGEs results in the upregulation of RAGE and exacerbates aging and disease condition. In this study, the ability of bioactives from various plant sources to inhibit RAGE expression and modulate metabolic dysfunction and cellular senescence was examined. The ethanol and methanol extracts from leaves of Vitex nigundo and Bryllophyllum pinnata showed high polyphenol content with significant antioxidant (radical scavenging assay) activity in comparison to water and acetone extract. The ethanol and methanol extract of *V. nigundo* showed the presence of two major bioactives, Agnuside and Vitexin along with other minor bioactives. Agnuside and Vitexin were further purified. Their inhibitory effect on RAGE expression will be studied in various model systems.



Novel bioactive food formulation to overcome chemoresistance and tumor recurrence (Syed Musthapa M)

Breast cancer is one of the major causes of cancer-related mortality. Cancer stemness and chemoresistance are crucial factors causing tumor recurrence and mortality in breast cancer patients. Dietary bioactives are known to exert anticancer activities, however, the role of the bioactives in inhibiting cancer stemness and chemoresistance is largely unknown. 3, 3' diindolylmethane (DIM), a dietary bioactive from the cruciferous vegetables, is known to possess various biological activities including anticancer activities. It was found that DIM enhances the therapeutic efficacy of the chemotherapeutic drug doxorubicin (Dox) and centchroman (CC) in breast cancer cells. Interestingly, DIM hindered stemness properties of breast cancer cells by inhibiting tumorsphere formation, clonogenic potential, and downregulating key stemness markers. Further, DIM enhanced the chemotherapeutic potential of CC by inhibiting the activity of chemoresistance protein P-gp and enhancing the intracellular concentration of CC in breast cancer cells. However, the major limitation of DIM is low availability and bioavailability in cruciferous vegetables for its therapeutic efficacy. Thus, DIM-enrichment technology was developed and found more than a ten-time increase in DIM quantity by using a novel processing method. Further, a DIM-enriched diet was prepared and anti-breast cancer efficacy was tested. It was found that DIM-enriched diet inhibited tumor growth and metastasis by downregulating the expression of key proliferative markers.

Overall, the novel DIM-enriched diet has demonstrated anti-breast cancer activities and enhances the efficacy of chemotherapeutic drugs. Further, the development of DIM-enriched smart foods and their characterization is in progress to effectively manage breast cancer.

Modulation of lipid accumulation by genetic and nutraceutical interventions (Ajay W Tumaney)

Aurantiochytrium limacinum accumulates large amount of omega 3 fatty acid docosahexaenoic acid. Two diacylglycerol acyltransferase (DGAT) genes were identified and isolated from A. limacinum. The two isolated DGATs were named as AIDGATa (1349bp) and AIDGATc (2574bp). The two DGATs were separately introduced into the plant binary vector pBI121. The vector was then inserted into Agrobacterium tumefaciens using freeze thaw method. The Arabidopsis plants were transformed with both the genes and screened for transformants. The successfully transformed T0 seeds are being grown to obtain T1 plants for characterization of oils in the plants.

To study the mode of action of quinoa saponins towards reduction in body weight, the mRNA and protein analysis of adipose tissue of C57BL/6 mice treated with 50 mg/kg BW quinoa saponins was performed. The treatment was given for a period of 8 wks along with high fat diet. The study indicated that quinoa saponins at 50 mg/kg BW is effective in bringing about weight loss even when 60% calorie by fat using high fat diet (HFD) is



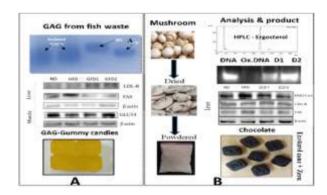
consumed. The hematological parameters suggest no negative effects on vital blood parameters. The urea and creatinine levels indicate no damage to kidneys. Further characterization of mRNA levels of genes involved in lipid metabolism are in progress.

Obestatin and Nt8U, the N-terminal fragment analog of obestatin is shown to reduce food intake and gain in body weight and also reduced epididymal and perirenal fat in mice. Towards studying the possible interactions amongst satiety peptides, the effect of obestatin and Nt8U on other satiety peptides (like CCK8, GLP-1, oxyntomodulin and peptide YY) was investigated. The high-fat fed C57BL/6 mice were administered with the peptides, obetstatin and Nt8U for a period of four wks intraperitoneally and body weight and food intake was monitored. Orlistat was used as the positive control. Various biochemical parameters including triglycerides and cholesterol was reduced in orlistat and Nt8U administered group. The plasma enzymes SGPT, SGOT, ALP and LDH assays, weight and appearance of the organs showed that the vital organs were unaffected by the treatment. Leptin and adiponectin levels were decreased in obestatin and Nt8U group and insulin level was decreased in obestatin group. There was no significant reduction in liver and fat pads but reduction in lipid content in both liver and adipose tissue was observed. Further experiments on the effect on other peptides are in progress.

Dietary products to downregulate obesity risk factors (Suresh Kumar G)

Sustainable counter measures to alleviate obesity and its associated risk factors can be

achieved by exploiting naturally occurring molecules that possess anti-obesity properties. Such measures using natural bioactive molecules can supplement the existing therapies in patients suffering from obesity and associated complications. Dietary molecules including soluble charge-based polysaccharides/ oligosaccharides of GAG/chitosan, anti-inflammatory molecules present in ginger (phenolic concentrate, gingerol, zerumbone) exhibit significant effects on the signalling events involved in the fatty acid oxidation, inflammation, neuro modulation, oxidative stress etc., that plays key roles in ameliorating obesity and associated complications. Thus, exploitation of such therapeutically potent molecules in the diet offers benefits. With this rationale, efforts are being made to understand the mechanisms by which the above-mentioned molecules work in tandem to exhibit anti-obesity properties. The products enriched with anti-obesity molecules will be further developed for societal outreach to cope up with growing obesity and associated complications.



A) GAG isolated from the fish waste and showed amelioration of obesity related metabolic disorders in animal experiments. B) Mushroom Processing, analysis of ergosterol and biological activity and product (chocolate; Ergosterol conc.0.4%+ Zerumbone (0.2%)) developed

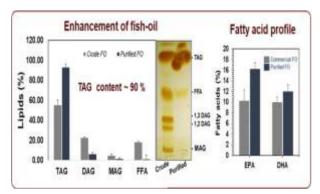


Curcumin enriched nanoemulsified coconut milk (Ramaprasad TR)

The coconut milk-based products (with and without curcumin nanoemulsion) exhibited no significant adverse effects on general growth and feed efficiency. The blood (serum) lipids were not altered in experimental groups fed coconut milk-based formulations and were comparable to the control group. The liver and heart function enzymes (SGOT, SGPT, ALP and CK-NK) were unaltered in experimental groups fed coconut milk-based formulations and were comparable with that of the control group. The liver lipids were not altered in experimental groups fed coconut milk-based formulations and were comparable with the control group.

Edible eicosapentaenoic acid and docosahexaenoic acid-enriched oil from fish-industrial discard (Vijayaraj P)

The increasing prevalence of lifestyle diseases escalated the consumption and market demand for polyunsaturated fatty acids, mainly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). However, only 30% of the fish biomass is utilized for fish oil (FO) production, whereas ~70% of biomass is



Glyceride and fatty acid composition of fish oil

discarded as a by-product. Furthermore, the current Refining, Bleaching, and Deodorisation (RBD) process have major drawbacks, reducing the FO yield. Hence, an enzymatic and non-RBD approach was proposed to effectively utilize and convert crude FO into edible FO enriched with EPA and DHA. Up to 90% conversion of EPA and DHA enriched oil was achieved. The physicochemical characteristics and oxidative stability of the purified FO were similar to the commercial oils.

Lipase for shelf life extension of selected millet products (Vijayaraj P)

Millets are considered "Nutri-cereals" due to their power-packed nutritional profile and provide all essential nutrients required for the normal functioning of the human body. The commercialization of the millet-based products is challenging because of the low stability and shelf life due to lipase, which deteriorates the stored oil or lipids. Targeting the active lipases present in the millets will be a promising strategy to manage it by applying biotechnological intervention. Millets contain ~5 to 25% oil and highly active lipase enzyme activity. Lipidome analysis of various millets revealed that they contain 55 to 74% unsaturated fatty acids particularly oleic (18:1), linoleic (18:2) and linolenic acid (18:3). Further studies are in progress.

Adipocyte-derived extracellular vesicles activate hepatic stellate cells mediated by SREBP-cleavage activating protein

(Madan Kumar P)

Studies have demonstrated the role of SREBPcleavage activating protein (SCAP) in lipid synthesis and in *in vivo* pathogenesis of



diabetic fatty liver and carbohydrate-induced hypertriglyceridemia. However, the role of SCAP on obesity-induced fatty liver is yet to be studied. Hence, this project hypothesized to find out the pro-fibrogenic role of SCAP enriched extracellular vesicles (EVs) in experimental obesity-induced fatty liver models. For this study, 3T3-L1 cells (mouse pre-adipocytes) and LX-2 cells (human hepatic stellate cells) were used, as they are the ideal models to study obesity and fatty liver. Transdifferentiation of 3T3-L1 cells to mature adipocytes was achieved by a standard differentiation protocol involving 2-day differentiation induction with media containing dexamethasone, IBMX and insulin followed by maintenance with maintenance media containing insulin. Oil red-O staining was performed to visualize the lipid droplets accumulated by mature adipocytes post differentiation showed large sized lipid droplets in mature adipocytes.

Biowaste management for value-added biotechnological products

(Swaroopa Rani D & Sarma MVRK)

Production of biogas from canteen waste: A biogas digester of 15 kg capacity of feed was designed. The digester was fed with cow dung mixed with water and left for 21 days for the inoculum development. The pre-treated canteen food waste was ground in a food processor and later mixed with cow dung in 1:1 ratio and fed to the digester. Different waste samples were collected from industrial and food heaps. Four samples were named as consortia-1, consortia-2, consortia-3 and consortia-4. All the four samples were inoculated to the biogas digester to check the production of biogas. Consortia-3

produced 53% biogas followed by consortia-2 with 49% and consortia-1 32% and least biogas was 12% in consortia-4. To understand the microbial dynamics during biogas production, metagenomic DNA was extracted from the time of inoculation of cow dung with waste and at the end from digested samples. DNA was sequenced by next generation sequencing and analysed. Metagenomic profiling revealed a clear shift in microbial diversity from *Bacteroidetes* to *Acetobacteria*. At the species level *C. tyrobutyricum*, *L. backii*, *L. lactis*, *Enterobacter* and *Cellulomonas* were highly abundant in digested samples than control.

Production of β-glucosidase using canteen waste: The canteen waste was pre-treated with H₂SO₄ (0.5%) and subjected to 90°C for a period of 3 h. The pre-treated material turned into a dark-brown slurry whose pH was measuredat 0.4. Carbohydrate, protein, fat and the moisture content of the slurry was estimated. This highly acidic slurry was stored at 4°C, until further use for fermentation. It was observed that 25% food waste resulted in higher enzyme activity when compared to 50% food waste. Also, the synthetic medium resulted in maximum enzyme activity 592 U/L. The lower enzyme activity from the food wastemedium may be due to compositional variation in the media. Later, experiments were conducted in bioreactor for enzyme production using 25% food waste and the results were compared with shake-flask. The enzyme activity increased gradually and slowly during the cultivation period in the bioreactor compared to the shake flask experiment. Maximum enzyme activity was observed at

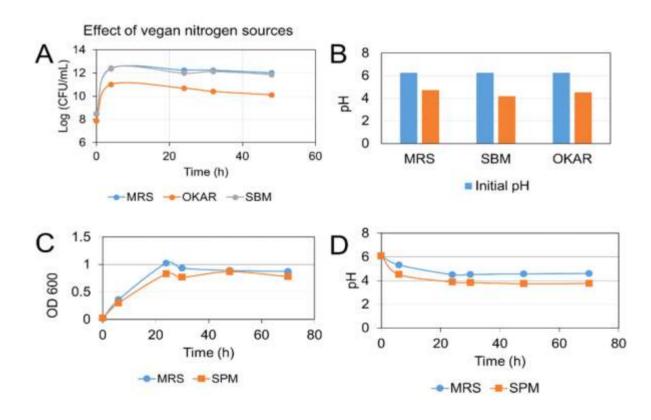


312 h of incubation. It was observed that the activity in bioreactor was close to 17-folds lesser when compared to the shake-flask. This could be due to variation in the food-waste composition.

Fermented foods for gut microbiome (Sarma MVRK)

The presence of animal derivatives in probiotic food products makes it uncomfortable for a few consumers. Use of vegan sources not only increase the acceptability but also reduce the cost of growth medium. The growth of the strain of lactic acid bacteria (LAB) *Pediococcus pentosaceus* was investigated in different vegan nitrogen sources, soya-peptone media

(SPM), soyabean meal (SBM) and okra, with MRS as a control was investigated. Since okra and SBM were insoluble, colony forming unit (CFU) was used instead of optical density for growth measurement. The growth in the okra was lower when compared to the SBM and MRS media. The growth curve of *Pediococcus* pentosaceus in SBM is similar to that of the control media (MRS). The final pH was almost same for MRS and okra and slightly decreased in SBM i.e 4.17 when compared to the other two. The growth of Pediococcus pentosaceus in SPM was compared to MRS medium in terms of OD 600. The growth in SPM was closer to the growth in MRS broth. The final pH of MRS and SPM were 4.6 and 3.76, respectively.



Growth of P. pentosaceus in different vegan media compared to MRS



Novel RNA biosynthesis inhibiting peptide antibiotics of probiotic bacteria (*Prakash M Halami*)

Fermentative media was optimized for enhanced production of antimicrobial compound from probiotic bacteria Bacillus licheniformis MCC 2514. The purification of antimicrobial has been achieved for further characterization. Upon pathway specific reporter assay it is known that antimicrobial compound act on RNA biosynthesis inhibition. The sequentially purified compound is confirmed for its proteinaceous nature by proteinase K treatment. Genome analysis found four bacteriocin clusters present in B. licheniformis MCC 2514 responsible for the production of the antibiotic compound. To identify the gene responsible for the production of this RNA inhibiting bacteriocin the gene expression profile of the wildtype and mutants were analyzed. The mutant's defective for bacteriocin production was found to be having no expression for any of the bacteriocin related genes while the wildtype showed a higher expression for the same. Bacillus licheniformis have shown good invasion ability against the K. rhizophila. Bacillus licheniformis did not show any toxicity on the HT-29 cell line, which proved that it is an efficient probiotic bacteria regarding colonization in the gut system. The sporeforming bacteria always have an advantage in adhesion when compared to the non-spore bacteria. Hence, the Bacillus licheniformis has shown greater adhesion efficiency. Overall, it is concluded that Bacillus licheniformis under in vitro conditions has shown better adhesion and invasion ability and also a good contender to colonize on gastrointestinal tract. The viability of the probiotic bacteria in carrot was found to be higher even after heat treatment, which

concludes that *Bacillus licheniformis* is a better contender for the product development.

Metabolic engineering of Saccharomyces cerevisiae for production of linalool (Sarma MVRK)

LIS gene was successfully expressed in *S. cerevisiae* strain and synthesis of linalool was observed. Apart for linalool there were other monoterpenes synthesized when LIS gene was expressed. Co-expression of tHMG1 improved linalool. SPME method coupled to GC-MS was standardized for confirmation of linalool synthesis. Quantification of linalool was established using GC and solvent procedure. ALD6 and TPI1 were cloned into *S. cerevisiae* for improvement of precursor pool towards to monoterpene synthesis. Towards construction of stable strain, biobricks are being constructed for integration into *S. cerevisiae* strain for linalool production.

Pectin derived prebiotic oligosaccharide in the prevention of food allergy (Mahejibin Khan)

Pectin is a versatile heteropolysaccharide that possesses various health-promoting properties. These properties are influenced by pectin's source, structure and physicochemical characteristics. The extraction condition of pectin from beetroot (BR), watermelon rind and tomato pulp and enzymatic hydrolysis of pectin for the production of pectic oligosaccharide (POS) was optimised. Bioactive and prebiotic properties of extracted pectin and POS were analyzed on *Limosilactobacillus fermentum* and further confirmed in the mice model. Mice supplemented with POS exhibited a higher IgG, IL-10, IL-12 and reduced IL-4, IL-5, IL-6, IL-



13 and IL-17. Moreover, POS also altered the gut microbial diversity and induced IgA production, acetate and butyrate production. *Lactobacillus, Prevotella, Rilenellaceae* and *Lachanospiraceae* groups were significantly higher in POS groups than in control.

Improved gut health with underutilized Indian berries/pseudo berries (*Praveena Bhat Mudliar*)

Berries have been implicated as chemopreventive agents in several life style diseases like ischemia, diabetes, cancer, etc. The focus is on investigating selected underutilized Indian berries (and pseudo-berries) for their beneficial attributes with a special emphasis on their prebiotic and nutraceutical potential. Extracts of five underutilized berries Syzigium cumini, Rhus coriaria, Carrissa carandas, Rubus niveus and Malphigia emarginata were evaluated for their prebiotic and nutraceutical potential by in vitro assays. Most of the extracts had a growth stimulatory effect on probiotic bacteria and could inhibit foodborne pathogens (except C. carandas). Effect of the extracts was found to be both sample as well as concentration dependent. Extracts of S. cumini, R. coriaria, and M. emarginata indicated an average 2-fold stimulation of probiotic bacteria with >90% inhibition in growth of pathogens namely E. coli and S. aureus, at the concentrations tested. Extracts also demonstrated appreciable antioxidant activity as observed from results of DPPH radical scavenging and FRAP assay. Phytochemical characterization revealed appreciable amounts of polyphenols and total soluble and reducing sugars in the extracts. Gallic, chlorogenic, ferulic, coumaric, syringic acid, catechin and rutin were found to be the

major phenolic acids in majority of them. Glucose, fructose and sucrose were found to be the predominant soluble sugars present in the extracts. Preliminary results indicated that *S. cumini* and *R. coriaria* extracts on fermentation by the probiotic cultures, enhanced the production of short chain fatty acids (SCFA). Extract supplementation also enhanced the adhesion potential of tested probiotic cultures to CaCO₂ cell monolayer. Based on the preliminary results, further work on the gut modulatory potential of the extracts is being investigated.

Regulatory genes involved in pungency in *Capsicum* sp. (*Giridhar P*)

High pungent chilli germplasm was procured and established seedlings in vitro and greenhouse. The seedling plants of 2 months were transplanted into fresh pots for further study. The in vitro seedling explants were used for induction of callusing both from cotyledonary leaf and placenta of pungent variety chilli. Studies on the influence of light in in vitro callus culture obtained from placental callus was done. Growth curve for biomass (1-4 wks) and metabolite profile i.e. HPLC analysis of capsaicin and dihydrocapsaicin was completed in the placental callus cultures. Primers were designed for CaMYB31, ERF, JERF and housekeeping genes (actin and alpha tubulin). PCR conditions were optimized for the same and recorded for expression studies in placental tissue of C. annuum Meghana variety.

Engineered production of searidonic acid in chia (Salvia hispanica) (Sreedhar RV)

Buglossoides arvensis is a newly established stearidonic acid-rich oilseed crop that contains



a unique combination of ω -3 (stearidonic acid (SDA), α -linolenic acid (ALA) and ω -6 (γ linolenic acid (GLA)) fatty acids in its seed oil. This plant produces large amount of polyunsaturated fatty acids (PUFAs; ~90%) in its seed triacylglycerols (TAGs), indicating that there is an efficient mechanism involved in the transfer of newly synthesized PUFAs from phospholipids to seed triacylglycerols. To uncover the critical TAG biosynthetic pathways contributing for high PUFA accumulation in this plant, lipidomic analysis of developing seeds was performed and functionally characterised major acyltransferases involved in the final step of TAG biosynthesis. The analysis suggests that DGATs play a crucial role in enriching TAGs with PUFA compared to PDATs. This was further confirmed by heterologous expression and fatty acid feeding studies in transgenic yeast carrying B. arvensis DGAT and PDAT genes. BaDGAT2 preferentially incorporated high amounts of linoleic acid (LA), ALA and SDA into TAG, compared to BaDGAT1. The results provide insight into the molecular mechanisms of TAG accumulation in this plant and identify target genes that can be used in the transgenic production of SDA in traditional oilseed crops.

Anaerobic co-digestion of FOG (Fats, Oils and Grease) containing sludge from dairy industry (Sandeep N Mudliar)

A novel high-performance bioreactor system integrated with sustainable pre-treatment for enabling anaerobic digestion of complex fatrich sludge from dairy industry has been developed. It has been further integrated with membrane bioreactor based-wastewater treatment to enable zero liquid discharge in the dairy industry. The developed bench-scale

bioreactor system has been tested on pilot scale. The technology can be used for solid and liquid waste management in food and allied industries with ZLD concept. The sustainable pre-treatment technique is applicable to all types of complex solid wastes to enhance biogas production as well as the robustness of anaerobic digestion process. Dairy and food industries are the likely industries which can benefit from the technology. The technology is also applicable for any biodegradable solid waste/sludge, food waste from any food industry as well as food industry waste waters.

Value addition to the superfood – chia (Salvia hispanica) (Sreedhar RV)

Seed oil was extracted from regular (with mucilage) and de-mucilaged seeds using oil extruder and power ghani. One set of seeds were de-mucilaged by hydration method and were used for extraction of oil using commercial oil expeller. Approximately, 21% oil could be recovered from extrusion. Similarly, another set of regular seeds were used for extraction of oil using power ghani. About 16% oil could be recovered. Fatty acid profile of the oil has been characterised and stability of the oil is being studied. De-fatted seed meal from de-mucilaged seeds was milled and subjected to sieving. The whole chia meal powder had 36% protein before sieving, whereas the sieved and un-sieved samples contain 47% and 21% of protein respectively. De-fatted meal is being explored as a rich source of protein and dietary fibre for development of different food products.

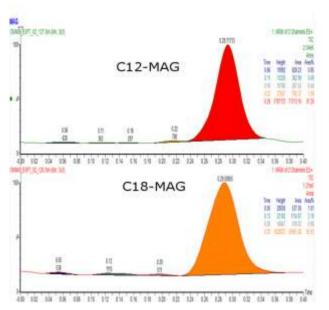


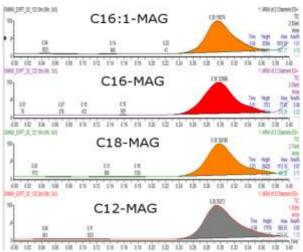
FOOD PROTECTION AND SAFETY

Monoacylglycerols and diacylglycerol isomers in margarines and milk products (Usharani D)

Market survey on esters of monoglycerides (MAG) and diacylglcyerides (DAG) of natural origin named as E471 emulsifiers in the deserts, dairy products, and margarineswas performed. Most of the emulsifiers are identifiedby thin layer chromatography and mass spectrometry. The survey indicated that most of the emulsifiers used in the dairy products include lauryl monoacyl glycerol and palmitylmonoacylglycerols. A simple method for extraction of fat in dairy products was

developed where lipid classes were analysed through thin layer chromatography. In detail structural characterization of 1-MAG, 1,2-DAG and 1,3-DAG were performed through ¹H and ¹³C NMR. An in-house LC-MS/MS method was developed for monoacylglycerols where the internal 18:1 (d7) MAG was identified and quantified with limit of detection of 3 ppb. The fatty acid profiling of the emulsifiers using gas phase chromatography and LC-MS/MS data indicate lauryl, palmityl and stearyl highest in amount. A standard optimization procedure was developed for identification and characterization of emulsifiers.





LC-MS/MS spectrum of Monoacylglycerols (MAG) of different chain lengths and mostly observed in dairy products



CSIR PROJECTS

Focused Basic Research / Niche Creation Projects

Non-digestible carbohydrates as functional mimics of human milk oligosaccharides (Ravi Kumar)

The polysaccharides were isolated from the dried powder of plant and marine sources and were subjected to the acid/enzymatic treatment and optimised to obtain a crude mixture of oligosaccharides. The oligosaccharides were used as a carbon source to monitor the growth of bifidobacteria. The study shows the selective growth of bifidobacterial using oligosaccharides from specific sources.

Chito-conjugates of spice bioactives and clove oil nano-encapsulated polymeric films (Bettadaiah BK)

Chitosan, a partially *N*-deacetylated chitin from crustacean shells (crab, shrimp, crawfish etc) has unique properties like biocompatibility, biodegradability, non-toxicity and excellent filmforming ability and hence useful in functional foods, biomedicals etc. Despite these applications, there is scope to make further value-added products of chitosan to overcome limitation of solubility in neutral or alkaline media, rigidity, compact crystalline structure and strong intra- and intermolecular hydrogen bonds. The presence of free amino groups in chitosan leads to the preparation of Schiff bases by covalent link. The reaction of chitosan with bioactive aromatic aldehydes from spices (vanillin, perillaldehyde, salicylaldehyde, citral, citronellal, cuminaldehyde) resulted in the

formation of Schiff bases which was confirmed by FTIR. Further, functional utility of these in making polymeric films is under progress.

Clove oil nanoencapsulated polymeric film (*Pooja J Rao*)

Films were prepared with the optimized clove oil nanoemulsion and addition of polysaccharide emulsifiers/plasticizer, by following solvent casting method. Four different compositions were selected for film preparations and these were characterized for FT-IR, XRD, AFM and encapsulation efficiency. The mechanical properties like surface pH, thickness, transparency, swelling index were measured. Antioxidant activity, *in vitro* release study and encapsulation efficiency were also evaluated.

Nutraceuticals from *Ulva lactuca* and their utilization in functional food (Revathy Baskaran)

Seaweeds are considered as 'super foods' which contain considerable quantities of major bioactives and other nutrients with a great



Ulva lactuca



Seaweed pasta



Ulva powder



health promoting efficiency and technological advantages. *Ulva lactuca* is one of the extraordinary source of biologically active compounds which aid in different health benefits in humans. As a rich source of nutrients, *U. lactuca* has been utilized for the preparation of many value added products such as Ulva flakes, Ulva powder, burger patty, pasta, soup mix and rusk.

Prototype of machine learning based ripening classifier (RIPETECH) (Vijayanand P)

Mangoes alphonso variety were harvested from local farm at Mysore. The fruits were washed, sorted and used for the ripening studies. Fruits were divided into two lots and one lot was treated with ethylene and the other with calcium carbide. The treated fruits were stored at ambient temperature for ripening. Color, total soluble solids, acidity and carotenoids were analysed periodically during ripening. Images of the surface colour and cut fruit were taken for both the treatments. Image processing of data was carried out to differentiate the type of ripening. Further studies are in progress.



Ethrel treated

Calcium carbide treated

Structure-function relationships in enzymes (*Ravi Kumar*)

Flavin adenine dinucleotide synthetase (FADS), a bifunctional prokaryotic enzyme, is involved in the synthesis of two vital cofactors, flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD). The biochemical characteristics of FADS from Staphylococcus aureus (Sa) was investigated with focus on the importance of a non-conserved residue F26 present in the N-terminal domain active site of SaFADS. The importance of this residue in FADS catalysis is shown by studying the enzyme kinetics parameters and molecular dynamics. Chromosomal shape and topological changes are monitored by condensins i.e. structural maintenance of chromosome proteins (SMC), MukB and MksB. SMC are vital proteins involved in this task. To understand the mechanism of condensation via Mycobacterium smegmatis MksB, an attempt was made to find the crucial amino acid residues in MsMksB hinge domain. The sequence analysis of MsMKsB and its homologues revealed the presence of conserved KDDR motif in hinge region. Using site directed mutagenesis method, these conserved residues in hinge was mutated. The data shows that this motif is important for MksB function.

SREBP inhibitors as novel therapeutics for non-alcoholic fatty liver disease (Madan Kumar P)

Recent studies have demonstrated an increased sterol regulatory element binding protein (SREBP) activation as one of a major characteristic of non-alcoholic fatty liver disease. In this study, it was attempted to



investigate the effect of SREBP inhibition using a food bioactive-based SREBP inhibitor. Based on the in silico and in vitro experiments, one food bioactive was chosen and further tested for SREBP inhibiting potential in high fructose diet (HFrD) fed ApoE deficient mice model. Oral administration of the food bioactive (100 mg/kg BW) for 8 wks on the HFrD fed mice significantly reduced the body weight as compared to the HFrD fed ApoE deficient mice. Ultrasound imaging result suggested that food bioactive treatment on the HFrD fed mice had soft texture of liver as compared to the HFrD fed ApoE deficient mice. Further, the histopathalogical evaluation confirmed the hepatoprotective effect of food bioactive in HFrD-induced ApoE deficient mice model. Silymarin (50 mg/kg BW) was used in this study as a positive control. Currently, the molecular analysis are underway to determine the SREBP inhibiting potential of the selected food bioactive.

Deciphering the mechanism of host endophytes coevolution enhanced secondary metabolite production and crop productivity (Nandini P Shetty)

Curcuma longa is a member of the ginger family (Zingiberaceae). It is the source of a bright yellow spice and dye. Curcumin is one of the most important natural products obtained from *C. longa* L. *Curcuma* rhizomes have antioxidant, antitumor, antibacterial, antifungal, antiviral properties. The major classes of secondary metabolites in the *Curcuma* species are polyphenolic curcuminoids containing a mixture of curcumin (60-80%), desmethoxycurcumin (15-30%) and bisdemethoxycurcumin (2-6%). The important feature of the plant is that the

rhizome provides a habitat for various plant growth promoting microorganisms. Endophytic fungi and bacteria were isolated from the healthy turmeric rhizomes from different accession from India. Endophyte screening was carried out from high yielding accessions for biotreatment for low yielding variety mainly Erode local. The total curcuminoids and the content of curcumin was estimated using spectrophotometer and HPLC respectively. with suitable standards. The endophyte treatment was given for rhizomes of low vielding variety at greenhouse level as well as in field. The isolation of endophyte from the rhizomes will aid in the understanding of hostendophyte interactions for the production of secondary metabolites.

Strategies to reduce mycotoxins in cereal grains during storage condition through "Seed-Endophyte" interactions

(Vivek Babu CS)

Annotations of maize grain-endomicrobiome and phylogenetic mapping through culture independent methods has been undertaken. Characterization of seed-endophytic diversity (bacteria and fungi) in selected maize genotypes through culture independent approaches has been carried out for heat and drought tolerant maize genotypes which are resistant to aflatoxin contamination. Hence, three maize genotypes of specific traits (heat and drought tolerant) were selected and subjected to endophyte (bacteria and fungi) diversity analysis through next generation sequencing (NGS) analysis. In case of bacterial endophytic diversity analysis, 16S (V3-V4 hyper variable regions) metagenome

sequencing has been carried out for three maize genotypes. Rarefaction curves analysis indicated all three genotypes have differential species diversity. Drought tolerant maize genotype has highest bacterial endophyte species diversity and richness with increased different OTUs as compared to other test genotypes. Furthermore, at genus level all the maize genotypes were dominated by the bacterial seed-endophytes belonging to Methanosaeta, Petrimonas, Clostridium, Acinetobacter and Psychrobacter. Similarly, fungal diversity analysis carried by metagenome sequencing of ITS2 regions of 18S rDNA for the three contrasting maize genotypes. The rarefaction curves analysis indicated that, drought tolerant maize genotype has highest fungal endophyte species diversity and richness with increased OTUs as compared to other test genotypes. Alpha diversity indices such as Chao1, ACE, Shannon, Simpson, InvSimpson and Fisher were calculated for each maize genotype. These indices represent both richness and relative abundance of fungal endophyte diversity within the sample. At genus level all the maize genotypes were dominated by fungal endophytes belonging to Aspergillus, Candida, Fusarium and Talaromyces. Furthermore, differential occurrence of three genus such as Curvularia, Macrophomina and Wallemia has also been noticed in the tested maize genotypes.

Capsicum and flaxseed improvement through genome editing (Nandini P Shetty)

Prevention of the post-harvest losses by modifying the N-glycan pathways in capsicum by targeting the β -D xylosidase gene is

attempted. In case of flaxseed, cyanogenic glycoside is a poisonous compound which limits the exploitation of its nutritive value and health benefits. UDP-Glucosyltransferase which play important role in the biosynthesis of cyanogenic glycoside is being targeted through CRISPR/Cas9 knockout experiment. CrRNA was designed using CRISPR direct by targeting the N-terminal region of the protein to cause frameshift mutation. Synthesised CrRNA have been cloned in to all-in-one CRISPR vector pFGC-PCO Cas9 and P63. Cloned construct was transferred to agrobacterium GV3101 strain using CaCl treatment. Plant transformation of these construct has been carried out using agrobacterium mediated floral dip and apical meristem-based method. Transformed plants were subjected to acclamatization in sterile pot condition and transferred to glass house. Efficiency of the gene editing and off targets will be carried out using NGS sequencing.

Biofertilizer, biorefinery, biofeed and recovery of biopolymers from fishery waste (*Tanaji G Kudre*)

Fish meal manufacturing and seafood processing industries generate considerable volumes of oil and crab/shrimp shells as byproducts. Most of these by-products are considered worthless garbage and dumped, which causes disposal and environmental problems. Hence, the study deals with the valorization of marine fish meal industry (MFMI) oil and crab/shrimp shells as feedstock and heterogeneous catalysts for sustainable biodiesel production. The physicochemical properties of the oil (moisture content, ash

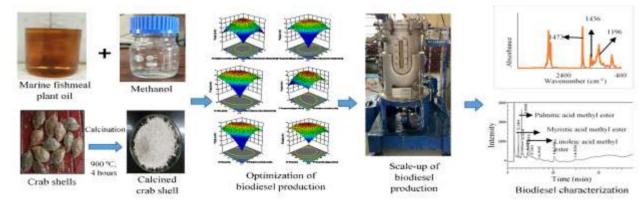


content, free fatty acid value, acid value, iodine value, dynamic viscosity) indicated that the MFMI oil could be a promising feedstock for biodiesel production. In contrast, the characterization of catalysts prepared from crab and shrimp shells by calcination at 900°C for 4 h unveiled that the catalyst was primarily composed of CaO and was mesoporous. The RSM results disclosed that optimum conditions for maximum biodiesel vield of 88.16 wt% from MFMI oil using calcinated crab shell catalyst: oil to methanol molar ratio 1:9 (mol/mol), catalyst concentration of 3 wt% of oil, reaction temperature of 60°C, the reaction time of 60 minutes and constant stirring rate of 200 rpm. Besides, calcined shrimp shell catalyst presented the maximum biodiesel yield of 86.56 wt% from MFMI oil at oil to methanol molar ratio of 1:12 (mol/mol), catalyst concentration of 5 wt% of oil, reaction temperature of 65°C and reaction time of 120 minutes at a constant stirring rate of 200 rpm. Based on the flask-level optimization results, the scale-up of biodiesel production using 50 L MFMI oil and calcined crab shell catalyst was attempted, and 87.47 wt% biodiesel yield was obtained at 1:9 (mol/mol), catalyst concentration of 3 wt% of oil, reaction temperature of 60°C, the

reaction time of 60 minutes and constant stirring rate of 250 rpm. The thin-layer chromatography (TLC), Fourier transform infrared spectroscopy (FTIR), and gas chromatography (GC) analysis confirmed the conversion of parental oil (MFMI oil) to biodiesel.

Diet (plant) derived exosomal miRNAs for inhibiting key metastatic targets in breast cancer cells (Gopinath M)

Cancer metastasis accounts for more than 90% of cancer deaths. Metastasis is stringently driven by specific set of genes, which if targeted by dietary bioactives, could prevent 90% of cancer related deaths. Even though, plant microRNAs could target human genes in a cross-kingdom fashion, their low bioavailability in vivo, limits their use against cancer metastasis. This project pivots on the use of miRNAs isolated as exosome-like nanovesicles (ENVs) from dietary plants to target cancer metastasis genes. ENVs-derived miRNAs may aid in oral delivery of dietary miRNAs to target key genes in metastasis in vivo. In this project, ENVs were isolated from ginger, turmeric, amla and garlic which showed size range between 272 to 446 nm and zeta potential values between -30 to -34 mVs. Ginger and turmeric ENVs showed



Process of production of biodiesel from marine fish meal plan oil



spontaneous intracellular entry in both breast cancer (BC) cells and normal keratinocytes but was selectively toxic to BC cells. Several miRNAs that could potentially target metastasis related genes in ENVs have been identified. The effect of ENVs and ENV-derived miRNAs to target metastasis genes *in vitro* and its effect on metastasis is currently being tested.

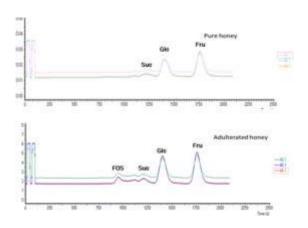
Synergizing marine ecology with bioprospecting (Mamatha SS)

Pectinases are a group of enzymes with broad application, including in plant fibre processing, pectic wastewater treatment, paper pulping, fruit juice extraction and clarification. With an increasing industrial demand for these enzymes, it is useful to isolate organisms that produce higher activity of pectinase and possess wide range of stability factors like temperature and pH.The study was undertaken for pectinase enzyme production from marine isolates. Around 70 bacterial isolates were isolated from sediment and screened for extracellular enzyme production. Pectinase enzyme production was observed in two isolates. Optimization of physico-chemical, cultural parameters and use of agro-wastes to maximize the enzyme production is being carried out.

Fast Track Translational / Fast Track Commercialization Projects

Rapid honey adulteration detection system (*Prasanna Vasu*)

Honey adulteration with sugar syrups is rampant and its detection is a challenging task. Recently, Food Safety and Standards Regulations (FSSR) enlisted 17 chemical quality parameters like moisture, specific gravity, ash, acidity, reducing sugar, sucrose, HMF, fructose/glucose ratio, electrical conductivity. C4 sugar adulteration, foreign oligosaccharides. Δ δ 13C (protein-honey. fructose/glucose, and max values) to determine the quality and authenticity of honey samples. Thus, in this project a multiparameter-based honey quality classification is proposed to ensure a better accuracy. In this direction, a hand held NIR and/or electrochemical detection based tool was designed for accurate, quick, low cost and simple honey quality checking. A lab prototype using NIR technique is designed, fabricated along with PCB (soldering). The system is designed to acquire data in trans-reflection mode for various honey samples and chemometrics based algorithms are implemented for qualitative analysis. The handy tool will be validated using EA-/LC-IRMS analysis, which can unequivocally distinguish the adulteration sugar, whether it is from C3 or C4 plants. An array of honey samples, genuine and adulterated with C3 and C4 sugars at different levels were prepared, analyzed by handy tool and validated using EA- and LC-IRMS.



LC-IRMS chromatogram showing separation of sucrose, glucose and fructose in pure and adulterated honey samples



Arabinoxylan from wheat bran and its incorporation in low dietary fiber food products (Sachin M Eligar)

Wheat bran is one of the major sources of arabinoxylan(AX) and is known to contain 22-26% AX. In India, there are no cost-effective processes for extracting AX from wheat bran. A green process to extract soluble and insoluble AX was developed, evaluated and safety studies were carried out. The process was optimized at the lab and was scaled up to pilot scale step-wise, starting from 1 kg to 8 kg. Soluble AX yield was 14-16%, and insoluble AX was 54-56%. The purity of the AX in both samples is >65% by wet weight. Both products have a typical characteristic appearance of AX with light yellowish-brown colour and bland taste. Bakery and meat products developed by incorporating AX products suggested that they can be incorporated up to 5% without altering the organoleptic properties of the food products. The process is cost-effective and greener. The reagents and equipment used are indigenously available and have a history of safe use in the food industries. The cost of production of soluble and insoluble AX was Rs. 973/- and Rs. 98/- per kg, respectively, for a batch of 500 kg starting material, including capital and operating costs. Due to its potential health benefits, the AX-rich products find application in developing various functional foods such as bakery, breakfast cereals and snacks, confectionery, dairy, meat products, infant food, beverages, pharmaceuticals and animal nutrition.

Export protocol (sea route) for fresh pineapples (Negi PS)

India is the fifth largest producer of pineapple (7% of total world production), however, nonavailability of protocol for extended shelf life is limiting its export by sea route. The low temperature required to extend the shelf life of fresh pineapples is reported to cause internal browning (IB). Experiments with the antibrowning formulation developed to control internal browning in pineapple resulted in delaying internal browning and the shelf life of untreated pineapples (2 wks) increased to 4 wks in treated fruits. This formulation also avoids use of sodium hypochlorite wash generally given to pineapple fruits to prevent microbiological spoilage. Although no significant difference in POD and PAL activities was observed between treated and untreated fruits, PPO activity showed difference from 2 wk storage onwards (~25% lower in treated fruits than untreated ones). The browning was 9.8% lower in treated fruits (as compared to untreated ones) after 1 wk storage, however, the difference doubled after 2 wks (19.7%) and tripled after 4thwk (32.5%) storage.

Minimally processed fruits with extended shelf life (Revathy Baskaran)

Value addition to fruits and vegetables by converting raw materials into ready-to-use products would help in increased economic returns to the nation both in domestic and international markets. Fresh-cut fruits available



in the Indian market do not have a shelf life beyond 1 wk. CSIR-CFTRI technology has resulted in a shelf life beyond 1 wk along with assured microbial safety. The pretreatments





Jackfruit

Grapes



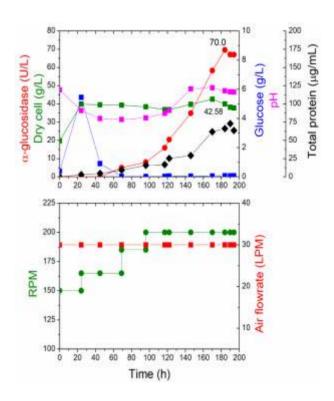
Pomegranate

given to fresh-cut fruits helps in improving the quality of the product with increased shelf life as compared to control. Also, selection of packaging material has a great impact on the overall quality and shelf life.

Isomaltooligosaccharides (IMO) using indigenous transglucosidase from starch sources (Sarma MVRK)

Towards the scale-up of α -glucosidase production, experiments were conducted at a scale of 55 L and 100 L in a pilot scale bioreactor.

A maximum of 75.3 U/L of enzyme activity was observed at the end of 116 h with maximum dry-cell weight of 23.73 g/L, whereas 70.0 U/L was achieved in 100 L scale with increased dry-cell weight of 42.58 g/L. The harvested culture from the bioreactor was centrifuged and the obtained supernatant was subjected to filtration and ultrafiltration to obtain a net of 5000 U of enzyme from 100 L. IMO production requires 10-15 U/L which indicates that from one 100 L batch reactor, the enzyme will be sufficient to make 300-500 L of IMO syrup.





Mission Projects

Advancing Technological Leads for Assuring Safety of Food (ATLAS)

Edible and biodegradable materials for electrostatic coating to fruits and vegetables for enhanced shelf-life

(Matche RS)

Edible coating is a solution to improve the quality and shelf life of post-harvest fresh fruits and vegetables. Methyl cellulose and sodium alginate based edible coating material was formulated using an approach of electrostatic coating. Clove essential oil (EO) was incorporated directly to enhance antifungal/antibacterial action. Electrostatic coating technology significantly improves the uniformity of coating, lowers volume of material with higher coating efficiency and other properties which is important for coating compared to conventional widely used dip method. The developed formulation effectively increases shelf life of tomato to more than 41 days under ambient storage conditions.

Native and recombinant bacteriophage based nanoprobes / biocontrol formulations for food preservation and food safety (Poornima Priyadarshini CG)

Isolation, characterization and development of bacteriophages with enhanced bacteriocidal activity to contain food contamination in natural way is the main objective of the project. Further, the final goal of the project is to develop a new phage based bioformulations in the form of spray and liquid that are non-toxic to humans

and friendly to the environment to decontaminate food commodities for use in food and food processing industries as an alternative tool to ensure food safety. It is also intended to develop strategies to develop an onsite strategy for detection of harmful pathogens present in food material based on change in colour. So far, several bacteriophages against Salmonella have been isolated and characterized. The genome sequencing is completed with stability studies. Toxicity studies in suitable cell lines indicated the safety use of the phages.

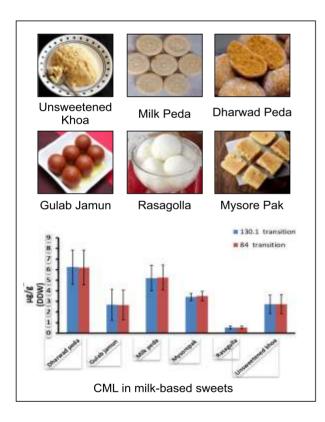
Ethylene and oxygen scavenger to increase the shelf-life of food products (Matche RS)

The commercial ethylene scavengers are mostly based on KMnO₄, NaMnO₄ and with this food safety is one of the concerns. In this line, industrial waste-based ethylene scavenger has been developed using various temperature. The scavenging capacity was found to be 186+1.4 µL/L/g. The applicability of the developed scavenger was tested on banana and leafy vegetable (coriander). It was observed that the developed scavenger can double the shelf life for selected ethylene sensitive fresh produce. It is nature friendly (made up of industrial waste) and chemically inert and non-toxic. It can be decomposed off as normal waste. These ethylene scavenger sachets from industrial waste can be an effective way to extend shelf life of ethylene sensitive fresh produce. Depending on the kind of fresh produce and quantity of ethylene produced from them, a recommended number of sachets can be placed along with fruit and vegetable in conventional corrugated boxes or export packing.



Estimation of carboxymethyl lysine in Indian foods (Nandini CD)

Carboxymethyl lysine (CML), one of the advanced glycation end products (AGEs) formed as a result of processing was determined in various traditional food products using ELISA as well as LC-MS/MS. Various milk-based products were tested namely, Mysore pak, Dharwad peda, rasagolla, gulabjamun and unsweetened khoa. Results revealed that Dharwad peda had relatively higher amounts of CML formed.



Insecticidal effect of plant essential oilsbased bio-fumigant on bulk grain storages (Ezil Vendan S)

Phosphine fumigation is a conventional method used to control stored product insect pests at bulk grain storage depots. However,

phosphine fumigant is highly toxic to humans. Some of the stored product insect pests have developed resistance against phosphine. Plant essential oils were recognized as natural alternatives to conventional gaseous fumigants. In-order to enhance the diffusion of phytochemical volatiles, air pressure has been used as carrier for phytochemical volatiles in the present study. Scaled up model of grain storage structures has been designed and developed with 250 Kg of grain storage capacity. The formulated bio-fumigant based on edible essential oils (garlic, onion and peppermint) were evaluated against three major stored product insect pests such as Callosobruchus maculatus, Sitophilus oryzae and Tribolium casteneum on the developed grain storage structure. Results showed that 100% insect control was achieved within 72 h of fumigation exposure at 48 µl/kg of biofumigant for C. maculatus and T. casteneum adults with 250 kg of green gram and wheat grain, respectively. For S. oryzae, less than 40% mortality was observed with 250 kg of wheat grain up to 7 days of fumigation exposure. However, S. oryzae was highly tolerant to the formulated bio-fumigant compared to C. maculatus and T. casteneum species.

Immunoassay based multiplexed lateral flow microarray system for detection of multiple mycotoxins (*Praveen Bhat Mudliar*)

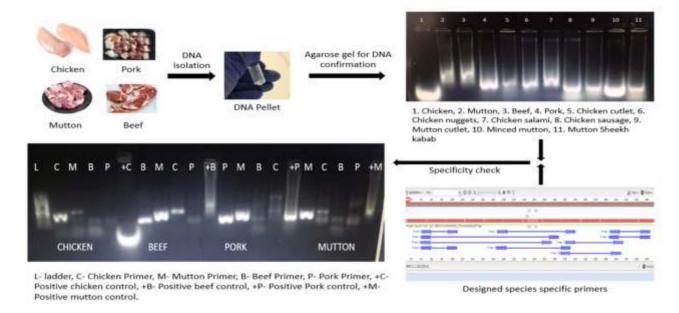
Parameters were standardized to determine the sensitivity and specificity for the detection of mycotoxins namely Aflatoxin B1 (AFB1), Ochratoxin A (OTA) and deoxynivalenol (DON), using the standard procedures. The linear detection range (LDR), limit of detection



(LOD) and limit of quantification (LOQ) was determined for all the individual mycotoxins. LDR, LOD and LOQ for detection of AFB1 was found to be 0.5-100 ppb, 1.28 ppb and 3.9 ppb, respectively, while LDR, LOD and LOQ for detection of OTA was estimated to be 2-100 ppb. 3.7 ppb and 11.34 ppb, respectively. Detection of DON using the AOAC method was found to be 100-2000 ppb, 304.3 ppb and 922 ppb, respectively. Real sample analysis for detection of AFB1 in simulated contaminated wheat flour samples indicated a recovery in the range of 83.9-99.2%, LOD 2.39 ppb, LOQ 3.75 ppb with precision between 1.59-3.47%. Also AFB1-BSA and OTA-BSA conjugates were prepared and characterized for their purity. These conjugates were used in the preparation of immunoassay based lateral flow devices (LFAs) along with monoclonal IgG antibodies which were immobilized on the conjugate pads. Further, the sensitivity and specificity of the LFAs will be determined using the standardized procedure, for their suitability in multiplexing the detection of multiple mycotoxins and application as a point-of-care device.

Hand-held platform device for on-site detection of meat authenticity and microbial contamination (*Tanaji G Kudre*)

DNA from different meat species obtained from the retail shops were isolated. Species-specific primers were designed with the help of NCBI. The primers were validated against the individual templates by PCR. The primers designed have proceeded further for specificity check to establish their specificity against other templates using PCR. Chicken primers against different templates such as goat, beef, and pork were evaluated. Likewise, other meat species primers (goat, pork and beef) were assessed for the specificity check. The PCR product was run on agarose gel and the results showed that the beef and pork primers were species-specific, and the chicken primer was more specific against mutton and pork than beef. At the same time, mutton primers were less specific against other templates. Two sets of chicken and goat primers sent by CSIR-IITR were validated for the meat specificity. Results implied that the primers (chicken and goat) are deemed specific against different templates.





Integrated approaches for bioactives and value addition for floral resources under `CSIR Floriculture Mission'

Natural bioactive agents immobilized freshness keeper (Matche RS)

Fresh cut flowers are perishable, have a limited shelf life and are vulnerable to various postharvest losses. Several technologies, such as ethylene blockage technology, pulsing solution, a chemical solution like silver thiosulphate, etc., are commercially used to extend the shelf life of cut flowers. In this project, roses vase life extension sheets were developed to help keep roses fresh with longer shelf life and avoid loss. Freshness keeper sheet was impregnated with synergetic botanicals extract that keep roses fresh for up to 1-2x longer. It helps to remove mould and fungal growth, decay, discoloration and results in no wilting, softening, scald, tenderness, weight loss etc. Freshness keeper sheets can be used to wrap around the roses and can be kept in the refrigerator crisper drawer, flower bowl, carton of flowers and can be placed in trays and boxes. Further, these sheets are biodegradable and compostable.

Isolation of marigold floral volatiles, pigments and spent utilization for value added products (Bettadaiah BK)

Marigold (*Tagetes erecta*) flower is the potential source of lutein and zeaxanthin. Lutein, a yellow pigment in marigold oleoresin is most commonly added to food products particularly in bakery produce (buns, muffins, burfi and pasta). It is associated with reduced risk of agerelated macular degeneration and cataracts.







Buns, muffin and burfi with bioactive natural colors

Marigold oleoresin was extracted from bright orange colour flowers (50 kg). Oleoresin was used in 0.1-0.4% concentration to prepare buns and muffins. These naturally coloured products retain carotenoids in >85%. There was no significant change in colour of buns and muffins after exposing to sunlight (three days).





Integral approaches for bioactives and value addition for floral resources (Rastogi NK)

In order to achieve economical and effective extraction of bioactive compounds from flowers (Hibiscus) the aqueous extraction process (citrate-phosphate buffer at pH 4.8 with 1:20 dilution ratio) was successfully optimized. Furthermore, in order to increase the shelf-life and durability of extracted bioactive compounds as well as to reduce storage and transportation costs, the extract was concentrated using novel membrane processing technology namely, forward osmosis. The process concentrated Hibiscus anthocyanin extract from 1000 mL to 97mL (10.3 folds) and total soluble solids was increased from 3.2°Brix to 32°Brix (10 folds). The forward osmosis concentrate was found to be stable for ~40 days at refrigerated condition. In order to further increase the stability of FO concentrated anthocyanin, the microencapsulation involving spray drying was used. The encapsulated powder was used as a natural colour additive in case of curd, milk and icecream which showed higher stability of the colour.

Extraction of bioactive and value-addition from floral resources (Giridhar P)

Many important bioactives such as alkaloids, monoterpernoids and flavonoids are present in the flowers of marigold and Chrysanthemum. Understanding pyretrhins mode of action would help in development of novel botanical formulation which can target wide pest groups. Preliminary analysis of the different concentration of flower extract has shown around 80% knockdown effect on cowpea

pest the Callosobruchus maculatus adults. Knockdown effect of flower extract powder of Chrysanthemum on the Callosobruchus maculatus adults at four different concentrations was carried out. More than 80% kockdown effect was observed within 1 h of exposure of 1.77 mg/cm² – 7.08 mg/cm² flower extract powder treatment. The particle size analysis results indicated that 269.23 um powder particles persisted on the body surface of C. maculatus adults and caused significant knockdown effects. Based on GC-MS analysis results, pyrethrin, jasmoline and chrysanthemol were found as major bioactives in the flower extract powder of Chrysanthemum, which might be causing neurotoxicity leading to knockdown effects in the C. maculatus adults. On the basis of preliminary leads obtained, a package film coated with floral bioactive extracts has been developed that extended cut flowers vase life by 7 days. Methods for extraction of carotenoids and lutenin from marigold flowers were optimized.

Immuno Modulatory Function of Nutritionals and Nutraceuticals for Health and Wellness (IMMUNITY Mission)

Spice-enriched nutraceutical supplement for immunomodulation (Ravindra PV)

Individual spice bioactive compounds in pure form such as curcumin, piperine, gingerol, cinnamaldehyde and cuminaldehyde were tested in suitable cell lines (macrophage cell line) for their effect of cell viability, innate immune, oxidative stress and inflammatory pathway assays. Results show that, individual



and combination of bioactives didn't affect the viability of cells but could suppress the LPSinduced ROS, nitrite and IL-6 production. To examine the cellular uptake of these bioactive compounds, cell lysates were examined for the presence of specific bioactive compounds by HPLC analysis. To examine the combination of bioactives showing synergistic effects, deletion experiments were carried out to find out the suitable combinations. Results showed that all five bioactive compounds together modulate the levels of interferon (IFN)-, IFN-β and IFN-y levels. Cellular mechanism of action including the modulation of NF-kB pathways, effect on humoral and cell mediated immune response are being examined both in in vitro and in vivo

preclinical studies. Furthermore, formulation in the form of decoction/powder/spice bars and or enrichment with VC, Zn and D3 is being carried out.

Digital portal on immunomodulatory food products/ formulation/ compounds (Bettadaiah BK)

A portal has been developed with required features displaying the bioactives, extracts, prebiotic and probiotic compounds and this can be accessed at http://172.16.1.12:8080/user. About 50 compounds with related technologies and products can be browsed from the database.

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