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CSIR-CFTRI
PERFORMANCE REPORT | 2022-23

CSIR-CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE

(A CONSTITUENT LABORATORY OF COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)

MYSURU - 570 020, INDIA

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Giving Food a Future

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From Director's Desk .....

It gives me immense pleasure to present the Performance Report of the Institute for the year 2022-23, which gives many accolades to the Institute from the Government machineries, Industries and above all the 'Society'. The year also witnessed number of events and visits of dignitaries including the Vice President of CSIR – Dr. Jitendra Singh, Hon'ble Minister of State (IC) Science & Technology.

The R&D outputs were extremely encouraging with 70 Grant-in Aid projects, 24 CSIR projects, 8 collaborative projects, 21-each of in-house MLPs and Industry projects. Gradual increase in average impact factor with good quality publications and development of ten new technologies were visible in this year. The highlights of the year include more than 160 nos. of technology transfers, 130 Nos. of articles in peer reviewed journals & book chapters and higher number of collaborations with 10 MoUs were signed.

To combat *malnutrition*-one of the biggest issues faced by our nation, the Institute successfully completed a Nutrition Intervention Program for Severely Acute Malnourished (SAM) / Severely Undernourished (SU) children of Para Development Block, Raghunathpur Sub Division, Purulia District, West Bengal. Another program has been launched for Nutrition Intervention for Severely Acute Malnourished (SAM)/Moderate Acute Malnourished (MAM) children in Nanjanagudu Taluk, Mysuru District for 250 nos. of beneficiaries.

The Institute conducted various Skill Development Programs and Short-Term Courses under various streams targeted to prospective entrepreneurs & entrepreneurial aspirants, Farmers/FPOs, SHGs, industry professionals and academics with duration spanning 2 days to 5 weeks. CSIR-CFTRI being a technical institution of the Govt. of Karnataka for the implementation of PMFME scheme, exclusive training programs were arranged for Farmers and FPOs. The Institute has been now registered as a Training Partner (TP) and Training Centre for conducting NSQF aligned training programs with job roles as Baking Technician/Operative (FIC/Q5005), Food Microbiologist (FIC/Q7603) and Spice Processing Technician (FIC/Q8502). More than 2300 participants representing 22 states/UTs of the country were trained during

the year under various streams/schemes such as PMFME, CSIR Integrated Skill Initiative, Farmer Centric Activities etc.

One of the major attractions of the year was the development of a Mobile Food Processing & Demonstration Unit (MFPDU) for Fruits & Vegetables processing, Grain Processing, Spices Processing and other food processing with analysis. This MFPDU is highly beneficial for the farming community to reduce wastage of fresh fruits and vegetables and to add value to them to resist the selling of commodities in throw-away prices.

As you know the year 2023 declared as International Year of Millets (IY0M) the Institute got a chance to show case the "CSIR innovations on Millets" at New Delhi during Jan-2023 and we are expecting a "Millet Mission" project as our Institute as Nodal Lab with around 10 more labs of CSIR in the coming days.

This year we have seen the "Nari Shakti" at CSIR-HQ as Dr. Kalaiselvi has taken charge as Director General - the first woman DG of CSIR in its rich history and legacy of over 80 years. I am very much grateful to the Director General, CSIR, Research Council & Management Council of continuous support and guidance throughout the year.

It is my duty to acknowledge the constant support received from CSIR HQ, really helped to achieve the deliverables. I further thank the external funding agencies including State & Central Govt. Departments/agencies, Academic Institutions etc. for their support during the journey.

Last but not least, I would like to thank each and every staff, students and outsourced personnel for contributing and putting their sincere efforts as **'Team CFTRI'** to meet the mandate and the way forward of this great Institute.

Date: January 22, 2024

Sd/-
(Sridevi Annapurna Singh)
Director, CSIR-CFTRI

Achievements at a Glance

Publications

Research Papers	92
Reviews	13
Book Chapters	25

Projects

Grant-in-aid	74
Consultancy	13
Sponsored	41
Technical Service	21
Collaborative Projects	10

Industrial Development

Patents Filed in India	3
Patents Filed in abroad	1
Patents Granted in India	10
Technologies Transferred	85
New Technologies Developed	10

Human Resource Development

M.Sc. (Food Technology)	32
Certificate Course in Flour Milling	27
Ph.Ds Awarded	30
Skill Development Programmes	2307

Achievements in Brief

1. Research Publications

SCI Publications

1. Ajana P., Bijesh P., Divya P., Sudha R., Chauhan V.S., Folate derivatives, 5-methyltetrahydrofolate and 10-formyltetrahydrofolate, protect BEAS-2B cells from high glucose-induced oxidative stress and inflammation, *In Vitro Cellular & Dev. Biol.-Animal*, 2022, **58(5)**, 419-428

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Non-SCI Publications

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Book Chapters

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Book Published

1. Coffee Science: Biotechnological Advances, Economics and Health Benefits, *Edited by: Akula Ramakrishna, Giridhar P. & Jeszka-Skowron M.*, CRC Press, Boca Raton FL, 2022, 326 pages

Short Communications / Short notes / Editorial notes

1. Kunal Sharan, Vascular and skeletal crosstalk in health and disease, *Frontiers in Endocrinology*, 2022, **13**, 1084940

2. Shruti Pandey, Fortification and value addition, *Shetkari Magazine-Special edition on Agriculture and Food processing*, 2022, **22(3)**, 31

2. Patents Filed / Granted in India

Filed in India

- A method for linalool synthesis in *Saccharomyces cerevisiae (Inventors: Sarma MVRK, Aneesha Abdullah, Nabarupa Gupta, Kalaivani Paramasivan)*
- A process for the preparation of nanovesicles containing curcumin and piperine *(Inventors: Gopinath M, Meghana N Kumar)*
- A protein enriched product and its preperation thereof *(Inventors: Mohankumari HP, Mohan A Dhale, Sathish HS, Selina Majhi)*

Filed abroad

- Dihydrofolate for hypoglycemic activity *(Inventors: Vikas Singh Chauhan, Bijesh P, Ajana Pathikkal, Ulaganathan Mabalirajan, Atmaja Karmakar, Divya Peethambaran)*

Granted in India

- An improved process for preparation of debitterd endosperm meal from fenugreek seed *(Inventors: Pura Naik J, Madhava Naidu M, Srinivas P)*
- A novel colorimetric method for the detection of ß-carotene in milk using nanoparticles *(Inventors: Anandharamakrishnan C, Vijaya Kumar Arun Kumar, Loganathan Bhavani Devi, Ram Rajesekharan)*
- An improved process for the premaration of betacyanin and betaxanthin from betalains *(Inventors: Chethana Sampangi, Raghavarao KSMS)*
- A process for the preparation of dehydrated green pepper (*Piper nigrum L.*) without using chemicals *(Inventors: Styagalam Ranganatha Desilkacharya Sampathu, HB Sowbhagya, Madhava Naidu M, Mysore Nagaraja Rao)*
- A process for the preparation of bio-oleoresins from spices *(Inventors: Sowbhagya HB, Purnima Kaul Tiku, Satyagalam Ranganatha Deshikacharya Sampathu, Bhashyam Raghavan, Appu Rao AG, Vishveshwaraiah Prakash)*
- Gingerols enriched ginger conserve *(Inventors: Jagan Mohan Rao L, Ramalakshmi K, Umesh Hebbar H)*
- Green tea nutraceutical ice cream *(Inventors: Jagan Mohan Rao L, Borse BB, Maya Prakash)*
- An improved process for the preparation of curcuminoids from turmeric (*Curcuma longa L.*) oleoresin *(Inventors: Jarpla Pura Naik, Madhava Naidu M, Sowbhagya HB, Hafeeza Khanum)*

- An improved process for production of turmeric powder from fresh turmeric rhizomes *(Inventors: Madhava Naidu M, Venkatesh Murthy K, Hafeeza Khanum, Puspha Srinivas Murthy)*
- Continuous online round grain separator *(Inventors: Sourav Kumar)*

3. Processes / Technologies Transferred for Commercial Exploitation

The following 85 processes were released to 163 parties.

- Online fortification of atta (whole wheat flour) / maida (refined wheat flour)
- Nutra chikki with added spirulina
- RTS fruit juices and beverages
- Pickles and chutneys: Preparation
- Rural based biotechnological production of spirulina
- Eggless cake premix
- Ready to cook multigrain whole mix for drink/porridge
- Fermented and dehydrated ready mixes for idli/dosa batter
- Virgin coconut oil
- Ready mix: Upma
- Baking powder

Convenience flour for ragi mudde

- Roller milling process for semolina (sooji/rava) from millets and preparation of multimillets semolina
- Instant halva mix from millets and multimillets semolina
- Instant upma mix from millets and multimillets semolina
- Instant rava idli mix from millets and multimillets semolina
- Nutri fruit bars with immune boosters
- Instant moringa leaf based products
- Fruit syrups and squashes
- Preparation of beverage mix from malted ragi
- Preparation of shelf stable biriyani paste
- Shelf-stable varieties of curry pastes for vegetarian & non-vegetarian traditional cuisines (Shahi paneer, Pindi channa, Sambar (without coconut), Dal – Tadka, Kitchen King)

Nutra chikki with added spirulina

Multigrain nutri cookies

- Preparation of ready to eat shelf stable egg crunchy bite
- Instant traditional foods: Sambar
- Ready mix: Maddur vada
- Instant idly mix
- Spice mix : Puliogre
- Roasted and flavoured cashew kernels
- Low GI beverage for diabetics
- High protein biscuits
- High protein rusk
- DOLY mix, a ready to use mix for soft and enhanced number of idlys
- Sugar free biscuits
- Sugar free cake rusk
- Sugar free rusk
- Sugar free cup cake
- Sugar free bread
- Process for extension of shelf life of bread with natural preservatives & Shelf stable muffins with natural preservatives
- A process for the preparation of gluten free bakery products
- Multigrain nutri cookies
- Bar cake
- Multigrain pasta
- Low glycemic index noodles
- Layered parotta (South Indian)
- Legume based pasta
- Process for production of quinoa germ
- Instant cake mix
- Dipping oil formulation for grapes
- Herbal fogging disinfectants for mist sanitizer system
- Tomato products
- Dehydrated drumstick powder
- Jamun fruit products (Squash, RTS beverage, Syrup)
- Fruit bar: Apple, Banana, Guava, Mango
- Improved banana fruit bar
- Osmo-air dried fruits (Amla, Jackfruit, Pineapple)
- Canning of fruits & vegetables
- Food for diabetics
- Quick cooking, germinated & dehydrated pulses
- Low fat expanded green snack using moringa
- Pulse based papads
- Ragi based papads
- Preparation of shelf stable roti from non-wheat cereal and mille
- Convenience flour from ragi suitable for stiff porridge
- A green process for production of methylxanthines for food and other applications

Shelf stable muffins with natural preservatives

Soya protein hyrolysate

- Chicken & egg wafers
- Preparation of shelf stable egg albumin and egg yolk cubes
- Instant gravy mixes (dehydrated)
- Preparation of dehydrated egg cubes
- Meat/fish/chicken/egg/pork/prawn wafers
- High performance advanced oxidation process for STP's grey water and industrial waste water (food and non food)
- Dehydration of coriander foliage
- Compounded asafoetida
- Tamarind juice concentrate
- Ginger paste
- Garlic paste
- Spray dried papain
- Instant traditional foods: Rasam
- Groundnut (peanut) butter
- Multigrain cereal legume bar & puffed rice bar
- Moringa chikki
- Energy food: New formulation
- Ready mix: Dosa
- Tamarind candy
- Ready mix: Jamun
- Production of soya protein hyrolysate
- Chikki / Nutra chikki

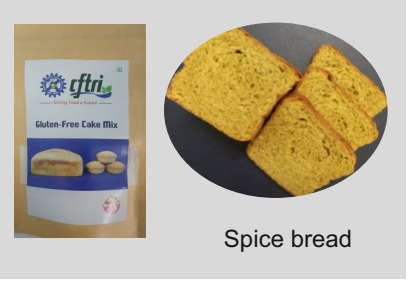
4. New Processes / Technologies Developed

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

- Barley-Seaweed based anti-obese supplement “SeaSlim”
- Process for the production of soluble and insoluble arabinoxylan from wheat bran
- Process for production of quinoa germ
- A process for preparation of spice bread
- A process for preparation of fiber enriched rusk
- Process know-how for gluten-free cake-mix
- Glucose-amla beverage mix
- Process for the production of transglycosylating α-glucosidase using novel fungal strain
- Process for the production of baker's yeast
- A process know-how for freshness keeper paper for extension of shelf life of cut roses

Quinoa germ

SeaSlim



Spice bread

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

Sl. No.	Type of project	No. of projects as on 31.3.2023	No. of projects completed during 2022-23	No. of new projects initiated during 2022-23
1.	Sponsored	32	9	18
2.	Consultancy	5	8	5
3.	Grant-in-Aid	50	24	20
4.	Technical Service	18	3	4
5.	Collaborative Projects	7	3	2

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

Sl. No.	Academic Programmes	Degree / Certificate Awarded
1.	M.Sc. (Food Technology)	32
2.	Certificate Course in Milling	27
3.	Skill Development Programmes	2307

7. Symposia, Conferences and Events Organised / Sponsored by CSIR-CFTRI

- **National Technology Day (May 11, 2022)**

National Technology Day celebrations was held on May 11, 2022. Prof. K Chidananda Gowda, Former Vice-Chancellor of Kuvempu University, Shivamogga was the Chief Guest and delivered talk on “Artificial Intelligence (AI) and Blockchain”. Certificates were distributed to entrepreneurs who have taken technology from CSIR-CFTRI during 2021-22. Seven new technologies developed during 2021-22 were also released on this occasion. Sri. B.V. Sathyendra Rao, Chief Scientist, Head, Technology Transfer and Business Development, CSIR-CFTRI presided over the function.

- **TechBharat 2022 (May 19-21, 2022)**

Techbharat 2022 (Edition 3.0), Empowering Agri-Tech & Food-Tech, an initiative of Laghu Udyog Bharathi-Karnataka (LUB-K) and IMS Foundation, Bengaluru was organised during May 19-21, 2022 at CSIR-CFTRI, Mysuru. Shri Kailash Choudhary, Union Minister of State for Agriculture & Farmer's Welfare, Govt. of India, Shri B.C. Patil, Hon'ble Minister for Agriculture, Govt. of Karnataka were Chief Guests for the inaugural session of the event on May 19, 2022. The Guests of Honour Shri Kris

Gopalakrishnan, Former CEO, Infosys Technologies & Chairman, Axilor Ventures, Dr. M. Angamuthu IAS, Chairman, APEDA, Dept. of Commerce, Govt. of India, Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI graced the event. The dignitaries inaugurated the Mobile Food Processing Unit developed by CSIR-CFTRI and witnessed the demonstration by Drone Federation India & Drone Technology companies.

Shri Jitendra Singh, Minister of State (IC), Ministry of Science and Technology & Ministry of Earth Science & Minister of State in the PMO was the Chief Guest on May 20, 2022 and released the products developed by CSIR-CFTRI. Director, CSIR-CFTRI presided over the function. The Hon'ble Minister along with Sushri Shobha Karandlaje, Hon'ble Minister of State for Agriculture & Farmers' Welfare, Govt. of India, inaugurated the EXPO, the main event of TechBharat 2022 and visited CSIR-CFTRI and CSIR Pavilions. He also inaugurated CSIR-CFTRI Showcase, released the Coffee Table Book covering 72 years of the journey of CSIR-CFTRI, monograph on Spices, interacted with the scientists and visited various facilities of CSIR-CFTRI.

Panel discussions on wide range of topics, including agriculture development, food business ecosystem, opportunities for women in agritech and food protech, trends in food technology etc., were held as a part of the TechBharat event. Business meets and interactions with the exhibitors & incubatees were also held.

- **World Nutrition Day (June 1, 2022)**

World Nutrition day organized by AFSTI(I) and CSIR-CFTRI was held on June 1, 2022. Dr. S. Kowsalya, Registrar, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore was the Chief Guest and she delivered a lecture on “Nutrition and Life Style-Disease Management”. Dr. Sridevi

Annapurna Singh, Director, CSIR-CFTRI presided over the function and delivered a talk on “Malnutrition”.

- **Environment Day (June 6, 2022)**

World Environment Day was celebrated in the campus by planting trees on June 6, 2022. Shri H.S. Chandrashekar, Deputy Range Forest Officer, Territorial Range, Mysuru graced the function. Director and staff of the Institute were present.

- **World Food Safety Day (June 7, 2022)**

World Food Safety Day celebrations organised by AFST(I) and CSIR-CFTRI was held on 7th June, 2022 at CSIR-CFTRI. Students and teachers from various schools and colleges of Mysuru participated in the awareness programme on Food Labelling and Food Adulteration. Dr. A.K. Srivastava, President, AFST(I) delivered the keynote address and Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI addressed the students on safety aspects of food.

- **International Yoga Day (June 21, 2022)**

CSIR-CFTRI staff and students participated in the International Yoga Day 2022 held on June 21, 2022 at Mysuru palace which was Inaugurated by Sri Narendra Modi, Hon'ble Prime Minister, Govt. of India.

- **Dr. B.R. Ambedkar Birth Anniversary (July 13, 2022)**

As part of 131st Birth Anniversary of Bharath Ratna Dr. B.R. Ambedkar, a seminar on “Dr. Ambedkar and Constitution of India” was held on July 13, 2022 at CSIR-CFTRI. The event was inaugurated by Dr. Ravindranath, IPS, Director General of Police (Training) and Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided over the function. The Chief

Guest Sri Balan, Advocate and Social Activist delivered the special address.

- **Independence Day Celebrations (Aug. 15, 2022)**

Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI, hoisted the National flag as part of the Independence Day celebrations and addressed the staff and students of the Institute.

- **Stakeholders Workshop (Aug. 17-18, 2022)**

A two-day Stakeholders Workshop on “Grain Storage and Pest Management” sponsored by UPL Ltd., Mumbai was organized. Dr. Prakash M Halami, Chief Scientist, CSIR-CFTRI briefed about the workshop and the Director, CSIR-CFTRI presided over the function. About 80 participants including farmers, industry personnel, research scholars and professionals attended the workshop.

- **National Nutrition Week Celebrations (Sept. 8, 2022)**

National Nutrition week was held at CSIR-CFTRI. The programme was attended by CSIR-CFTRI school students and teachers. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI distributed the prizes to winners of various competitions conducted on the theme “Celebrate the World of Flavors”.

- **Engineer's Day Celebrations (Sept. 15, 2022)**

55th Engineer's Day was celebrated on September 15, 2022 on the occasion of 162nd birthday of Bharat Ratna Sir M. Visvesvaraya wherein Er. H.S. Sathish, Chief Scientist, Director-in-charge, CSIR-CFTRI presided and garlanded the portrait of Sir M. Visvesvaraya and addressed the gathering.

- **Birth Anniversary Celebrations of Dr. V. Subramanyan (Sept. 16, 2022)**

Birth Anniversary of Dr. V. Subramanyan, Founder Director, CSIR- CFTRI was held at CSIR-CFTRI on September 16, 2022. The event was presided over by Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI. The lectures on Dr. V. Subramanyan's life and achievements was presented by former CSIR-CFTRI scientists Dr. Arun Chandrashekar and Dr. N. Chandrashekara.

- **Ayurveda day (Oct. 10, 2022)**

On October 10, 2022, CSIR-CFTRI hosted an Ayurveda Day programme. As part of the event, Dr. Kavya delivered a talk on "Disease Preventive Modalities in Ayurveda". Free health check-up for employees and students and distribution of free medicines were also organized.

- **CSIR Foundation Day (Oct. 25, 2022)**

CSIR Foundation Day and World Food Day celebrations were held on 25th October, 2022. Dr. Chindi Vasudevappa, Vice-Chancellor,

NIFTEM, Kundli, Sonepat (Haryana) was the Chief Guest and delivered a lecture on the topic "Social obligations for Food Scientists". Shri R.K. Labh was the Guest of Honour and Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided over. The dignitaries distributed prizes to school children who won CSIR foundation competitions as well as Mementoes to retirees and staff.

- **CSIR-CFTRI Foundation Day (Oct. 26, 2022)**

The 72nd CSIR-CFTRI Foundation Day was held on 26th October, 2022. Padmabhushan Dr. T. Ramasami, Former Secretary, Department of Science & Technology was the Chief Guest and delivered Foundation Day Address. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided. The Annual Institute awards were presented on the occasion.

- **Kannada Rajyotsava Day (Nov. 1, 2022)**

Kannada Rajyotsava celebration was conducted on 1st November, 2022 and the programme was graced by Prof. C.P. Krishna Kumar, Poet & Writer and former President, Kannada Sahithya Sammelana as the Chief Guest. Director, CSIR-CFTRI and the Chief Guest hoisted the flag on the occasion.

- **Vigilance Awareness Week (Nov. 4, 2022)**

The Vigilance Awareness week was held on 4th November, 2022 at CSIR-CFTRI. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided over the event and Shri H.S. Sathish, Chief Scientist addressed the gathering. Prizes were distributed to the winners of various competitions conducted as part of the awareness week.

- **ISMT Course Award Ceremony (Nov. 21, 2022)**

The award ceremony and valedictory function of 41st ISMT course was held on 21st November, 2022. The valedictory address was delivered by Mr. Haris Nellikote, Director, Parisons Foods Pvt. Ltd., Kozhikode (Kerala). The function was presided by Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI and medals were presented to the meritorious students.

- **Fit India Freedom Run (Dec. 23, 2022)**

Fit India Freedom Run 3.0 was held on 23rd December, 2022 in CSIR-CFTRI campus. Deputy Commissioner and also the District Magistrate of Mysuru District Dr. K V Rajendra, IAS, flagged off the event in the presence of Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI. About 200 participants including staff and students of the Institute took part in the event covering 3 km.

- **M.Sc. Course Award Ceremony (Dec. 23, 2022)**

Presentation ceremony of medals, awards and scholarships to M.Sc. (Food Technology) students was held on 23rd December 2022 at CSIR-CFTRI. The Chief Guest Dr. V. Prakash, Former Director, CSIR-CFTRI & Distinguished Scientist, CSIR delivered the inaugural address and distributed medals, awards and scholarships to meritorious students. The occasion was presided over by Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI.

- **Republic Day Celebrations (Jan. 26, 2023)**

As part of Republic Day Celebrations, Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI hoisted the National Tricolour Flag and delivered the Republic Day address on Jan 26, 2023.

- **International Year of Millets (IY0M) 2023 (Jan. 30, 2023)**

As part of International Year of Millets (IY0M) 2023 celebrations, Council of Scientific and Industrial Research (CSIR), New Delhi & Central Food Technological Research Institute (CSIR-CFTRI), Mysuru organised the event “CSIR innovations on Millets” on 30th January, 2023 at CSIR- National Physical Laboratory (NPL) Auditorium, New Delhi. Interaction with experts' scientists, industrial partners and release of Millet Calendar highlighting CSIR Innovations on Millets Technologies were the key activities of the event. Dr Jitendra Singh, Hon'ble Union Minister of State (Independent Charge) Science & Technology; Minister of State (Independent Charge) Earth Sciences; MoS PMO, Personnel, Public Grievances, Pensions, Atomic Energy and Space and Vice-President, CSIR was the Chief Guest for the function. Dr. Jitendra Singh, Hon'ble Minister inaugurated the exhibition and also the display of products and technologies developed by CSIR-CFTRI and other CSIR labs. The Hon'ble Minister released the Desktop Calendar 2023 on “CSIR Innovations on Millets” and delivered the Chief Guest's address. A video on millets and their health benefits and technologies / products brought out by CSIR-CFTRI in particular was presented. Dr. Venugopal Achanta, Director, CSIR-NPL, New Delhi welcomed the gathering. Dr Sridevi Annapurna Singh, Director, CSIR-CFTRI, Mysore spoke about the key contributions of CSIR in the area of millet processing.

- **National Science Day (Feb. 28, 2023)**

National Science Day lecture was held on 28th February, 2023 at CSIR-CFTRI campus. Prof. M.R.N. Murthy, Emeritus Professor, Indian Institute of Science (IISc) was the Chief Guest and delivered the lecture on "Excursions in the Wonderland of Proteins” and also interacted with school children. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI presided over the event.

- **Millet Jigyasa (Feb. 28, 2023)**

On the occasion of National Science Day on February 28, 2023, Jigyasa programme on millets was held at the CSIR-CFTRI campus. The Chief Guest was Sri Ramachandra Raje Urs, Deputy Director of Public Instruction, Mysuru, Govt. of Karnataka, and the Guest of Honour was Prof. H.S. Nagaraja, Prayoga, IER, who addressed the gathering. The occasion was presided over by Dr. Sridevi Annapurna Singh, Director of CSIR-CFTRI. Approximately 200 students took part in the programme.

- **International Women's Day (Mar. 8, 2023)**

International Women's Day was celebrated on 8th March, 2023. On this occasion, Smt. Nagamma, a small and marginal farmer involved in the conservation of historic varieties, was honoured. Prof. Bina Joe, University of Toledo, College of Medicine and Life Sciences, USA, was the Chief Guest and delivered an online Women's Day lecture titled "Celebrating the Pursuit of Happiness through Womanhood." Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI, presided over the occasion and delivered the International Women's Day address.

- **Industry Meet on Bio-fumigation technology for safe storage of food grains (Mar. 21, 2023)**

An Industry Meet entitled “Bio-fumigation technology for safe storage of food grains” was organized under the CSIR ATLAS Mission project for exploring the importance and opportunities of bio-fumigation technology. This industry meet was inaugurated by Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI, who highlighted the importance of food security, food safety and need of innovative technologies for sustainable grain storage management. Several industries participated and interacted with the CSIR-CFTRI team during the event, and shared their views and demand of alternative ecofriendly technologies for safe storage of food grains.

8. Azadi Ka Amrit Mahotsav Webinar Series

- Webinar on "Technologies on Nutritional Security" under Theme Agri & Nutri Biotech (ANB) – Event No. iCEN10 coordinated by CSIR-CFTRI was held through virtual platform on May 30, 2022, which was organised under I-CONNECT, Ministry of Science & Technology. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI was the theme coordinator for the event.
- On June 2, 2022, Prof. Hosahalli Ramaswamy, Department of Food Science and Agriculture Chemistry, McGill University, Canada gave a talk on the topic "Thermal Processing: A Journey from Apparet to Pascale." Dr. Sridevi Annapurna Singh, rendered presidential remarks.
- A National Hindi webinar was conducted on July 20, 2022. Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI delivered the inaugural address on this occasion. The lectures were given on “Pomegranate seed oil, chestnut and high pressure Technology” by scientific staff of the Institute.
- Technical invitation talk was held at CSIR-CFTRI on August 12, 2022. The talk on” Indian Sugar Industry: Sugar and beyond” was delivered by Dr. Narendra Mohan. Director, National Sugar Institute, Kanpur.

Dr. Sridevi A. Singh, Director, CSIR-CFTRI delivering the Azadi Ka Amrit Mahotsav Webinar lecture

Azadi Ka Amrit Mahotsav Webinar lecture series by Prof. Hosahalli Ramaswamy

9. MoU(s) Signed

- DBT-Centre for Cellular and Molecular Platformas (C-CAMP), Bangalore
- Aragen Life Sciences Pvt. Ltd. (ALSPL), Hyderabad
- Zum Heilen Diagnostic & Therapeutics Pvt. Ltd., Thrissur
- Khadi and Village Industries Commission (KVIC), Mumbai
- Karnataka Health Promotion Trust (KHPT), Bengaluru
- Development Consortium, New Delhi
- Defence Food Research Laboratory (DFRL), Mysuru
- Central Pulp and Paper Research Institute (CPPRI), Saharanpur
- Central Ayurveda Research Institute (CARI), Bengaluru
- Spices Board, Cochin

Signing of MoU between CSIR-CFTRI and DBT- Centre for Cellular and Molecular Platforms (C-CAMP), Bangalore

Signing of MoU between CSIR-CFTRI and Spices Board, Cochin

Signing of MoU between CSIR-CFTRI and Spices Board, Cochin

10. Awards and Recognitions

Ph.D. Degree awarded

a) University of Mysore

Name of the Student	Title of the Thesis	Guide
• Maria Sheeba Nazareth	Identification of bioactives from *Carissa spinarum* fruits and their anti-quorum sensing activity on food borne pathogens	Dr. Nandini P Shetty
• Abdul Majid	Targeting dipeptidyl peptidase-4 (DPP4) by peptide inhibitors for the management of type-2 diabetes and its complications	Dr. Poornima Priyadarshini CG
• Rekha M J	Studies on the anti-inflammatory properties aof flavonoids from karanja (*Pongamia pinnata*) seeds	Dr. Govindaraju K
• Jyothna Bommasamudram	Development of thermotolerant lactobacilli cultures for food application as synbiotics	Dr. Somashekar D

b) AcSIR

Name of the Student	Title of the Thesis	Guide
• Vinayak Hegde	Rational design of antibacterial molecules by targeting Rel proteins of food borne pathogens	Dr. Nandini CD Dr. Balaji Prakash (Co-Guide)
• Veeresh Toragall	Development of lutein nanocarrier and evaluation of its effect on retinal angiogenesis in the hyperglycaemic animal model	Dr. Baskaran V
• Janani R	Modulation of hyperglycemia induced oxidative stress-mediated retinal angiogenesis with astaxanthin *in vitro* and *in vivo*	Dr. Baskaran V
• Yeshvanthi Singh	Identification and evaluation of acyltransferase inhibitors from edible plant sources for management and prevention of obesity	Dr. Ajay W Tumaney

Name of the Student	Title of the Thesis	Guide
• Yogitha Bhatt	Formulation of cereal-based breakfast mixes with modulated starch digestibility for regulation of hyperglycaemia	Dr. Jyothi Lakshmi A
• Aishwarya Jaiswal	Enhancing the bioavailability of micronutrients in complementary foods through technological intervention	Dr. Jyothi Lakshmi A
• Mohmmad Shahabazudin	Studies on plant cell wall deconstruction of agro-industrial remnants and bioconversion assessment to value-added product	Dr. Sandeep N Mudliar
• Mohamed Anis	Inhibitory effects of barnyard millet phenolic compounds on the advanced glycation end product formation and diabetic retinopathy	Dr. Sreerama YN
• Amrita Ray	Fractionation of Quinoa (*Chenopodium quinoa)* using roller milling for their nutritional utilization in food product development	Dr. Alok K Srivastava Dr. Suresh D Sakhare (Co-guide)
• Jaisheela Marry SR	Development and validation of miniaturized abioactive compounds through its incorporation in wheat based food product targeting liver disease	Dr. Alok K Srivastava
• Shubha JR	Effect of phytochemicals from selected medicinal plant(s) on probiotic bacteria and their influence on gut health	Dr. Praveena Bhatt Mudliar
• Ayushi Dalmia	Role of Acyl-CoA: Diacylglycerol acyltransferase in accumulation of long chain polyunsaturated fatty acids in *Aurantiochytrium limacinum*	Dr. Ajay W Tumaney
• Palak Daga	Isolation, characterization and nutraceutical profiling of fixed oil from Indian spices	Dr. Ajay W Tumaney

Name of the Student	Title of the Thesis	Guide
• Darshan D	Studies on the regulatory mechanisms of α–mannosidase and β–*N*acetyl hexosaminidase during fruit ripening	Dr. Nandini P Shetty
• Akanksha Singh	Isolation, characterization and evaluation of biological activities of Arabinoxylan (AX) and Arabinoxylan Oligosaccharides (AXOS) from pearl millet bran	Dr. Sachin M Eligar
• Sallaram Sindhoora	Characterization of bioactive compounds from *Capparis zeylanica* fruit in attenuation of dyslipidemia and development of health beverage formulation	Dr. Vijayanand P
• Pramod GN	Evaluation of nanoencapsulated eugenol for its effect on Tau aggregation and related cellular markers of Alzheimer's disease	Dr. Poornima Priyadarshini CG
• Dhanamjai Penta	Combinatorial epigenetic approach against triple-negative breast cancer	Dr. Syed Musthapa M
• Kajal Kiran	Understanding the functional attributesof foodborne pathogen, *Staphylococcus aureus* RecA protein in homologous recombination and antibacterial resistancea	Dr. Neelakanteshwar Patil K
• Chaitra Rai	Anti-adipogenic and anti-obesity activity of bovine milk bioactives in 3T3L1 preadipocytes and in diet-induced obese mice	Dr. Poornima Priyadarshini CG
• Dheeran R	MicroRNA modulations in obesity-associated breast cancer: Therapeutic intervention using dietary piperine	Dr. Syed Musthapa M
• Arpita Das	Cereal and herbal based functional food and its hypoglycemic effect on molecular targets	Dr. Ramaprasad TR Dr. V Baskaran (Co-guide)
• Lidiya C Johny	Antimicrobial compound from microorganism of marine origin and elucidation of their characteristics	Dr. Suresh PV

c) *Other Universities*

Name of the Student	Title of the Thesis	Name of the University
• Manjunatha Prabhu BH	Quantitative trait nucleotide variation in select candidate genes associated with behavioural, productive and reproductive traits in deoni cattle	ICAR-National Dairy Research Institute, Karnal
• Rohith HS	Efficacy of probiotic bacteria in alleviating T helper cell associated immune response ***Guide: Prakash M Halami***	Mangalore University
• Shreelakshmi SV	Production of phenolics, 1-Deoxynojirimycin and reservetol from *in vitro* culture of mulberry and their biological activity ***Guide: Dr. Nandini P Shetty***	Mangalore University

d) CSIR-CFTRI Annual Awards 2021-22

- **Best Contribution Award - General Administration**

  Shri Sudhakar S., Sr. Secretariat Asst. (G)

- **Best Contribution Award - Finance and Accounts**

  Smt. Divya M.V., Assistant Section Officer (F&A)

- **Best Contribution Award - Stores & Purchase**

  Smt. Kavyashree L., Assistant Section Officer (S&P)

- **Best Research Publication Award for Basic Sciences**

  Madhubalaji C.K., Ajam Shekh, Sarada R., Sandeep Mudliar N., Volatile organic compounds involved in the communication of microalgae-bacterial association extracted through headspace-solid phase microextraction and confirmed using gas chromatography-mass spectrophotometry, *Bioresource Technology*, 2022, **348**, 126775

- **Best Publication Award for Applied Research**

  Sudha M.L., Soumya C., Saravanan M., Madhushree P., Jivjyot Singh, Saikat Roy, Prabhasankar P., Influence of short chain fructo-oligosaccharide (SC-FOS) on the dough rheological, microstructural properties and bread quality during storage, *LWT*-Food *Science and Technology*, 2022, **158**, 113102

- **Best Student Award - M.Sc. (Food Technology)**

  Ms. Shreya Khalai

- **Best Student Award – ISMT**

  Ms. Sujatha V

- **Best Research Fellow Award**

  - Mr. Madhubalaji CK, Department of Plant Cell Biotechnology

  - Mr. Veeresh Toragall, Department of Biochemistry

- **Best Technology Transfer Award**

  Dr. Babylatha R., Department of Traditional Food & Sensory Science, Pour over mini idli with four types of South Indian sambars and three types of pour over chutneys *(Contributors: Shri Sathyendra Rao B.V., Shri Rajeshwar S Matche, Dr. Sudheer Kumar Y. & Shri Jayaprakashan S.G.)*

- **Best R&D Department Award**

  Flour Milling, Baking & Confectionery Technology

- **Best Support Department Award**

  Central Instruments Facility & Services

- **Best Technical Support Staff [Gr. C(NT)]**

  Shri Puttaraju B.V., Department of Food Engineering

- **Best Technical Support Staff (Gr. I)**

  Shri Nataraja C., Establishment – VI

- **Best Technical Support Staff (Gr. II)**

  Dr. Narsing Rao G., Resource Centre – Hyderabad

- **Best Individual Award for Scientific Contributions (Gr. III)**

  Dr. Usha Dharmaraj, Department of Grain Science Technology

- **Best Individual Award for Technical Contributions (Gr. III)**

  Dr. Padmavathi T., FOSTIS

- **Best Individual Award for Scientific Contributions (Gr. IV)**

  Dr. Nandini P Shetty, Department of Plant Cell Biotechnology

Awardees with Chief Guest and Director, CSIR-CFTRI

- **Best Individual Award for Technical Contributions (Gr. IV)**

  Shri Keshava Prakash M.N., Department of Central Instruments Facility & Services

- **Individual Award for Maximum ECF Generation**

  Shri Matche R.S., Department of Food Packaging Technology

e) Recognitions by Academies

Recognition	Instituted by	Awardee
• Executive Councillor for Indian Society for Spices	ICAR-IISR, Calicut	Dr. Madhava Naidu M
• Professor of Practice	VelTech, Chennai	Dr. Giridhar P

f) Individual Awards

Recognition	Instituted by	Awardee
• Honorary Fellow	Karnataka Science and Technology Academy, a Unit of Department of Science and Technology, Government of Karnataka	Dr. Sridevi Annapurna Singh

Dr. Babylatha R., Principal Technical Officer, Dept. of Traditional Foods & Applied Nutrition, receiving the Shubhash Bhatnagar Memorial Award - 2021 instituted by AFST(I), Mysore

Dr. Harish Prashanth K.V., Principal Scientist, Dept. of Biochemistry, receiving the Dr. Wankhede Excellence Award instituted by AFST(I), Mysore

Recognition	Instituted by	Awardee
• Shubhash Bhatnagar Memorial Award - 2021	AFST(I), Mysore	Dr. Babylatha R
• Fellow	AFST(I), Mysore	Dr. Prakash M Halami
• Fellow	Microbiologist Society of India, 2022	Dr. Prakash M Halami
• MRSB	Royal Society, London	Dr. Rajagopal K
• Green Technology Innovative Award 2022	National Environmental Science Academy (NESA), Alaknanda Community Centre, New Delhi	Dr. Ezil Vendan S
• Dr. Wankhede Excellence award	AFST(I), Mysuru	Dr. Harish Prashanth KV
• Fellow of Royal Entomological Society	Royal Entomological Society, St. Albans, Hertfordshire, AL2 3NS, United Kingdom	Dr. Ezil Vendan S

g) Other Recognitions

Name	Member / Panel Expert & Host Institution
• Dr. Sridevi Annapurna Singh	• Member of CSIR Governing Body; Senate Member of AcSIR; Member of Task Force on Nutra Sector constituted by CSIR; Member of Advisory Committee of CSIR – Traditional Knowledge Digital Library (CSIR-TKDL); Steering Committee Member for MOU between CSIR and Amity University; Member, Task Force Committee to review/monitor and guide the implementation of Jigyasa 2.0 programme • Member, Task Force to propel research, manufacture & market access for nutraceutical sector Under Chairmanship of Principal Scientific Advisor to Prime Minister

Name	Member / Panel Expert & Host Institution
	• Member of Search-cum-Selection Committee for selection of Members of the Scientific Committee and Scientific Panels of FSSAI; Taskforce Chairperson on Standards Committee for Indian Mithai and Namkeen; Chairperson, Expert Committee, FSSAI
	• Chairperson, Expert Committee – 5 to examine the approval of Non-specified Food and Food Ingredients, FSSAI;Member, Codex Coordination Group (CCG3): Foods of Plant Origin (Sub-group on Fresh Fruits &Vegetables); Member, Codex Committee on Contaminants in Foods (CCCF15) of FSSAI
	• Chairperson on FAD14 on Water, Bureau of Standards; Alternate Chairperson of SIRO (DSIR) Screening Committee for recognition to In-house R&D (RDI) units
	• Member of DST Fund for Improvement of S&T Infrastructure (FIST) Program, DST, GOI, New Delhi; Member, Screening/Apex Committee for the enhancement of competitiveness in the Indian Capital Goods Sector of NRDC, Ministry of Heavy Industries
	• Governing Council Member for National Agri Biotechnology Institute, Mohali (DBR); Governing Council Member for CIAB, Mohali (DBT); Member, Project Review & Monitoring Committee, NECTAR, DST, GOI
	• Member, Technical Expert Committee on Public Health and Nutrition, DBT, Govt. of India; Member of Selection committee – National Awards 2022 of TDB/DST; Member of the Committee on 'Smart Proteins', BIRAC, DBT
	• Chairperson of the 'Task Force on Enhancement of Shelf Life of Millets' constituted by the Ministry of

Name	Member / Panel Expert & Host Institution
	Agriculture and Farmers Welfare; Member of Scientific Advisory Committee of International Life Sciences Institute (ILSI), India • Member of Pushti Committee of Department of Women and Child Development, Government of Karnataka; Member of Vision Group on Biotechnology, Government of Karnataka; Advisory Committee Member of International Conference (SAFETY 2022) at Tezpur University • Advisor for Editorial Board of IFI Magazine by AFSTI; Member of Board of Studies in the Department of Food Engineering at Jawaharlal Nehru Technological University, Kakinada; Member, Project Review and Monitoring Committee (PRMC), Mobile Fruits and Vegetables processing unit in North East
• Dr. Prakash M Halami	• Member, Scientific panel on antibiotic residue, FSSAI, New Delhi • Member, BOS in Life Sciences, JSS Academy of Higher Education, Mysore • Member, Board of Study, Department of Biotechnology, University of Mysore. • Member, Board of Study, St. Philomena's College, Mysuru • Member, Board of studies, St Joseph's University, Bangalore
• Dr. Umesh Hebbar H	• Member, Expert Member for reviewing of projects under S&T scheme of KVIC • Member, External Examiner / DAC Member / Reviewer for Ph.D. / M. Tech - JSS Science and

Name	Member / Panel Expert & Host Institution
	Technology University, Mysuru; Anna University, Chennai; School of Biosciences and Technology, School of Chemical and Bio Engineering (SCBE), Addis Ababa Institute of Technology, Ethiopia; VIT, Vellore; NIFTEM-Thanjavur
	• Member, Food and Agriculture Division Council (FADC) of BIS - FAD 20
	• Member, BOS, Food Science and Technology, University of Mysore, Mysuru
• 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
• Dr. Madhava Naidu M	• 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
	• Member, Spices Board, Ministry of Commerce, Bangalore
	• Head of ISO delegates (India), BIS, New Delhi, FAD-9, Spices and Condiments

Name	Member / Panel Expert & Host Institution
• Dr. Giridhar P	• Member, Research Advisory Board, MIT, ADT University, Pune • Executive Council Member, Indian Botanical Society, Lucknow
• Dr. Gothwal PP	• Executive Member, State Level Empowered Committee for Appraisal of Milk/Dairy Processing Industry, Govt. of Uttar Pradesh • Expert Member, Food/Dairy Technology for the selection of Chief Chemist/Analyst/Food Safety Officer (FSO), UPSC, New Delhi • Expert Member, Food/Dairy Technology for the selection of DHO, Food and Civil Supply Officers, MI Inspectors, Uttar Pradesh Public Service Commission, Govt. of Uttar Pradesh, Allahabad • Subject Expert in the area of Food and Nutrition/Dairy Chemistry/Technology Selection Committee of Agricultural Scientist Recruitment Board, ICAR, New Delhi • Food Science and Technology Expert, Bundelkhand University Jhansi, HBTU, Kanpur
• Dr. Mukesh Kapoor	• Member, Technical Committee, Technology Mission on Coconut, Coconut Development Board, Kochi
• 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

Name	Member / Panel Expert & Host Institution
	• 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 • Committee Member, Technical Committee Meetings of APEDA, New Delhi
• 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 • Expert Member, Karnataka State Lime Development Centre, Govt. of Karnataka • 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.

Name	Member / Panel Expert & Host Institution
• Dr. Jaydeep A	• Member, FSSAI Scientific Panel On Cereals & Pulses • Member, FSSAI Food Analysts Exam Board • Chairman, Board of Adjudicators for the Ph.D. Viva Voce in Biochemistry of M.G. University, Kottayam. • Member, Board of Examiners for the evaluation of the Ph.D. thesis in Biochemistry, University of Kerala, Thiruvananthapuram
• Dr. Usha Dharmaraj	• Panel Member, Screening & Selection Committee panel for the Millets theme, Atal Innovation Mission, Niti Aayog • Panel Member, Policy Round Table Session on Millet Markets and Local Economics organised by Revitalising Rainfed Agriculture
• 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 • Member, Subject Expert, BOS of Food Science Technology, St. Joseph's University, Bangalore
• Dr. Usharani D	• Research Council Member of ICAR-IINRG • Member, Scientific Panel of Pesticide Residues, FSSAI

Name	Member / Panel Expert & Host Institution
• Mrs. Vanajakshi V	• Alternate Member, Drinks & Drinking Water Section Committee, Bureau of India Standards (FAD14)
• Shri Matche RS	• Member, Scientific Panel on Packaging (SP-20) FSSAI • Member Expert Committee (EC), Meeting to look at the issues and develop a guideline/advisory document so as to ensure food safety and use of safe, suitable and sustainable packaging materials, FSSAI • Member, Plastics Sectional Committee, PCD 12, BIS • Member, Plastics Packaging Sectional Committee, PCD 21, BIS • Member, Methods of Sampling and Test for Plastics Sectional Committee, PCD 27, BIS
• Dr. Keshava Murthy P	• Alternate member, Plastics Sectional Committee, PCD 12, BIS
• Dr. Jeevan Prasad Reddy	• Alternate Member, Plastics Packaging Sectional Committee, PCD 21 BIS
• Dr. Arunkumar P	• Alternate Member, Methods of Sampling and Test for Plastics Sectional Committee, PCD 27, BIS
• Dr. Vivek Babu CS	• Member, Scientific Panel on Contaminants in the Food Chain (SP-07), constituted by FSSAI, New Delhi • Member, Expert Committee of Microbiology, constituted by Karnataka State Higher Education Council, Bangalore to draft model curriculum contents • Member of Expert Committee to examine various limits of Copper in the Food Commodities, constituted

Name	Member / Panel Expert & Host Institution
	by Food Safety and Standards Authority of India (FSSAI), New Delhi • Member of Electronic Working Group (EWG) in Codex Committee on Contaminants in Foods (CCCF-17: Pyrrolizidine Alkaloids) constituted by FSSAI and National Codex Contact Point (NCCP) of India, New Delhi • Alternative Member of Sectional Committee FAD 16-Foodgrains, Allied products, and other agricultural produce constituted by the Bureau of Indian Standards (BIS), New Delhi
• Dr. Prabhasankar P	• Member, BOS, Home Science, Sri Padmavathi Mahila Visvavidyalayam (SPMVV), Tirupati • Academic Council Member, Faculty of Food Technology, University of Mysore • Member, Nodal Scientist for the Nutritional Security under Agriculture and Nutritional Biotech (ANB) Theme (CSIR) • Member, Ready to Eat Foods and Specialized Products Sectional Committee, FAD 24 (Food and Agriculture Department, Bureau of Indian Standards) • Member, FSSAI- Scientific Panel on Cereals, Pulses & Legume and their Products (Including Bakery) • External Expert Member, Selection of RA & JRF at DFRL, Mysore
• Dr. Nandini CD	• Member, Fixed dose combination related to vitamins and minerals, Central Drug Standard Control Organisation, New Delhi

Name	Member / Panel Expert & Host Institution
	• External Member, BOS, Faculty of Community Science, Tamil Nadu Agricultural University, Coimbatore
	• IBSC (DBT-nominee), JSS-AHER, Mysore
• Dr. Asha Martin	• Principal Member, Technical Committee on Food Biotechnology Sectional Committee (FAD-23) of the Food and Agriculture Division of Bureau of Indian Standards (BIS)
	• Member, Human Ethical Committee, University of Mysore
	• Expert Member, Project Review and Steering Group (PRSG) for Ministry of Electronics and Information Technology
• 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

Name	Member / Panel Expert & Host Institution
• Dr. Vijayaraj P	• Expert Committee Member, FSSAI Scientific Panel on Oils and Fats (SP-15)
• Dr. Madan Kumar P	• Advisory Committee Member and Examiner for Diploma course in Food Safety Management, Sri Sankara Arts and Science College, Kanchipuram (TN) • Convener, Steering Committee of the Environmental Management System (EMS) – ISO 14001:2015 • Member, Steering Committee of the Quality Management System (QMS) – ISO 9001:2015
• Dr. Siva Sankara Reddy Singam	• Alternate Member, Sugar Industry Sectional Committee, FAD 2 constituted by the Bureau of Indian Standards (BIS), New Delhi
• Dr. Kudachikar VB	• Expert Member, Techno Financial Expert Committee (TFEC) of Indo-US Pace Setter Fund Programme under MNRE, GOI and US embassy
• Dr. Muthukumar SP	• Member, FAD 3, Apiary Industry Committee, Bureau of Indian Standards • Nominee, Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Govt. of India • Member, Institutional Biosafety Committee, JSS AHER, Vipragen, Mysuru • Member, Scientific Panel on Biological Hazards (SP-06), FSSAI, New Delhi • Joint Secretary, Laboratory Animal Scientists Association (LASA), India

h) Other Awards

Award Title	Instituted by	Awardee
• Young Scientist Award in Life Science	Don Bosco College of Agriculture, Goa	Mr. Anup Ramdas Kodape, SRF, FPIC Dept. (Guide: Dr. Vivek Babu S)
• Young Researcher Award-SASE 2023	National Environmental Science Academy (NESA), Alaknanda Community Centre, New Delhi	Ms. Urvasi Sahu, SRF, FPIC Dept. (Guide: Dr. S. Ezil Vendan)
• Young Scientist Award	Indian National Science Academy (INSA), New Delhi	Dr. Hrishikesh Tavanandi, PMFME Scheme Training Coordinator, FE Dept.

i) CSIR-CFTRI received the following awards:

- Best Institution (Food Technology)-Poshak Anaaz Award-2022 to CSIR-CFTRI: Mr. Ashok Dalwai, CEO, NRAA, Ministry of Agriculture presented the award during National Nutri Cereal Convention 4.0 held at Hyderabad on September 24, 2022 in recognition of the work done in the area of millets by CSIR-CFTRI. The Director, CSIR-CFTRI received the award along with Dr. M.S. Meera, Head, Grain Science & Technology Department.
- CSIR-CFTRI received the "Best Institute for Innovative Research and Development on Millets" award in Millets & Organics 2023 International Trade Fair (MOITF2023) held at Bengaluru during January 20-22, 2023.

j) Best Research Papers / Posters Awards

54th Annual Conference of Nutrition Society of India (NSI) at ICMR-National Institute of Nutrition Campus, Hyderabad, December 22-23, 2022

- Sulochanamma G., Narsing Rao G., Prabhakara Rao P.G., Madhusudhan Rao D., Sridhar R., Jyothirmayi T., Development of instant shelf-stable green moringa (*Moringa oleifera L.*) paste for culinary applications
- Monika Rani, Jyothi Lakshmi A., Preparation and characterisation of protein hydrolysates for geriatrics foods

9th Indian Convention of Food Scientists and Technologists, held at Thiruvananthapuram, Kerala, January 5-7, 2023

- Sandopu Sravan Kumar, Attar Singh Chauhan, Sachin Rama Chaudhari, Parvatam Giridhar, Unraveling the nutritional and nutraceutical potentials of *Basella rubra* L. fruits for smart, safe and sustainable food innovations
- Shashanka Rao J.N., Prabhasankar P., Charcoal pasta – Comparison of natural activated vegetable charcoal (AVC) and Brilliant black BN (E151), its influence on pasta processing and quality parameters
- Pallavi B.V., Harish Prasanth K.V., Inamdar A.A., Effect of different milling techniques on vitamin D3 fortification for whole wheat flour
- Pramod Kumar P., Harish Prashanth K.V., Development of microemulsions for bilobalide delivery for enhanced neuroprotective effect in beta amyloid peptide induced mice

7th International Conference on Opportunities and Challenges in Agriculture, Environmental & Biosciences for Global Development (OCAEBGD-2022), Goa, October 28-31, 2022

- Bincy K., Patole Reshma Prabhakar, Archana V. Ramesh, Vivek Babu C.S., Fumigant and contact biorational potential of Indian sweet basil essential oil and its active constituent against pulse beetle, *Callosobruchus chinensis*
- Anup Ramdas Kodape, Vivek Babu C.S., Diversity of aflatoxigenic fungal strains in stored groundnuts and its mitigation through essential oils
- Patole Reshma Prabhakar, Bhumika K.P., Bincy K., Jeevan Prasad Reddy, Keshava Murthy P.S., Vivek Babu C.S., Insecticidal activity of biorational embedded biodegradable films for control of stored grain insect pests

Best Research Papers / Posters Awards in Other Seminars

- Manjula N., Dheephiga M., Vanitha T., Tamarillo and passion fruit peel ameliorates high fat induced non-alcoholic fatty liver disease (NAFLD), International Conference on Revamping

food and Nutrition for the Next generation – Addressing Personal, public and planetary sustainable health, Organized by the Department of Food Science and Nutrition and Nutrition Society of India, Coimbatore chapter and Universiti Tunku Abdul Rahman, Malaysia, March 9-10, 2023

- Annapoorna B.R., Madan Kumar P., *Phyllanthus niruri* polyphenols exhibited anti-proliferative, pro-apoptotic and anti-cancer effects in liver cancer cells. 9th International Congress of the Society for Ethnopharmacology, India, organized by SFE - India Mysuru Chapter, JSS College of Pharmacy, JSS Academy of Higher Education and Research, Mysuru and Society for Ethnopharmacology, India, April 22-24, 2022

- Mondal P., Syed Musthapa M., Mahanimbine isolated from *M. koenigii* alters genomic stability and inhibits lung tumorigenesis, International Conference on Contemporary Research for the Sustainable Development of Biological Sciences (ICCRSDBS), Tiruchengode, Tamilnadu, India, February 1-2, 2023

- Madhurya L., Ezhil Vendan S., Limonene as bio-fumigant and therapeutic molecule for killing the red flour beetle, *Tribolium castaneum* and consuming as food ingrdient, International Conference on Antimicrobial Resistance & Microbiome under Changing Climate (AMRMIC), organized by Pondicherry University, Pondicherry, October 10-12, 2022

- Madhurya L., Ezhil Vendan S., Prediction of new attractant molecules from pulse, grain and flour beetle pests using SPME-GCMS technique and pherobase database analysis, Naational conference on Modern Food Preservation and Safety (MFPS), organized by Karpagam Academy of Higher Education (Deemed to be University), Coimbatore. January 10, 2023

- Madhurya L., Kumari S., Ezhil Vendan S., Nanoemulsion based phytochemical fumigants for the control of rice weevil and pulse beetle: A comparative analysis, Conference on Women in Academia, Research and Management of Food Safety and Toxicology (WARM-FoST), organized by CSIR-IITR, Lucknow, Feb. 24-25, 2023

- Archana Ramesh, Ashika R., Vivek Babu C.S., Transcriptomic alterations of *Stiophilus oryzae* (rice weevil) in response to *Ocimum gratissimum* essential oil and its insights on biorational potential for control of stored grain insect pests and aflatoxigenic fungi, World Bio Protection Summit-India 2022, Sharda University, Greater Noida, December 1, 2022

- Kesavapriya S., Ramyapriya R., Mahalakshmi R., Abinaya V., Aswathi K.S., Ezhil Vendan S., Bio-fumigant nanoemulsion based ball kit: A novel method of stored grain protection from insect pest infestation, 2nd International Conference on Food Bio-Nano Materials (ICFBN), Karpagam Academy of Higher Education (Deemed to be University), Coimbatore, March 17-18, 2023

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

Name	Role	Journal / Publisher
• Dr. Vijayendra SVN	Editor	Journal of Food Science and Technology, AFST(I), Mysore, Springer
• Dr. Prakash M Halami	Editor	Journal of Food Science and Technology, AFST(I), Mysore, Springer
• 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. 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
• Dr. Harish Prashanth KV	Special Issue Editor	Trends in Carbohydrate Research (TCR) Journal, Association of Carbohydrate Chemists and Technologists, India
• Kunal Sharan	Guest Editor	Frontiers in Endocrinology, Frontiers
• Gopinath M	Guest Editor	Frontiers in Oncology, Frontiers

I) Member of Editorial and Advisory Boards

Name	Journal / Publisher
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 Research & Reviews: J. Food Sci & Technol, STM
Dr. Rajagopal K	• Frontiers, Frontiers • MBio, American Society for Microbiology • 3Biotech, Springer • The Protein Journal, Springer
Dr. Negi PS	• Journal of Food Science, IFT, Chicago, USA • Signpost Open Access Journal of Organic and Biomolecular Chemistry, Research Signpost, Thiruvananthapuram, India • Indian Journal of Horticulture, Indian Academy of Horticultural Sciences, New Delhi, India
Dr. Syed Musthapa M	• Non-coding RNA research, KeAi • Indian Journal of Natural Products and Resources (IJNPR), CSIR-NIScPR
Mr. Matche RS	• Methodox, Elsevier • Indian Journal of Nutrition, Open Science Publications, Hyderabad • 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

11. Participation in Exhibitions

- **Anniversary Celebration of Govt. of Kerala 2022:** Organized by Govt. of Kerala at Palakkad Municipal Stadium ground, Palakkad, Kerala, April 27 – May 01, 2022
- **Eat Right Campaign and Walkathon:** Organised by ISRO, FSSAI, Hyderabad and AFSTI, Hyderabad Chapter at ICMR-NIN, Hyderabad, May 7, 2022
- **TechBharat – Food Technology and Agronomic Tech Expo – 2022:** Organized by IMS Foundation and LUB-Karnataka in association with CSIR-CFTRI, May 19-21, 2022
- **Govt. Achievements & Schemes Expo-2022:** Organized by NNS Media at Pragati Maidan, New Delhi, June 17-19, 2022

Shri Jitendra Singh, Minister of State (IC), Ministry of aScience and Technology & Ministry of Earth Science & Minister of State in the PMO inaugurated theTechBharat – Food Technology and Agronomic Tech Expo – 2022 and visited the CSIR-CFTRI stall

- **Science Expo-2022:** Organized by Mysore Science Foundation (MSF) at Sadvidya Semi-residential PU College, Vijayanagar, Mysuru, July 19-20, 2022
- **Ladakh AgriTech Mela 2022 for the stakeholders through Science Technology & Innovation Hub:** Organized by CSIR-IMTECH Chandigarh, NIELIT, Leh, and PGIMER Chandigarh Department of Science Science for Equity Empowerment and Development Division (DST-SEED) and Ladakh Autonomous Hill Development Council (LAHDC), Ladakh, August 10-11, 2022
- **Conclave on Expo in State S&T Ministers:** Organised by DST, Govt. of India along with Govt. of Gujarat at Main Auditorium, Science City, Ahmedabad, September 10-13, 2022
- **ANUTEC - International FoodTec India Co-located with PackEx India Food Logistics India and Anutec INGREDIENTS India:** Organized by

Hon Chief Minister of Uttar Pradesh inaugurated the Food Expo 2022

ANUFOOD India at Bombay Exhibition Centre, Mumbai, September 14 -16, 2022

- **62nd International Conference on "Microbes and Society: Current Trends and Future Prospects":** Organized by the University of Mysore, Mysuru, Association of Microbiologists of India in association with CSIR-CFTRI, DRDO-DFRL, JSS AHER, Mysuru, and KSTA at Vignan Bhavan, University of Mysore, Mysuru, September 21-23, 2022
- **Fi India & Hi:** Organized by Informa Markets, Mumbai at Bangalore Exhibition Centre, September 21-23, 2022
- **CSIR Foundation celebration:** Organised by CSIR-NIO at RC-NIO, RC campus, September 26, 2022
- **World Food Day Celebrations, 2022:** Organised by ICMR-NIN, Hyderabad, October 17, 2022
- **Market Linkages and Networking facets for Agri-startups – Role of funding:** Bagalkote, Karnataka, October 20, 2022

The world millet summit -A Curtain Raiser for 2023 International Year of Millets

- **Food Expo-2022:** Organized by Indian Industries Association at Indira Gandhi Pratisthan, Lucknow, UP, November 2-4, 2022
- **CSIR-IITR Open Day Exhibition:** Organized by CSIR-IITR, Lucknow, November 3, 2022
- **Science Festival:** Organized by AV College of Arts and Sciences, Domalguda, Hyderabad, Nov.15-16, 2022
- **Indo Uzbek Meet and International Conference on Trends and Innovation in Food Technology, Integral University:** Organized by Integral University, at Lucknow Integral University, Lucknow, November 24-25, 2022
- **13th Agrovision 2022-Mega National Expo:** Organized by Govt. of India and Govt. of Maharashtra at Nagpur, Maharashtra, November 25-28, 2022
- **STREE 2020 National Conference & Expo 2022:** Organized by SHAKTI along with JNU at Jawaharlal Nehru University, New Delhi, November 24-26, 2022

STREE 2020 National Conference & Expo 2022 at New Delhi

- **The world millet summit-A Curtain Raiser for 2023 International Year of Millets:** Organized by Maratta Chamber of Commerce, Industries and Agriculture (MCCIA) at Pune, Maharashtra, December 16, 2022
- **Science Mela: International Cultural Jamboree 2022:** Karnataka Government in association with Alva's Education Institute at Alva's Institute of Engineering and Technology, Moodbidre, December 21-27, 2022
- **Science Day Exhibition:** Jubilee Inter College, Lucknow, December 28, 2022
- **108th Indian Science Congress-2023:** Organised by Indian Science Congress Association (ISCA), DST and RTM Nagpur University at Rashtrasant Tukadoji Maharaj, Nagpur University (RTMNU), Nagpur, Maharashtra, January 3-7, 2023
- **29th Indian Convention of Food Scientists and Technologists on the Theme "Innovative Smart & Safe Solutions for Agro and marine food processing to achieve sustainable Nutritional Security":** Organised by Association of Food Scientists & Technologists (India) and AFSTI Kollam

Technologies Demonstration Pavilion in CSIR Innovation on Millets at NPL, New Delhi

India International Science Festival (IISF) 2022 Expo at Bhopal, MP

Indo Uzbek Meet and International Conference on Trends and Innovation in Food Technology, Integral University, Lucknow

CSIR-CFTRI Stall in the International Trade Fair on Millets and Organics 2023 at Bengaluru

chapter at Al Saj Convention Centre, Kazhakoottam Thiruvananthapuram, Kerala, January 5-7, 2023

- **International Trade Fair on Millets and Organics 2023:** Organized by Govt. of Karnataka, APEDA and IMMR, Hyderabad at palace grounds, Bengaluru, January 20-22, 2023
- **India International Science Festival (IISF) 2022 Expo on the theme 'Country moving towards Amrit kaal with science, technology and innovation':** Organized by DBT, DST, MoES, CSIR, ISRO, Department of Space, Department of Atomic Energy, Vigyan Bharati (VIBHA) and Maulana Azad National Institute of Technology (MANIT) and Madhya Pradesh Council of Science and Technology (MPCOST), MANIT, Bhopal, MP, January 21-to 24, 2023
- **Eat Right Millet Meal & Cyclothon:** Organised by SRO, FSSAI, Hyderabad at HITEX, Hyderabad, January 29, 2023
- **Technologies Demonstration Pavilion in CSIR Innovation on Millets:** Organized by CSIR-Central Food Technological Research Institute at NPL, New Delhi, January 30, 2023
- **Kisan Mela (One Week One Lab) CSIR-CIMAP:** Organized by CSIR-CIMAP at CSIR-CIMAP, Lucknow, January 31 to February 3, 2023
- **Krishi Mahotsav-2023- Global Agricultural festival:** Organized by Dindori Pranit Farmer Producer Company Limited at Dongre Vasti Gruh Maidan, Nashik, India, February 9, 2023
- **Women in Academia, Research and Management of Food Safety and Toxicology (WARM-FoST):** Organized by CSIR-IITR in association with CSIR-CSIR-CFTRI and the Lucknow Chapter of Association of Food Scientists & Technologists-India (AFSTI-Lko) at IITR, Lucknow, UP, February 24-25, 2023

CSIR-CFTRI Resource Centre, Hyderabad stall at Eat Right Millet Meal & Cyclothon

Shri P. Prasad, Minister for Agriculture, Government of Kerala visited CSIR-CFTRI stall in the OWOL programme of CSIR-NIIST, Thiruvanathapuram

- **Saras Aajeevika Fair 2023:** Organized by NRLM and Rural Development Ministry at NOIDA HAAT, March 2-4, 2023
- **One Week One Lab Celebrations at CSIR IICT, Hyderabad:** Organized by CSIR IICT, Hyderabad, March 6-10, 2023
- **Wayanad Seed Fest 2023:** Organized by Community Agrobiodiversity Centre of M.S Swaminathan Research Foundation, Wayanad, Kerala, March 10-11, 2023
- **CSIR-NIIST-One Week One Lab (OWOL) programme:** Organized by CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram, March 13- 18, 2023
- **Aroma Mission Phase II and Farmers Meet:** Organized by CIMAP Regional Centre, Hyderabad, March 18, 2023
- **Kisan Mela:** Conducted by CSIR-CIMAP, March 18, 2023
- **Socio-economic Impact of CSIR Food and Agri-Technologies: A Dialogue with Stakeholders:** Organized by CSIR-NIScPR, New Delhi, March 22, 2023
- **Millet Utsavam:** Organized by FSSAI at Mahbubnagar, Telangana, March 25, 2023

CSIR-CFTRI Resource Centre, Hyderabad stall at Aroma Mission Phase II and Farmers Meet

Saras Aajeevika Fair 2023

Participants at Millet Utsavam, Mahbubnagar, Telangana

12. Visit of International Delegation to Institute

- French delegation consisting of French Embassy officials and CNRS Bureau visited the CSIR-CFTRI on September 15, 2022 and interacted with scientific staff pertaining to Indo-French cooperation strategies including funding sources, research opportunities and student mobility
- Denmark delegation consisting of Dr. Jakob Williams Ørberg, Senior Advisor & India Lead and Ms. Louise Hindenburg, Team Coordinator, Novo Nordisk Foundation visited the Institute on 8th December, 2022 and interacted with scientists to explore possible alignments in the fields of biotech, preventive measures for lifestyle disorders, combat malnutrition etc.
- International delegates from developing countries (Africa and Asia) who were participants of ni-MSME, Hyderabad training programme visited CSIR-CFTRI on 17th January, 2023
- Mr. Al Harthy Mohammed Sulaiman Hamad, CEO, Nitaj, Oman Food Investment Holding Company, Sultanate of Oman visited CSIR-CFTRI on 18th January, 2023 and interacted with the Director, CSIR-CFTRI and scientists and also visited ISMT mill
- A French Delegation from the Embassy of France led by Mr. Thierry Berthelot, Consulate General of France in Bengaluru, India and Dr. Francois-Xavier Mortreuil, Attache for Science and Academic Cooperation, Embassy of France - French Institute India, Consulate General of France in Bengaluru, visited the Institute on 9th March, 2023 and interacted with scientists about Indo-French cooperation strategies for research and science translation

French delegation consisting of French Embassy officials and CNRS Bureau

Societal Programmes

Outreach Activities

a) Nutrition Intervention Programme at Nanjanagudu Taluk

CSIR-CFTRI initiated a nutrition Intervention programme for 250 of Severely Acute Malnourished (SAM)/Moderate Acute Malnourished (MAM) children at Nanjanagudu taluk in association with Department of Women Child Development (DWCD), Government of Karnataka. The programme was funded by M/s

Jubilant Bhartia Foundation under their Corporate Social Responsibility Scheme (CSR) for a period of six months starting from November 2022. Four consignments of food products were sent to DWCD for distribution.

b) CSIR-CFTRI Open day (Sep. 26-27, 2022)

On the occasion of 81st CSIR Foundation day, CSIR-CFTRI Open Day with the theme “Food Technology-Industry Connect” was held during September 26-27, 2022. Dr. K.S. Sadananda, Professor of Cardiology and Medical Superintendent, Sri Jayadeva Institute of

Cardiovascular Sciences & Research in Mysuru, inaugurated the event and the Food-Expo. A compendium of the licensees participating in the Food-Expo was also released. The event was presided over by Er. H.S. Sathish, Chief Scientist and Chairman of CSIR-CFTRI Open Day 2022. Nearly 18,000 people visited CSIR-CFTRI on these days of

which most of them were students. Machineries, processes and products developed by CSIR-CFTRI were demonstrated to the visitors.

c) CSIR-CFTRI Siridhanyada Siri : Radio Programa

"CFTRI Siridhaanyada Siri", a millet-based information series of twenty episodes in Kannada produced jointly by CSIR-CFTRI and All India Radio (Akashvani), Mysuru on the occasion of 'International Year of Millets 2023' has started its broadcast through Akashvani FM 100.6 (AIR, Mysuru) on every Saturday at 6.35 AM and repeat at 6.10 PM (5 mins each) from 4th Mar 2023 and it will be completed on 15th Jul 2023. In addition to the 20-episodes, an interview with the Director, CSIR-CFTRI is also planned to be aired by AIR, Mysuru. Positive feedback had been received about the four episodes broadcasted so far and will help in popularizing the use of millets.

Skill Development Programmes

a) Farmer's Training Programme under PMFME Scheme

The primary objective of PMFME scheme, introduced by Government of India and financially supported by both Central and State governments, is 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 along with 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.

During the year 2022-23, various training programmes were conducted by CSIR-CFTRI for different stake holders of PMFME Scheme. These programmes were conducted with the support from KAPPEC, Bengaluru, the State Nodal Agency for the implementation of PMFME Scheme. The training programmes include: Farmers training programme for farmers/beneficiaries (50 nos.) from various districts of Karnataka; District Resource Persons (DRPs) training programmes (4 nos.) in online mode benefitting 336 DRPs from various districts of Karnataka; Beneficiary training programmes (7 nos.) for 278 farmers/beneficiaries in offline mode at Hassan (1 no.), Vijayapura (2 Nos.), Belagavi (3 nos.), Bagalakote (1 no), Tumakuru (1 no.); Webinar on PMFME scheme for around 50 potential beneficiaries and officials and, Beneficiary training programmes (7 nos.) for SHG Seed capital (293 women entrepreneurs) at Bangalore, Arabhavi, Karwar, Kumta, Honnavara, Sirsi and Yellapura. These programmes helped farmers, DRPs and beneficiaries to know more about the scheme and provided guidance to become beneficiaries of the scheme

Details of Training Programmes

b) Farmer Centric Activities

Under the farmer centric activities, seven workshops cum training programs were conducted during 2022-23. A total of 116 farmers / FPOs from different States have been benefitted from these courses. The training programmes were organized at CSIR-CFTRI, Mysuru and expert faculties, latest instruments/equipment were made available for these training programs.

Farmer's Centric Activities & Cluster Formation (FCA&CF) 2022-23				
Agency /Group/ Cluster /FPO	**Details of training**	**No. of Participants**	**Duration**	**Beneficiaries**
Director of Horticulture, Mizoram	Processing of fruits and vegetables for value addition	9	18-04-2022 to 22-04-2022 (5 days)	Farmers from Mizoram
Sponsored by Forgex Consultancy on behalf of Raisin Cluster, Jath, Dist. Sangli, Maharastra	Raisins for value addition and quality aspects	25	24-08-2022 to 26-08-2022 (3 days)	Farmers from Jath, Dist. Sangli, Maharastra

Agency /Group/ Cluster /FPO	Details of training	No. of Participants	Duration	Beneficiaries
SCOPE (Society for Community Participation and Empowerment), Dharwad	Processing of pulses and value addition	15	02-11-2022 to 03-11-2022 (2 days)	Farmers from Dharwad, Karnataka
Wayanad Hills Farmer Producer Company Limited.	Processing of fruits and vegetables	9	30-11-2022 (1 day)	FPO from Wayanad, Kerala
Yermunai Farmer's Producer Company and Pasumai Boomi Farmers Producer company	Processing of vegetables and value-added products	17	07-12-2022 to 08-12-2022 (2 days)	FPOs from Rayakottai, Tamilnadu
Vegetable and Fruit Promotion Council Kerala (VFPCK), K akkanad, Kerala	Processing of fruits and vegetables		16-02-2023 (1 day)	FPOs and staff from VFPCK. Kakkanad, Kerala
Department of Agricultural Marketing and Agri Business (DAMAB), Udhagamandalam, T amilnadu	Value addition to vegetables and millets	32	23-03-2023 (1 day)	FPOs and staff from DAMAB, Udhagamandalam, Tamil Nadu

C. Short Term Courses/Skill Development Programs (STC/SDP) under CSIR Integrated Skill Initiatives

CSIR-CFTRI has conducted several national level Short Term Courses / Skill Development Programs (STC/SDP) under CSIR Integrated Skill Initiative in 2022-23. Total twenty-four programs were conducted out of which two programs were on hybrid mode (offline & online simultaneously), one program was on virtual mode and the rest offline mode. 517 participants representing from 22 States/Union Territories of India attended these programs.

1. Workshop on Entrepreneurship Development in Spice Processing in hybrid mode (September 20, 2022)

The topics covered in the program were current status and opportunities in spice processing, spice nutraceuticals and trends towards their value addition, analytical methods in spice processing, encapsulation of flavours and colorants, fumigation & infestation control for safe storage of spices, food safety standards & regulation in spice processing etc. A demonstration on processing of spices was also held. 78 participants attended the program of which 27 of them received the training in the Institute.

2. Online Workshop on Post-Harvest Technologies for Horticultural Crops (September 30, 2022)

This one-day workshop aimed to enlighten some basic concepts & techniques about post-harvest processing of fruits & vegetables. Main topics of this SDP were: Post-harvest technologies for horticultural crops, Post-harvest technologies for extension of shelf life of fruits and vegetables and pack house operation, Post-harvest spoilages, control measures and decontamination methods of fruits and vegetables, Packaging requirements for fresh fruits and vegetables, Minimal processing of fruits and vegetables, Drying and osmotic dehydration of fruits & vegetables, Preservation of fruits and vegetables, pickles and chutneys, Machineries for processing of fruits & vegetables, Technology transfer protocols for setting up fruit and vegetable processing industry. 54 participants attended this workshop representing 16 States.

3. Hybrid workshop on Egg-based value-added products – Processing, Packaging and Preservation

This hybrid workshop focused to create awareness for the value addition of egg-based products that would enhance the value and use of eggs to supplement human nutrition which will improve the sustainability and socio-economic development of the egg industry, poultry farmers and stakeholders. The key topics of the workshop were eggs composition, nutrition, consumption and human health; Snackification of eggs; functional properties of egg proteins and development of value-added egg products; chill food technology for egg-based snacks etc. in addition to a hands-on session covering quality evaluation, product development, egg products - display & presentation. A total of 48 participants (16 offline and 32 online) attended the workshop representing 8 States.

4. Hands-on Training and Workshop on High End Mass Spectrometry Based Lipidomics for Food and Biomedical Sciences (January 16 - 20, 2023)

Five-day Karyashala (workshop) for post-graduate and Ph.D. students, funded by Science & Engineering Research Board (SERB), DST, was organized from January 16-20, 2023. The program was inaugurated by Dr. Sridevi Annapurna Singh, Director, CSIR-CFTRI. Dr. Lalitha R. Gowda, Retd. Chief

Scientist, CSIR-CFTRI, was the guest of Honour. Prof. em. Jerzy Adamski, Technical University of Munich, Germany, delivered the keynote address in online mode. The 5-day program was well accepted by the 20 participants.

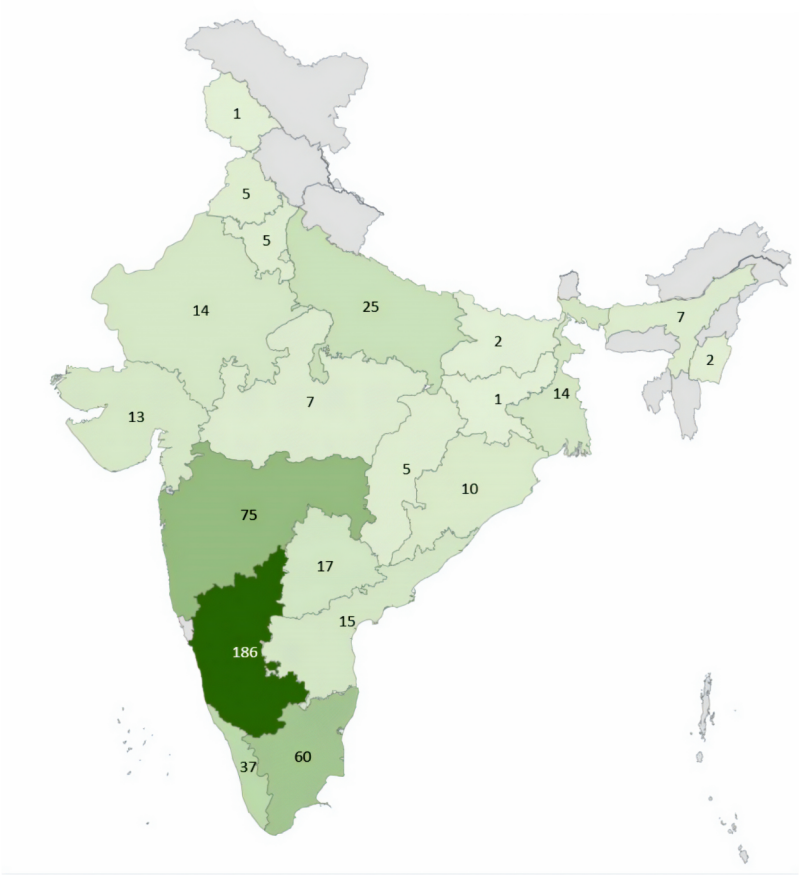
5. Strategies for probiotic dairy product development (November 28 – 30, 2022)

This newly introduced course was organized for three days with 9 participants. The course emphasised on how dairy products are being employed for the supplementation of probiotics, since milk or the product obtained from it offers *in situ* enrichment of bioactive molecules including enhancing the nutritional status of the finished product. This training program comprised of five lectures and two broad practicals in the form of hands on training. Lecture from experts in the field of probiotics comprised of probiotic and their health benefits, probiotic product development and management strategies in the industry. Other topics included were fermentation strategies of microbial metabolites, regulatory aspects of microbial food additives etc. Practical topics that were covered includes basic microbiological techniques to handle probiotic cultures and primary inoculum.

Apart from the above specialised programs, CSIR-CFTRI conducted other regular training programs as follows during 2022-23.

Title	Duration	Total No. of Participants
• Basics in flour milling and quality evaluation of flour	23-27 May 2022	13
• Fumigation prophylaxis and pest management atechniques for stored food commodities (Batch -1)	10-24 Jun 2022	43
• Baking science and technology	11-15 Jul 2022	13
• Post-harvest technologies for fruits and vegetables	18-29 Jul 2022	14
• Chromatographic technique (GC, HPLC, UHPLC) and their analytical approaches in food analysis	22-26 Aug 2022	19

Title	Duration	Total No. of Participants
• Technology for fruits & vegetables (for B. Voc & M. Voc students from JSS Arts, Commerce & Science College, Mysuru)	06-09 Sep 2022	20
• Paddy & rice processing and products	10-14 Oct 2022	8
• Science of sugar & chocolate confectionary	10-12 Oct 2022	7
• Sensory analysis: An approach towards consumer preference (Batch -1)	09-11 Nov 2022	23
• Sensory analysis: An approach towards consumer preference (Batch -2)	14-16 Nov 2022	25
• Wine fermentation	14-18 Nov 2022	8
• Grain process & products for health & wellness	21-25 Nov 2022	7
• Safety of food in plastics and metal packaging	28-30 Nov 2022	6
• Solid waste & waste water management in food industry with biogas recovery and ZLD implementation with LCA-ISO 14001 approach	09-13 Jan 2023	8
• Applications of sophisticated analytical Instruments (FT-IR GC-MS HRMS IR-MS & NMR) in the analysis	09-13 Jan 2023	9
• Extraction and quality assurance of edible fats and oils	16-18 Jan 2023	9
• Millets based bakery products (for bakery cluster Malegaon district, Nasik)	02-03 Feb 2023	12
• Analysis of Iron, Vit-B9, Vit-B12 in fortified rice (for officials from Indian Grain Storage Management & Research Institute, Govt of India)	06-08 Feb 2023	13
• Fumigation prophylaxis and pest management techniques for stored food commodities (Batch-2)	03-17 Feb 2023	51



State	No. of Participants
Andhra Pradesh	15
Assam	7
Bihar	2
Chhattisgarh	5
Delhi	13
Gujarat	13
Haryana	5
Jammu & Kashmir	1
Jharkhand	1
Karnataka	186
Kerala	37
Madhya Pradesh	7
Maharashtra	75
Manipur	2
Odisha	10
Puducherry	3
Punjab	5
Rajasthan	14
Tamil Nadu	60
Telangana	17
Uttar Pradesh	25
West Bengal	14
TOTAL	**517**

d) Training programmes organized by Resource Centres of CSIR-CFTRI

i. RC – Hyderabad:

Training conducted	Duration of Training programme	Total No. of Participants
• Quality control cum hands on training programme for students of RBVRR Women's College, Hyderabad.	11-13 April 2022	14
• Hands on training programme on fruit and vegetable processing and preservation for selected moringa based technologies to participants of Sambalpur University	05-10 September 2022	20
• Hands on cum quality control training programme for Bhavans Vivekananda College Arts, Science and Humanities	13-16 February 2023	14
• Hands on cum Quality Control Training Programme for AV College Hyderabad	14-17 March 2023	10

ii. RC – Lucknow:

Five days Skill-Entrepreneurship Development Program on processing, preservation and value addition of Food & Agro based products for commercial use in Siddharthnagar District of Uttar Pradesh with special emphasis on development of women entrepreneurs funded by DSIR at Siddharthnagar, Balrampur, Bahraich and Shravasti.

JIGYASA Activities

Highlights of the programs

- A lecture on "Importance of Artificial Intelligence in our daily life" was delivered by Dr. Mahanand, HoD, Information Science & Technology Dept., Jaya chamarajendra College of Engineering, Mysuru was organised on June 24, 2022. 50 students and 2 teachers of CSIR-CFTRI school was participated in the programme
- As part of the ATL School Adoption program in conjunction with Atal Innovation Mission, NITI Aayog, Govt. of India, a Student-Scientist interaction program was conducted for students of Adarsha Vidyalaya – Chamarajanagar on 15-07-2022 to mark the National Youth Skills Day
- Student - Scientist connect programs with 300 students of Jawahar Navodaya Vidyalaya, 300 of Kendriya Vidyalaya, 110 of Atomic Energy Central School 700 of Govt. High Schools, 505 of CFTRI School were conducted on 24-06-2022, 16-11-2022, 19-10-2022, 28-02-2023
- On-site demonstrations and in-house hands-on experiments on food adulteration, labeling and sensory evaluation of various volatile liquids were arranged for 1160 students and 61 teachers of different schools on 26-09-2022, 27-09-2022, 19-10-2022, 09-12-2022

- Demonstration of food adulteration and simple detection test were demonstrated along with experiential learning in collaboration with Not-for-Profit agencies like Agastya International Foundation and Prayoga Institute of Educational Research to extend the outreach for rural beneficiaries of these programs with 306 students and 15 teachers on 09-12-2022, 16-12-2022 & 21-12-2022.
- Interactive activities like Quiz, Poster Presentations, and Flavor tasting competitions were conducted at CFTRI School to celebrate International week of Nutrition from 02-09-2022 to 08-09-2022.
- The JIGYASA team involved in judging various science fair competitions conducted at GHS Varuna and Kumbarakoppal on November 15, 2022 and December 19-20, 2022
- CSIR JIGYASA Scientist - Student Connect Program was conducted on December 7, 2022. About 120 students from Kendriya Vidyalaya schools from Mysore, Mandya, BRBNMPL and Chamarajanagar participated in the programme.

Summary of activities done with various schools during Apr. 2022 - Mar. 2023

School	No. of Branches Participated	No. of Students	No. of Teachers
Kendriya Vidyalaya	5	300	16
Jawahar Navodaya Vidyalaya,	4	300	16
Govt. Schools	6	700	45
CFTRI School	1	505	20
Atomic Energy Central School	1	110	08
Adarsha Vidyalaya (ATL School)	1	30	03
Govt. Aided Schools	4	500	12
Total	**22**	**2445**	**120**

Progress Under R & D Projects

ENGINEERING SCIENCES

Integrated spouted bed roaster
(Shesha Narayana K)

The roaster unit is designed to dry/ roast food grains, nuts and berries in a spouted bed in an energy efficient manner. The unit uses the principle of multiple air draft system for effective use of roasting chamber and heat transfer. Design consideration includes operation of the unit under the full load and partial load conditions. The unit consisting of drying chamber, draft blowers, heating system, chaff / immature grain separator and venting system with necessary instrumentation has been designed.

Tender coconut water from shell to gel
(Roopa BS)

There is a need to develop an alternative processing method for the shelf-life of tender coconut water (TCW) as it is highly susceptible. The TCW concentrate at 10, 20, 30 and 40°Brix was developed by cryodesiccation method to enhance the nutritional profile and to retain the original organoleptic properties. The shelf-life was increased from hours to days using suitable packaging material studied at controlled storage conditions of 4°C and 10°C. The overall acceptable sensory score is 11.4 for fresh TCW, and for reconstituted TCW from the concentrate of 10, 20, 30 and 40°Brix sensory score was 10.9, 11.4, 11.0, and 11.2, respectively. This indicates the retention of organoleptic properties in reconstituted TCW from concentrate. Analysis of consumer results for fresh reconstituted TCW and reconstitution of stored TCW concentrate is liked very much by 66% of consumers, liked moderately by 22% and liked slightly by 9% of consumers and neither liked nor disliked by 3% of consumers. The mineral content of TCW concentrate showed increase in sodium, calcium and phosphorus. Fresh and concentrated TCW was used for gel formation. Gel strength was affected by the critical parameters of pH, time, temperature, permeability, amount of TCW entrapment, and electrolyte content.

Mobile processing unit (MPU) in North-East for processing of fruits and vegetables
(Punil Kumar HN)

Mobile unit for demonstration and processing of fruits and vegetables in North-Eastern States was developed. The equipments required for processing of major fruits and vegetables grown in North-Eastern regions were identified. Overall dimensions, mounting space, power required and weight of individual equipment were estimated. Total power and pay load required was calculated considering the auxiliary equipments like refrigerator, freezer, oven, induction stove, instruments, water tank etc.Based on the exact working area available and working space required, the layout was prepared. Different categories of vehicles available to suit the requirement was explored.

UV-Cold plasma to improve food quality and microbial safety of byadgi chilli
(Sukumar Debnath)

Samples of Byadagi chilli were subjected to Multipin Atmospheric Cold Plasma (MACP) treatment using different output voltages ranging from 10 and 20 kV. The treatment

duration varied between 1, 5 and 10 minutes, while maintaining a consistent 5 cm inter-electrode gap. Both control samples (untreated) and MACP-treated samples were analyzed to measure microbial population and various quality attributes, including colour, particle size, water activity, moisture content, total phenols, and antioxidant activity.The results demonstrated that a 5-minute MACP treatment significantly reduced the bacterial and colioform count by 3.7 log cfu/g and 3 log cfu/g (from an initial count of 23×10^7 to 42×10^3 log cfu/g and 59×10^3 to 4×10^1). Importantly, the MACP treatment did not cause any significant changes ($p>0.05$) in the chilli's particle size and color parameters, indicating that its visual appearance remained unaffected. However, some positive changes were observed in the quality attributes of the MACP-treated samples compared to the control samples. The moisture content decreased by 18.1%, the water activity decreased by 8.8%, and the total phenolic content increased by 18.7%. Additionally, the color, DPPH (a measure of antioxidant activity), and capsaicin content also exhibited improvements, with retention of 42.3% in capsaicin. Notably, the moisture content decreased with increasing treatment time, while the total phenolic content showed the highest value of 109.8 mg GAE/g at a treatment of 10 kV with a 5 cm gap for 5 minutes. Overall, this study indicates that the use of MACP treatment has the potential to emerge as a promising method for enhancing microbial safety and maintaining the desired quality attributes of *Byadagi* chilli.

Nanofiltration for processing vegetable oil and spice oleoresin *(Rastogi NK)*

Curcumin-removed turmeric oleoresin (CRTO) consists of volatile and fixed oils (40-50%), resins (20-35%), and curcuminoids. The solubility of hexane insoluble fraction, CRTO residue was estimated in the selected intermediate polar solvents (isopropanol, ethyl acetate and acetone). Solvent mixtures of hexane and intermediate polar solvents in suitable proportions were prepared matching the polarity index (2.8 to 3.4) employed for the elution of curcuminoids from CRTO by column chromatography. The intermediate polar solvents and hexane-IPA mixture (polarity index - 3.4) which exhibited the highest curcuminoid recovery (>96%) in the soluble fractions were selected for OSN processing. Three SRNF membranes, namely, GMT-oNF-1 (MWCO 500 Da), Solsep 030306 (300-500 Da) and Solsep 070706 (250 Da), were employed to separate the curcuminoids (300-360 Da) from the higher molecular weight resinous matter (>1000 Da). The Solsep 070706 membrane could improve the curcuminoid content from 21.1% in CRTO residue to >30% in the permeated solids, while the other two membranes did not exhibit any selectivity. Assessment of miscella flux revealed that adequate flux was observed only while processing in ethyl acetate (36.9 $L \cdot m^{-2} \cdot h^{-1}$) and acetone phase (40 $L \cdot m^{-2} \cdot h^{-1}$). Thus, the Solsep 070706 membrane was selected for stage-wise processing of CRTO residue in acetone and ethyl acetate diluted phases. Work is carried out to further concentrate the curcuminoids employing membranes.

Project implementation under PMFME scheme *(Umesh Hebbar H)*

The PMFME Scheme was implemented in Karnataka with the support of KAPPEC, Bengaluru. Under the project implementation plan of PMFME scheme, various training programs in both online and offline mode were conducted which included training in the preparation of DPRs for beneficiaries and potential entrepreneurs. Short video clippings of processes, brochures, reading materials were prepared for reference and distribution during the training programme.

Common incubation facility at CSIR-CFTRI, Mysuru *(Umesh Hebbar H)*

CSIR-CFTRI is establishing an Incubation Centre with a purpose to provide common facility for production of coffee based products. Coffee has been identified as a product under One District One Product (ODOP) theme for Kodagu district. In order to meet the requirements of entrepreneurs working/would like to work in this area, the incubation centre is being set up with dedicated line for coffee based products (green coffee, green coffee concentrate/extract, roasted and ground products, coffee concentrate and spray dried coffee powder). The civil work/ renovation work of Common Incubation Centre (CIC) has been completed. The coffee processing line with an approximate capacity of 100 kg/h consists of disc type coffee pulper, coffee huller, cabinet dryer, coffee colour/grader/sorter, multi mill, steam jacketed kettle, sparkler filters, vacuum packing unit, drum type coffee roaster with cooler, coffee grinder, extraction unit, semi-auto bottling filler, cap sealing machine, vacuum evaporator with accessories, steam generation system, RO water unit and a spray drier. The installation of the equipments was completed and the plant is ready for operation.

Common Incubation Centre (CIC)

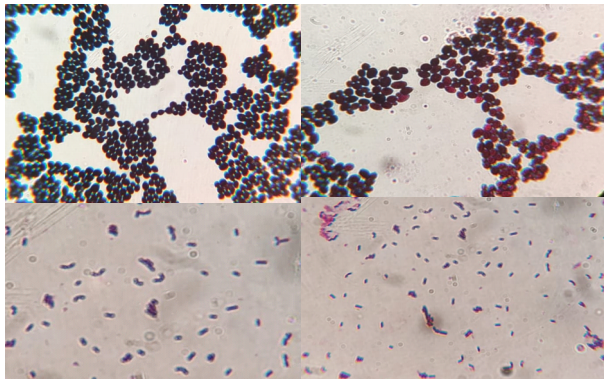
Development of intelligent food packaging for monitoring spoilage and extension of shelf-life of perishable foods *(Arunkumar P)*

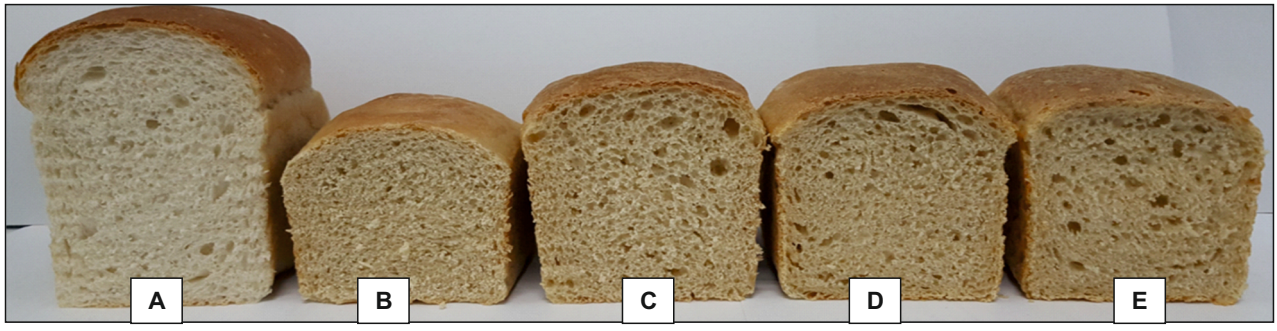
Micro-curcumin has been synthesised by homogenisation technique which had better dispersion in water than bulk curcumin (BCur). In a typical reaction, BCur was dissolved in dichloromethane, dispersed in boiling water and homogenised to obtain curcumin microparticles. The particle size was found using a dynamic light scattering technique that varied between 0.5-0.8 µm. Methylcellulose (MC) was incorporated with BCur (0.25%, 0.5% and 1.0%), and pure MC films were prepared by the solution casting technique. An improvement in Young's modulus (14-29%) and tensile strength (9-15%) was noted compared to pure MC film. A reduction in the water vapour transmission rate for MC/BCur was noted at the highest concentration because of the hydrophobic nature of curcumin.

TECHNOLOGY DEVELOPMENT

Convenience-based artisan bakery products
(Prabhasankar P)

Sourdough bread: Spontaneous natural fermentation was carried out using the conventional back slopping method to produce the mixed consortium starter for preparation of sourdough. A blend of flours and water were mixed in 1:1 ratio and incubated for a period of 24 h at 25ºC. When the mixture indicated active fermentation (visible as gas pockets on the surface of the dough), back slopping was carried out by removing portions of the fermented mixture and adding fresh flour and water in equal proportions (1:1:1). Parameters including pH, titratable acidity and leavening of the dough was monitored for up to 15 days when the dough seemed to stabilize with respect to fermentation time, pH and acidity. Test baking of the sourdough starter was carried out to check its baking performance. The sourdough starter was used at varying proportions (20, 30, 40 g) in the test breads. The sensory and physical characteristics of the test breads were assessed and compared against white and brown breads. Analysis results indicated that during fermentation, the pH varied from initial 5.7 to 4.1± 0.3, titratable acidity was between 0.9 to 1.8± 0.6 and leavening was in the range of 0-2.7 cm. For the enumeration of microorganisms involved in fermentation, the sourdough starter was

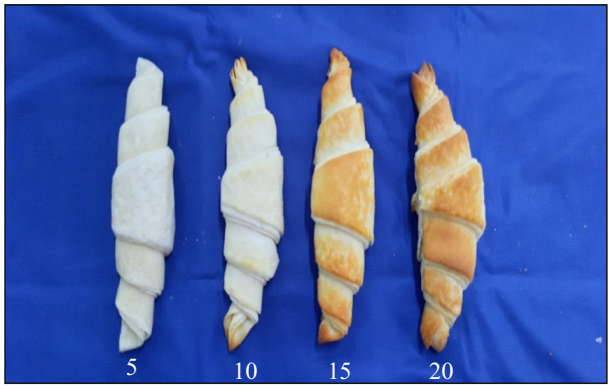




A- white bread, B- brown bread, C- brown bread with 20 g SD, D- brown bread with 30 g SD, E- brown bread with 40 g SD

inoculated in growth media and four presumptive lactic acid bacteria and seven yeast were identified. Further, characterization of the starter cultures is in progress. Results of test baking showed that the specific volumes of the test breads (2.32-2.63 ml/g) were higher than that of brown bread (1.95 ml/g). The reduced hardness values of 9618 g force, 6124 g force and 5701 g force in breads with 20 g, 30 g and 40 g sourdough starter respectively showed that there is a significant increase in soft texture of the test breads. The values for resilience and cohesiveness were also higher in the test breads which is a desirable attribute in sourdough bread.

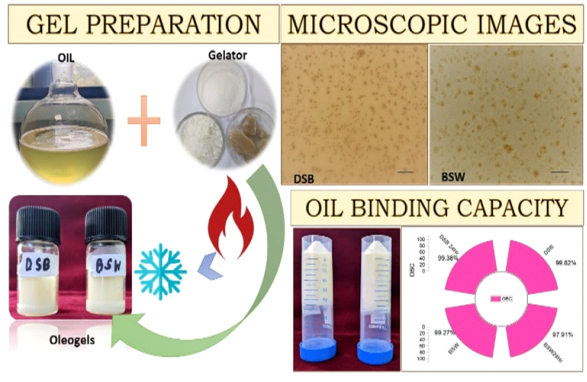
Par-baked product: In order to optimize the baking time and temperature, trials on par-baking of croissants were carried out by varying the first partial baking time (25%, 50% and 75%). The quality of the re-baked products after storage in room temperature and freezing was evaluated. Studies on the processing conditions for improving the quality of par-baked and frozen bakery dough are in progress.

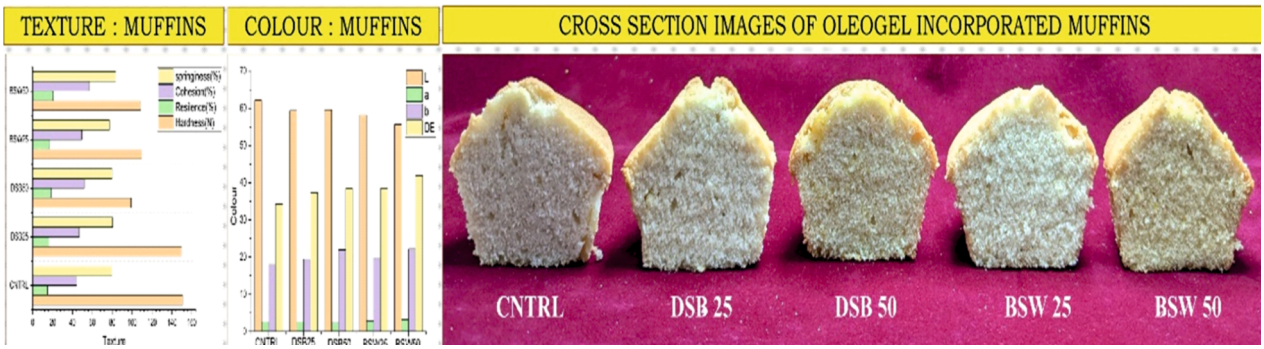


Par-baking of croissants

Coconut oil and bioactive compound enriched edible oleogel as a shortening alternate to bakery fats *(Prabhasankar P)*

Coconut oil have been blended with vegetable oil as per FSSAI regulations and the blended oil was structured using a combination of natural and polysaccharide based oleogelators. Although the relationship between the oleogel and lipophilic biomolecule has always been a focus of interest. To enhance the health benefits of this oleogel, it is loaded with lipophilic bioactive components to formulate healthier bakery products. The developed oleogel was characterized through oil binding capacity, textural, rheological, fatty acid profiling, differential scanning calorimetry, Fourier Transform Infrared (FTIR) spectrometer, confocal laser scanning microscopy, hot stage microscopy, X-ray diffraction. Further, the oleogels were incorporated in fat rich bakery product 'Muffin' by replacing the shortening fat with 25% and 50% in the product. Currently, the storage studies and nutritional evaluation is under progress.





Export protocol for fresh okra (*Abelmoschus esculentus*) *(Negi PS)*

Okra (*Abelmoschus esculentus*) or ladies finger is a nutritious vegetable with several health benefits. Postharvest loss in okra are estimated to range from 50 to 72%. The fresh okra pods deteriorate rapidly after harvest due to high water loss, fruit softening, and color degradation (blackening of ridges). High temperature increases respiration and ethylene production rates that initiate senescence, while storage at low temperature extends the postharvest life by inhibiting their rates. However, storage at low temperatures may also cause chilling injury stress in okra pods. Chilling stress also induces a high respiration rate and weight loss. Therefore, optimization of storage and packaging conditions for extending shelf life is essential. Okra treated with cold plasma, packed in plastic box, wrapped with cling wrap (10 m) and stored at 10^0C had better visual appearance and quality in terms of higher ß-carotene content and lower browning enzymatic activity than control sample until 16 days.

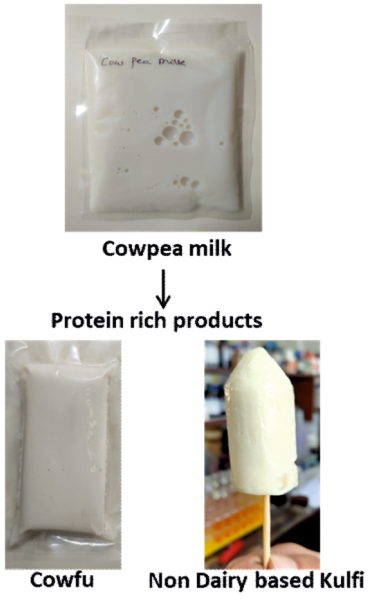
Industrial scale cold plasma unit for decontamination of fruits and vegetables *(Negi PS)*

A number of contaminant removal techniques for various fruits and vegetables (spinach, tomato, grape, and apple) studied included, cold plasma (10-30 KV) for 20-min, hypochlorite dip (0.15-0.3% sodium hypochlorite) for 10 min, ozone (5 ppm) for 10 min, infra-red exposure (10 cm distance) for 10 min, UV exposure (30 cm distance) for 20 min, and electrolyzed water dip (alkaline water with a pH of 13 and acidic water with a pH of 3) for 10 min.The cold plasma-treated spinach showed a 1.63 log CFU/g reduction in the microbial count, which was higher than other treatments. All the samples showed a significant reduction in a* values, indicating degradation of the green color, and compared to all other treatments, the a* values were retained in cold plasma-treated samples at the end of 6 days.The PPO activity showed an upward trend during storage of apples at ambient conditions, and treatments did not have any significant effect on PPO enzyme activity. However, the cold plasma-treated apples showed lower POD and PAL activities. Browning index was also low for cold plasma-treated samples throughout the 15 days storage at ambient. In cold conditions, no significant changes in hardness were observed till the 30th day, and on the 35th day all

the apples showed a reduction in hardness irrespective of the treatment used.In tomatoes, the cold plasma, UV and ozone-treated samples had less decay loss than other samples during storage of 28 days at ambient conditions. Lycopene content showed an increase during storage, however, cold plasma-treated samples showed lower lycopene values, which indicates the delayed ripening of tomatoes.In grapes, stored at ambient condition, after 8th day storage, a remarkable amount of softening was observed in the case of untreated grapes, whereas, the reduction in hardness was moderate in cold plasma treated samples. The cold stored, ultra-sonicated grapes showed a less microbial count (2.01 log CFU/g) after the 12th day of storage than treatments.The tomatoes and grapes spiked with chlorpyrifos (100 ppm) were subjected to cold plasma treatment for decontamination of pesticide residues, and complete removal of chlorpyrifos was observed in tomatoes, whereas, cold plasma-treated grapes showed a reduction of 35.92%.

***Monascus purpureus* CFR410 fermented cowpea tofu as functional food** *(Mohankumari HP)*

Cowpea milk packed under vacuum was pasteurized and did not show growth of any microorganisms in TPC, DRBC and MUG up to 21 days of storage at refrigeration condition. Cowpea milk was utilized in the preparation of kulfi which is protein rich.Value addition of cowpea milk was achieved by fermentation with *Monascus purpureus*MTCC 410. Cowpea milk inoculated with *M. purpureus* spore suspension was incubated for 12-14 days. The prepared fermented product was assessed for safety efficacy. Efficacy of *M. purpureus* MTCC 410 fermented cowpea tofu was carried out by conducting toxicological studies in CFT-Wistar strain albino rats. There were no significant differences with respect to gain in body weight and food intake of rats fed with different doses of *M. purpureus* fermented tofu. Relative organ weight of liver, heart, brain and kidney of treated groups were comparable to that of controls. No histological alterations were observed at any of the dosage levels. No marked alteration in any of the serum clinical enzyme activities was observed.



Functional foods for phenylketonurics and gastritis *(Shruti Joshi)*

The study was conducted to develop flour with low phenylalanine content for phenylketonurics which can be used to prepare chapattis, biscuits, etc. The flour

formulated was packed in packaging material, MET-PET (metallized polyethylene terephthalate (12 micrometer) and low-density polyethylene (50 micrometer)), under 90% RH at 38˚C (accelerated condition). The accelerated storage was planned for 6 months with 15 days interval. After the respective withdrawals, the samples were subjected to shelf life analysis, viz. moisture and free fatty acids (FFA). Moisture sorption studies were also carried out. The microbial analysis was done on a monthly basis. Moisture sorption studies and prediction of shelf-life of products using computer simulation software were carried out. The initial moisture content and equilibrium relative humidity of the flour was 12.4% and 31% respectively and the critical moisture content and critical relative humidity was 15.5% and 60% respectively. The FFA was reported to be initially nil and on over storage also. FFA could not be estimated in the flour as the fat content in the flour was negligible. The overall moisture increase in the flour over a period of 150 days of storage was approximately 18%, under accelerated conditions. The bacterial count was in permissible limit whereas the fungal count was initially nil for over a period of 105 days after which fungal count (6.6 CFU/g) was observed however within the permissible limit.

PKU Multi purpose flour | Biscuit from PKU flour | Chapati from flour

Numerical analysis of heat and mass transfer in various grain drying process
(Shruti Joshi)

A numerical model is presented to describe the distribution and amount of moisture content, as well as the volumetric expansion of a dehulled rice grain undergoing hygroscopic swelling at three different temperature cooking conditions. In order to simplify the complexity conditions, the following assumptions were applied: the rice grain was considered as continuous, homogenous and isotropic; the initial moisture content is considered as homogeneous; and the initial surface temperature of the rice grain is equal to the water temperature. The transient model applied to describe the phenomena of mass transfer and heat transfer during the cooking of rice was developed based on Fick's second Law and Fourier's Law, respectively. Rice puffing process is a complex interplay of mass, momentum and energy transport along with large volumetric expansion of the solid matrix. By treating rice as a porous material, a fundamental-based model of rice puffing process that can describe heat and moisture transport, rapid evaporation and large deformations of the solid matrix is presented to understand the factors affecting the puffing process.Presently mathematical modeling and numerical simulations are widely used in bioprocess engineering research. Mathematical modelling and computer simulation of a process minimize cost and time consuming experimentations and allow understanding the physical phenomena. The model simulation is being carried out with COMSOL multiphysics solver which is based on finite element method.

The model is able to predict the variation of temperature, moisture, change in volume, pressure, stress, strain as a function of time. A fundamental-based model that predicts the volume expansion of rice kernels during hot air puffing is being developed. Rate of evaporation plays a significant role during puffing. Volumetric expansion is an important quality attribute associated with puffed products and it is sensitive to evaporation rate. Rapid evaporation is required to generate intense gas pressure within the material in order to achieve a puffed product with high expansion ratio. Presently 3D dimensional numerical results are being validated.

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

Grain amaranth was fractionated to prepare different streams namely, bran, perisperm and endosperm rich fractions. The coarse husk fraction which is rich in calcium and protein, was pulverized into fine flour and mixed with maize flour and used for the preparation of ready-to-eat flakes. Grain amaranth fraction was incorporated in different proportions ranging from 10 to 40%. The process parameters for preparation of the flakes were optimized. The quality characteristics of the ready-to-eat flakes were evaluated. A steady increase in protein, minerals and dietary fiber contents was observed with an increase in the grain amaranth fraction. The mineral contents of the flakes also exhibited a steady increase. The colour characteristics indicated that, the flakes are with desirable colour and can be further improved by coating. The flakes showed desirable nutraceutical properties with protein digestibility values of more than 86%. The shelf life studies indicated that the flakes showed a shelf life of 3 months. The grain amaranth seed coat was blended with wheat semolina to prepare a composite ranging from 5 to 25%. It was observed that, amaranth semolina can be blended up to 25% level with wheat semolina to prepare the pasta without comprising much on the organoleptic characteristics. The extrusion cooking characteristics of little millet was optimized. Extruded little millet exhibited good nutrient contents and hence can be used as a snack product after coating with either sweet or savoury ingredients. Polishing improves the extrusion characteristics of the millet. However, polishing decreases the nutrient contents of the grains depending upon the degree of polishing.

Grain amaranth-corn composite flakes

Extruded little millet

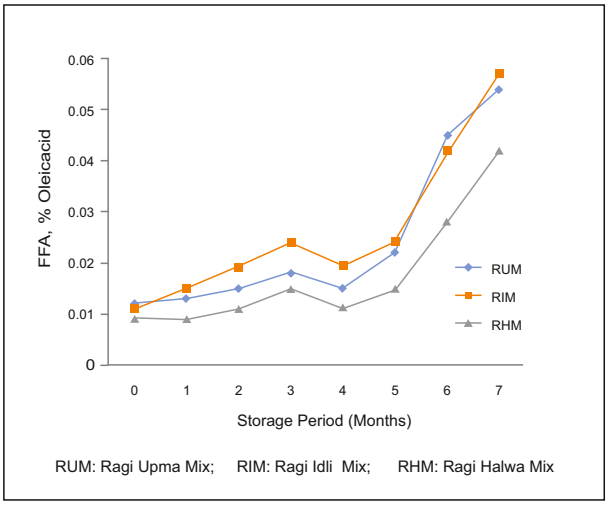
Grain amaranth-wheat composite pasta

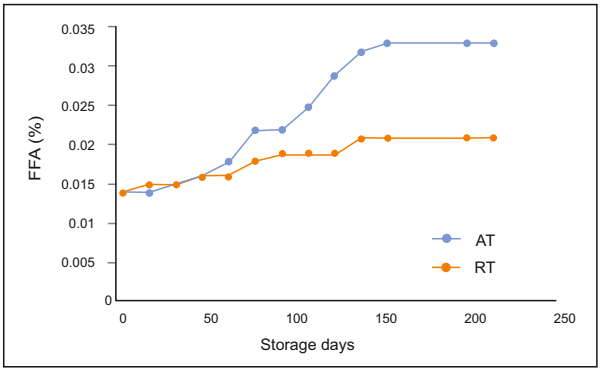
Empowering growers of ragi and other small millets in Odisha State through CSIR-CFTRI scientific intervention *(Usha Dharmaraj)*

Ragi based chatuua, a product suitable for using Take Home Ration was formulated based on roasted ragi flour, similar to wheat chatuua.The product contained 12.28 g of protein with 79.5% digestibility, 262 mg of calcium, 2.14 mg of iron and 2.35 mg of zinc. The total carbohydrate content of the product was 70 g/100 g. The studies revealed that, the product contains desirable sensory characteristics with an overall acceptability value of 7.12, on 10 point Hedonic scale. The shelf-life studies indicated that the sample exhibits 7 months of shelf-life without any deterioration. Ragi based semolina was evaluated for its shelf-life characteristics and further exploited for preparation of instant mixes such as upma, idli and kesaribath (halwa). These products were also evaluated for the physico-chemical and shelf-life characteristics.

Process optimization and physicochemical characterization of Take Home Ration *(Sridevi Annapurna Singh)*

The main objective of the project was to optimize the process flow chart for production of Take Home Ration with improved quality parameters and to evaluate their physico-chemical properties. The ingredient composition of the product was designed by SJRI, Bangalore and CSIR-CFTRI optimized the formulation in terms of process flow chart. Initially four formulations namely, Pushti500 #1- Roasted wheat and green gram, Pushti500 #2- Rice and green gram, Pushti500 #3- Roasted wheat and Bengal gram, Pushti500 #4 - Rice and Bengal gram were prepared. The products were evaluated for its sensory attributes at SJRI. The evaluation panel consisted of team from CFTRI, team from SJRI and team from WCD, Karnataka. Accordingly, two products namely Pushti500 #2 - Rice and green gram, and Pushti500 #4- rice and Bengal gram were selected, ragi, sugar and oil were the other major components. The products were formulated and sent to SJRI for acceptability studies. Rice-bengal gram combination was most preferred sample by the





Effect of storage on free fat acid contents of ragi based products

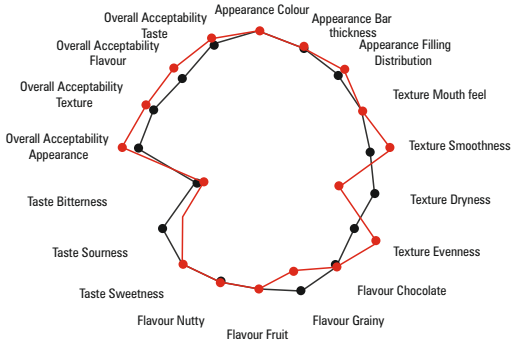
target population. Meanwhile, both the formulations were evaluated for different recipes, that can be easily prepared by mothers at home. The process for preparation of different recipes from the take home ration is standardized without forgoing the calorific requirement of the products. The products were also evaluated for their nutritional parameters and microbial safety.

Feeding trails at H. D. Kote Taluk

Recipes from Pushti, the Take Home Ration

Chicken egg white hydrolysate powder *(Suresh PV)*

Preparation and characterization of protein hydrolysate powder from chicken egg white and its application for the production of functional beverage, ice cream and bar was takenup. The hydrolysate was prepared by digesting chicken egg white using *Flavourzyme*® at the hydrolysis conditions of 24 h and enzyme/substrate ratio of 100 ml/20 L of chicken egg white. The hydrolysate was dried by spray drying method. The chicken white hydrolysate and its powder were analysed for their antioxidant capacity by %ABTS radical scavenging activity and various physico-chemical and functional properties. In the second part of the investigation a functional beverage, ice cream and bar were prepared using the spray dried powder of chicken egg white hydrolysate. The prepared functional beverage, ice cream and bar were analysed for their antioxidant capacity, physico-chemical properties and sensory attributes. Results of these studies suggested that the chicken egg white hydrolysate powder prepared could be explored for the production of RTU nutritious and functional food products.



Functional bar with chicken egg white hydrolysate powder

Egg chips and fingers *(Tanaji G Kudre)*

Different flavoured (garlic, ginger and onion at 2-8% w/w) egg chips were developed and characterized from whole egg. Egg chips incorporated with 6% onion, 4% ginger and 4% garlic showed better appearance, texture, taste, egg flavour, and overall acceptability. Development of whole egg and egg white finger were optimized and characterized. Binder and flavours were used for the formulations of egg fingers. The optimized ingredients for the preparation of whole egg fingers were whole egg liquid (54.32%), rice flour (13.19%), potato starch (9.70%), semolina (11.64%), corn starch (9.70%), salt (1.40%), and citric acid (0.05%). Whereas egg white fingers were optimised at egg white liquid (45.93%), rice flour (15.61%), potato starch (11.48%), semolina (13.78%), corn starch (11.48%), salt (1.65%), citric acid (0.06%). Optimized whole egg, and egg white fingers were incorporated with different concentrations of ginger (2-6% w/w), garlic (2-6% w/w), and black pepper (1-3% w/w) and characterised for colour, texture, nutritional profile and sensorial analysis. Fried whole egg fingers incorporated with 3% ginger, 3% garlic and 1% black pepper and fried egg white fingers added with 4% ginger, 3% garlic and 1% black pepper showed better sensorial characteristics and texture profile compared to other concentration of respective flavours.

Nuclear magnetic resonance based metabolites profiling of coconut water *(Sachin R Chaudhari)*

Maturity profile of tender coconut water (TCW) using internal standard based proton nuclear magnetic resonance (^{1}H-NMR) technique was studied. TCW samples were collected at different stages of maturity, ranging from 2 to 8 months after pollination. The ^{1}H-NMR spectra of the samples were obtained, and various metabolites were identified based on their chemical shifts. The results showed that the metabolite profile of TCW varied with maturity. The major metabolites identified were sugars (glucose, fructose, and sucrose). The levels of these metabolites changed significantly during the maturation of the coconut. Glucose and fructose levels initially increased with maturity, while sucrose levels were almost constant with maturity but finally shot up as and when the glucose and fructose levels dropped in the final stages of maturity. Amino acid levels initially increased but then decreased as the coconut matured. Organic acid levels also increased with maturity. The sugar analysis was validated by correlating it with the UPLC method. The results of this study suggest that ^{1}H-NMR techniques can be used as a rapid and non-destructive tool to determine the maturity profile of TCW. Further, microwave plasma atomic emission spectroscopy was utilized to obtain a deeper understanding of the mineral

Whole Egg fingers incorporated with 3% garlic paste

Whole Egg fingers incorporated with 4% ginger

Whole Egg fingers incorporated with 1% black pepper powder

content present in the TCW. This information can be useful in determining the optimal time for harvesting coconuts for the production of TCW with desired quality characteristics.

Nutritious supplements for geriatrics
(Jyothilakshmi A)

Muscle mass loss is a characteristic feature of geriatrics, aging is associated with progressive loss of muscle mass, quality, strength, and lean body mass declines which initiates at the age of forty. The maintenance of skeletal muscle mass is attributed to inadequate protein intake, reduced ability to absorb available protein, and greater demand. In view of the prevention of muscle mass loss, the investigation is undertaken for preparation and characterization of a branched chain amino acids rich protein mix with improved digestibility and its physico-chemical characterization for its incorporation in a porridge mix. Protein sources from cereals, legumes, and oilseeds were screened for the branched chain amino acid content, and pumpkin seeds and groundnuts were chosen. The protein concentrates prepared from groundnut and pumpkin had a protein content of 87% of which 82% was digestible. Whey protein concentrate of 70% protein with 89% digestibility was taken as positive control. The protein concentrates were hydrolyzed using thermolysin and alcalase for further increasing the digestibility. Dual enzyme hydrolysate showed a higher degree of hydrolysis, higher protein digestibility, and higher branched chain amino aicds. The *in vitro* protein digestibility increased by 10-14% in pumpkin seed and the groundnut protein hydrolysates and that of whey protein hydrolysate increased by 8%. This hydrolysate was incorporated at 10% level in a semolina and sprouted green gram-based porridge for geriatrics. The efficacy of the porridge mix containing hydrolyzed proteins in the prevention of muscle mass loss will be tested in a protein deficiency-induced rat model.

Protein beverage for diabetic population
(Sachin M Eligar)

Pearl millet bran arabinoxylan oligosaccharides (AXOS) showed promising antiglycation effects 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 glucose-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 can be scalable. The protein supplement was developed using commercially available protein supplements and skimmed milk powder by incorporating AXOS. The organoleptic properties of the food product did not change at 1% incorporation. The AXOS re-

extracted from the protein supplement showed the antiglycation effect.

Farm based S&T interventions for socio economic development in the aspirational district of Nabarangpur, Odisha (II Phase) *(Jyothirmayi T)*

Setting up of a Common Facility Centre (CFC) for organising training programmes and also processing the local horticultural produce by prospective entrepreneurs, SHGs and tribals was undertaken. Trainers training programme on food processing methodologies for value addition and shelf stable products was imparted.

Online EDP lectures and hands-on training program on food processing sector *(Jyothirmayi T)*

Six months EDP programme for prospective entrepreneurs from Sambalpur University, Odisha was organised. Online lecture programme was conducted twice a week covering topics on bakery products, beverages, cereal products, food machinery, fruit and vegetable products, food packaging, food safety etc.

Five day Hands on Training Programme was organised at CSIR-CFTRI Resource Centre, Hyderabad encompassing food processing operations such as dehydration, pickling, RTS fruit juices and squashes, moringa incorporated chikki, mahua flower based jams and jellies etc. Based on the requirement, few technologies of CSIR-CFTRI were selected for transfer to Sambalpur University and technology demonstrations were organised. An industry tour was organised to major food processing industries such as bakery, traditional snacks, beverages, fruit processing, frozen foods and oil industries to provide an exposure to the participants to the food processing environment. Training was also provided on preparation of Detailed Project Report (DPR).

Skill development programme on processing, preservation and value addition of food and agro based products for commercial use in aspirational districts of Uttar Pradesh *(Gothwal PP)*

A survey of the aspirational districts of Uttar Pradesh such as Balrampur, Bahraich, Shravasti and Siddharthanagar were conducted for finalizing food and agro based raw materials availability and training schedules. Prospective women entrepreneurs were selected with the help of leading NGOs of the region as well as through State Government officials. A bilingual training manual both in English and Hindi regarding geography, production of fruits and vegetables, cereals and pulses and other agro crops grown in Balrampur, Bahraich, Shravasti and Siddharthanagar districts of Uttar Pradesh were prepared. The preparation, preservation and management of the food and agro based value added products as proposed in the project were given in detail in the manual with recipes and methodology to be distributed among women trainees. Five days training-cum demonstration programs on technologies developed by the Institute were conducted in the aspirational districts of Uttar Pradesh for processing and value addition of agro/food based raw materials available in the region.

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

Comparison of iron absorption from holo-ferritin and lactoferrin and its potential in fortification in food processing was studied. Commercially available lactoferrin and ferritin were quantified from WPI and SPI and further enriched using the ultrafiltration. The enriched fractions were analyzed for its iron content. Apo- protein of lactoferrin and ferritin were prepared by dialysis to remove the bound iron from the enriched fractions. Re-saturation of Apo-LF and Apo-Fr were carried out to maximize the iron content in the enriched fraction. Holo, native and apo-lactoferrin showed 98, 96 and 94% of protein, 1395, 181 and 12 ug/g lactoferrin and 99.7, 12.9 and 0.9% iron saturation respectively. Also, these saturated-enriched fractions were evaluated for its *in vitro* bioavailability using Caco-2 cells. A novel finding of the study is that the addition of holo-ferritin significantly increased (+40.8%) iron absorption from ferritin added to supplemented diet. Changes in serum iron and iron parameters (such as ferritin that was measured in this study) are expected to be more significant with longer exposure of anemic rats to iron administration. The study supports the importance and potential of ferritin to treat iron deficiency anemia, especially in a vegan population where some of the conventional therapies would fail to act. Also, it opens a new window for food industries to explore the possibilities for incorporating the iron in different industrially processed food.

Deep learning and NIR spectroscopy to identify adulteration in commonly used edible oil *(Arun Kumar V)*

The project aims to use a machine learning method to uncover fatty acids of commonly used edible oil and its heterogeneity pattern variations and a deep learning model to decode the quantitative compositional status of the oils. The ultimate goal of the proposed study is to develop a rapid detection method for common contaminants and adulterants in two selected edible oils. The initial experiments started with low-cost unhealthy oils such as palm oil and used oil. These two oils were adulterated with sunflower, groundnut oil, and rice bran oil, the most commonly used for cooking. The palm oil adulteration was performed at different ranges from 2.5 to 10%, and the fatty acid composition was monitored by GS/MS analysis. Further, adulteration (0.1 to 10%) of argemone oil with sunflower, groundnut oil, rice bran oil, and mustard oil was performed, followed by fatty acid profiling. The data was collected from ~80 different variations, and data processing is in progress. These preliminary data are being used to build an unsupervised model to identify sub-clusters and narrow down to specific fatty acid variance among the sub-clusters. The generation of FT-NIR data was initiated for the samples for training the dataset and for *in silico* simulation of the large dataset for building a supervised deep learning model to quantify the fatty acid composition of the oil. The study will provide comprehensive data and methods for NIR spectroscopy to perform a rapid quantitative analysis of edible oil adulteration.

TRANSLATIONAL RESEARCH

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

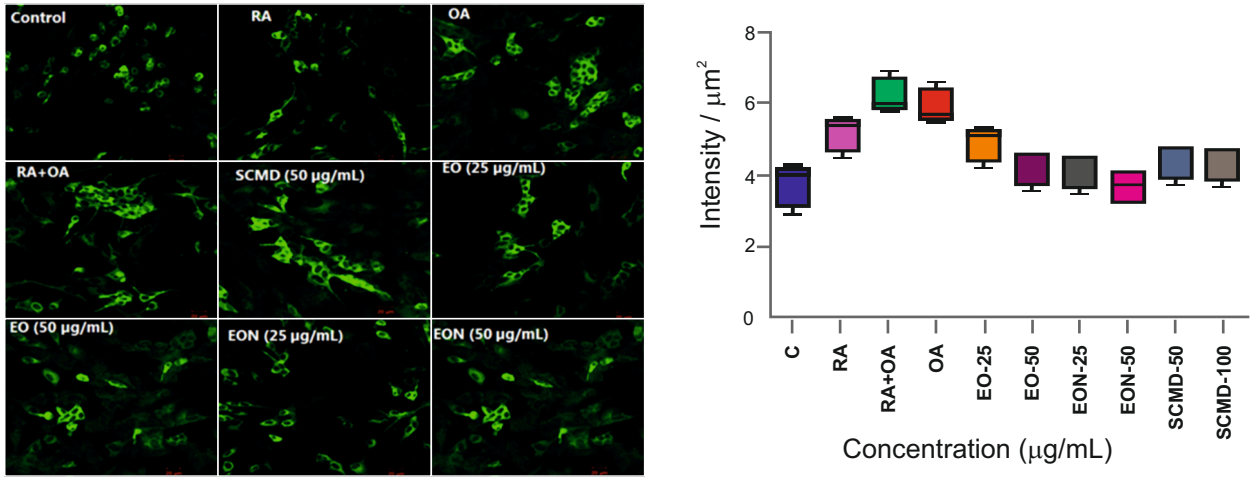
Selective PPARγ modulators (SPARMS) are being extensively developed in recent years to circumvent the problem associated with full agonists. Some of the bioactives from plants can act as SPARMS. Bioactives have been isolated using a green solvent and have microencapsulated it. The microencapsulated bioactive was incorporated in chapati to determine the effect of processing condition on the bioactive. It was able to modulate PPARγ in cell culture models after treating it with the extract from chapati.

Valorization of byproducts from fish industry *(Nandini CD)*

Fish processing discards from abattoirs can serve as a valuable source of biomolecules such as glycosaminogycans (GAGs). Efficient utilization of by products has direct impact on the economy and environmental pollution of the country. GAGs isolated using green solvents showed preponderant presence of chondroitin/ dematan sulfate. It supported early osteogenesis and is able to bring about collagen fibrillogenesis. Further studies on mechanism of action are underway.

Nanoencapsulated Eugenol (NE) *(Poornima Priyadarshini CG)*

Eugenol, a bioactive compound found in *Syzygium aromaticaum* essential oils, positively affects memory, neurogenesis, and neuronal differentiation. Tau, a 441-amino acid protein, regulates cell signaling, synaptic plasticity, and genomic stability. In Alzheimer's disease (AD), hyperphosphorylation and self-aggregation of Tau lead to the abnormal



Confocal microscopy and quantification Tau expression in differentiated SH-SY5Y cells in presence of eugenol (EO), nanoencapsulated eugenol (EON) and carrier control (SCMDC). Alexa Fluor® 488 for Tau is shown in green

accumulation of neurofibrillary tangles (NFTs). Clinical trials have shown the effectiveness of Tau-based therapies over anti-Aβ treatments in AD patients. Therefore, there is a significant shift towards Tau aggregation inhibitors. Intracellular uptake and effect of NE on Tau phosphorylation in differentiated SHSY5Y cell line was studied. It induced a clear morphological change with several neuritic projections that connect to surrounding cells as against the control cells, which was large, flat, epithelial-like phenotype. Okadaic acid (OA) treatment of neuroblastoma cells in culture induces a high molecular weight phospho-Tau immunoreactive species thus making it a suitable culture system to study molecular mechanisms involved in the early events of Tau aggregation and neurodegeneration. The study showed that Tau expression was higher in RA+OA combined group when probed by K9JA antibody. K9JA is a monoclonal antibody that interacts with phosphorylated Tau protein and showed significant reduction in fluorescent intensity in the differentiated cells treated with 50 µg/mL concentration of EO and NE.

Maternal hypercholesterolemia induced programming of epigenetic circuits involved in the growth and maintenance of offspring's skeleton *(Kunal Sharan)*

Studies were conducted in two strains of mice (C57BL6/J and Swiss Albino) and human subjects (65 mother–female newborn dyads) to understand the regulation of offspring skeletal growth by maternal high cholesterol. It was found that mice offspring from high-cholesterol-fed dams had low birth weight, smaller body length, and delayed skeletal ossification at the E18.5 embryonic stage. Moreover, it was observed that the offspring did not recover from the reduced skeletal mass and exhibited a low bone mass phenotype throughout their life. This effect was attributed to reduced osteoblast cell activity with a concomitant increase in the osteoclast cell population. Investigation of the molecular mechanism revealed that offspring from high-cholesterol-fed dams had a decrease in the expression of ligands and proteins involved in hedgehog signaling. Further, the cross-sectional study of human subjects showed a significant inverse correlation between maternal blood cholesterol levels and cord blood bone formation markers. Moreover, the bone formation markers were significantly lower in the female newborns of hypercholesterolemic mothers compared with mothers with normal cholesterolemic levels. Together, the results suggest that maternal high cholesterol levels deleteriously program offspring bone mass and bone quality and downregulate the hedgehog signaling pathway in their osteoblasts.

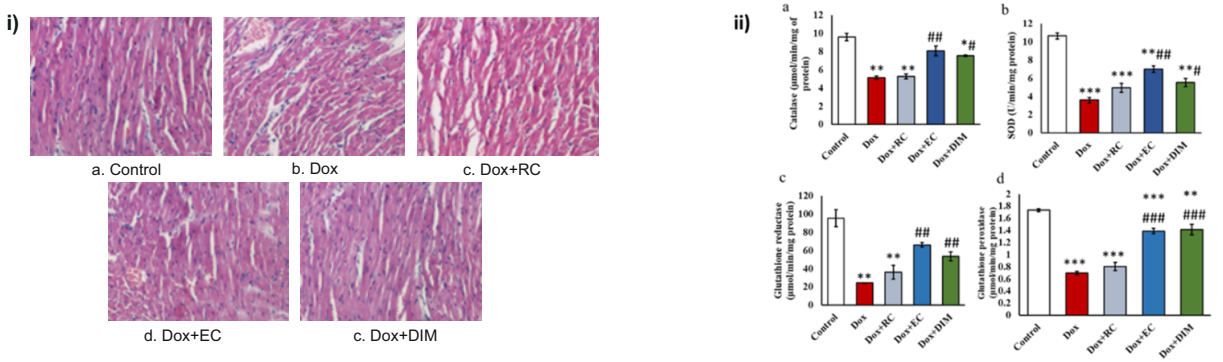
Novel bioactive food formulation to overcome chemoresistance and tumor reoccurrance *(Syed Musthapa M)*

Chemotherapy is the most widely used treatment strategy against various cancers. However, chemotherapy-induced toxicity poses significant challenges against effective cancer treatment and negatively impacts the quality of life of a cancer patient. Diindolylmethane (DIM), a dietary bioactive

from cruciferous vegetables, is reported to have several health benefits, including anticancer activities, and has also been demonstrated to enhance the efficacy of chemotherapeutics. However, its therapeutic efficacy is limited due to its low occurrence and bioavailability. Therefore, a processing technology using cabbage that enriched DIM content by nine-fold was developed. DIM-enriched cabbage diet was developed to investigate its efficacy in reducing chemotherapy-induced toxicity. It was found that the DIM-enriched cabbage diet reversed doxorubicin (Dox) (a standard chemotherapeutic drug) -induced cardiotoxicity in mice. Histopathological examinations demonstrated severe degeneration and structural damage in the myocardial tissue upon Dox treatment, which was ameliorated by the DIM-enriched diet. Moreover, the DIM-enriched diet significantly inhibited oxidative stress and inflammatory markers while enhancing the activity of antioxidant defense enzymes in the cardiac tissues that were disrupted by Dox administration. Overall, the DIM-enriched diet is complementary for cancer patients under chemotherapy.

Functional validation of COVID-19 Main Protease (Mpro) inhibitors by activity-based protein profiling and enzyme assay
(Vijayaraj P)

The protease, particularly the COVID-19 main protease (Mpro), plays a vital role in the self-replication of viral RNA. Therefore, Mpro is an attractive target for drug development due to its essential role in processing the polyproteins translated from viral RNA. The objective of this study was to identify and functionally validate nutraceutical molecules that can inhibit Mpro. The coding region of the Mpro gene was cloned into a bacterial expression vector, and the purified recombinant protein served as the enzyme source for inhibitor screening. The inhibitory potential of the nutraceutical molecules was validated using a fluorescent-based enzyme assay under various physiological conditions to monitor compound stability. Interestingly, a range of dietary molecules exhibited maximum inhibitory activity. These findings provide experimental evidence for the presence of potent Mpro inhibitor molecules in Indian diet. This

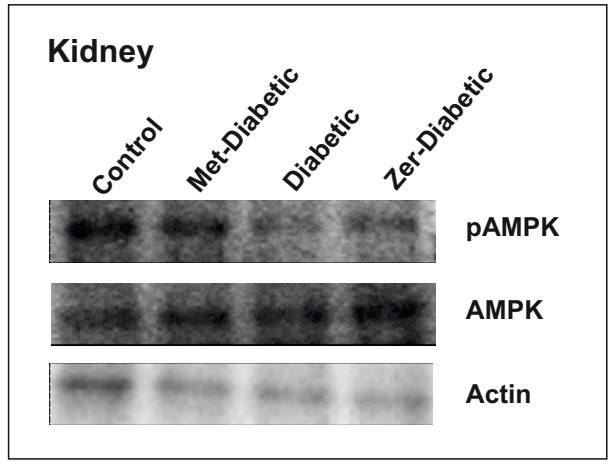


The DIM-enriched cabbage diet alleviates Dox-induced cardiotoxicity in mice by modulating redox balance in the cardiac tissue. RC: Raw cabbage; EC: Enriched cabbage

information can aid in the development of personalized diets to combat COVID-19. Furthermore, these empirical findings will pave the way for further *in vivo* validations.

Food formulation for diabetics targeting energy sensor molecule *(Pullareddy B)*

AMP-activated protein kinase (AMPK) is known as the energy sensor of the cell and acts as a fuel guage. During diabetes, AMPK activity decreases which leads to hyperglycemia and dysregulation of lipid metabolism. One of the primary functions of AMPK activation in diabetics is that it promotes glucose uptake and hence helps in glucose disposal. Pharmacological AMPK activator, metformin is the first line of treatment for diabetes. A food formulation, which is able to promote AMPK activation and glucose uptake, will go a long way in managing diabetes and its secondary complications. In recent years, plant bioactives are being exploited for functional food formulation. Recently, a sesquiterpenoid (zerumbone) was identified from a plant source (*Zingber zerumbet*) that activates AMPK. A formulation made from it will be helpful in managing diabetes. Such a formulation will be well accepted by the populace. Both *in vitro* (MDCK cell lines) *and in vivo* (C57BL6 mice) studies has been completed. The main bioactive compound, Zerumbone has shown to activate the AMPK. AMPK modulation was determined in kidney and the results revealed that in diabetic animals there was a decreased activation of AMPK as determined by phosphoAMPK levels which was ameliorated in Zer-treated diabetic and Metformin-treated diabetic animals. The product was formulated for the consumption bydiabetic patients. Sensory and storage studies have been completed. This zerumbone will be able to control the diabetes through the activation of AMPK and pAMPK. Further studies on different formulation and efficacy of the product has to be carried out.



Phosphorylation/activation of AMPK by zerumbone. In zerumbone treated mice kidney pAMPK was activated as compared to diabetic mice

Iron-fish collagen/gelatin peptide chelate incorporated food products *(Uma V Manjappara)*

There are significant evidence in animal models that administration of peptide-iron chelates lead to increased iron bioavailability. Towards sustainable production of peptides for preparation of iron chelates, fish scale gelatin has been hydrolysed which is a by-product of fish processing industry. Hydrolysis has been optimised for three proteases and 60% hydrolysis has been achieved.

Food products with enhanced protein bioavailability *(Anbarasu K)*

Value-addition of vegan milk formulation enriched with exosomes from soy milk and sprouted ragi to meet the protein and mineral requirement was studied. Isolation and characterization of soy as well as sprouted ragi derived exosomes by ultracentrifugation are under progress. The characterization pertaining to the isolated exosomes included DLS for both size and zetapotential alongside SEM. As per the obtained results the exosomes from ragi was of the size 102 nm and zetapotential was around -23 µV and for soy derived exosomes the size was around 161 nm and zetapotential was around -22 µV which was ideal for an exosome. The structural morphology of these exosomes was further confirmed by SEM analysis.

Novel biomarker development and therapeutics in breast cancer progression *(Anbarasu K)*

Mitochondria (mt) are the major source and target of Reactive Oxygen Species (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 observed. These observations suggest for a functional link between SH3GL2 and mt reprogramming leading to apoptotic induction in the breast cancer cells.

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

An enzymatic and non-RBD (Refining, Bleaching and Deodorisation) approach to effectively utilize and convert crude fish oil (FO) into edible FO enriched with eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) was proposed. Up to 90% conversion of EPA and DHA enriched oil was achieved. The non-edible crude FO was converted to high-quality EPA and DHA-enriched FO (FO-CFTRI) by a novel non-thermal process. The glycerides composition of the FO was monitored by TLC, and the fatty acid composition was performed by GC/MS. Physicochemical properties were analyzed as per the AOCS methods. The oxidative stability of oils was also studied. The free fatty acid content was significantly reduced to 2% in FO-CFTRI, whereas it was 10% in FO. The peroxide value was reduced to ~1% in FO-CFTRI and it was 38% in crude FO. The triacylglycerol content was significantly high in FO-CFTRI (90%), whereas it was low in crude FO (50%). The level of EPA and DHA was enhanced (12 to 15%), and the saturated fatty acid content was low in the FO-CFTRI. The oxidative stability of the FO-CFTRI was

similar to the commercial FO, even though the PUFA was high. All other parameters were similar to the commercial FO. Collectively, the results ensure that the EPA and DHA-enriched oil produced from fish-industrial by-products is suitable for human consumption.

Adipocyte-derived extracellular vesicles activate hepatic stellate cells mediated by SREBP-cleavage activating protein *(Madan Kumar P)*

The pro-fibrogenic role of SREBP-cleavage activating protein (SCAP) enriched extracellular vesicles (EVs) from mature adipocytes is evaluated in the study. Initially, transdifferentiation of 3T3-L1 cells to mature adipocytes was achieved following a standard differentiation protocol. The mature adipocytes were characterized by oil red-O staining and measuring the markers such as Glut4, adiponectin, perilipin by real-time PCR and Western blot analysis. Total EVs from pre-adipocytes (PA) and mature adipocytes (MA) conditioned media were extracted by kit-based isolation method. The average size of PA-EVs was found to be around 86 nm while MA-EVs had greater size of around 128 nm. The presence of EV-specific markers such as CD9 and Flotollin1 were confirmed by Western blotting. Further, the effect of PA-EVs and MA-EVs on HSCs activation was studied by MTT assay. Both PA-EVs and MA-EVs at 0, 1, 3, 10, 30 and 100 µg/mL showed no significant difference in cell viability after 24 h of treatment. The enrichment of SCAP-EVs and testing against an experimental fatty liver model is currently underway.

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

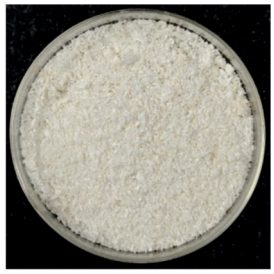
The present study focusses on identifying active lipases in pearl millet (PM) using activity-based protein profiling (ABPP). ABPP is a functional proteomic strategy that detects and identifies enzymes irrespective of their abundance. PM was fractionated into aleurone layer, embryoand endosperm and total protein was extracted to measure lipase activity. Lipase activity was observed in all fractions, with the highest activity found in the embryo. In-gel ABPP of PM fractions revealed the presence of active lipases, and each fraction exhibited a unique pattern. The majority of lipases were detected in the 20 to 50 kDa region. Lipidome analysis revealed significantly higher levels of linoleic acid (18:2) in triacylglycerol compared to other lipids. Trilinoleoylglycerol was the predominant triacylglycerol, while 1-oleoyl-2-linoleoyl-sn-glycero-3-phosphocholine was found in phospholipids. This study provides initial evidence for the existence of different types of lipases in each layer of PM. Further gel-free ABPP is required to identify the lipases.

Spent coconut fiber (SCF) and amino acid sequencing of spent coconut protein (SCP) *(Ramaprasad TR)*

The proximate composition of spent coconut fiber (SCF) and protein amino acid sequence were conducted. SCF was extracted after separation of coconut milk from the whole pared coconut. SCF was tray dried at 60^{0}C overnight and subjected to proximate composition. SCF had 0.39% moisture, 7.89%

fat, 9.91% protein, 3.8% ash and 77.8% fibre in which 62.6% was insoluble fibre and 15.2% was soluble fibre. The total protein in Spent Coconut Protein (SCP) was found to be 85.86%. The same was analysed for AA profile to evaluate the quality of the protein. SCP was found to be rich in glutamine (1152.99 nM) and arginine (744.78 nM). Total AA concentration is found to be 6456.18 nM/100 mg protein.

Dried SCF

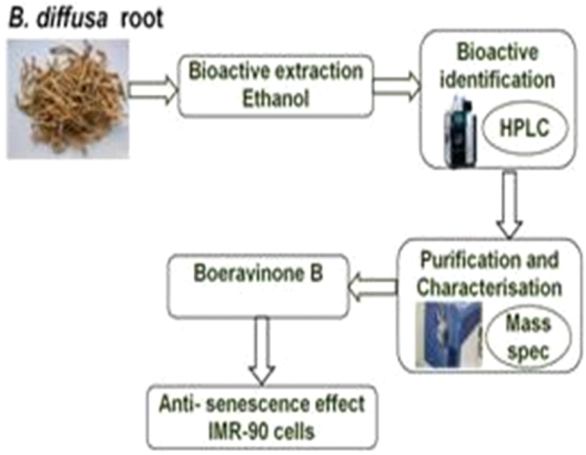


Defatted and pulverised SCF

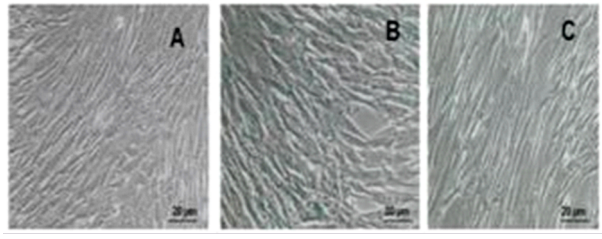
The laxative property of coconut fiber was determined by measuring the intestinal transit. The easy movement of food in the intestine determines the transit time and hence the fecal output. The results indicated that administration of loperamide decreased the intestinal transit compared to control group, whereas supplementation of rat diet with coconut fiber significantly enhanced the intestinal transit ratio at both the tested concentrations. Control was considered as 100%. When compared to control, loperamide intestinal transit ratio was foiund to be decreased by 46.89%. Whereas, in 2.5% and 5.0% CF fed group, it was found to be increased by 156 and 199% respectively. Further, administration of coconut fiber prevented the lesion formation in the intestine as triggered by loperamide.

Mechanism of AGE-R1 regulation and therapeutically targeting AGE-R1 to modulate pro-inflammatory dietary factors *(Singh RP)*

Boeravinone B was extracted from the root powder of *Boerhavia diffusa* usingethanol. The isolated boeravinone B was characterized and purified by mass spectrometry and RP-HPLC. The anti-senescence effect of purified boeravinone B was studied in the cellular model.



The ethanolic extract of *B. diffusa* root showed high polyphenol content with significant antioxidant (radical scavenging assay) activity. The presence of boeravinone B was confirmed by HPLC and mass spectrometry and

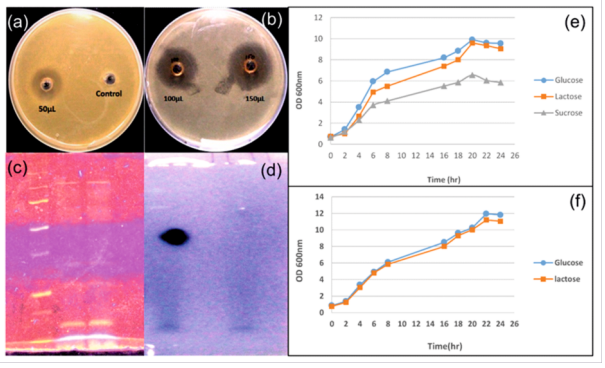


Anti-senescence effect of Boeravinone B was evaluated by the expression of senescence associated β-galactosidase in IMR-90 cells. A: Control, B: MG-BSA treated, C: Boeravinone B treated

subsequently purified on preparatory HPLC. It showed inhibitory effect on MG mediate AGEs formation *in vitro*. Further, in senescence cellular model of IMR-90, boeravinone B showed a reduction in the expression of senescence associated β-galactosidase, a marker of cellular senescence. Thus boeravinone B could serve as a potent therapeutic agent in treating various senescence associated health complications.

Fermented foods for gut microbiome *(Sarma MVRK)*

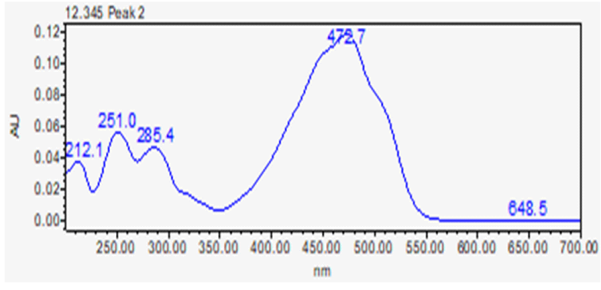
*Pediococcus pentosaceus*was cultivated in a developed medium devoid of animal derivatives. The obtained culture filtrate was carried for antibacterial activity. It was observed that protein at ~15-20 kDa was seen. Finally, growth was enumerated in using different carbon sources and it was adjudged that lactose and glucose are the ideal substrates for this strain when cultivated aerobically and anaerobically.

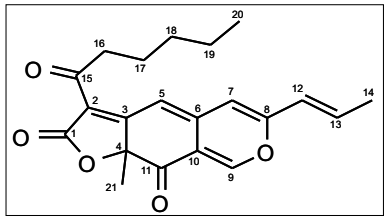


Bacteriocidal activity (a) 50 µL (b) 100 and 150 µL. (c) SDS PAGE of bacteriocin containing concentrate (d) Native page of bacteriocin containing concentrate, growth of *Pediococcus* in different C source (e) aerobic (f) anaerobic

***Monascus purpureus* CFR410-11 antifungal pigment fraction(s) and characterization of antifungal molecule(s)** *(Mohan A Dhale)*

The fungus *Monascus* produces several secondary metabolites of different pigment hues. *Monascus purpureus* pigment were tested against *Penicillium expansum* MTCC 4900, *Rhizopus stolinfer* MTCC 10595, and *Aspergillus niger* MTCC 8652 for antifungal activity. The yellow, orange and red pigments were separated in solvent extraction. The *M. purpureus* pigment extracts inhibited the radial growth and conidial germination of the fungi. The pigment extracts have affected the membrane potential of the treated fungi. Hence, the fungicidal activity of the pigment extracts is due to the disruption of the cell membrane. The UV-visible spectrum corresponding to the HPLC peak revealed the presence of orange pigment rubropunctatin. Apparently, the rubropunctatin present in the extracts exhibited fungicidal activity.

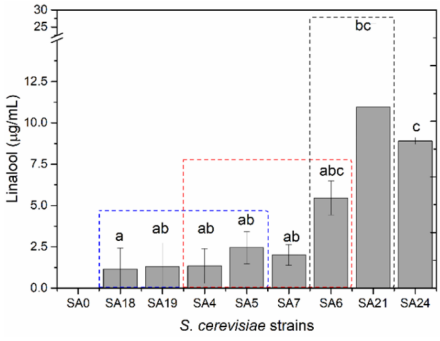




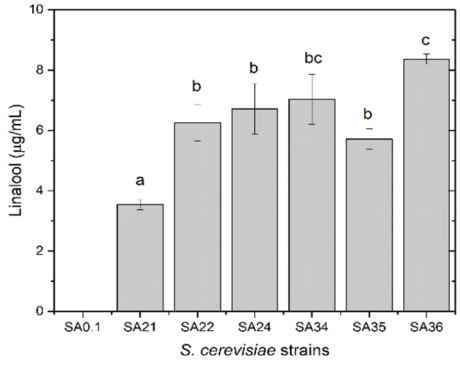
UV-visible spectrum showing the peak at 248, 285 and 472 nm corresponding to the orange pigment rubropunctatin molecule

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

Variants of *S. cerevisiae* strain with linalool synthase (LIS) gene were tested for synthesis of linalool. It was observed that SA24 strain had highest and stable linalool synthesis. This strain was further modified for improved NADPH regeneration and acetyl-coA flux to obtain SA36. When tested against some selected co-expression SA36 has marginally improved linalool synthesis. Further, SA36 has been cultivated in bench bioreactor using fed-batch strategy. The analysis and further improvement of SA36 strain is being carried out.



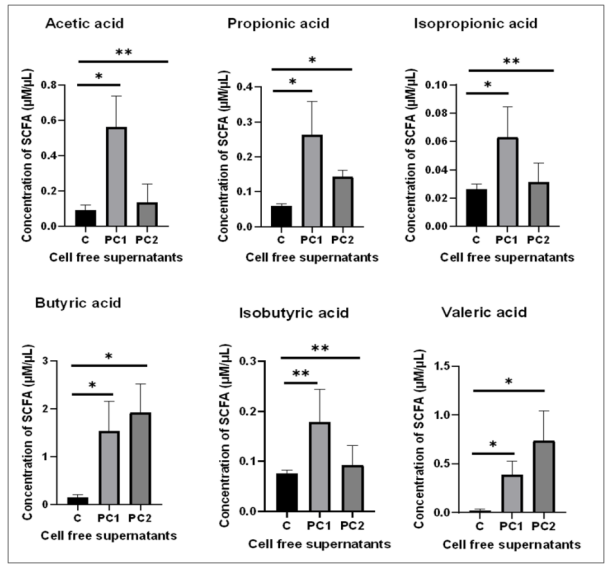
Effect of LIS, co-expression and integration on linalool synthesis in *S. cerevisiae* strains



Effect of co-expression of NADPH regeneration and Acetyl-CoA flux improvement in *S. cerevisiae* strain

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

Allergies are a serious public health problem causing severe symptoms in the gastrointestinal, skin, and respiratory systems and even anaphylactic shock and death. Intestinal permeability and oxidative stress increase the severity of symptoms. The study demonstrated that citrus pectic oligoisaccahride (POS) stimulated the proliferation of butyrogenic bacteria and SCFA production in poly I:C treated mice groups and inhibited the secretion of Th2 cytokines, IL-4, IL-5 and IL-13 in serum and lungs tissues, which are directly related with mast cells inhibition. Moreover, POS upregulated the expression of intestinal tight junction and intestinal barrier proteins muc1, claudin1, ZO and tff3, which protects the mucosal layer and airway lining.Based on these findings, two prophylactic dietary supplement PC1 (citrus, beetroot pectin, and

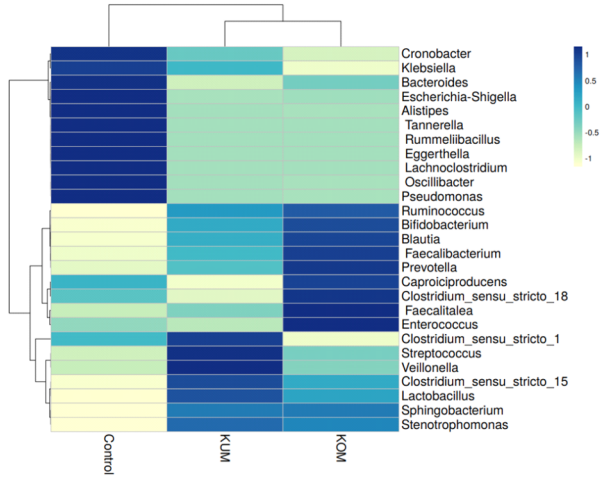


SCFA analysis of PC1 and PC2 after *in vitro* fermentation (* significant at p<0.05, ** non-significant)

POS) and PC2 (wheat bran and little millet) were formulated, which stimulated SCFA production and promoted the growth of *Bifidobacterium*, *Prevotella, Lactobacillus, Feacalibacteria* and *Clostridium leptum* and inhibited the growth of pathogenic *Enterobacteria* in *in vitro* fermentation using human gut microbiota. Post fermented cell free supernatant showed higher antioxidant activities than control. Therefore, both nutraceutical formulations can be used as an effective prophylactic dietary supplement to inhibit mast cells activation, alleviate oxidative stress and prevent allergic disease.

Prophylactic/ therapeutic and nutrient supplements for functional gastrointestinal disorder (FGID) *(Mahejibin Khan)*

To decipher the millets-gut microbiota interaction, the effect of different millets (Kodo, Kutki, Brown top, Finger and Pearl millets) on gut microbiota modulation and metabolites produced during batch *in vitro* fermentation with human fecal samples were investigated. Metagenomic analysis revealed that Kodo (KOM) and Kutki millets (KUM) stimulate the growth of different bacterial genera. A two-fold increase in firmicutes and an 18.95 and 9.74-fold increase in the relative abundance of actinobacteria in the KOM and KUM group was observed respectively. *Bacteroidetes* counts decreased by 17.4% in the KOM and 98.2% in the KUM group. The genera *Caproiciproducens* and *Clostridium sensu stricto 18* were significantly higher in KOM group but their count decreased in the KUM group. Moreover, PICRUSt analysis confirmed the upregulation of carbohydrate and glycan metabolism genes in both the groups. The metagenomic sequencing of other millets is under progress.



Heat map of most abundant bacteria at genus level in fermented samples

Galactomanno-oligosaccharides as potential therapy for inflammatory bowel disease using omics based approaches *(Mukesh Kapoor)*

The colonic tissue of the colitis control group showed greater histopathological damages when compared to the tissue of the normal control group. However, the severity of inflammation, epithelium destruction, and crypt loss was attenuated in colitis mice treated with GG-β-MOS and FOS. A significant increase in the concentrations of butyrate, acetate, propionate, isovalerate, lactate, and succinate in the colonic contents of mice treated with GG-β-MOS (up to $p<0.001$), and FOS (up to $p<0.0001$) was observed when compared with the colitis control group. The increased pro-

inflammatory cytokines (protein/mRNA levels) by DSS were effectively attenuated by GG-β-MOS administration (up to $p<0.01$). Chao1 index which measures the species richnessshowed that among all the treatment groups, the highest species diversity was observed in GG-β-MOS(ii) (GB3B3). Similarly, Fisher index also revealed highest species diversity in the groups treated with GG-β-MOS. Both Shannon and Simpson indices showed that GG-β-MOS treatment group had more species abundance when compared to other treatment groups. No significant clustering (PERMANOVA; F = 6.6545, R^2 = 0.72691, p<0.001) was observed between the DSS and NOR groups with oligosaccharides (GG-β-MOS and FOS) treatment groups. A significant clustering was exhibited between samples of GG-β-MOS(i) and FOS groups. Highest number of Operational Taxonomic Units (OTUs) were seen in case of GG-β-MOS treatment followed by FOS while, DSS treatment showed lesser species diversity. The taxonomical analysis suggested presence of 21 phyla among the treatment groups. Five major phyla viz., Firmicutes, Bacteroidetes, Proteobacteria, Actinobacteria, and Verrucomicrobiawere seen in all treatment groups. Firmicute phylum was the most prevalent among all phyla and was present maximally in group treated with GG-β-MOS (up to 79%), followed by FOS (up to 66%) and had least prevalence in DSS group (42-52%). On the contrary, Bacteroidetesphyla showed more abundance in DSS group (46%) when compared to groups treated with GG-β-MOS (33%) and FOS (26%). The treatment groups showed presence of 39 classes among which 13 classes had OTUs > 10 reads.Clostridia, Bacteroidia, Bacilli, Clostridia, Coriobacteriia, Gammaproteobacteria, Deltaproteobacteria, Verrucomicrobiae were the most prevalent classes. More than 30 genera had OTUs > 10 reads among the treatment groups. *Bacteroides*, *Lactobacillus*, *Olsenella*, *Clostridium*, *Alistipes*, *Pseudomonas*, *Desulfovibrio*, *Muribaculum*, and *Blautia* were the most prevalent genera. Significant differences were seen with respect to abundance of *Lactobacillus* in groups treated with GG-β-MOS (up to 21%), FOS (up to 26%) and DSS (up to 0.2%). Twenty-five bacterial species constituted the core microbiome as they were present across different treatment and control groups (based on 20% prevalence and 0.1% relative abundance). Dendrogram showed clustering of treatment and control groups into three groups viz., Group-I, Group-II and Group-III. A hierarchical clustering heatmap was employed to elucidate the differential abundance of bacterial species in the various treatment groups. The dominant species in GG-β-MOS treated groups were *Acinetobacter pittii, Hydrogenophaga* sp PAMC20947, *Bacteroides ovatus*, *Cupriavidus* sp., *Aeromonas* sp., *Rhizobium* sp., *Clostridium argentinese*, *Bacillus simplex*, *Brevefilum fermentum*, *Prevetella denticola*, *Clostridium tyrobutyricum*, *Ruthenibacterium lactatiformans*, *Bifidobacterium* sp., and *Lactobacillus reuteri*. However, the FOS treatment group showed an abundance of species such as *Blautia* sp., *Eggerthella leta*, *Bacteroides vulgatus*,

Lactobacillus reuteri, *Streptococcus mutans*, *Lactobacillus fermentum*, *Akkermansia muciniphila*, and *Corynebacterium* sp. The DSS group was majorly constituted by *Bacteroides* sp., *Flavonifractor plautii*, *Anaerostipes hadrus*, *Blattabacterium* sp., *Bacteroides uniformis*, *Lacnoclostridium* sp., *Blattaorientalis*, *Odoribacter splanchnicus*, *Alistipes communis*, and *Clostridioides difficile*.

Ready-to-use multi-grain idli and dosa batters with extended shelf-life *(Somashekar D)*

A process for preparation of idli/dosa batter with multigrain was developed. The multigrain batter was prepared using defatted soyabean, green gram, toor dal, oats, horse gram, finger millet, wheat, Bengal gram along with rice and blackgram. The batter had a shelf life of up to 7 days at 5°C. The multigrain idli and dosa batter had higher protein and mineral contents when compared to the normal idli/dosa batter. The shelf-stable ready-to-use multigrain idli and dosa batter in retail packs was meant for instant use by consumers. The ready-to-use multigrain batter can be used for making both dosa and idli the popular breakfast food items. Sensory analysis of the samples were evaluated using 7 points hedonic scale for consumer acceptance study. The results of the analysis showed that the product was acceptable.

Eukaryotic like serine, threonine kinases (eSTKs) of *Bifidobacteria* spp. *(Rajagopal K)*

The signal transduction pathway of prokaryotes involves a peptidoglycan synthesis cluster (PG) to sense external stimuli. One of the major components of the PG synthesis cluster is protein kinases (pknA - G). The sequence data of probiotic eSTKs (Eukaryotic like Serine, Threonine kinases) are obscure, scarce and essentially required to understand the role of probiotic microbes in combating infectious diseases. The most essential need to understand and develop certain therapeutic drugs against pathogens is the eSTK sequence data. Hence, a comprehensive user-friendly data repository of probiotic eSTK's (PeSTK) was developed which holds 830 STK sequences. Therefore, the data resource of PeSTK developed is unique, open-access, very summative containing various probiotic eSTK's in a single locality. The sequence datasets of the eSTK developed with easy-to-operate browsing as well as searching. Therefore, eSTK data resources should be useful for sequence-based studies and drug development.

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

RT-PCR studies for the expression of TFs CaMYB31, ERF, JERF in placental callus cultures of *C. annuum* Meghana variety grown under different conditions was carried out. Studies on the influence of colored LEDs in *in vitro* callus culture obtained was done. Growth curve for biomass (1-4 wks) and metabolite profile i.e. HPLC analysis of capsaicin and dihydrocapsaicin was completed in the callus cultures. Sample was analyzed for the secondary metabolite profiling (capsaicin content and dihydrocapsaicin by HPLC). Transcription factor MYB, ERF, JERF and

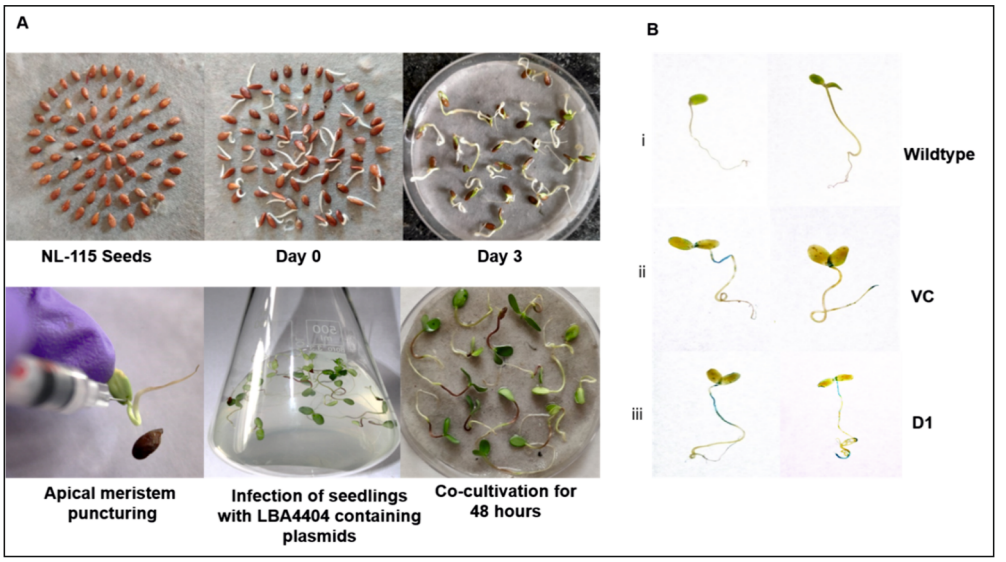
capsaicinoids biosynthesis gene expression studies was performed. The effect of indoleamines stress on callus cultures and bioactives was studied. The optimum cell biomass production was upscaled with inoculum volume 0.5 at 24°C of 16:8 h (light:dark) for 30 days of the growth cycle and 100 RPM was evident, while the optimum biomass production was obtained 30 days of the cycle. The highest TPC value was obtained in the cultures treated with 25 Mm NaCl and without serotonin, with a value of 795.12 mg/100 g. On the other hand, the TFC content exhibited variations with different concentrations of serotonin and NaCl, with the highest TFC content being observed in the cultures treated with 50 µM serotonin and without NaCl, with a value of 207.26 mg/100 g. The antioxidant activity of the samples was found to increase with an increase in the NaCl concentration, indicating a positive correlation between callus cultures and antioxidant capacity.

Plant based formulation in immunomodulatory therapeutic and antiviral therapy against Covid-19 *(Giridhar P)*

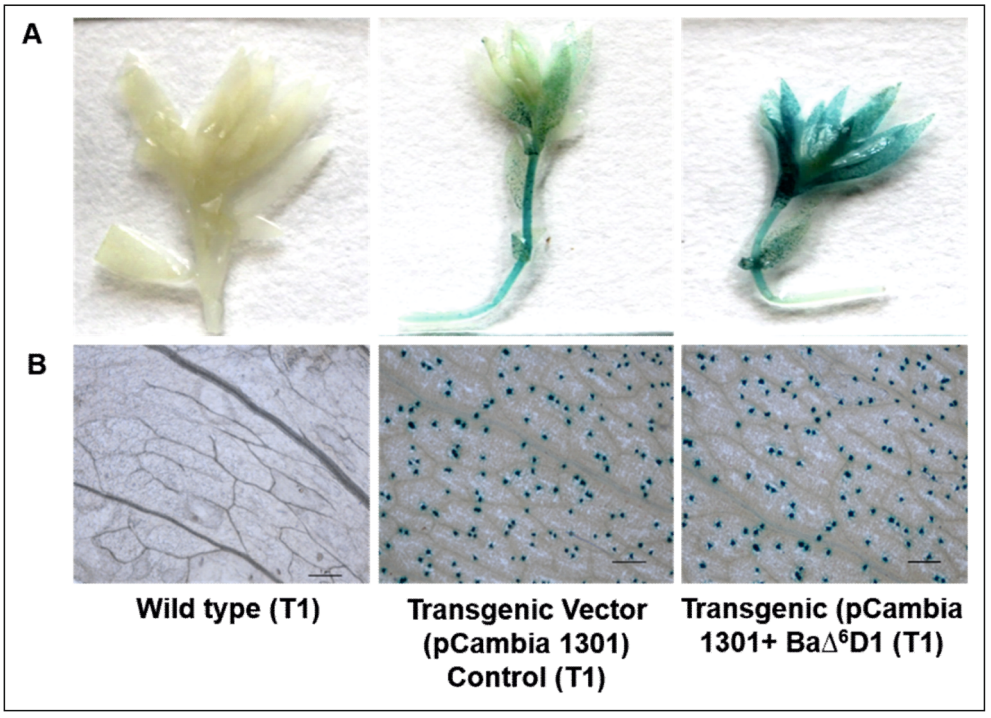
In vitro nutraceutical potential of the prepared blend formulation was assessed after 2 months of storage and the results were found consistent with preliminary data. The cytotoxic effects of Spirulina and *D. hamiltoni* in macrophage cell lines was found to be encouraging. Animal studies to confirm safety and efficacy will be undertaken.

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

Buglossoides arvensis (*Ba*) seeds are rich in nutraceutically important, non-traditional omega-3 polyunsaturated fatty acid - Stearidonic acid (SDA, C18:4, 17-21% of total fatty acids). Poor agronomical adaptation, low seed yield and low oil content are major challenges for its wide commercial cultivation. Most of the terrestrial plants synthesise ALA (alpha-linolenic acid, C18:3) as the final omega-3 fatty acid. The health benefits of SDA rich oils are found to be better than ALA oils because SDA can bypass the rate-limiting step catalysed by Delta-6-desaturase in the human liver and thereby enrich tissues with EPA (eicosapentaenoic acid, C20:5) more efficiently compared to ALA. SDA is produced through desaturation of ALA by D6D enzyme in *Ba*. Transgenic expression of *B. arvensis D6D* (*BaD6D*) in an ALA rich plants can be a sustainable option to produce SDA rich oil. Chia and flax are plants with highest ALA content (~55-60% of total fatty acids) which can serve as precursor for SDA synthesis and hence can be a potential candidate to synthesise SDA. Genetic transformation of chia and flax for possible transgenic expression of *Ba*D6D and synthesis of SDA in their seeds were carried out. Presence of the trans gene was confirmed by GUS assay in T1 plants. Integration of the gene into the chia and flax geno me was confirmed by PCR analysis of $Ba\Delta^6D$ and a fragment of the T-DNA that contains $Ba\Delta^6D$ and glycin in promoter.



Transient expression of pCAMBIA 1301+*Ba*Δ^6*D1* expression cassette in *L. usitatissimum*. A: Apical meristem-mediated transformation of *L. usitatissimum* seedlings. B: *GUS* reporter gene expression in the apical meristem region (i) Wildtype seedlings showing absence of *GUS* expression (ii) vector control- pCAMBIA 1301 (VC) and (iii) pCAMBIA 1301+*Ba*Δ^6*D1* (D1) developing blue color in the apical-meristem region

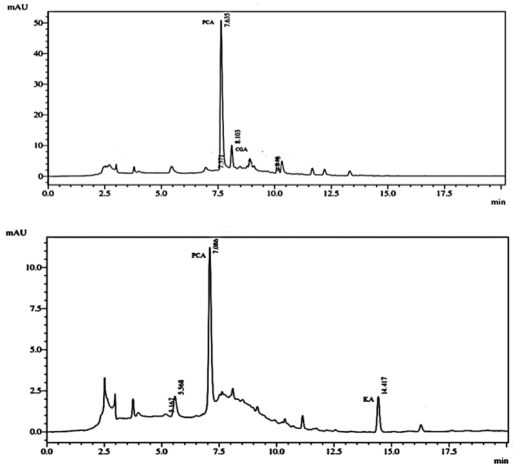


GUS histochemical assay of the T1 seedlings. (A) T1 seedlings of flax after GUS assay (B) Blue product distribution in the leaves of the T1 seedlings after GUS assay

FOOD PROTECTION AND SAFETY

Authentication of honey by analysis of specific phenolics and oligosaccharide markers *(Prasanna Vasu)*

Phenolic acid and flavonoids are stable, non-volatile, secondary plant metabolites which are carried by the honeybees along with the nectar to form honey, and hence explains their suitability in the geographical and botanical authentication of honey. Around 25 different wild, raw, and processed honey were procured from authenticated stores of Coorg, Karnataka and Wayanad, Kerala. The highest phenolic compound content was observed in Raw honey while the lowest in Karanj and Litchi honey. Majority of the honeys are within the range of 208 to 389 mg GAE/Kg. The total flavonoids of honey ranged between 114.4 and 823.8 mg QE/Kg honey. Polyphenols that could help in identifying honey originated from similar floral sources but from different geographical location with a fine line of distinction with respect to certain phenolic and flavonoid contents were identified. The preliminary data indicate that wild raw honey and wild honey can be identified on the basis of p-coumaric (p-CA) and protocatachuic acid content with former being the minor and later the major. Berry honey from Kashmir and blackberry honey from Karnataka also had identical polyphenol namely Chrysin (CH) as the major flavonoid, which can be a marker. Upon determining major and minor polyphenol in each of the honey samples, the presence of specific phenolic acid or flavonoid as the identity marker can be concluded. The work with additional honey sample is in progress.



Chromatograms showing the phenolics peaks obtained for the different honey

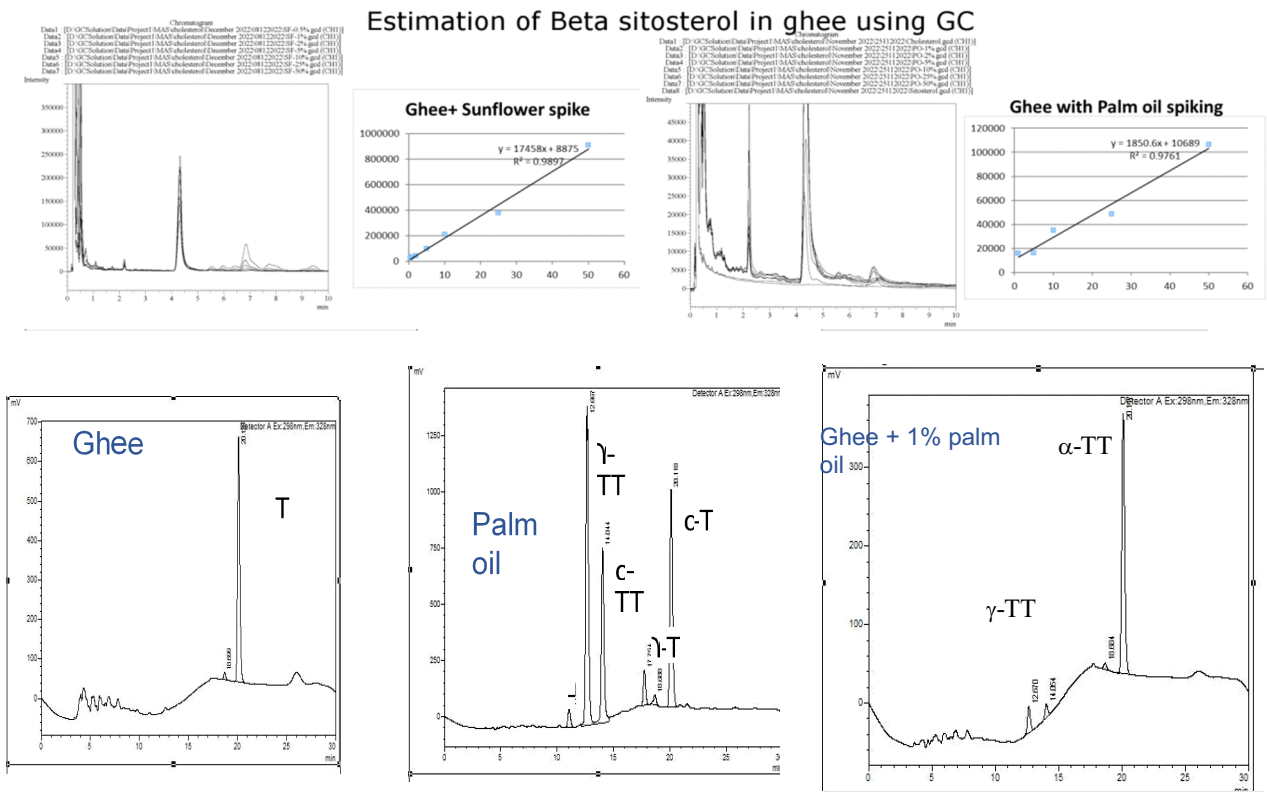
Network for scientific cooperation for food safety and applied nutrition *(Jayadeep A)*

Assessment of adulteration of vegetable oils in ghee through alternate analytical methods: Due to the increasing demand of ghee in the market, its adulteration with various vegetable oils is a matter of concern. Analysis of beta sitosterol which is present only in vegetable oils is the method to detect adulteration and this is done by HPLC method. There is a need for method improvement and validation of sterol estimation. An in-house GC-FID method was developed where ghee samples were spiked with different oils such as palm oil, coconut oil, sunflower oil and groundnut oil at different concentration (0.5%, 1%, 2%, 5%, 10%, 25% and 50%), and beta-sitosterol was detected at all ranges.Palm oil is unique to have the

presence of tocotrienol components especially gama-tocotrienol which is absent in ghee. A method was developed for the identification of palm oil in ghee by analysing the tocotrienol and tocopherols components by using HPLC. Ghee sample was spiked with 1% of palm oil and extract analysed for tocols by using simple extraction protocol and analysis by HPLC using fluorescence detector. Further, the short chain fatty acids in house method was developed to understand the free fatty acid profiling of ghee.

Fine tuning of millet value chain for export markets *(Sridevi A Singh/ Jayadeep A)*

Work has been carried out under various verticals. Under engineering and machinery for millet milling, de-hulling efficiency of various millets were studied using rubber roll sheller at different passes, hydro thermal treatment and de-hulling, and thermal treatment and use of combination of de-hullers. A design drawing for de-hulling of millet with integrated sheller was made ready. In the study on processing of millets, production of semolina with improved shelf-life and development of instant products, processing of kodo and proso millet for production of shelf stable semolina was initiated, and thermal processing and roller milling resulted in coarse and fine semolina of uniform size. Storage study of proso millet semolina showed shelf stability of up to 9 months. In the investigation on technology for shelf-life extension of pearl millet flour, pearl millet lipase inhibitory potential was observed



HLPC chromatogram of tocotrienol and tocopherols in ghee spiked with palm oil.

by thermal and milling treatment. Studies in different packaging materials in accelerated condition for 4 months which is equivalent to 8months showed shelf stability for pearl millet flour. In the basic studies of lipid composition and lipase of selected millets, quantitative and qualitative aspects of millet brans for lipid class and fatty acid types were carried out. The study provided the first level of evidence for the existence of different types of lipases in bran, germ and endosperm of pearl millet using activity-based protein profiling (ABPP). Effect of degree of polish of specific varieties of millets on nutrients, nutraceuticals and storage quality showed that degree of polishing of selected small millets (foxtail, little and proso millet) revealed minimum polish for the retention of nutritional and nutraceutical quality. In the section on development of novel/ nutraceutical/ fortified products from millets, phytocomponent rich convenience ready to cook (RTC) and Instant Multi Millet Mix (MMM) for gluten free ready to cook beverage/soup and Spirulina fortified multi millet RTC beverage/ porridge mix (SP-MM) was developed and found to be rich in nutrients and phytonutrients with acceptable sensory and storage stability of more than 9 months.

Microsomal epoxide hydrolases through multiscale modeling to understand lipid signaling and metabolism *(Usharani D)*

Epoxide hydrolase (EH) enzymes are part of alpha beta hydrolase domain family, which are ubiquitously expressed in all living organisms and present in almost all organs and tissues. They are key drug targets for obesity, cardiovascular disease, diabetes and cancer. The balance of epoxy lipids and the respective dehydroxylated lipids governs the lipid signalling and the cascade of cellular events there off. The endogenous epoxy lipids, epoxyeicosatrienoic acids (EETs) are hydrolysed by microsomal EH1 and soluble EH2. The structural flexibility of proteins EH1 and EH3 were elucidated using molecular dynamics simulations. The structural diversities observed in the catalytic site of EH3 and EH1 compared to X-ray crystal structure of EH2 led to the understanding on binding mode of inhibitors. The inhibitors known for EH2 classified to four groups based on the class including urea, amide, amine and pyrazoles. The binding of each classes was thoroughly inspected and identified the key interactions of sub pocket that could lead to inhibitor selectivity towards EH isoforms. The molecular dynamics of EH-inhibitor complexes further ensured stability of the complex and strong binding affinity towards EH isoforms.

CSIR PROJECTS

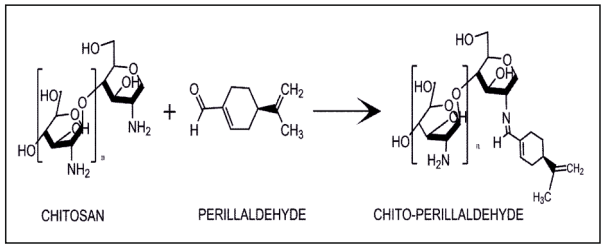
Focused Basic Research/ Niche Creation Projects

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

In 16S rRNA metagenomic study on infant fecal samples, *Bifidobacterium infantis*, *B. breve*, and *B. bifidum* were identified as the most abundant bacterial species. Interestingly, *B. breve* was found to be abundant only in the gut of Indian infants and not in infants from Western populations. Extensive screening of polysaccharides was also conducted and discovered two crucial oligosaccharides, one from a plant source and another from an animal source, that promote the growth of *B. infantis* and *B. bifidum*, giving them a competitive advantage over *B. adolescentis*. Importantly, these oligosaccharides were found to be unutilizable by pathogenic bacteria such as *E. coli*, inhibiting their growth. These findings have significant implications for the development of functional foods that support the growth of beneficial bacteria while suppressing pathogenic bacteria.

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

Spice bioactives like vanillin, salicylaldehyde, perillaldehyde and citral were linked covalently to the chitosan. Conjugates were characterized by spectroscopic data and up scaled the preparation of conjugates to 50 g. Polymeric films of chito-conjugates were prepared and tested for suitability as packaging material. The aqueous miscibility of the conjugates were tested and a suitable condition for the solubility was established.



Chito-conjugate of perilladehyde

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

Clove oil nanoemulsion with particle size 156 nm was prepared and used for orodispersible films formation. The influence of different emulsifiers on the mechanical, physico-chemical properties and biological acivities such as antioxidant and antimicrobial activity was tested. The encapsulation efiiciency of nanoemulsions was in the range of 93-98% with varied amounts of wall-material. The FTIR spectra of films indicated a complete masking of clove oil by the wall-material and other emulsifiers. The orodispersible films were studied for surface pH, thickness, transparency and swelling index also. The *in vitro* release study at salivary fluid pH 7.4 showed that the presence of emulsifiers controlled the release of the clove oil from the films compared to the release of unencapsulated clove oil. The anti-

bacterial activity of orodispersible film, with an optimized composition, against *Staphylococcus aureus* (MTCC 12900) was better than the unencapsulated clove oil while the wall-material used did not show any activity.

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

Seaweeds have been consumed from ages for its health benefits and nutritional value. It is a rich source of fiber, protein, vitamins and other bioactives which have shown to have positive effect on human health. However not much work has been carried out to tap their potential as functional food. In order to popularize this and understand their stand on health claims, the nutrition, nutraceutical potential, safety and efficacy needs to be carried out in order to develop a functional food with health claims. Hence studies on the safety of the seaweed *Ulva lactuca* through toxicological studies *in vivo*, characterization of the nutritional and nutraceutical profile and development of functional products based on this seaweed were carried out. Characterization of sea lettuce showed that they are rich source of protein (18%) and dietary fiber (total DF= 63%; IDF= 41% ; SDF=22%). Acute and sub-acute toxicity studies revealed that *Ulva lactuca* was found safe for consumption. Five products (flakes, powder, burger patty, pasta, rusk) based on *Ulva* were developed and shelf-life studies completed.

Ulva seaweed based burger patty

Ulva seaweed based rusk

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

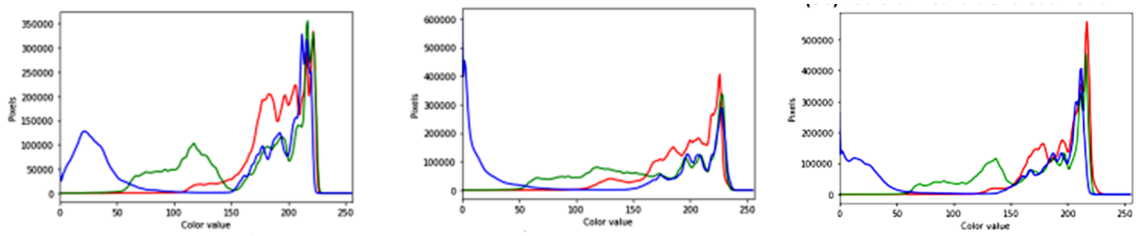
Mangoes of different varieties were ripened with ethrel and calcium carbide under different conditions. Mango varieties, Alphonso, Raspuri and Totapuri were investigated for the ripening studies. Mangoes mature, unripe were washed and ripened under different conditions with ethrel and calcium carbide such as T1-ethrel treated; T2-calcium carbide treated; T3-hot water treatment followed by ethrel treatment, T4-hot water treatment followed by calcium carbide treatment. The fruits were treated and stored at 24^0C for ripening. Ripening took place after 5-6 days, The fruits were examined daily for the changes in surface color. Ripened fruits were analysed for the physico chemical characteristics viz., color reflectance measurement (L a b) of the surface and cut

fruit, image acquisition, reducing sugars, carotenoids, pH, acidity and texture. The images of the fruits of a large number of samples were collected and processed for features collection. Data processing and correlation of the image data with ripening method were carried out.

Ethrel treated and hot water ethrel treated mangoes of all the three varieties showed higher development of colour, flavour, total soluble solids and carotenoids compared to calcium carbide ripened mangoes. Colour reflectance values showed increase in redness and yellowness of ethrel ripened mangoes as compared to calcium carbide ripened fruits. The ripened mangoes were analysed for the physico-chemical characteristics, colour analysis of surface and internal flesh colour. Mango pulp extracted from ripened mangoes under different conditions were subjected to hydro distillation and the volatiles extracted were analysed by GC-MS. About 60 to 70 volatile compounds were detected in ripened mangoes from different treatments. Images of the mangoes ripened with different treatments were collected, processed and subjected to machine learning for generating the model and database creation.

Deep learning based approach: Transfer learning based approach with AlexNet as base module for feature extraction part and SVM as classification algorithm was employed. A machine learning based algorithm for classifying mango ripening was developed. A software was developed with limited number of datasets and it can further be improved by generating a large number of data sets. A demonstrable software model was generated using matlab software and Python for algorithm testing in the project.

a. Control b. Ethrel treatment c. Calcium caribide treatment



d. Natural color histogram e. Ethrel color histogram f. Cac2 color histogram

Color histogram of different treatment for mango ripening

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

Novel drug targets were characterized to address antimicrobial resistance. Specifically, the significance of Structural Maintenance of Chromosome (SMC) proteins were demonstrated, highlighting their role in chromosome condensation and cell division. Additionally, SMC-like proteins in mycobacteria were identified and characterized, expanding the understanding of their functions. Furthermore, the extensive study on FAD synthetases (FADS) from pathogenic and commensal bacteria has revealed species-specific attributes in this enzyme. These findings together offer an opportunity to design species-specific or narrow-range antimicrobials that selectively target pathogens without disrupting the gut microbiota.

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

The study was undertaken to validate the SREBP inhibitory effect of a selected food bioactive in ApoE deficient mice model. To determine the optimal dose of the selected food bioactive, a methionine/choline deficient (MCD) diet-induced study in mice was conducted. AST, ALT, GTT, ITT and histopathological results suggested that selected food bioactive at 100 mg/kg BW offered maximum hepatoprotection against MCD diet-induced mice. Thus, for the ApoE deficient mice study it was decided to fix the dose of food bioactive as 100 mg/kg BW. Administration of food bioactive (100 mg/kg BW) to high fructose diet-induced ApoE deficient mice significantly decreased the AST, ALT, cholesterol and triglycerides levels. Also, food bioactive treatment protected liver damage by improving insulin sensitivity and glucose tolerance. The liver fibrotic marker, α-SMA was significantly reduced in food bioactive treated group exhibiting it's anti-fibrotic effect. Western blot and qPCR results also confirmed that food bioactive treatment inhibited the SREBP activation and its downstream targets. For the first time, the research findings demonstrated that food bioactive treatment inhibited SREBP activation and attenuated high fructose diet-induced liver fibrosis in ApoE deficient mice.

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

Turmeric (*Curcuma longa* L.) belongs to the Zingiberaceae family and is known for containing numerous secondary metabolites in its rhizomes. Among these, curcumin stands out as a significant natural compound derived from the rhizomes of *Curcuma longa*. The most common secondary metabolites found in *Curcuma* species are polyphenolic curcuminoids, which consist of a mixture of curcumin (60-80%), desmethoxycurcumin (15-30%), and bisdemethoxycurcumin (2-6%). The accumulation of curcumin content in the host plant is greatly facilitated by endophytic bacteria and fungi associated with turmeric. Different germplasm of *Curcuma longa* from

various geographical locations were collected and endophytic bacteria and fungi were isolated. The low-yielding variety was subjected to endophyte treatment under field conditions, and phenotypic traits and accumulation of curcumin content were recorded at 3, 6 and 9 months interval. To understand the mechanism of how endophytes helps in accumulation of curcumin enzyme studies, such as catalase, peroxidase, and hydrogen peroxide, were carried out on field-harvested samples. Additionally, biochemical studies on total phenolics, total flavonoids and total carotenoids were carried out on samples collected at different months. The antioxidant activity of turmeric was assessed using the DPPH method, and changes in rhizome colour were compared across different 3, 6 and 9 months samples. To gain insights into the biosynthetic pathway, phytohormone studies using salicylic acid and jasmonic acid were performed through the HPLC method. The data showed that the endophytes used jasmonic pathway to enhance the production of curcumin content.

Strategies to reduce mycotoxins (fungal secondary metabolites) in cereal grains during storage condition through "Seed-Endophyte" interactions *(Vivek Babu CS)*

Fungal spoilage and mycotoxin contamination are the major concern during storage of cereal grains such as rice, wheat and maize. Management of mycotoxins in stored grains (maize) requires a multifaceted approach including preharvest and postharvest strategies. Understanding the diversity of mycotoxin producing microflora in storage grains especially cereal grains and their possible management using native seed endophytes makes a sustainable approach to prevent post harvestation losses. Four fungal endophytes (*Aspergillus flavus FE1, Diaporthe phaseolorum FE2, Schizophyllum commune FE3 and Stenocarpella maydis FE4*) identified and characterized through ITS 4 and ITS 1 sequencing analysis. These fungal endophytes further deployed for mitigation of mycotoxigenic fungi of cereal grains (maize) through competitive exclusion assay. All the above fungal endophytes revealed good biocontrol traits against aflatoxigenic fungi such as *Aspergillus flavus and Aspergillus parasiticus*. Non-aflatoxigenic nature of the selected fungal endophytes (*Aspergillus flavus* FE1, *Diaporthe phaseolorum* FE2, *Schizophyllum commune* FE3 and *Stenocarpella maydis* FE4) and their toxic metabolites such as Aflatoxin B and Aflatoxin G has been analysed through thin layer chromatography. Interestingly above fungal endophytes revealed complete absence of aflatoxins. Furthermore, these endophytes were subjected for *in vitro* competitive exclusion assay using *Aspergillus flavus* and *Aspergillus parasiticus* on maize grains as a substrate. Co-inoculation of non-aflatoxigenic fungal endophytes with aflatoxigenic fungal strains on maize system revealed differential suppression of aflatoxins in parent strains. However, complete mitigation of aflatoxins was noticed by non-aflatoxigenic *Aspergillus flavus* FE1 fungal endophyte. Furthermore, bioformulations of above selected fungal

endophytes were prepared using wheat bran-based carrier system and evaluated their shelf life for six months. The endophyte based bioformulations were used as bioinoculants for maize cultivation through both seed and soil treatment.

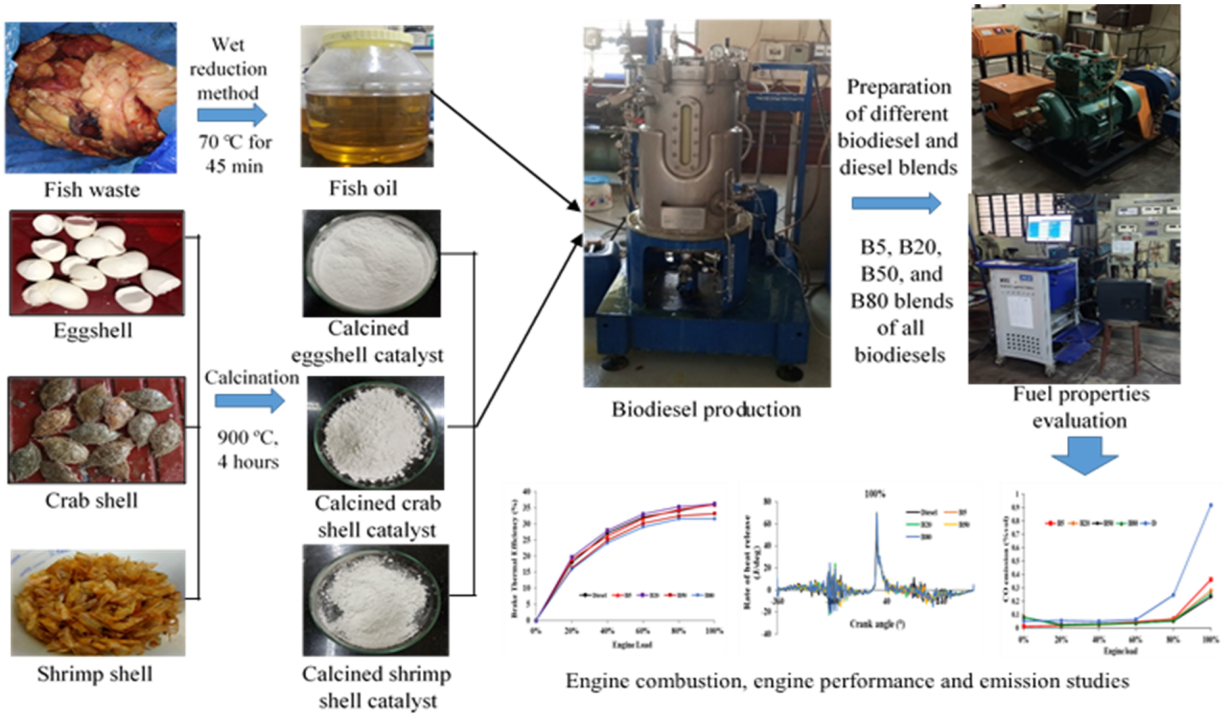
Capsicum and flaxseed improvement through genome editing *(Nandini P Shetty)*

Strategies to enhance shelf life in capsicum fruits will reduce the post-harvest loss, as excessive softening limits the shelf life and cause the fruit to deteriorate. Supressing the expression of the genes which are associated with the fruit ripening is a strategy to extend shelf life. Knockdown of fruit ripening associated genes like α-mannosidase, β-D-N-acetylhexosaminidase and β-D-xylosidase with CRISPR/Cas9 gene editing have been carried out to enhance the shelf-life of capsicum. Flax or linseed (*Linum* L.) is a dicotyledonous plant from the family Linaceae, cultivated for its seeds and fiber. Seeds are rich in oil and protein and contain a good amount of α-Linolenic Acid (ALA), an omega-3 fatty acid. Despite its excellent nutrition profile with high levels of omega-3 fatty acid, flaxseed cannot be consumed in large quantities as whole seed due to the presence of anti-nutrient properties. Among many antinutritive compounds, cyanogenic glycosides (CG) and phytate have raised more attention. CG, the minor component found in the seed of mature flaxseed, are the major source of flaxseed toxicity due to the release of hydrogen cyanide (HCN) when hydrolysed. The present study addresses this problem by eliminating the genes expressing this antinutrient property from the *L. usitatissimmum* genome. CRISPR/Cas9 gene editing will be used to decrease the anti-nutrient content. Hence gRNA has been designed and plants transformed for reduced production of cyanogenic glycosides.

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

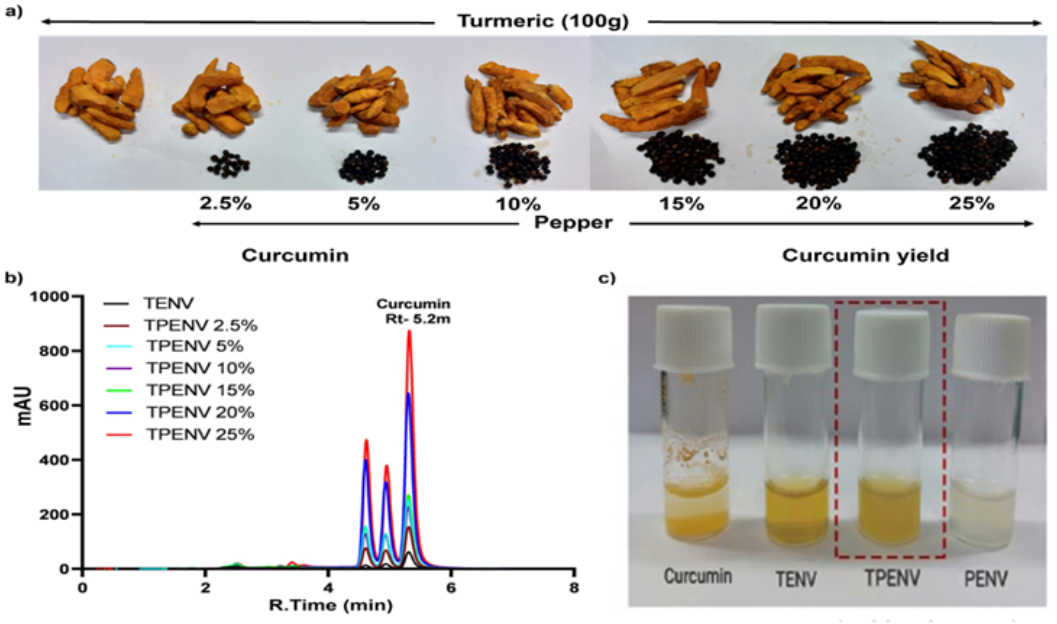
The study aims to valorize the fishery (marine and freshwater) waste as feedstock source and waste biomass such as eggshells, crab shells, and shrimp shells as catalyst sources for sustainable biodiesel production. Similar to the marine fish processing waste (MFPW) oil and marine fishmeal industry (MFMI) oil, the physicochemical properties of freshwater fish processing waste (FFPW) oil also showed its suitability to be used as feedstock for biodiesel production. Based on the adopted central composite design (CCD) of response surface methodology (RSM), the maximum biodiesel yield of 82.57 wt% was obtained from FFPW oil using calcined shrimp shell catalyst at FFPW oil to methanol molar ratio of 1:11, catalyst concentration of 6 wt%, reaction temperature of 65ºC, and reaction time of 150 min at a constant stirring rate of 200 rpm. The TLC, FTIR, and GC analysis confirmed the conversion of parental FFPW oil to its corresponding methyl esters (biodiesel). The physicochemical properties of FFPW oil biodiesel were within the ASTM standards. Further, the calcined eggshell catalyzed MFPW oil biodiesel (ESBD) and calcined crab shell,

and calcined shrimp shell catalyzed MFMI oil biodiesels (CSBD and SSBD) were produced to prepare different blends and to validate their feasibility in diesel engine. Three different ESBD, CSBD, and SSBD blends with petroleum diesel (B5- 5% biodiesel and 95% diesel, B20-20% biodiesel and 80% diesel, B50-50% biodiesel and 50% diesel) were prepared. The physicochemical and fuel properties such as free fatty acid content, acid value, viscosity, flash point, calorific value, cold filter plugging point and cetane number for B5, B20, and B50 blends of ESBD, CSBD, and SSBD authenticates their application in diesel. The impact of different ESBD, CSBD, and SSBD blends with petroleum diesel (B5, B20, B50, and B80) on the combustion and performance of the diesel engine (twin cylinder four stroke) at different engine loads (0%, 20%, 40%, 60%, 80%, and 100%) was studied. The B5, B20, B50, and B80 ESBD, CSBD, and SSBD fuel blends exhibited brake specific fuel consumption (BSFC) value in the 0.21-0.25 kgs/kWh range and brake thermal efficiency in 31.58-36.29% range at 100% engine load, slightly higher than diesel. The B80 and B50 blends of ESBD, CSBD, and SSBD displayed maximum in-cylinder pressure (52-56 bars) and heat release rate (64-71 J/deg) than other prepared fuel blends and diesel. Besides, the B50 and B80 blends of ESBD, CSBD, and SSBD showed a 69.23% and 27.35% reduction in CO and HC emissions than diesel, respectively. The B50 and B80 blends of ESBD, CSBD, and SSBD reduced CO, CO_2, and HC emissions to 65-87%, 6-17%, and 35-59%, respectively. The findings emphasize that besides B5 and B20 blends, higher blends (B50 and B80) of ESBD, SSBD, and CSBD could also be used in the diesel engine without any major engine modifications.



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

Curcumin has been extensively studied for its anti-cancer properties, though its therapeutic use is limited by a lack of aqueous solubility and bioavailability. Piperine from black pepper is known to synergistically enhance the bioavailability of curcumin. However, both curcumin and piperine are extracted by non-eco-friendly solvents and require further nano-encapsulation for their application *in vivo*. Exosome-like nanovesicles (ENVs) are natural extracellular vesicles produced by plants. ENVs purified from several edible plants contain host-plant derived phytochemicals in soluble form with enhanced bioavailability. Herein, a green method to co-purify both curcumin and piperine by combined homogenization of plant materials was developed followed by polyethylene glycol based precipitation of ENVs from the aqueous extract. ENVs isolated from a mixed homogenate of turmeric and pepper (TPENV) possessed both curcumin and piperine. TPENVs showed spontaneous intracellular entry and displayed anti-inflammatory activity by downregulating LPS-induced pro-inflammatory markers in murine macrophages. Intriguingly, this approach also endowed TPENVs with ~8 fold higher recovery of curcumin. Overall, the process developed here provides a simple, environmental-friendly and sustainable strategy for one-pot isolation of curcumin with piperine in the form of ENVs in soluble and bioavailable form.



Pepper dose-dependently increase in curcumin yield in TPENVs. A) Macroscopic images of turmeric and pepper. B) HPLC chromatograms TPENVs with different pepper amounts. C) Water soluble curcumin in ENVs.

Application of marine collagen on wound healing activity in animal model (*in vivo*) *(Mamatha SS)*

Acute full-thickness wounds necessitate a longer healing time, hence increasing the risk of infection. Severe infection frequently caused wound ulceration, necrosis, and even fatal consequences. Marine collagen (MC), which are environmentally safe, low-cost, and long-lasting, were used to make the MC with minimal immunogenicity and great biocompatibility. Collagen extract derived from marine and fresh water fish have been tested for acceleration of wound healing. In this study, to improve full-thickness wound healing, a hydrogel composed of marine collagen (MC derived from jelly fish) and sodium alginate (SA) was developed for topical application and also MC and water formulation are used for oral administration. Low, medium and high were the three different dosages followed for the study. Effect of collagen on wound healing in rat was observed on the alternative days. A significant wound area reduction was observed on high dosage treated rat by 6th day when compared to the control group. On the 10th day the wound had completely healed on high test dosage group on comparison with control group. From the observations it was found that the wound healing time was 5-7 days and by this time, most rats had smaller wound area which was almost closed. The study indicated that the hydrogel had potential applications in wound healing, which would increase the utilisation of marine fish resources in food processing.

Fast Track Translational / Fast Track Commercialization Projects

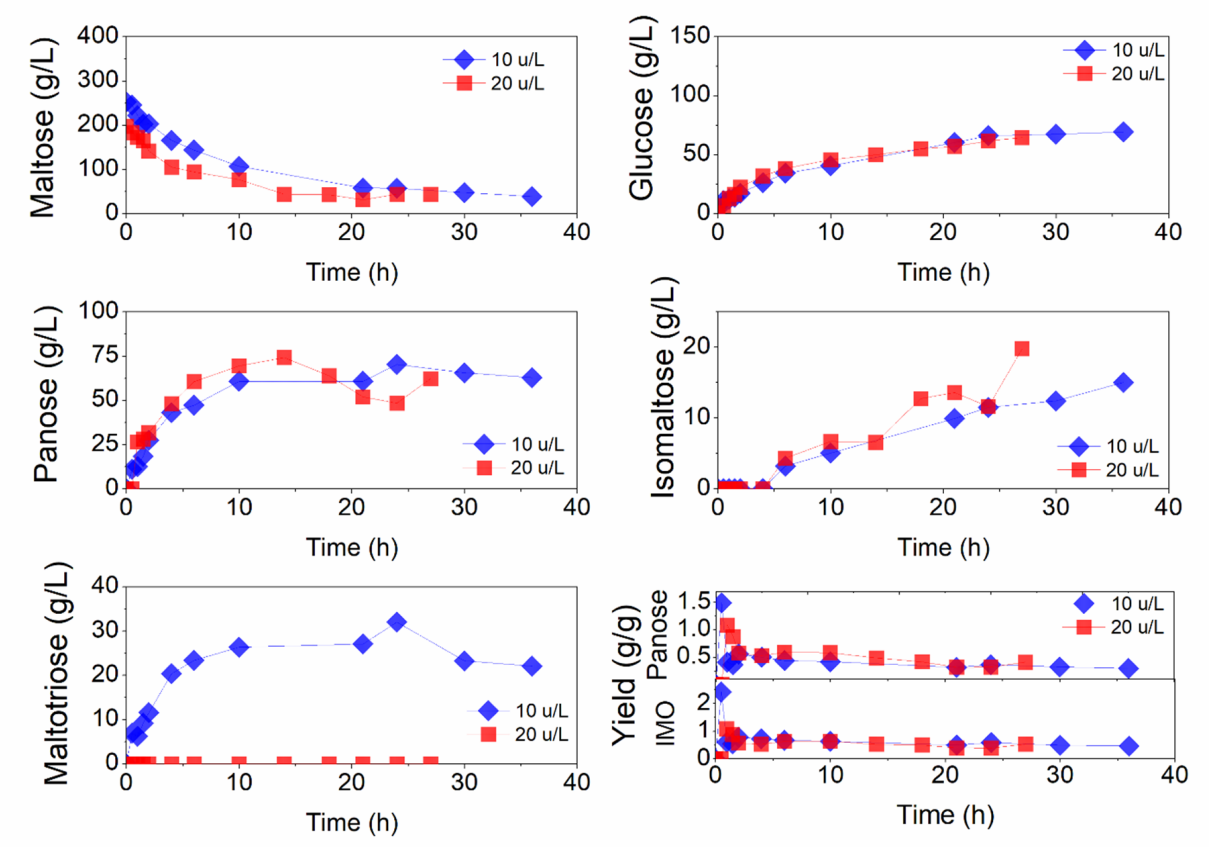
Rapid honey adulteration detection system *(Prasanna Vasu)*

Honey adulteration with sugar syrups is rampant and its detection is a challenging task. A multi-parameter-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. The system was designed to acquire data in trans-reflection mode for various honey samples and chemometrics based algorithms were implemented for qualitative analysis. The handy tool was 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 were sent for validation using EA- and LC-IRMS. A set of these samples (42 samples) were analysed by different chemical based tests. It was observed that 100% of the honey samples tested were confirming (passing) on the basis of acidity and diastase activity, 98% based on moisture and total ash, 95% based on HMF and electric conductivity, 93% based on total reducing sugars, and fructose glucose ratio, while 88% of honey samples were passing based on sucrose content. Based on EA- and LC-IRMS, 19% of the sample failed in C4 sugar adulteration, while 55% of the sample failed on rice syrup

adulteration. A clear correlation between physicochemical parameters and C3 and C4 sugar analysis is evident. A PCA correlation of this adulteration study was performed by CSIR-CEERI. The data indicated that there is a clear correlation between confirming and non-confirming honey samples analysed by IRMS and other physicochemical methods with that analyzed by the developed methods.

Value-added products using trans-glycosylating α-glucosidase *(Sarma MVRK)*

Experiments were conducted to assess the dosage of enzyme (transglycosylating α-glucosidase) during maltose conversion to isomalto-oligosaccharides (IMO). Two different dosages, viz., 10 and 20 U/L were used for this purpose. In 10 U/L dosage higher IMOs (maltotriose) were seen, which were not observed in 20 U/L. In an another experiment, the effect of RPM (mixing) on the IMO composition and yield were studied. It was observed that at higher RPM of 800, the maltose conversion was not effective and the IMO composition was affected significantly. At lowest RPM of 200, the isomaltose and panose production were highest. Both IMO and panose yields were observed highest at 200 RPM when compared to other higher RPMs.

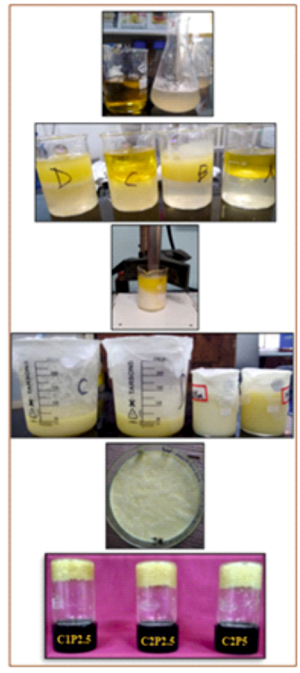


Effect of enzyme dosage in the IMO composition and yield

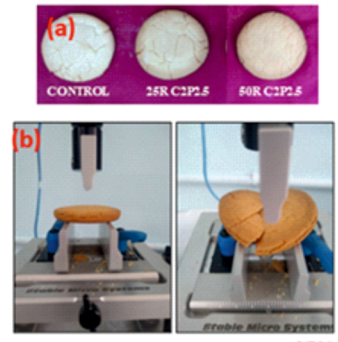
Functional oleogel based bakery products
(Prabhasankar P)

The project was undertaken to eliminate binge eating disorder by adding spice based lipophilic biomolecules in oleogel matrix. Further, the natural spice lipophilic biomolecule incorporated functional oleogel based bakery products could enhance the nutraceuticals potential and thus increase satiety and appetite control mechanisms. Preparation of PUFA and natural spice lipophilic biomolecule incorporated functional oleogel based spicy cookies / biscuits/ crackers and laminated (puff pastry, khari and croissant) bakery products are under progress.

Indirect method
(Emulsion approach - Cold Swell Starch)



Indirect method
(Emulsion template approach)



(a) Cookie with 100% shortening, 25% & 50% shortening replaced with oleogel (b) Texture images of cookies

Mission Projects

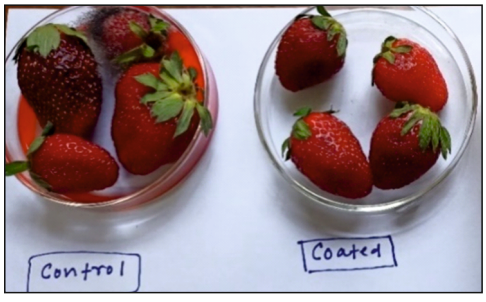
Advancing Technological Leads for Assuring Safety of Food (ATLAS)

Edible and biodegradable materials for electrostatic coating to fruits and vegetables for enhanced shelf-life *(Matche RS)*

Edible coating on fruits and vegetables retards the respiration rate significantly and aids in extending shelf-life of the produce.The study is a step towards reducing the food wastage of perishable food commodities with enhanced efficiency and effectiveness of edible coatings. The coating material to be applied over the food commodity must be edible such as shellac, antimicrobials, antioxidants, polysaccharides and protein-based coating materials. Electrostatic coating methods with uniform coating and lesser amount of coating material were used. The performance of the developed edible coating materials were evaluated with respect to existing commercial coating methods and materials such as carnauba wax, chitosan etc. Results indicated that controlled avocado (uncoated) and coated by dipping method at 27^{0}C after 4 days showed microbial growth, loss in weight and shrink on the surface. Electrostatic coated avocado showed the same sign after 10 days. Thus, the applicability of electrostatic coating enhanced the shelf-life of avocado by 6 days whereas in dip coating the non-uniformity and material wastage were more compared to electrostatic coating.

Commercially available coating materials

Developed Coating Materials



Polysaccharide based coating agents

Protein based coating agents

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

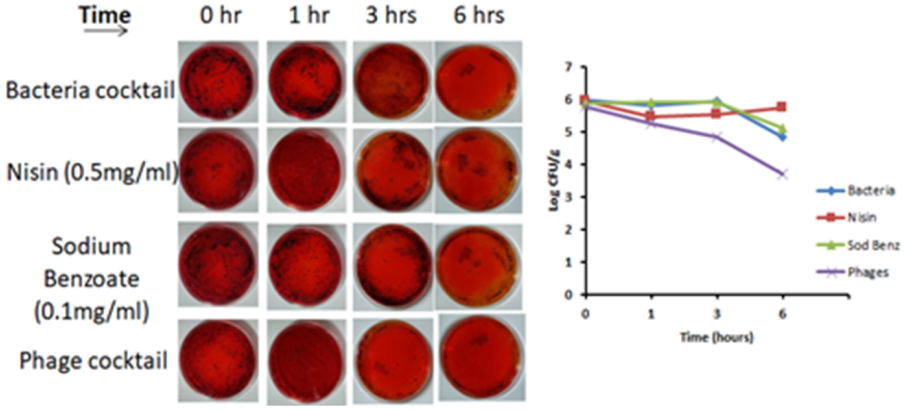
Phage preparations against non-typhoidal foodborne bacterial pathogen *Salmonella typhimurium* and *Enteritidis* was developed under this project and tested for its activity and efficacy on food samples at lab scale. It is unique blend of ten individual lytic phages that provide broad spectrum activity. The preparation was an odourless liquid with a pH of 7.0 -7.5 and does change the texture of the sample. The formulation was stable at varied temperature (4 – 70^{0}C), pH (3, 7 and 10). The preparation was tested *in vitro* and on meat samples at lab scale.

Biodegradable membrane and indigenous barrier film based intelligent packaging material *(Matche RS)*

A single or mono layer biodegradable packaging material with biodegradable coating that gives same oxygen as well as moisture barrier properties like conventional non-biodegradable polymers was developed. This packaging film will reduce the burden of recycling process as they are easily recyclable and economical. The film (membrane) has been tested for its barrier against moisture and oxygen. The water vapour transmission rates for the material were determined as 42.34 ± 3.71 g/(m^2/day) at 100% RH and 37.8°C and the oxygen transmission rates were higher than 10000 cc/(m^2/day) at 0% RH and 23°C. The material was found to be having high transmission rates and thus optimisation is needed to improve the barrier properties.

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

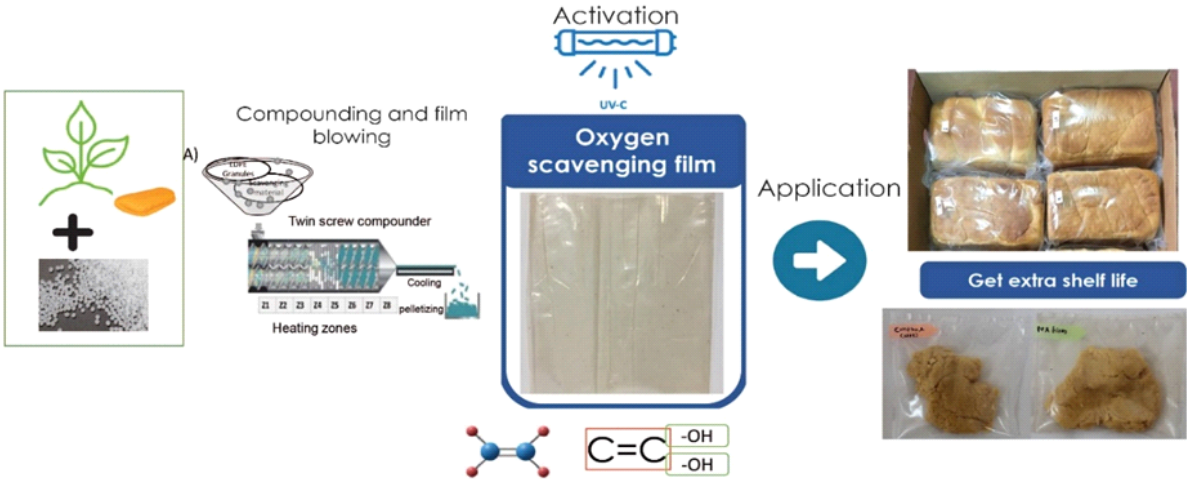
Most commercially available ethylene scavengers are based on potassium permanganate ($KMnO_4$) which have limitations due to food safety issues. In the study, an industrial by-product brick ash (BA) having a significant capacity to adsorb ethylene at room



Evaluation of the antibacterial activity of phage cocktail on meat sample (A) XLD spread plate showed reduction in *Salmonella* count (B) Graphical representation of reduction in *Salmonella* count in 6h after phage cocktail treatment X - axis – Time in hours, Y- axis – Log CFU/g

temperature was reported. The material was subjected to thermal treatment for activation and subsequently characterized by a Scanning Electron Microscope (SEM), particle size and surface analysis, Fourier Transform Infrared Spectroscopy (FTIR) studies, and elemental composition analysis. A significant change was observed in the surface morphology of BA obtained from SEM and BET analysis wherein the surface of BA became highly porous after being activated at 1000°C. This was accompanied by reduction in the average particle size of BA to less than 250 microns. The ethylene adsorption capacity was estimated using a 200-ppm commercial ethylene gas stream. It was observed that the ethylene adsorption capacity increased from 52.5±3.5 to 187.28±6.2 µl/g as the temperature of activation varied from 500°C to 1000°C, respectively. The adsorption of ethylene on the BA was confirmed by the observance of FTIR peaks at 1380 cm^{-1} and 1872 cm^{-1}. The practical applicability of the developed ethylene scavenger was evaluated through shelf-life studies on bananas, conducted at 22-24°C and 65% relative humidity (RH). Analysis of various quality parameters concluded that the treated sample showed an increase in shelf-life of 8 days compared to the control sample. The comparison was made with commercially available $KMnO_4$ based ethylene scavengers which showed similar scavenging capacity. Thus, BA can be effective and sustainable alternative ethylene scavenger to extend the shelf-life of ethylene sensitive fresh produce.

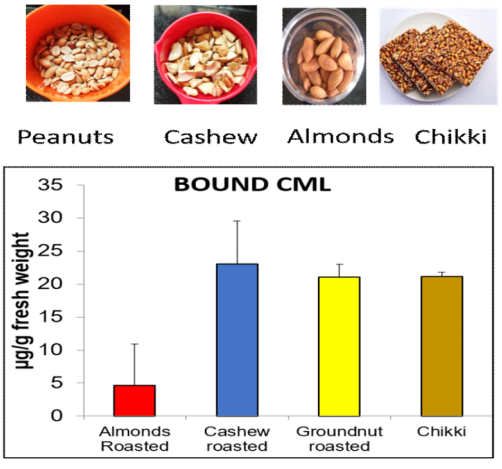
Oxygen scavenging film, an emerging active packaging, plays a vital role in maintaining the freshness and quality of food products. In this study, an extruded Low-Density Polyethylene (LDPE) film with 5% Natural Rubber (NR) was proposed as the oxygen scavenging film. Upon characterization of the film, it was determined that the morphological and barrier properties were maintained, with an added enhancement in the elongation attribute. Obtained film was standardized for activation scavenging kinetics by varying the UV dose (time and distance). The total scavenging capacity of the film at the optimal UV dose was 61 cc/g. FTIR spectra of activated film were monitored before and after



exposure to oxygen to understand the oxidation of the film. Observance of peak at 1718, 3425 cm^{-1} in IR spectrum confirmed oxygen scavenging functionality of the film. As bread and khoa are sensitive to oxygen, these were tested for application. Based on sensory analysis of bread samples (appearance/mold formation) and microbial load studies, the shelf-life of bread was found to be 2-3 days for control and 4-5 days for packed in NR based film stored at 27 ± 2°C. In case of khoa, a fatty food, an increase in shelf life by 3 days was observed as compared to control whilst maintaining sensory attributes and preserving nutritional value such as fatty acid. Overall, the developed functional film can be an effective solution for preventing the negative effects of oxygen exposure in food industries and thereby increasing the product shelf life.

Estimation of carboxymethyl lysine in Indian foods *(Nandini CD)*

Carboxymethyl lysine (CML), one of the Avanced Glycation Endproducts (AGEs) formed as a result of processing was determined in various traditional Indian food products by LC-MS/MS. Various cereal-based products, nuts and Indian sweets were tested for the presence of CML. Among various products tested, sweets had high amounts of CML, followed by nuts and cereal-based products.



CML in roasted nuts

Phytochemical volatiles as biofumigant on the bulk grain storages *(Ezil Vendan S)*

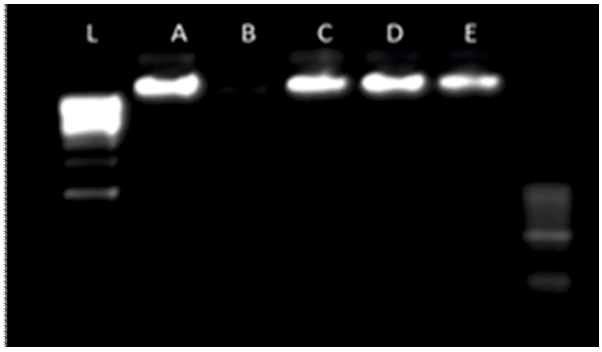
Edible essential oils based synergistic mixture as biofumigant formulation has been prepared for the control of stored product insect pests. Fumigant toxicity of the biofumigant formulation was evaluated against the pulse beetle and grain beetle pests with bulk grain storages. The biofumigation process has been optimized with bulk grain storages on the one tonne capacity of grain storage structure. A biofumigation system has been designed and built inside the grain storage structure for even distribution of phytochemical volatiles on the bulk grain storages during fumigation process. After 72 h of fumigation, absolute mortalities of pulse beetle and grain beetle pests were recorded on bulk quantity of green gram and wheat grain, respectively. In order to understand the diffusional characteristics of phytochemical volatiles on the bulk grain storage, fumigant residues were collected from the fumigated grains inside the upper, middle and lower layers and investigated the residues using Gas Chromatography coupled with Mass Spectrometry (GC-MS). Based on the GC-MS analysis, the menthol compound was detected as major residue (36.73 x 10^6 peak area)

followed by diallyl disulphide, diallyl trisulphide, menthone, isomenthyl acetate, isomenthone and menthene (7.84, 7.05, 5.25, 3.49, 2.10 and 0.08 x 10^6, respectively) residues. There was no remarkable variation on the phytochemical residue levels at three different layers. The study result indicates that the designed biofumigation system has enhanced the diffusion characteristics of phytochemical volatiles throughout the bulk grain storage.

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

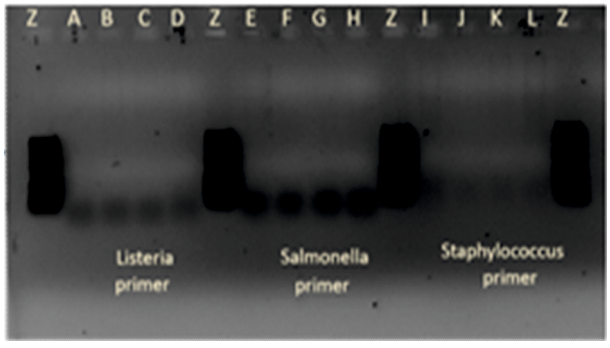
The DNA was isolated from raw meat (chicken, goat, beef, and pork meat) and meat products (chicken cutlet, chicken nuggets, chicken salami, chicken sausage, minced mutton, mutton cutlet, and mutton kabab) for the quantification and validation of primers. DNA primers for chicken, goat, beef, and pork were designed and validated as individual templates for species-specificity. The result revealed that the primers bind to the template correctly in all specified annealing temperatures, and beef and pork primers exhibited species-specificity. Further, the chicken and goat meat DNA primers, designed by CSIR-IITR (Lucknow) were validated for species specificity. CSIR-CFTRI has designed its microbial primers for meat pathogens and examined them for species specificity. Results found that *Listeria* and *Salmonella* primers were not species-specific, and *Staphylococcus aureus* primers were species-specific. IITR designed the fluorescence probes for the meat and microbial contaminants. Further, CSIR-CEERI and CSIR-IITR developed the FluoriPCR prototype and performed the preliminary validation. Optimization for multiplexed fluorescence is in progress by CSIR-IITR. The final FluoriPCR prototype is yet to be received by CSIR-CFTRI from CSIR-IITR and the final validation of the developed FluoriPCR for meatand microbial contaminants will be performed by CSIR-CFTRI.

Isolated DNA of bacterial contaminant of meat



L-ladder: A-*Listeria monocytogenes*; B-*Bacillus cereus;* C-*Staphylococcus aureus*; D-*Salmonella enterica*; E-*Escherichia coli*

Primer designed and specificity check



Listeria, Salmonella and *Staphylococcus* primers against other species. Z-ladder 50bp: A-*Bacillus*; B-*Staphylococcus*; C-*Salmonella*; D-*E. coli*; E-*Listeria*; F-*Staphylococcus*; G-*Bacil*lus; H-E. coli; I-Listeria; J-*Salmonella* and K-*E. coli*

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

Natural bioactive agents immobilized freshness keeper(s) *(Matche RS)*

Fresh-cut roses are vulnerable to postharvest losses due to their limited shelf life. The study aimed to develop a paper-based approach as part of anti-microbial packaging to extend the shelf life of fresh-cut roses. To achieve this, a synergistic solution was developed from a mixture of bay, fenugreek, and lemon extract in the ratio 1:1:1 with an additional 3% sucrose. It was found effective against *Pseudomonas fluorescens*, *Salmonella typhimurium*, and *Enterobacter cloacae*, which are the primary microorganism responsible for the spoilage of rose flowers. GC-MS analysis shows that the presence of eugenol, oleic acid, ascorbic acid, caryophyllene, α-bisabolene, methyl eugenol, α-curcumene, humulene, and allene compounds contributed to the anti-microbial and antioxidant properties of the active matrix. The developed active matrix was coated on a kraft paper called Freshness Keeper (FK). FK paper was subjected to various characterization techniques, such as SEM, FTIR, and GC-MS. The study revealed that the mechanical and barrier properties of the paper remained largely unchanged, except for the % elongation break and water absorptiveness. These changes were observed following the paper's coating with the matrix. The results suggest that the coating has the potential to affect the physical properties of the paper. To assess its effectiveness on the vase life and physiochemical characteristics of *Rosa hybrida* L. cut flowers were tested. The control flowers (without FK) displayed signs of wilting, color change, and bacterial growth after 10-12 days of storage at 2-4 with 85% relative humidity. In contrast, the FK-wrapped flowers showed similar signs after 18-20 days of storage, effectively enhancing shelf life by an additional 8-10 days. Furthermore, the FK maintained the freshness and diameter of the cut rose bunches, while simultaneously maintaining the petal moisture content, petal color, and sensory attributes and controlling ethylene production. These results suggest that extending the shelf life of fresh-cut roses can reduce postharvest losses and add value to the flower industries, both domestically and in export markets.

Freshness keeper paper | Freshness keeper with rose flower bunch | Anti-microbail environment | Fresh cut rose flower

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

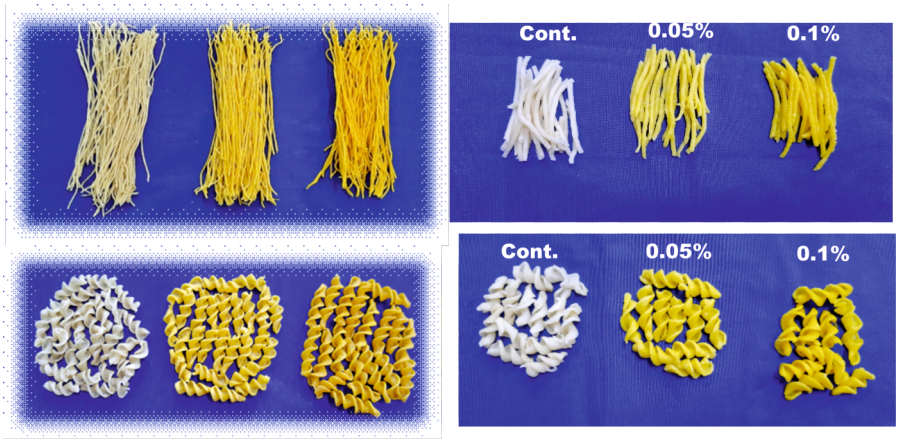
Bright orangish marigold (*Tagetes erecta*) flowers were used to collect the pigments by hexane extraction. Pasta and noodles were prepared with two levels of marigold pigments (0.05% and0.1%) and studied cooking loss and texture profile compared to control samples. The retention of color and the shelf stability of products was also studied. The cooking loss study indicated that the incorporation of marigold oleoresin decreased the cooking loss of pasta from 2.90% (control) to 2.70% (0.1% oleoresin). However, the cooking loss in noodles increased from 2.71 to 3.26%. The hardness and chewiness characteristics of the noodle didn't differ significantly with the incorporation of oleoresin. It has been demonstrated using spectrophotometric analysis and HPLC that there was neither a quantitative nor a qualitative carotenoid loss during processing and observed more than 80% retention of carotenoids in both pasta and noodles.

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

The conditions to achieve efficient extraction of anthocyanin from hibiscus flowers was successfully optimized (citrate-phosphate buffer at pH 4.8 with 1:20 dilution ratio). To increase the shelf-life and as well as to reduce the storage and transportation costs, the anthocyanin extract was concentrated using forward osmosis. The hibiscus anthocyanin was concentrated by ~10 folds (total soluble solids was increased from 3.2°Brix to 32°Brix). The concentrate was found to be stable for ~40 days at refrigerated condition.The stability of FO concentrated anthocyanin was achieved by microencapsulation. The encapsulated powder was used as a natural color additive in case of curd, milk and ice-cream, which showed higher stability of the colour.

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

A botanical spray formulation to arrest the activity of storage pests was tested at lab level and also at storage houses. Based on the



Raw and cooked noodles and Pasta with marigold pigments (control, 0.05% & 0.1%)

response further scale up of the testing area was taken up. The formulated botanical insecticide has been evaluated as prophylactic spray for the prevention of *C. maculatus* and *S. oryzae* infestations on stored food commodities. Within 3 h of exposure, 100% significant knockdown effect was observed against *C. maculatus* at 9.43 µl/cm^2 concentration of botanical formulation compared to deltamethrin positive control. Stability of the botanical formulation has been observed upto 3 months of storage at room temperature. GC-MS analysis results revealed that the bioactive molecules were stable during the storage period.

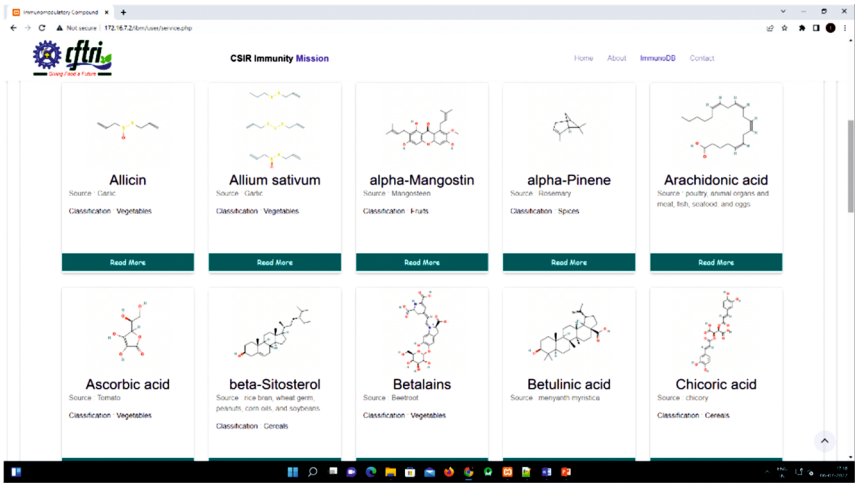
Immuno Modulatory Function of Nutritionals and Nutraceuticals for Health and Wellness (IMMUNITY Mission)

Spice-enriched nutraceutical supplement for immunomodulation *(Borse BB)*

The immunomodulatory properties of spices were used to formulate, evaluate and integrate so as to develop beverage spice mixes, confection, RTE tabs and hydrogels. Further, the immunomodulatory properties of spices were evaluated by collaborating with CSIR-CDRI and multiple use spices mixes (tea bags), spice balls/ cookies, RTE tabs (coffee/tea) and hydrogels having bioactive constituents were developed. The findings indicate that the servings of the products would meet the RDA and positively impact the immune boosting function.

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

Digital portal was developed with comprehensive information of evidence based immunomodulatory nutraceuticals from plant and spice/food origin. It is helpful for industries related to food processing, health and dietary supplements, nutritional and nutraceuticals, pharma companies and start-ups working for innovative products based on natural resources.



Digital portal of nutraceutical compounds

Identification of potential locations across India for Seaweed cultivation and their valorization

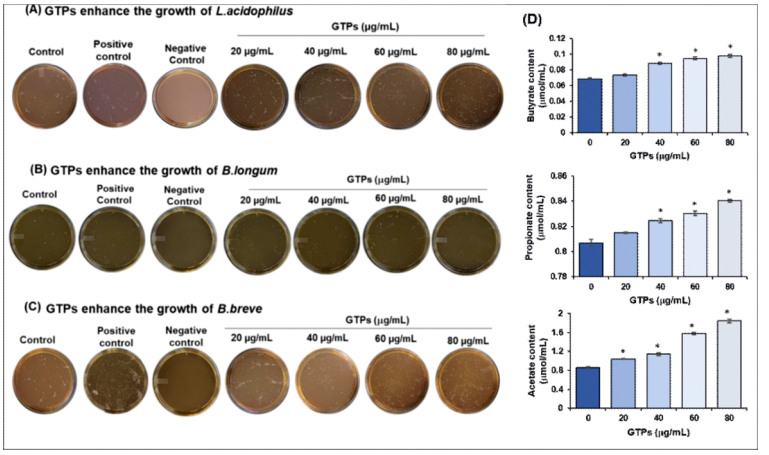
Cultivation and efficient utilisation of edible seaweeds for value addition, functional food *(Chauhan VS)*

The *Gracilaria debilis* (GD) showed a rich profile of important minerals like Ca, Fe and Zn and phenolics. The fermented biomass showed a markedly improved *in vitro* digestibility of about 80-82%. Noodles were prepared incorporating the GD biomass. The cooking loss increased from 5.84% to 7.75% as the level of GD powder increased from 0-15%. Water absorption capacity and cooking yield decreased with increasing amount of GD powder. GD incorporated noodle was evaluated for its quality attributes and acceptance. Buns were prepared incorporating the GD biomass. As the level of incorporation of GD powder increases, the bun volume decreases and weight increases. Based on the sensory quality, incorporation of GD up to 10% level is found to be optimal for both the noodle and bun.

CSIR First Projects

Investigating the homeostasis of the gut microbiome and its impact on the epigenetic regulation of breast cancer *(Syed Musthapa M)*

The gut microbiome plays a significant role in host physiology, metabolism, and immunomodulation, which greatly influences cancer initiation and progression. Recent studies have demonstrated that energy metabolites produced by the gut microbiome have epigenetic modulatory activities, wherein a high probiotic population has a positive impact, whereas metabolites produced during dysbiotic condition causes dysregulations in the epigenetic machinery. Epigenetic dysregulations are proven to play a major role in cancer progression and metastasis. Hence, maintaining gut homeostasis and epigenetic machinery is crucial for prevention of breast carcinogenesis. Dietary green tea polyphenols (GTPs) are a mixture of polyphenols known to possess several functions, including epigenetic modulatory and prebiotic activities. In the study,



Dietary GTPs enhance the growth of probiotic microbes and increase the production of epigenetic modulatory short-chain fatty acids (SCFAs)

it was found that GTPs enhance the growth of probiotic microbes, such as *L. acidophilus*, *B. longum,* and *B. breve,* in a dose-dependent manner. Interestingly, it was also found that GTPs treated *L. acidophilus* enhanced the production of short-chain fatty acids (SCFAs), such as acetate, propionate, and butyrate. These SCFAs are known to have a vital role in the modulations of the epigenetic machinery involved in cancer progression. Overall, the study reveals the prebiotic effect of GTPs, which enhances the beneficial gut microbe populations, whose metabolites could prove to be effective epigenetic modulators. Further, GTPs implicate the effect on gut homeostasis and modulate the epigenetic machinery, thereby preventing breast tumor progression.

Status of phosphine resistance in stored-product insect pests from Southern States of India *(Ezil Vendan S)*

Phosphine gas has been used as potential fumigant for the management of stored product insect pests, worldwide. In India, phosphine fumigant is used as conventional insecticide for the control of stored product insect pests at warehouses, godowns and other bulk grain storage depots. Due to the repeated use of phosphine fumigant, some of the stored product insect pests have developed resistance against phosphine. In order to understand the status of phosphine resistance in insect pests, economically important four different stored product insect pests (viz., *Sitophilus oryzae*, *Tribolium castaneum, Oryzaephilus surinamensis* and *Rhyzopertha dominica* adults) were collected from the different regions of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. The collected insect samples were maintained at the laboratory and the first generations were used for insect bioassays. Phosphine resistance was determined on the insect strains based on the FAO methods. Insect bioassays results revealed that 9 populations (KLAMSO03, APKLSO27, TNCETC08, KAKRTC24, KAMUTC32, KANUTC36, KAKROS21, KANUOS33 and APKARD42) were found as strong resistance and 2 populations (APKLTC28 and APKARD42) were found as weak resistance at 0.25 and 0.04 mg/L of phosphine dosage, respectively. About 33.75, 11.36, 5.88, 2.57 and 1.29 RF values were recorded for KLAMSO03, KANUTC36, TNCETC08, APKLSO27 and KAMUTC32 populations as more strong resistance against phosphine, respectively.

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31.03.2023

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