Performance Report
2016-17

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CSIR - CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE, MYSURU

CSIR-CFTRI
PERFORMANCE REPORT

2016-17

CSIR-Central Food Technological Research Institute
(A constituent laboratory of Council of Scientific & Industrial Research)
Mysuru - 570 020, India

Published by :

Director
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India

Compilation, Editing & Production :

Team CSIR-CFTRI

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From Director's Desk . . . . .

I am extremely delighted to present the Performance Report of the Institute for 2016-17.

The year 2016-17 was very fruitful to us, as the Institute has been able to consolidate XII plan projects with focused delivery. A variety of products under AGROPATHY and WELFO have been developed for the benefit of farmers and health-conscious consumers. Further leads from these projects were taken forward as translational projects in the fast track mode. The commercial processes for arabinoxylan, carbonated fruit beverages and non-thermal processing are progressing well as per the schedule.

CFTRI has been patronising the MSME sector aggressively and large number of technologies were transferred to Industry during this period. The manpower requirements in the food sector are met at different levels with various flagship programs of the Institute. These include the short-term training programs for entrepreneurs, working professionals and farmers.

In the societal front, the momentum was maintained and various socially-relevant initiatives such as S&T interventions in Anganwadis, assessment of Mid-day Meal Schemes are notable among them. Both the programs were intended to ensure nutritious and hygienically prepared balanced food to younger population of the nation.

Earnest attempts were made to align the major programs with National Government's programs such as Make in India, Skill India, Swasth Bharath and Doubling Farmer's Income.

Overall it was a good year of progress. However, the larger challenge is always our inspiration to serve the people better with multitude of knowledge skills existing with our workforce.

I wish to acknowledge the support provided by Director General, CSIR; Research Council, Management Council and other government agencies to us in order to have a vibrant ecosystem in pursuing our goals. I wish to thank the entire CFTRI staff for working hard in realising a reasonable growth in terms of public, private, social and strategic goods.

I look forward to the support of all the stakeholders for guidance and suggestions in taking forward our prime agenda of ensuring enhanced food and nutrition security for the whole population.

Sd/-

Shri Jitendra J Jadhav
Director, CSIR-CFTRI

Date: December 12, 2017
Place: Mysuru

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Achievements
in Brief

1. Research Papers Published

SCI Papers

1 Akshath U.S., Praveena B. Mudliar, Gold nanoparticle synthesis coupled to fluorescence turn-on for sensitive detection of formaldehyde using formaldehyde dehydrogenase, *RSC Adv.*, 2016, **6**, 54777-54784

2 Akshath U.S., Praveena B. Mudliar, Tunnelling of redox enzymes to design nano-probes for monitoring NAD^+ dependent bio-catalytic activity, *Biosensors and Bioelectronics*, 2016, **85**, 240-246

3 Amrutha Kala A.L., Nanishankar V. Harohally, O-hydroxy Schiff bases derived from 2-hydroxy-4-methoxy benzaldehyde: Synthesis, X-ray studies and hydrogen bonding attributes, *Mol. Cryst. Liq. Cryst.*, 2016, **629**, 146-157

4 Amrutha Kala A.L., Sabeena K., Priya Pramod H., Determination of triacyl glycerol and sterol components of fat to authenticate ghee based sweets, *J. Food Sci. Technol.*, 2016, **53(4)**, 2144-2147

5 Anand Prakash, Prabhudev S.H., Vijayalakshmi M.R., Maya Prakash, Revathy Baskaran, Implication of processing and differential blending on quality characteristics in nutritionally enriched ketchup (Nutri-Ketchup) from acerola and tomato, *J. Food Sci. Technol.*, 2016, **53(8)**, 3175-3185

6 Anindya Basu, Sarma Mutturi, Prapulla S.G., Production of isomaltooligosaccharides (IMO) using simultaneous saccharification and transglucosylation from starch and sustainable sources, *Process Biochem.*, 2016, **51**, 1464-1471

7 Anudeep S., Vaddi K. Prasanna, Shruthi M. Adya, Radha C., Characterization of soluble dietary fiber from *Moringa oleifera* seeds and its immunomodulatory effects, *Int. J. Biol. Macromol.*, 2016, **91**, 656-662

8 Arunkumar R., Ravi H., Baskaran V., Biocompatible lutein-polymer-lipid nanocapsules: Acute and subacute toxicity and bioavailability in mice, *Mat. Sci. Eng.: C*, 2016, **69**, 1318-1327

9 Balaswamy K., Prabhakara Rao P.G., Narsing Rao G., Satyanarayana A., Physico-chemical and antioxidant properties of foam mat dried muskmelon (*Cucumis melo*) and application in dairy products, *J. Sci. Ind. Res.*, 2016, **75(4)**, 225-230

10 Bhargava K. Mallandur, Gururaja R., Nanishankar V. Harohally, Synthesis, characterization and antimicrobial activity of Schiff bases derived from 2- hydroxyquinoline-3-carbaldehydes, *Indian J. Heterocy. Chem.*, 2016, **26(1&2)**, 75-80

11 Bhaskaragoud G., Rajath S., Mahendra V.P., Sunil Kumar G., Gopala Krishna A.G., Suresh Kumar G., Hypolipidemic mechanism of oryzanol components - ferulic acid and phytosterols, *Biochem. Biophys. Res. Commun.*, 2016, **476(2)**, 82-89

12 Breetha R., Sadashivaiah B., Ramaprasad T.R., Dietary omega-3 but not omega-6 fatty acids down-regulate maternal dyslipidemia induced oxidative stress: A three generation study in rats, *Biochem. Biophys. Res. Commun.*, 2016, **477(4)**, 887-894

13 Chandralekha A., Hrishikesh Tavanandi A., Amrutha N., Umesh Hebbar H., Raghavarao K.S.M.S., Ramachandra Gadre, Encapsulation of yeast (*Saccharomyces cereviciae*) by spray drying for extension of shelf-life, *Drying Technol.*, 2016, **34(11)**, 1307-1318

14 Chanukya B.S., Maya Prakash, Rastogi N.K., Extraction of citric acid from fruit juices using supported liquid membrane, *J. Food Process. Preservation*, 2017, **41(1)**, 1-10

15 Chanukya B.S., Rastogi N.K., Ultrasound assisted forward osmosis concentration of fruit juice and natural colorant, *Ultrason. Sonochem.*, 2017, **34**, 426-435

16 Daris P. Simon, Anila N., Gayathri K., Sarada R., Heterologous expression of β-carotene hydroxylase in *Dunaliella salina* by agrobacterium-mediated genetic transformation, *Algal Res.*, 2016, **18**, 257-265

17 Darshan N., Manonmani H.K., Prodigiosin inhibits motility and activates bacterial cell death revealing molecular biomarkers of programmed cell death, *AMB Express*, 2016, **6**, 1-12

18 Deepa C., Umesh Hebbar H., Influence of micronization on physicochemical properties of maize grains, *Starch-Starke*, 2017, **69(3-4)**, 1-9

19 Devaraju S.K., Prachi Thatte, Jamuna Prakash, Jyothi Lakshmi A., Bioaccessible iron and zinc in native and fortified enzyme hydrolyzed casein and soya protein matrices, *Food Biotechnol.*, 2016, **30(4)**, 233-248

20 Dhanashree, Sharika Rajashekharan, Balamurugan Krishnaswamy, Rajagopal K., Bifid shape is intrinsic to *Bidobacterium adolescentis*, *Frontiers Microbiol.*, 2017, **8**, 478

21 Ezhilarasi P.N., Muthukumar S.P., Anandharamakrishnan C., Solid lipid nanoparticle enhances bioavailability of hydroxycitric acid compared to a microparticle delivery system, *RSC Adv.*, 2016, **6(59)**, 53784-53793

22 Gaurav Kumar Pal, Nidheesh T., Govindaraju K., Jyoti, Suresh P.V., Enzymatic extraction and characterisation of a thermostable collagen from swim bladder of rohu (*Labeo rohita*), *J. Sci. Food Agric.*, 2017, **97**, 1451-1458

23 Gaurav Kumar Pal, Suresh P.V., Comparative assessment of physicochemical characteristics and fibril formation capacity of thermostable carp scales collagen, *Materials Sci. Eng.* C, 2017, **70**, 32-40

24 Gaurav Singh Kaira, Deepesh Panwar, Mukesh Kapoor, Recombinant endo-mannanase (ManB-1601) production using agro-industrial residues: Development of economical medium and application in oil extraction from copra, *Bioresource Technol.*, 2016, **209**, 220-227

25 Girish T.K., Prasada Rao U.J.S., Protein glycation and aggregation inhibitory potency of biomolecules from black gram milled by-product, *J. Sci. Food Agric.*, 2016, **96(5)**, 4973-4983

26 Gopirajah R., Raichurkar K.P., Wadhwa R., Anandharamakrishnan C., The glycemic response to fibre rich foods and their relationship with gastric emptying and motor functions: An MRI study, *Food & Function*, 2016, **7(9)**, 3964-3972

27 Govardhan Singh R.S., Uma V. Manjappara, Selective reduction of fat accumulation by soyasaponins A and B in high fat fed C57BL/6J mice, *J. Functional Foods*, 2016, **27**, 95-103

28 Harish Prashanth K.V., Revathy Baskaran, Dhanyasri E.B., Rajashekaramurthy, Bioactive chitosan based coatings: Functional applications in shelf-life extension of Alphonso mango – a sweet story, *Pure Appl. Chem.*, 2016, **88(9)**, 853-863

29 Hithamani G., Srinivasan K., Bioaccessibility of polyphenols from selected cereal grains and legumes as influenced by food acidulants, *J. Sci. Food Agric.*, 2017, **97(2)**, 621-628

30 James Bound D., Pushpa S. Murthy, Srinivas P., 2,3-Dideoxyglucosides of selected terpene phenols and alcohols as potent antifungal compounds, *Food Chem.*, 2016, **210**, 371-380

31 Jeevitha C.G., Sowbhagya H.B., Umesh Hebbar H., Application of microwaves for microbial load reduction in black pepper (*Piper nigrum* L.), *J. Sci. Food Agric.*, 2016, **96(12)**, 4243-4249

32 Jilai Li, Shaodong Zhou, Jun Zhang, Maria Schlangen, Thomas Weiske, Usharani Dandamudi, Sason Shaik, Helmut Schwarz, Electronic origins of the variable efficiency of room-temperature methane activation by homo- and heteronuclear cluster oxide cations $[XYO_2]^+$ (X, Y = Al, Si, Mg): Competition between proton-coupled electron transfer and hydrogen-atom transfer, *J. Am. Chem. Soc.*, 2016, **138(25)**, 7973-7981

33 Jilai Li, Shaodong Zhou, Jun Zhang, Maria Schlangen, Usharani Dandamudi, Sason Shaik, Helmut Schwarz, Mechanistic variants in gas-phase metal-oxide mediated activation of methane at ambient conditions, *J. Am. Chem. Soc.*, 2016, **138(35)**,11368-11377

34 Jyotsna Rajiv, Soumya C., Swati S., Prabhasankar P., Rheology, texture, quality characteristics and immunochemical validation of millet based gluten free muffins, *J. Food Measurement and Characterization*, 2016, **10(4)**, 762-772

35 Kamlesh Kumar Yadav, Neelima Singh, Praveen Kumar Rajvanshi, Ram Rajasekharan, The RNA polymerase I subunit Rpa12p interacts with the stress-responsive transcription factor Msn4p to regulate lipid metabolism in budding yeast, *FEBS Lett.*, 2016, **590(20)**, 3559-3573

36 Karima Laleg, Denis Cassan, Cecile Barron, Prabhasankar P., Valerie Micard, Structural, culinary, nutritional and anti-nutritional properties of high protein, gluten free, 100% legume pasta, *PLoS One*, 2016, **11(9)**, e0160721

37 Karthik P., Anandharamakrishnan C., Enhancing omega-3 fatty acids nanoemulsion stability and *in-vitro* digestibility through emulsifiers, *J. Food Eng.*, 2016, **187**, 92-105

38 Kavitha M.D., Seema Shree M.H., Vidyashankar S., Sarada R., Acute and subchronic safety assessment of *Porphyridium purpureum* biomass in the rat model, *J. Appl. Phycol.*, 2016, **28(2)**, 1071-1083

39 Kavitha M.D., Shanmugam Kathiresan, Sila Bhattacharya, Sarada R., Culture media optimization of *Porphyridium purpureum*: Production potential of biomass, total lipids, arachidonic and eicosapentaenoic acid, *J. Food Sci. Technol.*, 2016, **53(5)**, 2270-2278

40 Lakshmikanth C.L., Jacob S.P., Kudva A.K., Latchoumycandane C., Yashaswini P.S., Sumanth M.S., Goncalves-de-Albuquerque C.F., Silva A.R., Sridevi A. Singh, Castro-Faria-Neto H.C., Prabhu S.K., McIntyre T.M., Marathe G.K., *Escherichia coli* braun lipoprotein (BLP) exhibits endotoxemia-like pathology in Swiss albino mice, *Scientific Rep.*, 2016, **6**, 34666

41 Mahendranath G., Shaik A.B., Salimath P.V., Prasada Rao U.J.S., Supplementation of mango *(Mangifera indica* L.) peel in diet ameliorates cataract in streptozotocin-induced diabetic rats, *J. Food Biochem.*, 2017, **41(1)**, e12300

42 Manivannan S., Gisha E.K., Swati A.P., Response of phosphine-resistant mixed-age cultures of lesser grain borer, *Rhyzopertha dominica* (F.) to different phosphine-carbon dioxide mixtures, *J. Stored Products Res.*, 2016, **69**, 175-178

43 Manivannan S., Swati A.P., Hemalatha P., Gisha E.K., Roopa R.S., Phosphine gas generated from an aluminium phosphide tablet exhibits early knock down effects on tamarind pod borer, *RSC Adv.*, 2016, **6**, 90024-90030

44 Manjulatha Devi S., Aishwarya S., Prakash M. Halami, Discrimination and divergence among *Lactobacillus plantarum*-group (LPG) isolates with reference to their probiotic functionalities from vegetable origin, *Syst. Appl. Microbiol.*, 2016, **39(8)**, 562-570

45 Nagaraj S., Uma V. Manjappara, Studies on the influence of CCK-8 on the ability of obestatin to reduce food intake, gain in body weight and related lipid parameters, *Biochimie*, 2016, **125**, 126-130

46 Nagaraju R., Rajini P.S., Adaptive response of rat pancreatic β-cells to insulin resistance induced by monocrotophos: Biochemical evidence, *Pesticide Biochem. Physiol.*, 2016, **134**, 39-48

47 Nagaraju V.D., Ramalakshmi K., Sridhar B.S., Cryo assisted spouted bed roasting of coffee beans, *Innovative Food Sci. Emerging Technol.*, 2016, **37**, 138-144

48 Nayana Venugopal Y., Sadashivaiah B., Breetha R., Pooja Acharya, Lokesh B., Ramaprasad T.R., Sesame oil and rice bran oil ameliorates adjuvant-induced arthritis in rats: Distinguishing the role of minor components and fatty acids, *Lipids*, 2016, **51(12)**, 1385-1395

49 Neha Vithani, Sahil Batra, Balaji Prakash, Nisanth N. Nair, Elucidating the GTP hydrolysis mechanism in FeoB: A hydrophobic amino-acid substituted GTPase, *ACS Catalysis*, 2017, **7(1)**, 902-906

50 Nidhina N., Bhavya M.L., Bhaskar N., Muthukumar S.P., Pushpa S. Murthy, Aflatoxin production by Aspergillus flavus in rumen liquor and its implications, *Food control,* 2017, **71**, 26-31

51 Padmaja R.J., Prakash M. Halami, Taming C-terminal peptides of *Staphylococcus aureus* leukotoxin M for B-cell response: Implication in improved subclinical bovine mastitis diagnosis and protective efficacy *in vitro*, *Toxicon,* 2016, **119**, 99-105

52 Parthasarathi S., Anandharamakrishnan C., Enhancement of oral bioavailability of vitamin E by spray-freeze drying of whey protein microcapsules, *Food Bioprod. Process.*, 2016, **100**, 469-476

53 Parthasarathi S., Muthukumar S.P., Anandharamakrishnan C., The influence of droplet size on the stability, *in vivo* digestion and oral bioavailability of vitamin E emulsions, *Food & Function*, 2016, **7(5)**, 2294-2302

54 Pavithra K., Chauhan A.S., Shashirekha M.N., *Opuntia dillenii* (Ker-Gawl) haw cladode mucilage: Physico-chemical, rheological and functional behavior, *Carbohydrate Polymers*, 2017, **157**, 1057-1064

55 Pradeep Kumar Yadav, Ram Rajasekharan, Misregulation of a DDHD domain-containing lipase causes mitochondrial dysfunction in yeast, *J. Biol. Chem.*, 2016, **291(35)**, 18562-18581

56 Pradeep Matam, Giridhar P., Putrescine and polyamine inhibitors in culture medium alter *in vitro* rooting response of *Decalepis hamiltonii* Wight & Arn., *Plant Cell Tissue and Organ Culture*, 2017, **128(2)**, 273-282

57 Praneeth Juvvi, Chakkaravarthi A., Sukumar Debnath, Emerging technique for healthier frying for production of reduced-fat beetroot (*Beta vulgaris*) chips, *J. Food Sci. Technol.*, 2016, **53(9)**, 3502-3511

58 Pravin Vasantrao Gadkari, Shashidhar M.G., Manohar B., Delivery of green tea catechins through oil-in-water (O/W) nanoemulsion and assessment of storage stability, *J. Food Eng.*, 2017, **199**, 65-76

59 Preetham Kumar K.V., Usha Dharmaraj, Suresh D. Sakhare, Aashitosh A. Inamdar, Flour functionality and nutritional characteristics of different roller milled streams of foxtail millet (*Setaria italica*), *LWT - Food Sci. Technol.*, 2016, **73**, 274-279

60 Preetham Kumar K.V., Usha Dharmaraj, Suresh D. Sakhare, Aashitosh A. Inamdar, Preparation of protein and mineral rich fraction from grain amaranth and evaluation of its functional characteristics, *J. Cereal Sci.*, 2016, **69**, 358-362

61 Preetham Kumar K.V., Usha Dharmaraj, Suresh D. Sakhare, Aashitosh A. Inamdar, Effect of grain moisture content during milling on pasting profile and functional properties of amaranth fractions, *J. Food Sci. Technol.*, 2016, **53(5)**, 2434-3442

62 Rajesh M., Harish Prashanth K.V., Preparation and characterization of chitosan-poly-ε-caprolactone based nanocomposite blend films, *J. Polym. Materials*, 2017, **34(1)**, 235-248

63 Raksha Rao K., Vipin A.V., Hariprasad P., Anu Appaiah K.A., Venkateswaran G., Biological detoxification of aflatoxin B_1 by *Bacillus licheniformis* CFR1, *Food Control*, 2017, **71**, 234-241

64 Ramya V., Ram Rajasekharan, ATG15 encodes a phospholipase and is transcriptionally regulated by YAP1 in *Saccharomyces cerevisiae*, *FEBS Lett.*, 2016, **590(18)**, 3155-3167

65 Ravi H., Baskaran V., Chitosan-glycolipid nanocarriers improve the bioavailability of fucoxanthin via up-regulation of PPARγ and SRB1 and antioxidant activity in rat model., *J. Functional Foods*, 2017, **28**, 215-226

66 Roopesh Sreedhar, Purnima Kaul Tiku, Cupincin: A unique protease purified from rice (*Oryza sativa* L.) bran is a new member of the cupin superfamily, *PLoS One*, 2016, **11(4)**, e0152819

67 Sabeeta Kapoor, Shylaja M. Dharmesh, Pectic oligosaccharide from tomato exhibiting anticancer potential on a gastric cancer cell line: Structure-function relationship, *Carbohydrate Polymers*, 2017, **160**, 52-61

68 Sachin R. Adsare, Ashwini N. Bellary, Sowbhagya H.B., Revathy Baskaran, Maya Prakash, Navin K. Rastogi, Osmotic treatment for the impregnation of anthocyanin in candies from Indian gooseberry (*Emblica officinalis*), *J. Food Eng.*, 2016, **175**, 24-32

69 Sandhya R. Shewale, Umesh Hebbar H., Effect of infrared pre-treatment on low humidity air drying of apple slices, *Drying Technol.*, 2017, **35(4)**, 490-499

70 Sandopu Sravan Kumar, Manoj P., Giridhar P., Micropropagation for mass multiplication and enriched production of ascorbic acid in tissue culture foliage of roselle (*Hibiscus sabdariffa* L.), *In Vitro Cellular Dev. Biol. - Plant*, 2016, **52(4)**, 427-436

71 Sandopu Sravan Kumar, Manoj P., Nimisha G., Giridhar P., Phytoconstituents and stability of betalains in fruit extracts of Malabar spinach (*Basella rubra* L.), *J. Food Sci. Technol.*, 2016, **53(11)**, 4014-4022

72 Sarat Chandra T., Deepak R.S., Maneesh Kumar M., Mukherji S., Chauhan V.S., Sarada R., Mudliar S.N., Evaluation of indigenous freshwater microalga *Scenedesmus obtusus* for feed and fuel applications: Effect of carbon dioxide, light and nutrient sources on growth and biochemical characteristics, *Bioresource Technol.*, 2016, **207**, 430-439

73 Sathisha U.V., Mallikarjuna S.E., Harish Nayaka M.A., Shylaja M Dharmesh, Antimetastatic pectic polysaccharide from *Decalepis hamiltonii*, galectin-3 inhibition and immune-modulation, *Clinical Exp. Metastasis*, 2017, **34(2)**, 141-154

74 Sharanappa T., Chetana R., Suresh Kumar G., Evaluation of genotypic wheat bran varieties for nutraceutical compounds, *J. Food Sci. Technol.*, 2016, **53(12)**, 4316-4324

75 Shashidhar M.G., Manohar B., Acidified hot water extraction of adenosine, cordycepin and polysaccharides from *Ophiocordyceps sinensis* CS1197 (Ascomycetes): Application of artificial neural network, evaluation of antioxidant and antibacterial activities, *Int. J. Med. Mushrooms*, 2016, **18(10)**, 915-926

76 Shashidhar M.G., Pravin G.V., Manohar B., Nano-engineering of liposomes using a supercritical CO_2 mediated gas anti-solvent method, *RSC Adv.*, 2016, **6**, 57739-57750

77 Sheema Faiza, Nasirullah, Sukumar Debnath, Molecular finger printing of nutracoconut oil with improved health protective phytoceuticals and its efficacy as frying medium, *J. Am. Oil Chem. Soc.*, 2016, **93(9)**, 1301-1310

78 Shirish D. Mane, Maikho Thoh, Deepak S., Santosh K.S., Akhilender Naidu K., Ascorbyl stearate promotes apoptosis through intrinsic mitochondrial pathway in HeLa cancer cells, *Anticancer Res.,* 2016, **36(12)**, 6409-6417

79 Shobharani P., Prakash M. Halami, *In vitro* evaluation of the cholesterol-reducing ability of a potential probiotic *Bacillus* spp., *Annals Microbiol.*, 2016, **66(2)**, 643-651

80 Shwetha N., Krishna H., Praveena B. Mudliar, Fluorescence based turn-on probe for the determination of caffeine using europium-tetracycline

as energy transfer complex, *J Fluoresc.*, 2016, **26(3)**, 1115-1121

81 Sindhuja H.N., Marjan Askari, Srinivas P., Shylaja M. Dharmesh, A novel β-carotene associated carrot *(Daucus carota* L.*)* pectic polysaccharide, *Nutrition*, 2016, **32(7-8)**, 818-826

82 Sinjitha S. Nambiar, Anindya Basu, Nandini P. Shetty, Navin K. Rastogi, Prapulla S.G., Infusion of fructooligosaccharide in Indian gooseberry (*Emblica officinalis*) fruit using osmotic treatment and its effect on the antioxidant activity of the fruit, *J. Food Eng.*, 2016, **190**,139-146

83 Sinjitha S. Nambiar, Venugopal K.S., Nandini P. Shetty, Anu Appaiah K.A., Fermentation induced changes in bioactive properties of wine from *Phyllanthus* with respect to atherosclerosis, *J. Food Sci. Technol.*, 2016, **53(5)**, 2361-2371

84 Soneya Majumdar, Abhishek Acharya, Sushil Kumar Tomar, Balaji Prakash, Disrupting domain-domain interactions is indispensable for EngA-ribosome interactions, *Biochimica et Biophysica Acta - Proteins and Proteomics*, 2017, **1865**, 289-303

85 Sowmya Shree G., Jhansi Lakshmi M., Sharavana G., Gunaseelan S., Sreerama Y.N., Baskaran V., Lactucaxanthin - a potential anti-diabetic carotenoid from lettuce *(Lactuca sativa)* inhibits α-amylase and α-glucosidase activity *in vitro* and in diabetic rats, *Food & Function*, 2017, **8**, 1124-1131

86 Sridevi V., Giridhar P., Variations in diterpenes-cafestol and kahweol content in beans of robusta coffee grown at different altitudes, *Proceed. Nat. Academy Sci., India, Sect. B. Biol. Sci.*, 2016, **86(2)**, 291-297

87 Sudha M.L., Shylaja M. Dharmesh, Hasitha P., Shivaleela V.B., Sushma W. Eipson, Rajarathnam S., Shashirekha M.N., Antioxidant and cyto/DNA protective properties of apple pomace enriched bakery products, *J. Food Sci. Technol.*, 2016, **53(4)**, 1909-1918

88 Sudha M.L., Soumya C., Prabhasankar P., Use of dry-moist heat effects to improve the functionality, immunogenicity of whole wheat flour and its application in bread making, *J. Cereal Sci.*, 2016, **69**, 313-320

89 Sudha M.L., Viswanath P., Siddappa V., Rajarathnam S., Shashirekha M.N., Control of rope spore forming bacteria using carambola (*Averrhoa carambola*) fruit pomace powder in wheat bread preparation, *Quality Assurance and Safety of Crops & Foods*, 2016, **8(4)**, 555-564

90 Sunita Mehta, Saravanan Murugeson, Balaji Prakash, Deepak, Microbes based printing for fabrication of microlenses for organic light emitting diodes, *Organic Electronics*, 2016, **35**, 199-207

91 Suresh D. Sakhare, Aashitosh A. Inamdar, Preetham Kumar K.V., Usha Dharmaraj, Evaluation of roller milling potential of amaranth grains, *J. Cereal Sci.*, 2017, **73**, 55-61

92 Susmita Barman, Srinivasan K., Attenuation of oxidative stress and cardioprotective effects of zinc supplementation in experimental diabetic rats, *British J. Nutr.*, 2017, **117(3)**, 335-350

93 Susmita Barman, Srinivasan K., Zinc supplementation alleviates hyperglycemia and associated metabolic abnormalities in streptozotocin induced diabetic rats, *Canadian J. Physiol. Pharmacol.*, 2016, **94**, 1356-1365

94 Sutapa Mukherji, Renormalization group analysis for an asymmetric simple exclusion process, *Phys. Rev. E*, 2017, **95(3)**, 032131

95 Usha M.T., Sarat Chandra T., Sarada R., Chauhan V.S., Removal of nutrients and organic pollution load from pulp and paper mill effluent by microalgae in outdoor open pond, *Bioresource Technol.*, 2016, **214**, 856-860

96 Vadivelan G., Prabhakara Rao P.G., Venkateswaran G., Influence of supplementation of vegetable oil blends on omega-3 fatty acid production in *Mortierella alpina* CFR-GV15, *Biomed Res. Int.*, 2017, **2017**, 1-8

97 Vemana Gowd, Sandeep M.S., Nandini C.D., Effect of pathological conditions on peripheral macrophage glycosaminoglycans: Impact on cytoadherence, *Int. J. Biol. Macromol.*, 2016, **92**, 182-188

98 Venkataramanamma D., Aruna P., Singh R.P., Standardization of the conditions for extraction of polyphenols from pomegranate peel, *J. Food Sci. Technol.*, 2016, **53(5)**, 2497-2503

99 Vijayakumar Reddy K., Akhilender Naidu K., Maternal and neonatal dietary intake of balanced n-6/n-3 fatty acids modulates experimental colitis in young adult rats, *Eur. J. Nutr.*, 2016, **55(5)**, 1875-1890

100 Vijaykrishnaraj M., Roopa B.S., Prabhasankar P., Preparation of gluten free bread enriched with green mussel (*Perna canaliculus*) protein hydrolysates and characterization of peptides responsible for mussel flavour, *Food Chem.,* 2016, **211**, 715-725

101 Vishwanath S.V., Arun Tapal, Shinde Vijay Sukhdeo, Govindaraju K., Purnima Kaul Tiku, Effect of arginine:lysine ratio in free amino acid and protein form on L-NAME induced hypertension in hypercholesterolemic Wistar rats, *RSC Adv.*, 2016, **6**, 73388-73398

102 Yashaswini P.S., Appu Rao A.G., Sridevi A. Singh, Inhibition of lipoxygenase by sesamol corroborates its potential anti-inflammatory activity, *Int. J. Biol. Macromol.*, 2017, **94**, 781-787

103 Yashaswini P.S., Sadashivaiah B., Ramaprasad T.R., Sridevi A. Singh, *In vivo* modulation of LPS induced leukotrienes generation and oxidative stress by sesame lignans, *J. Nutrn. Biochem.*, 2017, **41**, 151-157

Non-SCI Papers

1 Agbagwa O.E., Swaroopa Rani D., Prakash M. Halami, Antibacterial potential components of *Bacillus* species and antibiotics residues in branded and unbranded honey samples from Nigeria, *African J. Biotechnol.*, 2017, **16(2)**, 58-64

2 Anudeep S., Kishan R. Bharadwaj, Radha C., Data for chitin binding activity of *Moringa* seed resistant protein (MSRP), *Data in Brief*, 2016, **9**, 335-337

3 Archer A.C., Prakash M. Halami, Probiotic functional food through native isolates of *Lactobacillus delbrueckii*: Immunomodulatory potential, *Indian Food Ind.*, 2016, **35(2)**, 31-34

4 Chalamaiah M., Jyothirmayi T., Diwan P.V., Venu Babu V., Sharma P.K., Dinesh Kumar B., Nutritional composition, ACE-inhibitory and metal chelating properties of rohu (*Labeo rohita*) egg protein hydrolysate produced by alcalase, *Int. Food Res. J.*, 2016, **23(3)**, 1017-1026

5 Debomitra Dey, Prakash M. Halami, *Lactobacillus plantarum*: a dominant microflora in *Mesu*- a non-salted fermented bamboo shoot product from Sikkim, India, *Indian J. Sci.*, 2016, **23(82)**, 499-508

6 Divyashri G., Prapulla S.G., Production and characterization of fermented rice flour containing gamma-aminobutyric acid (GABA), *Int. J. Environ. Agric. Res.*, 2016, **2(10)**, 98-106

7 Divyashri G., Rajagopal K., Prapulla S.G., Draft genome sequence of *Lactobacillus plantarum* Kanjika 2007 isolated from Kanjika, a South Indian traditional food, *Genome Announcements*, 2016, **4(6)**, e00924-16

8 Geetha V., Bhavana K.P., Chetana R., Gopala Krishna A.G., Suresh Kumar G., Studies on the composition and *in vitro* antioxidant activities of concentrates from coconut testa and tender coconut water, *J. Food Process. Technol.*, 2016, **7(5)**, 588

9 Girish T.K., Anil Kumar K., Prasad Rao U.J.S., C-Glycosylated flavonoids from black gram husk: Protection against DNA and erythrocytes from oxidative damage and their cytotoxic effect on HeLa Cells, *Toxicol. Reports*, 2016, **3**, 652-663

10 Hithamani G., Srinivasan K., Bio-accessibility of polyphenols from onion (*Allium cepa*) as influenced by domestic heat processing and food acidulants, *Indian J. Nutr. Dietetics*, 2016, **53(4)**, 391-404

11 Kamlesh Kumar Yadav, Ram Rajasekharan, Microarray data analyses of yeast RNA Pol I subunit RPA12 deletion strain, *Genomics Data*, 2016, **8**, 104-105

12 Kanjilal S., Shanker K.S., Rao B.V.S.K., Indrani D., Reddy S.R.Y., Prasad R.B.N., Lokesh B.R., Application of low calorie hypocholesterolemic structured lipid as potential bakery fat, *Int. Food Res. J.*, 2016, **23(2)**, 854-859

13 Leema Roseline T., Sachindra N.M., Characterization of extracellular agarase production by *Acinetobacter junii* PS12B, isolated from marine sediments, *Biocatalysis and Agricul. Biotechnol.*, 2016, **6**, 219-226

14 Mrudula G.B., Matche R.S., Lactic acid based spoilage indicator for milk, *Indian Journal of Adv. Chemical Sci.*, 2016, **S1**, 68-72

15 Niharika Shanker, Sukumar Debnath, Hypolipidemic effect of purslane (*Portulaca oleracea* L.) in rats fed on high cholesterol diet, *J. Nutr. Food Sci.*, 2016, **6(6)**, 1-8

16 Om Prakash, Amarjeet Kumar, Kudachikar V.B., Influence of pre-treatments on post-harvest quality characteristics and shelf-life extension of green tamarind fruits stored under different conditions, *Int. J. Agric. Sci.*, 2016, **8(58)**, 3199-3204

17 Padmavathi T., Krishnamurthy M., Ontology for the domain of food science, *SRELS J. Inf. Management*, 2016, **53(5)**, 409-417

18 Pankaj Satapathy, Chinnu Salim, Madhava Naidu M., Rajini P.S., Attenuation of dopaminergic neuronal dysfunction in *Caenorhabditis elegans* by hydrophilic form of curcumin, *Neurochem. and Neuropharmacol.*, 2016, **2(1)**, 1-8

19 Sandopu Sravan Kumar, Giridhar P., Stabilization of bioactive betalain pigment from fruits of *Basella rubra* L. through maltodextrin encapsulation, *Madridge J. Food Technol.*, 2017, **2(1)**, 74-78

20 Sathiya Mala K., Anjali E.K., Srinivasulu K., Effect of pre-treatments on the proximate composition of pumpkin flour, *Int. J. Innovative Studies in Sci. and Eng. Technol.*, 2016, **2(5)**, 1-8

21 Soma G., Mahadevamma S., Sudha M.L., Characterisation of tea fiber and its utilisation as a functional ingredient in the preparation of biscuits, *Int. Food Res. J.*, 2016, **23(6)**, 2525-2533

22 Sriranjini Venkat Rao, Greeshma Mohandas, Muralidhara, Rajini P.S., Neuromodulatory potential of aqueous extracts of cumin, cinnamon: Evidence from rotenone model in drosophila: Implications to Parkinson's disease, *Int. J. of Neurology Res.*, 2016, **2(3-4)**, 1-11

23 Vrinda R., Louella C.G., Niranajan S., Chandrashekar J., Prakash M. Halami, Bhaskar N., Extraction and purification of lipase from *Enterococcus faecium* MTCC5695 by PEG/ phosphate aqueous-two phase system (ATPS) and its biochemical characterization, *Biocatalysis and Agricul. Biotechnol.*, 2016, **6**, 19-27

Reviews

1 Arti Pandey, Negi P.S., Traditional uses, phytochemistry and pharmacological properties of *Neolamarckia cadamba*: A review, *J. Ethnopharmacol.*, 2016, **181**, 118-135

2 Gaurav Kumar Pal, Suresh P.V., Sustainable valorisation of seafood by-products: Recovery of collagen and development of collagen-based novel functional food ingredients, *Innovative Food Sci. and Emerging Technol.*, 2016, **37**, 201-215

3 Kalpana Platel, Srinivasan K., Bioavailability of micronutrients from plant foods: An update, *Critical Rev. Food Sci. Nutr.*, 2016, **56(10)**, 1608-1619

4 Nimisha S.M., Negi P.S., Traditional uses, phytochemistry and pharmacology of wild banana (*Musa acuminata* Colla): A review, *J. Ethnopharmacol.*, 2017, **196**, 124-140

5 Pradeep Kumar Yadav, Ram Rajasekharan, DDHD domain-containing lipases: Targets for the treatment of rare diseases, *J. Rare Dis. Res. & Treatment*, 2016, **1(2)**, 34-38

6 Praveen K. Srivastava, Mukesh Kapoor, Production, properties and applications of endo-β-mannanases, *Biotechnol. Adv.*, 2017, **35(1)**, 1-19

7 Srinivasan K., Anti-cholelithogenic potential of dietary spices and their bioactives, *Critical Rev. Food Sci. Nutr.*, 2017, **57(8)**, 1749-1758

8 Srinivasan K., Biological activities of red pepper (*Capsicum annuum*) and its pungent principle capsaicin: A review, *Critical Rev. Food Sci. Nutr.*, 2016, **56(9)**, 1488-1500

9 Srinivasan K., Ginger rhizomes (*Zingiber officinale*): A spice with multiple health beneficial potentials, *PharmaNutrition*, 2017, **5(1)**, 18-28

10 Vijaya R. Dirisala, Rahul R. Nair, Krupanidhi Srirama, Prakash Narayana Reddy, Sambasiva Rao K.R.S., Satya Sampath Kumar N., Giridhar P., Recombinant pharmaceutical protein production in plants: Unraveling the therapeutic potential of molecular pharming, *Acta Physiologia Plantarum*, 2017, **39(18)**, 1-9

11 Yogesh D., Prakash M. Halami, Fibrinolytic enzymes of *Bacillus* spp.: An overview, *Int. Food Res. J.*, 2017, **24(1)**, 35-47

Book Chapters

1 Aadinath, Triroopa Ghosh, Amaladhas P.H., Anandharamakrishnan C., Dried dairy products and their trends in global market, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 15-22

2 Amit K. Das, Sachin R. Adsare, Madhuchhanda Das, Pankaj S. Kulthe, Ganesan P., Advanced techniques in extraction of phenolics from cereals, pulses, fruits and vegetables, In: Plant Secondary Metabolites: Stimulation, extraction and utilization, Volume 2, *Ed: Mohammed Wasim Siddiqui, Vasudha Bansal, Kamlesh Prasad*, Published by: CRC- AAP Press, USA, 2017, 27-76

3 Anandharamakrishnan C., Introduction to drying, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 1-14

4 Anindya Basu, Prapulla S.G., Sustainable utilization of food industry waste and by-products for the production of prebiotic isomaltooligosaccharides (IMO), In: Biotechnology and biochemical engineering, *Ed: Prasanna B.D., Sathyanarayana*

N. *Gummadi, Praveen V. Vadlani,* Published by: Springer Science + Business Media, Singapore, 2016, 55-64

5 Anu Bhushani J., Anandharamakrishnan C., Food-grade nanoemulsions for protection and delivery of nutrients, In: Nanoscience in food and agriculture 4, *Ed: Shivendu Ranjan, Nandita Dasgupta, Eric Lichtfouse*, Published by: Springer International Publishing, Switzerland, 2017, 99-139

6 Anu Bhushani J., Anandharamakrishnan C., Freeze drying, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 95-121

7 Anu Bhushani J., Udayakumar Harish, Anandharamakrishnan C., Nanodelivery of nutrients for improved bioavailability, In: Nutrient delivery: Nanotechnology in the agri-food industry, *Ed: Alexandru Mihai Grumezescu*, Published by: Academic Press Publications, UK, 2017, 369-411

8 Avinash Kumar, Simmi P., Sreedharan, Nandini P. Shetty, Giridhar P., Developing sustainable disease resistance in coffee: Breeding vs transgenic approaches, In: Plant pathogen resistance biotechnology, First edition, *Ed: David B. Collinge*, Published by: John Wiley & Sons, Inc., USA, 2016, 217-243

9 Gimbun J., Law W.P., Anandharamakrishnan C., Computational fluid dynamics modelling of the dairy drying processes, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 179-201

10 Gopirajah R., Anandharamakrishnan C., Packaging of dried dairy products, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 229-248

11 Ishita Roy, Anu Bhushani J., Anandharamakrishnan C., Techniques for pre-concentration of milk, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 23-41

12 Karthik P., Chhanwal N., Anandharamakrishnan C., Drum drying, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 43-56

13 Madhava Naidu M., A novel process for production of turmeric powder from fresh turmeric rhizomes, In: Spices handbook 2017, 4th edition, Published by: Foretell Business Solutions Pvt. Ltd., Bangalore, 2017, 72-76

14 Mukesh Kapoor, Deepesh Panwar, Kaira G.S., Bioprocesses for enzyme production using agro-industrial wastes: Technical challenges and commercialization potential, In: Agro-industrial wastes as feedstock for enzyme production, *Ed: Gurpreet Singh Dhillon, Surinder Kaur*, Published by: Academic Press, USA, 2016, 61-93

15 Nimish Mol Stephen, Gayathri R., Niranjana R., Yogendra Prasad K., Amit K. Das, Baskaran V., Ganesan P., Carotenoids: types, sources, and biosynthesis, In: Plant secondary metabolites: stimulation, extraction and utilization, Volume 2, *Ed: Mohammed Wasim Siddiqui, Vasudha Bansal, Kamlesh Prasad*, Published by: CRC-AAP Press, USA, 2017, 77-106

16 Padma Ishwarya S., Anandharamakrishnan C., Andrew G.F. Stapley, Spray freeze drying, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 123-148

17 Padma Ishwarya S., Anandharamakrishnan C., Spray drying, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 57-94

18 Parthasarathi S., Anandharamakrishnan C., Optimization of dairy products drying processes, In: Handbook of drying for dairy products, *Ed: Anandharamakrishnan C.*, Published by: John Wiley & Sons Ltd., UK, 2017, 149-177

19 Pooja J.A. Rao, Madhava Naidu M., Nanoencapsulation of bioactive compounds for nutraceutical foods, In: Sustainable agriculture reviews: Nanoscience in food and agriculture 2, *Ed: Eric Lichtfouse*, Published by: Springer-Verlag, Berlin, 2016, 129-156

20 Pradeep H., Muralidhara, Rajini P.S., Pursuit of cure for Parkinson's disease: Recent advances and future perspectives, In: Rehabilitation of Parkinson's disease, Published by: Avid Science, Germany, 2016, 2-59

21 Ram Saran Chaurasiya, Umesh Hebbar H., Reverse micelles for nanoparticle synthesis and biomolecule separation, In: Nanoscience in food and agriculture 4, *Ed: Shivendu Ranjan, Nandita Dasgupta, Eric Lichtfouse*, Published by: Springer International Publishing, Switzerland, 2017, 181-211

22 Rohinishree Y.S., Varadaraj M.C., Negi P.S., Pathogens associated with fruits and vegetables: Contamination, incidences and prevention, In: Food toxicology, *Ed: Debasis Bagchi, Anand Swaroop*, Published by: CRC Press - Taylor and Francis Group, USA, 2016, 115-150

23 Saini R.K., Sandopu Sravan Kumar, Priyanka P.S., Kamireddy K., Giridhar P., Alternative sweeteners: Current scenario and future innovations for value addition, In: Biotechnological production of natural ingredients for food industry, *Ed: Juliano Lemos Bicas, Mário Roberto Maróstica, Glaucia Maria Pastore*, Published by: Bentham Science Publishers, UAE, 2016, 21-59

24 Sandopu Sravan Kumar, Aruna M.C., Giridhar P., Improvement of green leafy vegetables: The role of plant tissue culture and biotechnology, In: Plant tissue culture: Propagation, conservation and crop improvement, *Ed: Anis M., Ahmad N.,* Published by: Springer Science+Business Media, Singapore, 2016, 547-582

25 Sarma Mutturi, Anindya Basu, Modeling and theoretical analysis of isomalto-oligosaccharide (IMO) production using fed-batch process, In: Biotechnology and biochemical engineering, *Ed: Prasanna B.D., Sathyanarayana N. Gummadi, Praveen V. Vadlani*, Published by: Springer Science + Business Media, Singapore, 2016, 73-83

26 Sarma Mutturi, Vikram Sahai, Bisaria V.S., Fed-batch cultivation for high density culture of *Pseudomonas* spp. for bioinoculant preparation, In: Modern tools and techniques to understand microbes, *Ed: Varma A., Sharma A.K.*, Published by: Springer International Publishing AG, Switzerland, 2017, 381-400

27 Shruti Pandey, Jayadeep A., Fortification of paddy and rice cereals, In: Developing technologies in food science - status, applications and challenges, *Ed: Murlidhar Meghwal, Megh R. Goyal*, Published by: Apple Academic Press Inc., USA, 2017, 281-304

28 Shruti Pandey, Sathyendra Rao B.V., Potential use of pseudocereals: Buckwheat, quinoa and amaranth, In: Food process engineering - Emerging trends in research and their applications, *Ed: Murlidhar Meghwal, Megh R. Goyal*, Published by: Apple Academic Press Inc., USA, 2016, 227-256

29 Srivatsan Vidyashankar, Simon Daris P., Mallikarjuna K.G., Sarada R., Microalgae as a source of nutritional and therapeutic metabolites, In: Plant secondary metabolites, Volume 1, Biological and therapeutic significance, *Ed: Mohammed Wasim Siddiqui, Kamlesh Prasad*, Published by: Apple Academic Press Inc, USA , 2016, 3-62

Book Published

1 Handbook of drying for dairy products, *Edited by: Anandharamakrishnan C.*, John Wiley & Sons., United Kingdom, 2017, 336 pages

Innovative food products developed by the Institute on display

2. Patents Filed / Granted in India

Filed

- A device useful for continuous cooking and discharging of ragi mudde and other similar kind of dumpling products
- An integrated electrospray-freeze-drying device
- A process for the preparation of a yeast concentrate useful in the reduction of aldehyde
- A process for preparation of manno-oligosaccharides from galactoamannan using immobilized recombinant endo-beta-mannanase (manb-1601)
- A novel colorimetric method for the detection of β-carotene in milk using nanoparticles
- A process for preparation of sterilized black pepper seeds using infrared energy

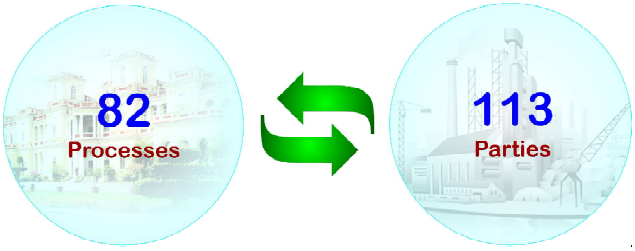
Granted

- A device useful for continuous frying and discharging of deep fat fried urd vada and other similar kind of products
- A process for haziness and sediment free-coconut and similar oils
- A process for the preparation of antiulcer powder from swallow root (*Decalepis hamiltonii*)
- A process for outdoor cultivation of microalga *Botryococcus* species
- A pharamaceutical composition useful for treating of diabetic nephropathy
- Flavour-enriched compounded asafoetida
- Novel o,o-dialkyl/arylalkyl phosphorothioates

Carbonated fruit beverages

Arabinoxylan from cereal brans

3. Processes released for commercial exploitation



- Atta with multigrains / multi whole grains flour
- Baking powder
- Bar cake
- Blends from banana pseudo stem juice
- Blends of coconut oil with other edible oil
- Bombay halwa mix
- Bottling of sugarcane juice
- Cake rusk
- Chutney spreads
- Coffee concentrate
- Compounded asafoetida
- Continuous idli making machine
- Date syrup concentrate
- Dehydrated whole lime
- Desiccated coconut
- Dhal based nutritional supplement for foods
- Dipping oil for grapes
- Fermented and dehydrated ready mixes for idli/ dosa batter
- Fish pickle
- Food for diabetics
- Fortified mango bar
- Fruit jams & jellies: Preparation
- Garlic paste
- Ginger beverage
- Ginger paste
- Gluten free bakery products
- Low-fat high protein snack foods
- Groundnut (peanut) butter
- Instant cake mix
- Instant gravy mixes: dehydrated
- Instant soup mix mushroom
- Instant traditional food : Bisibele bath
- Instant traditional food: Rasam
- Instant traditional food: Sambar
- Instant traditional food: Urdbath
- Layered parotta (South Indian)
- Low GI noodles
- Microbial inoculums for the management of coffee pulp effluent
- Modified atmosphere packaging of minimally processed vegetables (beans, bittergourd, cucumber, spinach leaves and onion)
- Multigrain cereal legume bar and puffed rice bar
- Multi-grain instant semolina
- North Indian (Punjabi) halwa mix
- Nutra chikki with added spirulina
- Osmo air dried mango
- Pasta: chocolate, multigrain and legume-based
- Paushtik atta
- Pickle & chutneys
- Plant growth promoter containing n-triacontanol
- Prawn pickle
- Prawn wafers
- Preparation of beverage blends from banana psuedo stem juice
- Preparation of mixed fruit & vegetable juices
- Preparation of ready to eat shelf stable egg crunchy bite
- Production of coconut spread based on mature coconut water concentrate and coconut dietary fibre
- Quick cooking, germinated & dehydrated pulses
- Ragi based papads
- Ready mix: Dosa
- Ready mix: Jamun
- Ready mix: Jelebi

- Ready mix: Maddur vada
- Ready mix: Pakoda
- Ready mix: Upma
- Ready mix: Vada
- Roasted and flavored cashew kernels
- Roller milling process of fenugreek fiber and gum
- RTE thermo processed in retort pouches
- RTS fruit juice & beverages
- Rural based biotechnological production of spirulina
- Shelf-stable biryani paste
- Shelf-stable chapati
- Shelf-stable chicken biriyani
- Shelf-stable convenience mix: a cooking base
- Shelf-stable kabab mix with chicken meat
- Shelf-stable varieties of curry pastes for veg & non-veg traditional cuisines
- Spice mix: Puliogre
- Spirulina chocobar & spirulina cereal bar
- Tamarind powder
- Tomato products
- Turmeric powder from fresh turmeric rhizome
- Tutti fruity (papaya/carrot)
- Virgin coconut oil
- Wheat vermicelli

Demonstration of Food Adulteration Test kit to High School students

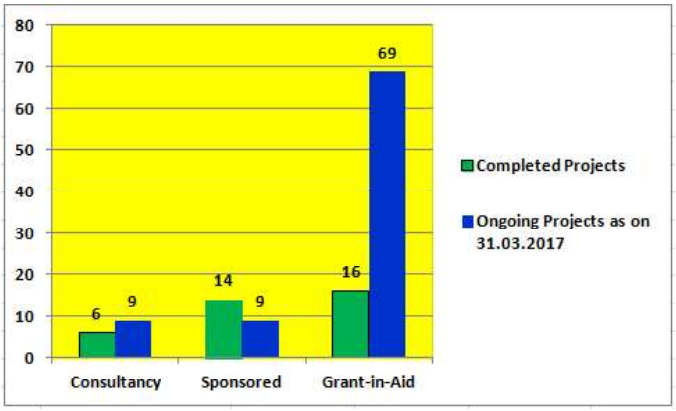
Flaxseed oil nanoemulsion

4. New processes ready for commercial exploitation

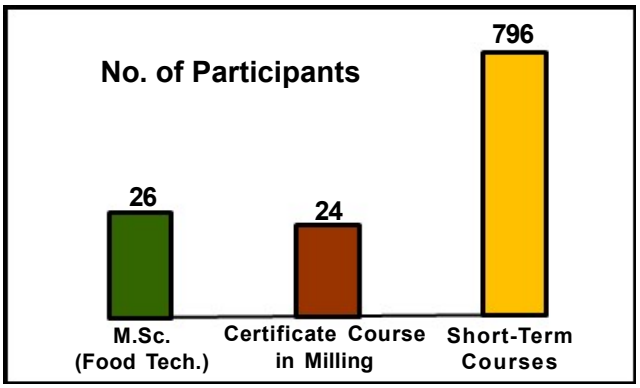
Two new processes were developed for commercial exploitation as per the list given below:

- Preparation of beverage from cactus
- Preparation of bael nectar & RTS beverage

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



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



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

- **MSMEs Minister's visit to Institute (April 23, 2016)**

Shri Giriraj Singh, Hon'ble Minister of State for MSME, Govt. of India visited the Institute on April 23, 2016 and held discussion with Scientists & Technologists for evolving a robust framework to support food processing industry.

- **Banana Growers, Processors & Market Players: Stakeholders Meet (April 26, 2016)**

A Stakeholders Meet was organised in which the representatives of banana farmers, processors, officials from Women & Child Dept., Govt. of Karnataka participated. Avenues for processing and preparation of value-added products from banana were discussed. Demonstration of selected technologies was also arranged for the benefit of farmers & processors.

- **Workshop on Biological Diversity Act, 2002 (June 24, 2016)**

Half-a-day workshop was organised on Biological Diversity Act, 2002 in association with the Karnataka Biodiversity Board in order to create awareness and sensitize about biological diversity of India in which over 100 researchers, scientists and faculty from the local Institutions participated.

- **Workshop on Empowering Banana farmers: Waste to Wealth (June 27, 2016)**

CSIR-Central Food Technological Research Institute, Mysuru organized half a day workshop involving banana growing farmers, processors and market players in Mysuru, on June 27, 2016. The meet was intended to create a robust market value chain and to improve sustainability of farming by converting waste to wealth which would be beneficial to large number of banana growing farmers.

Banana growing farmers in the region of Hadinaru village, Nanjangud Tq. raised concern on waste generated on-field during banana cultivation. Approximately 30 tons of waste has been generated per acre in one crop season from stem alone. To add commercial value to these waste, AcSIR students of the Institute took up the task and initiated interactions with farmers of Hadinaru village. Accordingly CSIR-CFTRI proposed a Waste to Wealth Model wherein, the waste generated from fields could be used for fiber extraction, stem juice production using CSIR-CFTRI technologies and for vermi-composting. This model completes the sustainability cycle by bringing income to farmers from waste via fiber, juice and organic manure production.

- **Awards Day (July 8,2016)**

On the Awards Day, Dr. Vijayamohanan K Pillai, Director, CSIR- CECRI, Karaikudi distributed meritorious awards, medals, scholarships and certificates to the outgoing students of M.Sc. (Food Technology) and Flour Milling Certificate Courses. Prof. Ram Rajasekharan, Director, CSIR- CFTRI presided over the function.

- **Startups Day at CSIR-CFTRI (August 02, 2016)**

The incubation centre, Nutro-Phyto Incubation Centre & Common Instrumentation Facility (NPIC-CIF) established in association with KBITS, Govt. of Karnataka formally admitted the first batch of start-up

Hon'ble Minister for MSME addressing the staff and students

companies into the facility. A formal function was held in the Institute on the occasion.

- **Hindi Fortnight Celebration (September 14-28, 2016)**

As part of the Hindi Fortnight celebration, various competitions were conducted for the employees and students of the Institute. Prizes and cash prizes were distributed to the winners of the competitions in the valedictory function.

- **World Food Day Celebrations (October 17, 2016)**

World Food Day was celebrated at CSIR-CFTRI Resource Centre, Hyderabad in association with AFST (I), Hyderabad Chapter with lectures, essay writing competition and quiz competitions for students.

- **CSIR Foundation Day and CSIR-CFTRI Foundation Day (October 21, 2016)**

CSIR Foundation Day and CSIR-CFTRI Foundation Day was celebrated in the Institute. Prof. Ram Rajasekharan, Director, CSIR-CFTRI presided over the functions. Prizes to winners of the various competitions conducted for wards of staff members were distributed. Retired staff and those who completed 25 years of service in CSIR were honoured. The Annual Institute awards were also distributed by the Director, CSIR-CFTRI in the function.

- **85th Annual Meeting of SBC(I) (Nov 21-24, 2016)**

The 85th Annual Meeting of the Society of Biological Chemists (India) was organized in the institute on the theme, "Innovations in Biological Research on Health & Diseases". The meeting was inaugurated by Prof. Samir K Brahmachari, Former DG, CSIR, New Delhi. Over 600 faculty and students attended the technical and poster sessions.

- **National Conference on Spices: Challenges and Opportunities (February 2-3, 2017)**

CSIR-CFTRI hosted a National Conference during February 2-3, 2017 on the theme, "Towards 2020: Strategies for sustainable spice processing". About 300 delegates which include national experts, young researchers, progressive spice growers/farmers, entrepreneurs, academicians and other stakeholders shared their rich experience and the potential of the spice industries.

- **Colloquium on Current Food Safety and Regulatory Concerns (February 28, 2017)**

To mark the National Science Day celebration and completion of 40 years of establishment of Central Food Laboratory at CSIR-CFTRI a colloquium was organised. Since its inception in 1950, CSIR-CFTRI has played a vital role in improving the quality of food and monitoring its safety. CFTRI was notified as a Central Food Laboratory in 1977 following the recommendations of a Joint Committee of Parliament and continues to function as the Referral Food Laboratory under the provisions of the Food Safety and Standards Act 2006. The colloquium was inaugurated by Deputy Commissioner of Mysuru district, Shri. D. Randeep, IAS who also delivered the National Science day address. Prof. Ram Rajasekharan and Director, CSIR-CFTRI presided over the function. On this occasion, Col O.P Kapoor, the founder Head of Central Food Laboratory, Mysore was felicitated for his

Hindi fortnight celebration

Inaugural address by Prof. S.K. Brahmachari, former DG, CSIR at SBC Annual Meet

outstanding contribution in the area of food safety and analysis.

- **Visit of IAS Officer Trainees Batch 2016 to CSIR-CFTRI (February 17, 2017)**

The IAS Officer Trainees Batch 2016 comprising of 14 officers visited CSIR-CFTRI on February 17, 2017. The visiting team was taken around the Institute facilities such as Food Engineering Centre, Food Safety & Analytical Quality Control Laboratory and International School of Milling Technology.

- **Free Technology Entrepreneurs Meet (March 2, 2017)**

CSIR-CFTRI released a total of 12 proven and successful technologies free of cost by means of publishing the detailed technology dossiers on the Institute web site in the year 2013. The technologies which are made free include: Amla candy, Composite ragi bread, Fruit spreads, Ginger dehydration and bleaching, Green chilli sauce, Protein enriched buns, Ready-to-use dosa batter, Ready-to-use idli batter, Turmeric curing and polishing, Cereal flakes Rice and refining of millets. The Institute has been arranging the demonstrations of these technologies to the benefit of entrepreneurs. Further the registrants were contacted with a questionnaire about the status of downloaded technologies. It was found that over 125 entrepreneurs have either started manufacturing or in the process of establishing a unit. In view of it, an Entrepreneurs Meet was organised in the Institute on March 2, 2017 in which over 40 entrepreneurs participated . Sessions were arranged with lectures on food processing, sharing of success stories by entrepreneurs and interactive session.

- **National Conference on Malnutrition: Challenges, Success Stories and Way Forward (March 3-4, 2017)**

CSIR-CFTRI along with Govt. of Karnataka and JSW Foundation organised the National Conference on 'Malnutrition – challenges, success stories and way forward' for addressing malnutrition across the country through various innovative approaches. The challenges, success stories, cultural acceptance, cost-effectiveness and potential mechanism of action of the mission and its impact on combating malnutrition were presented by experts and various stakeholders. Academicians and experts from CFTRI, Mysore Medical College, Mysuru; National Institute of Nutrition, Hyderabad; St. John's Research Center, Bengaluru; Reliance Foundation, Scania CSR, Nestle India, UNICEF and NGOs shared the various challenges and success stories. Over 100 participants attended in the various deliberations.

Interation with High School Science Teachers as part of faculty training & motivation programme

Chief guest giving away the medals on Award Day

8. MoUs Signed

- Department of Biochemistry, University of Turku, Finland
- Indian Railway Catering and Tourism Corporation Ltd (IRCTC), New Delhi
- Karnataka State Mango Development and Marketing Corporation Ltd (KSMD & MCL), Bangalore
- University of Horticultural Sciences, Bagalkot
- Kautilya Entrepreneurship & Management Institute (KEMI) Jakkasandra, Bangalore
- Grassroots Research and Advocacy Movement (GRAAM), Mysore
- The Central Arecanut and Cocoa marketing and Processing Cooperative Ltd (CAMPCO), Mangalore
- Mangalore University, Mangaluru
- National Research Development Corporation (NRDC), New Delhi
- Sri Sri Rural Development Programme Trust, Bangalore
- Millers Process Intelligence & Engineering, Bangalore
- The Indigram Labs Foundation, New Delhi
- Indian Society of Agribusiness Professionals, New Delhi

Low GI noodles

Quinoa Plant and Processed seeds

Quinoa Laddu and Quinoa Upma

9. Awards and Recognitions

Ph.D. Degree Awarded

a) University of Mysuru

Name of the student	Title of the thesis	Guide
• Amit Kumar Das	Phytochemical composition and antioxidant properties of Indian maize genotypes with reference to the production of maize-noodles	Dr. Vasudeva Singh
• Poorna Chandra Rao Y	Studies on effects of elaidic acid on selected inflammatory mediators in the presence of alpha - linolenic acid and oryzanol in rats	Dr. Lokesh BR
• Kumudha A	Evaluation of microalage for vitamin B12 production and its bioactivity	Dr. Sarada R
• Vidyashankar S	Studies on microalgal lipid production and elucidation of stress related biochemical changes	Dr. Sarada R
• Rajam R	Spray-freeze-drying method for preparation of synbiotics using microencapsulation technique	Dr. Ananadharamakrishnan C
• Akitha Devi MK	Augmentation of isoflavones and folic acid in soybean through biotechnological approaches	Dr. Giridhar P
• Daris P Simon	Genetic transformation of *D. salina* for production of xanthophylls	Dr. Sarada R
• David HE	Fermentative production of native lactic acid bacteria producing exopolysaccharides	Dr. Prapulla SG
• Divya N	Effect of dietary ghee on rats with a focus on risk factor indicators for cardiovascular diseases	Dr. Lokesh BR
• Namitha KK	Biotechnological approaches for the enhancement of β-carotene in tomato (*Lycopersicon esculentum*) fruits and its use in preparation of processed product	Dr. Negi PS
• Vaddi Prasanna Kumar	Immunomodulatory properties of the lectin and fructans from onion bulbs (*Allium cepa L.*)	Dr. Venkatesh YP
• Sowmya R	Biochemical and molecular charecterization of carotenoids produced by marine bacteria	Dr. Sachindra NM
• Savitha YS	Quality profile of rice noodle with low glycemic index / low carbohydrate digestibility	Dr. Vasudeva Singh
• Jeevitha GC	Electromagnetic field assisted processing of vegetable and spice for improved quality	Dr. Umesh Hebbar
• Mukthamba P	Synergy between hypolipidemic spice garlic and dietary fiber-rich fenugreek seeds in their health beneficial cardio protective influence	Dr. Srinivasan K

Name of the student	Title of the thesis	Guide
• Sindhuja HN	Studies on the role of dietary galectin-Inhibitor on galectin and galectin binding protein mediated metastasis	Dr. Shylaja M Dharmesh
• Hithamani G	Studies on the bioavailability of polyphenols from Indian foods	Dr. Srinivasan K
• Nagaprabha P	Grain based micronutrient rich food gels: Development, characterization and bioaccessibility	Dr. Sila Bhattacharya
• Vijayakumar Reddy K	Studies on the dietary lipids as modulators of inflammation in experimental ulcerative colitis	Dr. Akhilender Naidu K
• Mahendranath Gondi	Effect of mango (*Mangifera indica L.*) peel on hyperglycemia and changes in crystallin during cataract formation in diabetic rats	Dr. Prasad Rao UJS
• Raja Rajan RG	Preparation of phytosterol ester of alpha-linolenic acid and its utilization in food	Dr. Gopala Krishna AG
• Raju N	Investigations on the potential of monocrotophos, an organophosophorus insecticide to induce insulin resistance in rats	Dr. Rajini PS
• Shanthilal J	Role of hydrocolloids to modify the characteristics of model systems of dough and batter based foods	Dr. Suvendu Bhattacharya
• Nishita KP	Anti-proliferative properties of azurin derived hexapeptides	Dr. Manonmani HK
• Shreeranga N	Studies on co-administration of select gastrointestinal satiety peptides with obestatin to counter obesity	Dr. Uma V Manjappara
• Kavitha BC	Mode of action of gastro-protective components from potato (*Solanum tuberosum*) and ginger (*Zingiber officinale*); Effect of various cooking processes	Dr. Shylaja M Dharmesh
• Ravi H	Polymer–lipid nanocarriers to improve stability, bioavailability and anti-cancer property of carotenoid fucoxanthin	Dr. Baskaran V
• Savitha Prashanth MR	Studies on purified arabinoxylans isolated from Finger Millet (*Eleusine coracana)* bran with respect to their structural characterization and biological activity	Dr. Muralikrishna G

b) AcSIR

Name of the student	Title of the thesis	Guide
• Chanukya BS	Integrated approach involving liquid membranes and forward osmosis for the processing of fruit juice and natural colorants	Dr. Navin K Rastogi
• Neelima Singh	Zinc-responsive Activator Protein1 regulates lipoic acid content and triacylglycerol metabolism in budding yeast	Prof. Ram Rajasekharan
• Kamlesh Kumar Yadav	Impact of phosphate limitation on eukaryotic lipid metabolism and its regulation	Prof. Ram Rajasekharan
• Kanaga Vijayan D	Lipid profiling of yeast *RAD* deletions, identification of lipid gene responsible for lipid accumulation and its transcriptional regulation	Dr. Malathi Srinivasan
• Nidheesh T	Microbial production of chitosan oligosaccharides and its potential applications	Dr. Suresh PV
• Vasantha Raghavan	Synthesis and characterization of nanomaterials for detection and removal of Bisphenol-A	Dr. Navin K Rastogi
• Priya Kumari	Transcriptome analysis of Chia (*Salvia hispanica L.*): Identification and biochemical characterization of lipid genes	Dr. Malathi Srinivasan
• Ramya Visvanathan	Transcriptional regulation of phospholipases by Yeast Activator Protein-1 in *Saccharomyces cerevisiae*	Prof. Ram Rajasekharan
• Bavisetty Sricharan Bindu	Anti-virulent and cytoprotective effects of squalene and related mechanistic studies	Dr. Bhaskar N

High school children in a practical session during the program for motivation of students towards science career

c) CFTRI Annual Awards 2016-17

CFTRI Annual awards were presented to the exemplary performance of staff and students for the year 2016-17. Details of the recipients are given below:

- **Best Technical support – Gr.D (N.T)**
  Mr. S. Chikkaswamy, Group D(NT) Higher, Protein Chemistry & Technology
- **Best Technical Support – Gr. (I)**
  Mr. P. Devaraju, Lab Assistant, Group I, Health Centre
- **Best Technical Support – Gr. (II)**
  Mr. B.A. Umesh, Sr. Technician (1), Grain Science & Technology
- **Best Technical Support – Gr.(III)**
  Mr. K. Anand Kumar, Technical Officer, Construction & Civil Maintenance
- **Best Technical Contribution – Gr. (III)**
  Dr. C. Radha, Sr. Technical Officer (2), Protein Chemistry & Technology
- **Best Student Award: Research Scholar category**
  - Ms. P.S. Yashaswini, Protein Chemistry & Technology
  - Dr. Pradeep Kumar Yadav, Lipid Science Department
- **Best Contribution – Gen. Administration**
  - Mr. M.D. Satheesh Kumar, Section Officer (Gen.)
  - Mrs. K. Preetha, Assistant Grade I (MACP), Establishment - EIII/IV
- **Best Contribution – Finance & Accounts**
  Mr. V. Rajesh, Section Officer (F&A)
- **Best Contribution – Stores & Purchase**
  Mr. C.R. Shivakumar, Assistant (S&P) - Grade I
- **Best Support Department**
  Central Instruments Facility & Services
- **Best Technology Transfer**
  Dr. M. Madhava Naidu, Sr. Principal Scientist and Team, Spices & Flavour Sciences
- **Best Research Paper Award**
  Dr. Praveena Bhatt Mudliar, Sr. Scientist, Microbiology & Fermentation Technology
- **Best Scientist Award**
  - Dr. Suresh D Sakhare, Sr. Scientist, Flour Milling, Baking & Confectionery Technology
  - Dr. V. Baskaran, Sr. Principal Scientist, Department of Biochemistry
- **Best R&D Department Award**
  Department of Biochemistry

d) Individual Awards

Award Title	Instituted by	Awardee
• Subhash Bhatnagar Memorial Award	AFST(I), Mysuru	Nagender A
• Dr. M. Mahadeviah National award	All India Food Processors Association (AIFPA), New Delhi	Harish Prashanth KV
• VASVIK Industrial Research Award	VASVIK, Mumbai	Raghavarao KSMS
• Col. O.P Kapoor 2016 Award	All India Food Processors Association (AIFPA), New Delhi	Asha Martin
• Kejriwal Award	All India Food Processors Association (AIFPA), New Delhi	Math RG
• Dr. (Smt.) Rajammal P. Devdas Memorial NABS – Best Scientist Award	National Academy of Biological Sciences, Chennai	Giridhar P

e) Recongnitions by Academies

Recognition	Instituted by	Awardee
• Raman Research Fellowship	Council of Scientific and Industrial Research, New Delhi	Dr. Negi PS
• Fellow	AFST(I), Mysore	Dr. Rastogi NK
• JICA-KIRIN Fellow	Japan international cooperation agency and Kirin holding company limited	Dr. Vijayaraj P
• Fellow	Indian Academy of Microbiological Sciences (FIAMSc-2016)	Dr. Prakash M Halami
• Fellow	Indian Association of Applied Microbiologists (FIAAM-2016)	Dr. Prakash M Halami
• Fellow	National Academy of Biological Sciences, Chennai	Dr. Giridhar P

Kannada Rajyotsava celebration

f) Other Recognitions

Awardee	Member/Panel Expert & Host Institution
• Manohar B	UGC-DDU Kaushal Kendra, JSS College of Arts and Science, Mysore
• Shashirekha MN	American College, Madurai (BoS), University of Mysore (BoS), University of Agricultural Sciences, Bangalore (BoS); FSSAI, New Delhi
• Purnima Kaul Tiku	TIFAC-DST (Task Force on Nutraceuticals)
• Rajagopal K	Kerala Biotechnology Commission, FAD 15.1
• Sarada R	NIOT, Chennai (Project Review Board)
• Sandeep N Mudliar	Karnataka State Pollution Control Board, Bangalore (Technical Advisory Committee)
• Venkateswaran G	Thiruvalluvar University, Vellore (Academic Council), Davenagere Unversity, Karnataka (BoS), Goa University (BoS), Technology Development Board, DST, New Delhi (Screening Committee), BIRAC, DBT, New Delhi (Project Monitoring Committee)
• Ajay W Tumaney	FAD 15 BIS, FAD 13 BIS, FSSAI, New Delhi
• Badgujar PM	State Level Cluster Coordination Committee, Mumbai; State level Cluster Monitoring cum Guidance Apex Committee under MSICDP, Mumbai; Inter Departmental Panel (IDP) of EIA for assessments of approval/ renewal for export of Food processing units, Mumbai; National Horticulture Mission Schemes, Pune (Project Appraisal Committee); FSSAI, New Delhi
• Negi PS	FSSAI, New Delhi
• Vijayanand P	FSSAI, New Delhi
• Pushpa S Murthy	Siddaganga Institute of Technology (BoS)
• Arun Kumar P	PCD 27, BIS
• Matche RS	PCD 12, PCD 21, PCD 27 (BIS); ISO/TC61 Plastic SC 09 & 11 (Working Groups)

Visit of Hon'ble Minister for Science & Technology to CSIR-CFTRI stall during IITF exhibtion at Pragati Maidan, New Delhi

g) Best Research Papers / Posters awards

1. 85th Annual Meeting of SBC (I) at CSIR-CFTRI, Mysore, November 21-24, 2016

- Shaik Abdul Dileep, Usharani Dandamudi, Ram Rajasekharan, Sucrase Inhibitor from sugarcane for controlling calorie intake in mammals
- Hasitha P., Shylaja M Dharmesh, Inflammation and gut microbiota changes during skin cancer progression; effect of dietary intervention
- Mohan Kumar B.V., Prabhasankar P., Modification of wheat flour using prolyl endopeptidase to reduce its immunoreactive wheat flour proteins

2. 25th ICFoST, Amritsar, Punjab, November 10-12, 2016

- Amarjeet Kumar, Kudachikar V.B., Effect of organic solvents on development of vegetable oil based emulsifiable concentrate to control anthracnose disease in mango fruits during postharvest storage
- Rajalakshmi, Kalai Selvi I., Pushpa S Murthy, Nagarajan S., Epigallocatechin-3-gallate derivative and its antibacterial potential against Gram negative bacteria
- Ushadevi A., Traditional quinoa products – A boon to health and wellness of Indian population

3. Research Papers / Poster awards in other seminars

- Tanaji G. Kudre and Bhaskar N., Safe disposal of fish processing waste: Preparation of biodiesel and purification of glycerin from waste marine oil, EIQASFISH'16, International Conference on Emerging Issues in Quality and Safety of Fish and Shellfish, Fisheries College and Research Institute, Thoothukudi, Chennai, Tamil Nadu August 11-12, 2016.
- Debomitra Dey, Prakash M Halami, *Lactobacillus plantarum*, a dominant microflora in Mesu: a fermented bamboo shoot from Sikkim, National conference on Emerging Trends in Food processing and Quality Assurance, SRM University, Chennai, April 12-13, 2016
- Jaimee George, Mechanism of aminoglycoside resistance in lactic acid bacteria, National Conference on Molecular characteristics of multidrug resistant bacteria – causes, consequence and control, Bannari Amman Institute of Technology, Sathyamangalam Tamilnadu, March 22-24, 2017
- Purba Sarkar, Nawneet K Kurrey, Somashekar B.S., The Chemo-Preventive Mechanisms of Cruciferous Vegetables Derived Phytochemicals on Ovarian Cancer Metabolism: An NMR-based Metabolomics Study, 7th Asia Pacific NMR Symposium & 23rd Annual Meeting of NMRS-India, Indian Institute of Science, Bangalore, February 16-19, 2017
- Srinivasulu K., Sathiya Mala K., Sorption characteristics and shelf life prediction of pumpkin flour incorporated extruded products, National Seminar on Challenges and Opportunities in Food Packaging, Indian Institute of Crop Processing Technology, Thanjavur, Tamil Nadu, September 23, 2016
- Sindhura G., Sulochanamma G., Nagender A., Jyothirmayi T., Development of pulse- cereal-millet based extruded product with low fat, high protein, fibre and carotenoid enrichment. National Seminar on Pulses 2016: Innovative approaches for sustainability in production and promotion of utilisation, Koti Women's College, Hyderabad, October 21-22, 2016
- Suresh D Sakhare, Joythsna Rajiv, Prabhasankar P., Roller milled fenugreek fiber for development of high fiber pasta, International Conference on Food, Nutrition & Health, Madurai, June 6-8, 2016
- Aashitosh A Inamdar, Shivakumara M., Prabhasankar P., Hydro-thermal processing of wheat: Effect on grinding characteristics, physico-chemical, rheological and functional properties, International Conference on Food, Nutrition & Health, Madurai, June 6-8, 2016
- Shruti Pandey, Sivanandhini T., Jayadeep A., Quality Characteristics of Beta-Carotene Fortified Rice, National Conference on Malnutrition: Challenges, Success stories & Way Forward, CSIR-CFTRI, Mysore, March 3-4, 2017
- Bhavya ML, Madhava Naidu M, Pushpa S Murthy, Mycotoxins in chilli (*Capsicum-annum*) and its products and their inhibition using natural biomolecules, National Conference on Spices: Challenges and opportunities organized by CSIR-CFTRI, Mysore, February 2-3, 2017

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

- Journal of Food Technology and Preservation (2016), Omics Intl, USA (Rastogi NK)
- Journal of Food Measurement and Characterization (Prabhasankar P)
- Indian Food Industry Mag. (Suresh D Sakhare)
- International Journal of Genuine Traditional Medicine, published by Association of Humanitas Medicine, Republic of Korea (Negi P.S.)
- Indian Food Industry Mag, Published by AFST(I), Mysuru (Anu Appaiah KM)
- Indian Food Industry Mag, Published by AFST(I), Mysuru (Vijayendra S.V.N)
- Indian Journal of Microbiology, Springer Publisher (Venkateswaran G)

i) Editorial Boards

- International journal of Fermented Foods (Rajagopal K)
- International journal of peptide and therapeutic proteins (IJPR) (Rajagopal K)
- mBio journal RSC publication (Rajagopal K)
- International Journal of Genetic Engineering and Biotechnology (Rajagopal K)
- Blue Biotechnology, Nova Publishers, USA (Prabhasankar P)
- International Journal of Immunology (Prabhasankar P)
- Journal of Molecular and Genetic Medicine, published by Omics Publishing Group, Foster City, CA, USA (Negi P.S)
- International Journal of Food Science and Nutrition Engineering, Scientific & Academic Publishing Co. Rosemead, CA, 91731, USA (Matche RS)
- International Journal of Agriculture Food Science & Technology (IJAFST), Research India Publications, Delhi (Matche RS)
- International Journal of Knowledge Management and Information Technology (IJKMIT), Research India Publications, Delhi (Matche RS)
- Indian Journal of Nutrition, Open Science Publications, Hyderabad (Matche RS)
- Applied Food Science Journal, Pulsus Group, London, UK (Matche RS)
- Nature Scientific Reports, Nature Press (www.nature.com/srep) (Balaji Prakash)

j) Advisory Board

- Trends in Carbohydrate Research (Muralikrishna G)
- Signpost Open Access Journal of Organic and Biomolecular Chemistry, published by Research Signpost, India (Negi P.S.)

CSIR-CFTRI stall during 17th National Jamboree organised by Bharath Scouts & Guides, Karnataka

10. Participation in Exhibitions

- **North East Biz:** Organized by Indian Chambers of Commerce (ICC), Mumbai, June 29 - July 01, 2016
- **One Day Workshop on Super food crops-Chia and Quinoa, Lucknow:** Organized by Dept. of Irrigation and Water Resources, Alibag, Lucknow, July 13, 2016
- **Bharath Utsav Exhibition:** Organized by RAISE & supported by Academic Partner JNTUH, State Govt. Telangana Tourism & TSCOST, Hyderabad, August 18-24, 2016
- **CSIR Foundation Day Celebration:** Organized by CSIR, New Delhi, September 23-27, 2016
- **Krishimela - Pulse Workshop:** Organised by UAS, Dharwad, September 24-27, 2016
- **ASPA Conference:** 20th Asian Science Park Association (ASPA) with association of ICRISAT (Member), Hyderabad, October 19, 2016
- **5th Food Fest 2016 Exhibition and Seminar 2016:** Organized by Key2Green Pvt. Ltd., New Delhi at Colvin Taluqdar's College Ground, Lucknow, October 22-25, 2016
- **Exhibition based on CFTRI Technologies:** Organised by Uttar Pradesh Khadi Village Industry Board, Govt. of UP, Lucknow, October 24-25, 2016
- **International Conference on Post-Harvest Expo 2016:** International Congress on Post – Harvest Technologies of Agricultural Produce for Sustainable Food and Nutritional Security held at Integral University, Lucknow, November 9-10, 2016.
- **CSIR Platinum Jubilee Techno Fest 2016**: Organised by CSIR at Pragati Maidan, New Delhi, November 14-27, 2016
- **India International Science Festival (IISF):** Organized by Union Ministry of Science and Technology and Earth Sciences in association with Vijnana Bharati (VIBHA), CSIR-NPL, New Delhi, December 5-12, 2016
- **Exhibition on Grains and Spices:** Organized by Kerala State Government Thodupuzha, Kerala, December 2016
- **Horticulture Fair-2016:** Organized by University of Horticultural Sciences, Bagalkot, December 17-19, 2016
- **17th National Jamboree:** Organized by The Bharat Scouts and Guides, Karnataka, Adakanahalli, Nanjanagudu Road, Mysore, December 29, 2016 - January 4, 2017
- **National Science Expo:** Kerala Science Congress, Thiruvalla, Kerala, January 26-20, 2017

Inaugural function of the workshop on Super foods at Lucknow

School students at CSIR-CFTRI stall during IISF, New Delhi

- **Make in Karnataka Conference:** Organized by Ministry of Commerce and Industry, Govt. Of India, CII & Govt. Of Karnataka, February 13-14, 2017
- **Food Tech 2017:** Organized by Madurai District Tiny & Small Scale Industries Association (MADITSSIA), Tamukkam Grounds, Madurai, February 24-27, 2017
- **Technology Clinic on Agro Food Processing for entrepreneurs:** Organized by District industries Forum, Trissur, Kerala, Mar 1, 2017
- **Odisha MSME Trade Fair 2017:** Organized by MSME Department, Odisha, March 5-10, 2017

11. Entrepreneur Development Programmes

No. of EDPs	:	8
No. of beneficiaries	:	249

12. Visit of International Delegation & Training

- Prof. Seyed Mohammad Reza Khalili, Research Counsellor, Embassy of the Islamic Republic of Iran, New Delhi visited the Institute and interacted with Scientists (May 11, 2016)
- A high level Ethiopian Governments delegation comprising of Ministers and representatives from research establishments and industry of the country visited the Institute for identifying and exploring avenues in developing twinning programme in the area of meat processing (June 9, 2016)
- Ms. Krittalak Pasakawee & Ms. Nowwapan Noojuy from TISTR attended a short training related to advanced food technology, food analysis, functional food and testing & analysis of coffee under CFTRI-TISTR MoU (June 20-24, 2016)
- Around ten International participants attended various short term training programmes.
- A total of 10 students and 2 faculty of Wisconsin University-River Falls attended the Study Abroad programme (January 12-16, 2017)

13. Support Department Activities

New instruments such as Bruker FT-NIR, Bruker FT-IR, Martin Christ Freeze Dryer and Eppendorf Table Top Centrifuge were installed at the Central Instruments and Facility Service department.

The library subscribes 110 high impact journals from leading international as well as Indian publishers and provides access to around 4183 e-journals through CSIR-network. The institutional repository holds a total of 9482 research publications.

The Institute LAN was upgraded to a VLAN which enable the ease of administration and enforcement of security policies of the network

A total of 5217 visitors comprising of students from schools and colleges, entrepreneurs, farmers and officials were taken around Institute facilities and showcase by the Information & Publicity Department.

Visit of Ethiopian delegation to CSIR-CFTRI

Visitors interacting during Food Tech 2017 at Madurai

Societal Programmes

I. Technology development in the area of food processing and enabling hygienic and safe food for rural folks

i) Setting up a Food Processing Learning Centre for Farmers

Efforts are underway for establishing a Food processing and Innovation centre in the Institute exclusively for the farmers, SHGs and Startup entrepreneurs who are visiting CFTRI and seeking advice and hands-on-training in the areas of Food processing. In this connection, more than 35 food processing equipment and machineries appropriate for low cost rural food processing technologies were purchased.

ii) Design and development of a Street Vending Cart

In a major initiative for empowering the street food vendors to serve safe and hygienic foods, an innovative and energy efficient-solar powered modular street vending cart was designed. In the survey conducted by our AcSIR students in 2015-16, it was observed that the cart used by the street vendors was inadequate in terms of the infrastructure and quality services. In this context, CSIR-CFTRI intervened by designing and developing a new mobile cart with features to ensure better hygiene, improved food safety, ease of operations and better aesthetics.

The new cart, which is about four feet wide and six feet long, with a modular design makes it easier to cook, hold and serve the food. SmartCart includes a restaurant-grade kitchen made with stainless steel, on-board refrigerator, food warmer and a sink with separate tanks for fresh and waste water system - helping to create a better culinary experience for consumers. The cart also comes with a built-in system to hold a gas cylinder and a dustbin. The array and design of the units in the SmartCart can be realigned as desired by the end user without changing its core features on food safety, operational efficacy and energy efficiency.

The Eco friendly, self-sufficient SmartCart, has a solar panel unit on its rooftop and stores energy in its battery. The system is powered with a 1500VA inverter system to support the energy needed in the cart for about 6 hrs. The solar panel is sensitive to absorb even low light. This provides an essentially cost-free, pollution-free source of electrical energy for its operations. The cart also has ease of mobility on wheels and an option for towing.

iii) Empowering a Women SHG in Manipur

The **"Oinam Awang Leikai Women's Development Association"** Bishnupur District is an SHG registered in 2008 with more than 100 members. The current activity of the SHG is to procure raw fruits and vegetables, cereals, meat, fish etc. and then processing into value added products in a tiny scale by adopting locally available technologies with the available infrastructure. The major tiny scale processed products are bamboo pickles, juices from pineapple, orange, passion fruits and lemon, fermented fish, fermented soybean, chili powder etc. The production capacity is too small due to lack of suitable equipment and machineries. The proposed augmentation of the processing unit with improved machineries can add value to the commercially important locally available fruits and vegetables thus enhancing the economic status of the local economy. The machineries were purchased and delivered at the site. The Institute is in the process of installing the machineries.

Banana Stakeholders Meet

iv) Nutritious Products through Anganwadis -Nutri-invention to overcome malnutrition

The banana bar developed and manufactured by the Institute from ripened banana was distributed to the Anganwadis of Mysore district with the coordination of Women & Child Development Department, Govt. of Karnataka. A total of 200 Kg banana bar was supplied to 374 children from 9 Talukas of Mysore district.

v) Conducting awareness/workshops for targeted communities such as banana farmers, tomatoes farmers and food safety

CSIR-CFTRI organized the following awareness and technology demonstration programs for value addition of agri-resources for helping the rural entrepreneurs. These include :

- **Stakeholders Meet for Banana farmers**

The Institute organized half-a-day Stakeholders Meet on April 26, 2017 which comprised of representatives from Farmers, Processors, State Govt. officials and R&D staff of CFTRI. Representatives of Karnataka Raitha Sangha, Chamarajanagar and Madari Thotagarika Sangha, Puttegowdanahundi were present.

- **Empowering Banana farmers: Waste to Wealth**

CSIR-Central Food Technological Research Institute, Mysuru organized half a day workshop involving banana growing farmers, processors and market players in Mysuru, on June 27, 2016. The meet was intended to create a robust market value chain and to improve sustainability of farming by converting waste to wealth which will be beneficial to large number of banana growing farmers.

Banana growing farmers in the region of Hadinaru village, Nanjangud Tq. raised concern on waste generated on-field during banana cultivation. Approximately 30 tons of waste has been generated per acre in one crop season from stem alone. To add commercial value to these waste, AcSIR students of the Institute took up the task and initiated interactions with farmers of Hadinaru village. Accordingly CSIR-CFTRI proposed a 'Waste to Wealth Model' wherein, the waste generated from fields could be used for Fiber extraction, stem juice production using CSIR-CFTRI technologies and for vermi-composting. This model completes the sustainability cycle by bringing income to farmers from waste via fiber, juice and organic manure production.

Two tonnes of waste stem was brought from fields to CSIR-CFTRI and the fiber extraction, stem juice and biocompost preparation was demonstrated to farmers. Farmers groups, buyers, processors along with officials of NABARD, Mysuru and Technologists from CSIR-CFTRI attended the workshop. The institute has asserted to work on establishing semi-processing units through farmers and SHGs with the support of Govt. and other agencies, transfer of technology to agri enterprises, training and creating a network amongst them for ensuring proper returns to farmers and growers.

- **Workshop on value added products from Tomatoes**

A workshop was conducted on "Value added products from Tomatoes' to Women SHG and others of Puttegowdanahundi village on Nov. 8, 2016. A total of the 100 participated in this programme. In the programme conducted later the papad products manufactured by the SHGs was released by Director, CFTRI on the occasion.

Demonstration of value added products from tamatoes at Puttegowdanahundi village

vi) Technological Interventions for School & Anganwadi

Under the village adoption programme, the classrooms of the School in Puttegowdanahundi Village were electrified. Three classrooms along with kitchen were electrified. Also 500L Water Tank was provided to the Govt. School. Similarly, a Solar Panel was provided to Anganwadi for facilitating the electricity along with a Water tank unit. A formal inauguration was done on November 8, 2016.

vii) Half-a-Day workshop on Food Safety and Hygiene

CFTRI conducted a workshop on Food Adulteration in association with Pratham (NGO), Mysore on November 8, 2016 in which various sessions with respect to hygiene and nutritious food was highlighted. Food Adulteration Test Kits were distributed to Teachers and demonstration was held as part of the workshop.

viii) Mid day Meal assessment Programme

A pilot study to assess the Mid-day Meals served at Schools of Mysore District for their safety and quality with a target of covering 10% of Schools randomly was carried out.

Work done :

- Total list of Schools of Mysore District numbering 2398 was provided by the JD, MDM, Bangalore for random assessment and sampling of cooked meals for their safety and quality evaluation.
- A questionnaire was specially prepared for the study, which included assessment of infrastructure, hygiene, resources and health aspects apart from safety and nutritional evaluation.
- 270 Schools (More than 10% of total schools) located in 9 Zones of Mysore District were covered by 9 teams comprising of 15 scientists and 65 Research Scholars who were involved in assessment, sample collection, testing and compilation.
- Schools located in different geographical location of Mysore District i.e. H.D.Kote, Hunsuru, K.R.Nagar, Mysore North, Mysore South, Mysore Rural, Nanjangud, Periapatna, T.N.Pura were covered for this study. A minimum of 30 schools from each zone was covered during the study
- Schools were visited by the research team without prior intimation by showing the letter received from the MDM Secretariat, Bangalore to the Head of schools before commencement of assessment. All the officers of Mysore MDM and schools cooperated with the CSIR-CFTRI research team for the smooth conduct of the study.
- School visits started from 18th January 2017 and ended on 28th Feb 2017.
- More than thousand samples of Cooked Rice, Sambar and Drinking Water were collected from the schools. Samples like milk, Upittu, Payasam, Cooking water etc. were also collected depending on its availability at the schools.
- Scientific method of sample collection was followed while drawing the samples and same was brought to the laboratory (CSIR-CFTRI, Mysuru) on the same day for analysis.
- Samples of Cooked Rice, Sambar, Uppittu, Payasam were analyzed for their Nutritional Quality and Microbial safety parameters; Milk for Microbial

AcSIR students during the assessment of MDM scheme in schools

safety and samples of Drinking water were tested for pH, Hardness, Chlorides and Microbial Parameters.

- Testing of the samples are complete and data compilation is in progress.
- It is proposed to take forward the results with State Government officials for replicating the same programme across the state.

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

i) Motivation program for High School Students:

The Institute organised a motivational program to inculcate scientific temperament and inquisitiveness during Jan 5-6, 2017 in which 20 students from the selected High Schools of Mysore District participated. Apart from visit to important facilities of the Institute, lectures and demonstrations were arranged on the topics such as Importance of Nutrition, Opportunities in Science and Hygienic practices for leading a healthy life.

ii) Motivational Training Program for High School Science Teachers

A two-day training program was conducted for High School Science Teachers during 23-24 Aug 2016 from various schools of Mysore district. Lectures were arranged on Science Education & Motivation such as Science in ancient India, Teaching basics of physics, adolescence, learning, personality and confidence building and Emerging technologies in science teaching.

iii) Student Camp for promoting innovation

A camp for motivation and promoting innovation to students was held during 7-8 Sep 2016, which was oriented towards motivating bright science students of 11th standard towards taking up science as a career and promoting innovations and technological development in the field of science. Emphasis was given to have a holistic approach to enlighten the students as well as induce curiosity and passion among them towards science.

Lectures were delivered on Science Education & Motivation topics such as Eminent Scientists of India, Stress in adolescents and its management, scholarships/fellowships/educational support available for students to take up science as a career. The competitions were held to students such as innovative solutions to current problems and Brainteasers that involved cracking science related puzzles. The scientific temper of the young students was further triggered by demonstrating simple science based experiments, including chromatography, microbial analysis techniques, microscopy, electrophoresis, principle of siphoning, Archimedes principle and son on.

iv) Innovative clinic for college students (idea presentation, Essay writing etc.)

An Innovative clinic for college students (undergraduate) was organised during February 14-15, 2017. The main goal of this program was to promote interest, excitement and excellence in science education at the school and undergraduate level. Oral and poster presentation competitions were held for undergraduate students. Oral presentations were held for students on topics such as addressing malnutrition in India, Future Food, Life style diseases in India and Mechanization in food processing.

Innovation Clinic for College Students as part of the Students Motivation Programme

III. Cluster Development, Awareness programmes and other activities:

CSIR-CFTRI facilitated support to over 30 food clusters in Maharashtra which include: Technical vetting on DSR/ DPR, Soft intervention programs - HRD activities/ capacity building programs on technology up gradation, quality improvement and management, packaging, regulatory aspects and GMP; establishment of common facility which includes assistance in packaging and advisory technical assistance.

One day Workshop/exhibition on "Super Food Production, Livelihood Development and Products Exhibition" on 13 July 2016 at Indira Gandhi Prathisthan, with the collaboration of Integrated Watershed Management Program (Govt. of India) –State Level Nodal Agency (Govt. of U.P.), Lucknow. The programme was inaugurated by Hon'ble Minister Shri Shivpal Singh Yadav in which Ministers and senior IAS officers attended the programme. About 500-600 progressive farmers, entrepreneurs, departmental heads and officers from different sectors of UP govt. from various districts participated in the workshop. Shri Anjaneya Kumar Singh, CEO and Special Secretary, SLNA UP Govt addressed participants on the importance of super food crops Quinoa and Chia in drought area/wasteland and their further prospects. Prof. Ram Rajasekharan, Director CFTRI, delivered keynote lecture on Agro-technology and Value added products for Super Food Crop – Quinoa and Chia.

- Half-a-Day workshop for Women Entrepreneurs (15 nos.) coordinated by Laghu Udyod Bharati, November 9, 2016
- Workshop for Millets and Pulses farmers (34 nos.), December 22, 2016
- New Super Foods for Agricultural Revolution and Sustainability (500 nos.), June 6, 2016

IV. Popularization of Millet based technologies

Project was initiated on Technology diffusion in the millet processing industry specific to Karnataka, Andhra Pradesh and Maharashtra states to understand the pattern of technology diffusion and to popularize value added products based on millets. A one day brain storming session on **"Prospects and challenges in diffusion of millet based technologies and products"** was held on June 28, 2016 in which representatives from academic Institutions, Industry and

High School Students interacting with faculty during the programme on Motivation of Students towards Science Career

NGOs participated. A Souvenir and a booklet on Millet based technologies were released on the occasion. MilletPro, a mobileapp for the popularization of millets with videos of 21 millet based technologies from CFTRI was developed. A survey was initiated to understand the adaption of millet based technologies in Maharashtra, Andhra Pradesh, Telengana and Karnataka. Similarly a web site, exclusively to popularize the millet technologies is under progress. Also multi-lingual pamphlets on Millet based products in Hindi, Kannada & English were brought out.

Progress Under
R&D Projects

VALUE ADDITION TO AGRICULTURAL RESOURCES

Chitosan based coating formulation *(Harish Prashanth KV)*

E-nose & E-tongue sensor array system has been used to assess quality changes in mango juice flavor prepared from Alphonso mango samples studied for chitosan based coated-mangoes and compared with control. The principal component analysis can explain 91.923% (PC 1), 5.094% (PC 2) and 2.596 variations such that altogether it accounts for about 99.613% of the variations which infers that the mango flavor from coated sample was significantly different from the control. This supports the previous observations, that coating has enhanced sweetness and altered the taste quality.

Separation of turmerone from turmeric oil *(Manohar B)*

C. longa, commonly known as turmeric, is a widely used medicinal plant of the family Zingiberaceae. The major bioactive components in turmeric include curcumin, turmerone and zingeberone. However, the commercial importance of turmerone was not studied. The conventional techniques used for the extraction of turmerone are Soxlet extraction, fractional distillation and molecular distillation. Supercritical CO_2 extraction technique was used for the separation of turmerone. The amount of yield extracted along with the solubility of turmerone in different solvents was observed. The maximum yield was observed using methanol as a solvent, where the highest yield was obtained at 5 h. Hexane was observed to contain the maximum yield of turmerone. Also the extraction of turmerone from curcumin removed turmeric oil (CRTO) using fractional and molecular distillation and also using supercritical CO_2 extraction was obtained. The maximum yield of turmerone was observed in molecular distillate at pressure of 10-15 torr and supercritical extracted fluid at 100 bar.

Vegetable based health products *(Iboyaima Singh)*

Herbal sugar based ready-to-serve (RTS) beverages from beetroot, carrot and pumpkin

The process conditions were optimized for RTS beverages of beetroot, carrot and pumpkin (with and without vacuum concentration). The beetroot, carrot and pumpkin based RTS beverages had excellent colour, flavour and good storage stability. Increasing vegetable purees with herbal sugar concentration resulted in highly acceptable beverages. Sensory and microbiological quality of the beverages was found to be acceptable. The herbal sugar based RTS beverages of beetroot, carrot and pumpkin are the rich sources of carotenes and betalains, total phenolic contents, total flavonoids and vitamin-C. Vacuum concentration of pulps resulted in the retention of phenolic acids. Pumpkin puree based RTS beverages were found to be an excellent source of ferulic acid (557.91 μg/100ml) as compared to beetroot and carrot RTS beverages. The beverages were found to be stable at low temperature (LT, 7±1°C) and room temperature (RT, 29±2°C) for a period of 3 months and 2 months respectively. Beetroot, carrot and pumpkin beverages with herbal sugar as a sweetening agent will be useful in the diet of diabetic persons due to their low calorie content (20-25 Kcal/100g).

Vegetable based jelly candy

Confectionary jellies are commercially prepared using synthetic color, acid, flavour with gelatin as a gelling agent which are low in nutrition and vitamins. Vegetable based jelly candies were prepared using carrot, beetroot and lemon-ginger extracts with pectin as gelling agent. All the candies were highly acceptable with good color and flavour. The jellies exhibited similar shear rate with a load range of 3.04 to 6.07 N. Carrot jelly was found more yellow which could be attributed to the boiling of the extract during the preparation of jelly. In case of beetroot, the value of “a” only indicated a slight red hue and more towards the brown color.

Mixed vegetable juice beverage (V-9)

Mixed vegetable juices containing nine different and commonly found vegetables were used for the preparation of beverages. Two types of beetroot and pumpkin based RTS beverages prepared. Nine vegetables for V-9 formulation were chosen based on the health benefits of the nutraceutical components found in those vegetables. These vegetable beverages can boost health

and wellness of the population with basic nutrition and phytonutrient benefits.

Mechanism of cellular metabolism of important nutrients in fresh cut fruits and vegetables
(Vanitha T)

Mixed salads treated with and without spices were evaluated for the nutritional content, microbial, sensory quality and gene expression during storage (processing to consumption). Salads treated with spices exhibited the higher amount of calcium, iron and zinc compared to control. The calorific value of mixed salads ranged from 21-45 kcal per 100 g. There were no drastic changes in colour and firmness of salads during storage. Salads were sensorily acceptable with the typical desirable colour of the vegetables, optimum firmness and specific aroma of typical vegetables used in the salad without any undesirable off-flavour after the third day of storage. Microbial counts in both treated and control were within the acceptable limits prescribed by FSSAI with total coliform counts not exceeding <101 cfu/g and total aerobic counts <103 cfu/g indicating that the salad preparations were safe for consumption. No yeast or mold growth or *E. coli* was detected in any of the samples.

Processes/ technologies from grain based products
(Manisha Guha)

Multigrain drink mix

A multigrain drink mix as breakfast food was developed which is rich in phenolics, flavonoids and free radical scavenging bioactivity. The powder can be mixed with hot milk and consumed as a breakfast adjunct.

Rice varieties – Nutraceutical properties

Four rice cultivars of which two medicinal folk rice cultivars viz., Kabiraj sal and Kalabhatt along with Talmugur (a high amylose cultivar) and Soha Mahsuri were assessed for their physicochemical, nutritional and nutraceutical properties. Dehusked brown rice was used for analysis. Kabiraj sal variety possessed 22% amylose (inter-mediate amylose category) whereas Kalabhatt var. possessed 5% amylose (waxy/ low amylose category). Kalabhatt var. showed the highest protein (12%), iron (10.09 mg/100g), insoluble (8.3%) and total dietary fiber (8.67%), whereas Kabiraj sal showed lowest insoluble dietary fiber (6.37%). B vitamins such as thiamine (0.89 mg/100g) and riboflavin (0.081 mg/100g) were highest in Kalabhatt variety compared to Kabiraj sal. *In-vitro* starch digestibility results revealed that Kabiraj sal possessed highest starch digestibility (78%), rapidly digestible starch (36.7%), whereas Kalabhatt var. showed the lowest starch digestibility (61.5%), lowest rapidly digestible starch (29.10%) and highest resistant starch (4.29%). Nutraceuticals properties such as polyphenols, flavonoids and anthocyanin content were estimated. Results revealed that 1% HCl methanol extract of Kalabhatt var. showed highest total phenolic (5.33 mg/g), flavonoid (43.7 mg/g) and anthocyanin content (9.48 mg/g).

Proso millet flour

Proso millet flour from dehusked grain was evaluated for nutrient and antinutrient contents. Oil absorption capacity, water absorption capacity, emulsion activity and emulsion stability of proso millet flour were 1.76, 2.36, 46.93 and 49.40% respectively. Proso millet flour inhibited α-amylase and trypsin activities with IC_{50} values of 18.18 μg/ml and 15.26 μg/ml respectively. Proso millet flour is a rich source of various bioactive phenolics such as flavonoids (0.42 mg/g) and proanthocyanidins (0.30 mg/g). Cookies prepared from three different formulations of proso millet-based composite flour contained significantly higher amount of proteins, minerals and carbohydrates.

Barnyard millet phenolics

Evaluation of barnyard millet phenolics for antioxidant activities revealed that these phenolics exhibited multiple antioxidant activities such as free radical scavenging and reductive abilities. DPPH- and ABTS-radical scavenging activities of millet were found to be 1.94 and 0.97 μmol trolox equiv/g flour, respectively. These phenolics also showed strong reductive capacity (11.64 mmol Fe^{2+} equiv/g flour). Barnyard millet phenolics also effectively scavenged reactive intermediates in hexose-induced glycation. Furthermore, phenolic extracts inhibited aldose reductase activity in a dose-dependent manner with an IC_{50} value of 14.56 mg/ml. These results suggest that barnyard millets are the rich sources of antioxidants and natural inhibitors for protein glycation and aldose reductase activities.

Fortification of IR-64 paddy

IR-64 paddy variety was fortified with folic acid by parboiling and infusion techniques separately. The fortified rice is being analysed for folic acid content and better of the two methods would be selected for large scale and shelf-life studies.

Ready-to-eat weaning foods

RTE weaning foods were formulated based on malted grains such as ragi, rice and wheat using drum drying technology. The cereals were malted and a refined flour was prepared. The refined malted flour was blended with malted legume flour and the blend was drum dried to

prepare a ready-to-eat weaning food. The quality characteristics of the products were evaluated. The shelf-life studies of the products were also determined.

From the accelerated storage studies of the formulations it was observed that, the initial free fatty acid value for the samples was 0.0182%, 0.0042% and 0.01405% for ragi, rice, wheat based weaning foods respectively, but as the storage time increased the free fatty acid content of the products increased. After 15 days of storage, FFA of products packed in PET/PE pouches increased to 0.0283% (ragi), 0.0154% (rice) and 0.0175% (wheat) and that in metalized PET/PE pouches increased to 0.02175% (ragi), 0.0154% (rice) and 0.0126% (wheat). At the end of 3 months the FFA of products packed in PET/PE pouches increased to 0.04199% (ragi), 0.03595% (rice) and 0.04071% (wheat) and those in metallised PET/PE pouches increased to 0.04598% (ragi), 0.0363% (rice) and 0.04071% (wheat).

Sorghum

Sorghum grains and flour were modified using different modes of heat like hydrothermal, microwave and infrared and the physicochemical properties and the dough texture studied. It was observed that hydrothermal and infrared modified flour resulted in flour with reduced particle size (127-113 μm) and improved water absorption index. Dough could be prepared using water at ambient temperature in heat modified flours and the stickiness was reduced drastically (13N). The dough from heat modified grains had rollability characteristics similar to wheat dough and could be rolled without breaking (12-15 cm diam.).

RTP sambar and rasam tablets

Vegetables like carrot, onion, potato and tomato were cleaned, cut and dehydrated for use in a formulation. Spices were ground to size and pulses and grains were milled and processed. They were pressed into circular discs and "burfi" shaped square discs. These discs were reconstituted into sambar or rasam by boiling with requisite quantity of water.

One sambar cube weighing ~20-25 g when reconstituted in water gave 200-250 ml of sambar which can fulfil the requirement of 3-4 people. Similarly, one rasam disc weighing 5.5 g will give approximately 50 ml of rasam when reconstituted in water, with a pH of 5.5. Sensory analysis indicated good acceptability for both the products. The nutrient analysis indicated that the sambar mix had a protein content of 15.52% with 3.19% fat. The rasam mix had a protein content of 14.4% and fat content of 3.13%. The crude fibre content of sambar mix was lower (1.95%) than rasam mix (2.19%).

Fabricated dhal (dhal analogue)

Shaping of dhal analogue grits into dhal-like product was attempted using a Kompak extruder. Raw materials used were maize, sorghum, bengal gram, tur dhal and defatted soybean flour with and without xanthan gum. The experiments were conducted under various conditions of moisture and particle size of the flour (with and without xanthan gum) and operation parameters of the extruder. Addition of xanthan gum gave a product with slight puffing at temperatures above 100°C. It was found that the particle size of the flour had little bearing on the shaping characteristics. Higher pressures of extrusion gave a hard product and cooking time was higher as compared to control. Dhal analogue prepared was found to be lighter in colour as compared to control (tur dhal). Cooking time for dhal analogue was less than 10 minutes and tur dhal was about 28-30 mins. Dhal tadka and sambar prepared using dhal analogues were found acceptable sensorily. A few panellists indicated slight stickiness in the cooked dhal analogue product.

Sambar cubes

Rasam cubes

Fabricated dhal

Fish processing waste oil for biodiesel production
(Tanaji Kudre)

Biodiesel production from marine fish oil (procured from fish plant) and fresh water fish oil (extracted from fresh water fish processing waste) was carried out in a controlled batch reactor (10L) with 5L working volume (oil). Three runs (5L batch) for each oil using respective optimum conditions obtained was carried out. Biodiesel produced from marine fish oil gave 94.6% biodiesel yield at 1% NaOH, 1:0.5 oil to methanol ratio, 50°C reaction temperature, 90 min reaction time and 300 rpm stirring rate whereas, fresh water fish oil gave 93% biodiesel yield at 0.75% KOH, 1:0.5 oil to methanol ratio, 55°C reaction temperature, 60 min reaction time and 300 rpm stirring rate. Physicochemical properties of both biodiesel produced in 5L batch reactor from marine and fresh water waste oils were studied.

Biodiesel production from marine fish plant oil was carried out in controlled batch reactor (70L) with 50L working volume using 1% NaOH, 1:0.5 oil: methanol ratio, 55°C reaction temperature, 60 min reaction time and 250 rpm stirring rate. 93.9% (v/v) biodiesel yield was obtained at used aforementioned conditions. The purity of biodiesel was investigated by employing TLC analysis. The TLC result revealed the presence of single spot band in produced biodiesel sample, which indicates that the triglycerides in the fish oil have completely converted into biodiesel. The final biodiesel had moisture content, ash content, flash point, fire point and smoke point of 0.20%, and 0.06%, 110°C, 115°C and 12 mm, respectively.

Glycerine from by-product fish oil biodiesel

Effects of different acids on recovery and purification of crude glycerol obtained from biodiesel production using both marine and fresh water fish waste oils were studied. In this study, crude glycerol under gentle stirring was acidified with different acids (sulfuric acid, hydrochloric acid, and phosphoric acid, respectively) to a desired pH level and was kept for a sufficiently long time to allow the formation of separate layers. Glycerol-rich phase was separated and neutralized using 12 M KOH solution followed by evaporation of water at 110°C for 2 h and filtration to remove the precipitated salt. The resulted glycerol was further purified by solvent extraction process using methanol as solvent. Amongst all acids used, hydrochloric acid (HCl) found to be the best purifying agent for crude glycerol obtained from both marine and fresh water fish oil biodiesel production, followed by phosphoric acid (H_3PO_4). HCl gave 94.6% and 90.4% purity in glycerol derived from marine and fresh water fish oil biodiesel production, respectively. The moisture content, ash content, pH and viscosity of purified glycerin from byproduct of marine oil biodiesel were 0.8%, 1.0%, 8.4 and 696 cP, respectively which is closer to that of the commercial sample.

Fish meat based texturized products
(Rathina Raj K)

Attempts were made to develop a process for texturized convenience products like fish balls, fish cutlets, fish patty, fish cubes from fresh water cat fish, basa, which has bland taste. Preparation of convenience fish products involves the use of binders and fillers. Fish balls were prepared using basa fish and the different flours (as fillers) in varying combinations. Sensory and texture profile indicated that 5% refined wheat flour and 15% skim milk powder was optimum for good quality fish balls. A fish cake is a croquette made of minced fish meat together with mashed potatoes, filler ingredients like corn, potato starch or refined wheat flours and mix of spices. It is coated in egg batter, bread and fried fish cakes made with steam cooked fish mince and potato starch received highest overall sensory acceptance.

Fish balls

Fish cakes

Fish patties

Fish cubes

Steam cooked basa fish mince was used for the preparation of fish patties. Formulated spice mix and cooked fish mince were mixed thoroughly and made into patties using patty making machine. The patties were then battered and bread coated, kept frozen until sensory analyses after frying. Patties prepared with 1:2 ratio of vegetables and fish meat were most preferred by the panellists. Paste consisting of minced basa fish meat, salt, sugar, seasonings, oil, texturing agents and STPP was prepared and made in to small cubes after steam cooking. The cubes can be frozen or can be dried for storage. The frozen cubes or rehydrated cubes can be added to gravies. Among the wheat flour, rice flour, maida flour and corn flour, which are used as the texturing agent for preparing fish cubes, corn flour at 15% level was found to be the best suitable texturing agent level for making good quality texturized fish meat cubes when compared to other flours such as rice, wheat or maida.

Effects of different drying methods and cryo/ dryoprotectants on physicochemical and functional properties of surimi prepared from *Piaractus brachypomus* were evaluated. The surimi powders added with cryo/ dryoprotectants showed protein contents in the range of 55.5-62.45%, 27.56-31.35%, 3.12-5.12%, 3.75-7.29% and 0.85-1.50%, respectively. Surimi powders prepared with cryo/ dryoprotectants presented slightly higher whiteness as compared to surimi powders prepared without cryo/ dryoprotectants at all drying methods. SDS-PAGE revealed that the surimi samples dried by vacuum shelf dryer (VSD) and freeze dryer (FD) exhibited high intensity MHC bands than that of surimi powders dried by dehumidified dryer (DH), infrared dryer (IRD) and hot air tray dryer (HATD), respectively, regardless of cryo/ dryoprotectants used. Amongst all cryo/ dryoprotectants used, the 4% maltodextrin + 4% sorbitol (MS) and 4% trehalose + 4% sorbitol (TS) had the lowest degradation of MHC molecules followed by 4% sucrose + 4% sorbitol (SS) and 8% sorbitol (S), respectively in all drying methods. Furthermore, control surimi powders were presented higher TBARS values and surface hydrophobicity than that of surimi powders contained dryoprotectants. VSD and FD displayed high protein solubility of surimi powders as compared to other drying methods. Amongst the cryo/ dryoprotectants used, the surimi prepared with MS and TS had higher protein solubility, followed by surimi added with SS and S, respectively. Surimi powders prepared with MS and TS using VSD and FD exhibited better emulsification, foaming and gelation properties compared to other surimi powders. Overall, the study found that drying of surimi from *Piaractus brachypomus* using vacuum shelf drying/ freeze drying in the presence of 4% maltodextrin/4% trehalose in combination of 4% sorbitol provided the best cryo/ dryoprotective effects with exhibiting good functionalities. Further, Chakli (Indian snack) was prepared from surimi powder and optimized the spice formulation.

An inexpensive, natural origin formulation consisting of chitosan-green tea extract with antimicrobial and antioxidant activity was developed for preservation of fish fillets.

Dehulling of niger seeds *(Sridevi A Singh)*

In the present study, colour pigments were extracted from niger seeds (*Guizotia abyssinca*), a minor oilseed. Niger seeds extracted by repeated extraction and precipitation resulted in a yield of 5 g/L (dry weight basis). The colour was soluble in DMSO but insoluble in other solvents such as water, HCl, ethanol, methanol, chloroform etc. The purity of this colour were also determined. The extract possessed significant antioxidant activity. Stability of the pigment was checked in order to determine its potential used as a natural colourant. Under continuous effect of temperature, light, metal-ions, oxidant and reductant, the pigment was found stable. The pigment can find applications in food, cosmetics and functional food industries.

Teff and millet extruded product

Injeera

Dense millets and shelf-stable intermediate moisture vegetable pastes *(Jyothirmayi T)*

Dehydrated chukkakura (*Rumex vesicarius*) leaf protein isolate was prepared with a protein content of 74% and it was used in the preparation of biscuits to enhance the protein content up to 15-20%.

Low-calorie ready-to-serve beverage was developed from *Hibiscus cannabinus* (*gongura*) using a natural sweetener (steviol glycosides). The product was found to be microbiologically safe and acceptable.

Extruded RTE products using cereal, millet and pulse combination

Millet based soup sticks were standardised and ERH and packaging studies were carried out. Protein enriched millet-cereal-pulse in combination with carrot puree were optimised based on ERH and packaging studies were carried out. Trials were undertaken for millet based (foxtail millet) premixes for a sweetmeat such as paramannam/pongal.

Snack products based on teff and minor millets

Teff flour and minor millet flours were used to prepare extruded products. Instant injeera mix was developed and prepared injeera (African traditional product) for sensory evaluation. The products were found acceptable in sensory studies.

Capsicum and capsicum-chilli sauce: Red, yellow, green capsicums in combination with green and ripened wet red chilli were used in the preparation of sauce and storage studies are in progress.

Seasonal dehydrated vegetables: Various seasonal vegetables (gajar, capsicums, lettuce, onion, green chilli, carrots) with various pre-treatments as well as dehydration methods were dried and stored in flexible packaging materials.

Instant manchurian mix: Instant manchurian mix using ingredients such as corn flour, amchur, spices and dehydrated vegetables such as tomato, onion, garlic, green chillies, etc. is being standardised.

Value added products from vegetable wastes: Capsicum, onion and lettuce wastes have been dehydrated for use in vegetable mixes (base materials for vegetable manchurian) and tomato was processed into puree and the seed separated was extracted for oil.

Processing of fresh green/red chilli: Development of culinary multipurpose product from fresh chilli (*Capsicum annum L.*) pastes and studies on storage stability is under progress.

Puffed amaranth (*Amaranthus paniculatus*) seed snack bar: Amaranth seed (rajgira) was used in the preparation of a baked energy bar using puffed amaranth seed, puffed rice, roasted peanuts, jaggery, butter and rice flour. It was evaluated for acceptability, nutritional composition, antioxidant activity and shelf-life. The optimized energy bar showed 5.6% moisture, 11.5% protein, 11.9% total fat, 1.1% crude fiber and 63.1% carbohydrates.

Antioxidant and antimicrobial potential of fresh fennel herb (*Foeniculum vulgare*): Fennel (*Foeniculum vulgare*) herb was analysed for volatiles by GC. Ethanol and aqueous extracts of fennel leaves were investigated for their antibacterial activity. The ethanol extract showed moderate inhibition against *Staphylococcus aureus* (ATCC-25923) and *Streptococcus pyogenes* (MTCC-442) while aqueous extract was resistant when compared to chloramphenicol. The leaf was also utilized in the preparation of *vada*, a traditional deep fat fried snack.

Cinnamon flavoured candies/burfi: The process parameters such as ingredients (sugar, liquid glucose,

Amaranth seed snack bar

Fresh Fennel Leaves

Fennel leaves incorporated *vada*

honey, desiccated coconut and cinnamon powder/ cinnamon oil), temperature, etc. for the development of cinnamon flavoured hard boiled candies and cinnamon based coconut burfi were standardised.

Value added products from pumpkin
(Sathiya Mala K)

Pumpkin flour incorporated extruded products: Pumpkin flour was incorporated in vermicelli, noodles and pasta. The prepared extruded products were evaluated for shelf-life studies. However, in all the three extruded products the pumpkin flour could be incorporated at levels of 10%. Incorporation beyond 10% affected the acceptability as well as texture of the extruded products with a shelf-life of more than 6 months when packed in Met/PET/PE and stored under normal storage conditions without affecting the texture or colour of the products.

Drum-dried pumpkin-cereal flakes: Pumpkin flakes were prepared using pumpkin pulp along with ingredients such as ragi flour/corn flour, sucrose, glucose and pectin. The pumpkin-cereal flakes can be used as an ingredient in beverages, jellies, ice creams and other products as a source of β-carotene.

Stability of carotene rich pumpkin vermicelli was evaluated in extruded samples using α-amylase treatment followed by extracting with hexane. It was observed that there was lower loss of β-carotene in the extruded product.

Carotene fortified peanut and olive oils were exposed to ambient (29 ± 3°C) and accelerated conditions (60 ± 3°C). The samples were analysed for colour, FFA, POV and β-carotene was analysed by HPLC to evaluate the losses during storage (0, 7, 14, 21 and 30 days and 3, 7, 10 and 12 days respectively).

Technology protocols for commercial mangoes grown in North India *(Gothwal PP)*

Data revealed that the PLW of fruits increased with progress in storage period. PLW of control fruits have shown maximum weight loss while treated fruits recorded lower PLW. This could be due to increased transpiration losses and enhanced respiratory activities in fruits. TSS of treated fruits increases gradually during ripening and attained maximum 19.0°Brix in *Dashehari* mangoes and 20.7°Brix in *Langra* mangoes. The decrease in titratable acidity during ripening in treated mangoes was slow whereas the acidity decreased at faster rates in control fruits exhibiting accelerated ripening of control fruits over treated. Total sugars showed a continuous increase during ripening; however the decrease in reducing sugar was faster in control fruits as compared to treated fruits. Total carotenoids content increased with progress of days of storage in both treated and control fruits. Total chlorophyll content in fruits decreased with progress of days of storage in both treated and control fruits. The mangoes were evaluated for sensory parameters at various intervals i.e. 0, 10, 14, 21 and 27 days (*Dashehari* mangoes stored in cold storage); 0, 5, 10 and 14 days

Pumpkin Flour


Pumpkin Flour Incorporated Vermicelli


Pumpkin flour incorporated noodles

Pumpkin flour incorporated pasta

(*Dasheshari* mangoes stored at room temperature) and 0, 5, 10, 20 and 25 days (*Langara* mangoes stored in cold storage); 0, 5, 10 and 15 days (*Langra* mangoes stored at room temperature) respectively. *Dashehari* mangoes stored at a temperature of 12-13°C were good up to 27 days of storage period. However, in case of mangoes kept at room temperature were better up to 14 days of storage period. *Langara* mangoes stored at a temperature of 12-13°C were good up to 25 days of storage period. However, the mangoes kept at room temperature were better up to 15 days of storage period. Products prepared from ripened mangoes (after completion of study of shelf-life extension) were good and further storage studies are under progress.

Value added products from underutilized rhizomes
(Madhava Naidu M)

Development of a facile process for de-bittered starch flour from Curcuma angustifolia L. rhizomes

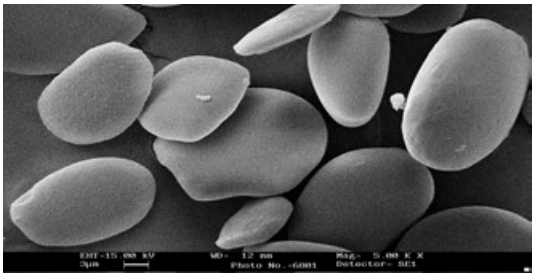
Curcuma angustifolia L. rhizomes were washed, air-dried and stored in cold room at 4ºC. Rhizomes which contained ~60% moisture were taken in each experiment. Peels were removed by de-skinning of the rhizomes. The de-skinned rhizome were sliced and made into a paste form. Water was added to paste and passed through a muslin cloth. The fibrous residue was discarded. The filtrate in each trial was subjected to pretreatments with different reagents. The treated mixture in each case was centrifuged at 5000 rpm for 30 minutes supernatant discarded and residue was re-dissolved in water. This was neutralized to pH 7 and centrifuged. The resulting flour sediment was washed with water to afford a clean white product. The concentrations of 0.25% gelatin, NaOH (0.1%) and $K_2S_2O_5$ (2%) were found to be optimum for the removal of bitterness from *Curcuma angustifolia* with little effect on physico-chemical characteristics of flour. The product obtained after sun drying was subjected to sensory studies for its color and taste attributes and also the prepared flour was evaluated for its chemical composition, mineral profile, and functional properties. A simple solution for effectively removing the bitterness of *Curcuma angustifolia* L. rhizomes and obtaining quality shelf-stable flour has been developed. The new process is less tedious and time saving compared to the traditional process.

Value added products from green coffee
(Pushpa S Murthy)

Green coffee beans (GCB) are rich in phenolic acids, especially the chlorogenic acid (CGA) with potential health benefits for consumers. The solvent residues of the green coffee extracts were impassive and on analysis were confirmed to have very low levels. The extracts did not contain any ochratoxin and the microbial load was safe. Thus, pre-treatment and decaffeination using GRAS solvents enabled enriched CGA from coffee beans which could be useful for commercial purpose and in application of green coffee extracts for use in food formulations and beverages. Further, the coffee extracts were encapsulated in nano-size range using milk protein

Curcuma angustifolia rhizomes

Curcuma angustifolia Starch



Curcuma angustifolia starch granules

as the carrier material. The samples were characterized for thermal stability, emulsion-droplet size, morphology, chemical properties and storage stability. The investigation signified the nanoencapsulation of green coffee conserves increased its thermal stability up to 150°C compared to native extracts (~80°C). The nanoencapsulation efficiency was found to be 80%. The particle size of samples with varied concentration of extracts was in the range of 30-100 nm. The absorption maximum observed at wavelength 325 nm of native and nanoencapsulated samples have confirmed the retention of chemical properties. The nanoencapsulated green coffee extracts can be used for the development of novel food products.

Up-gradation of sugarcane juice technologies *(Ramalakshmi K)*

Experiments were conducted to optimize the protocols for the preservation of sugarcane juice in PET bottles to ensure the safety as well as acceptability of the product. Sugarcane after pre-treatment were crushed and formulated with permitted additives, thermally pasteurized and hot filled in PET containers. Fresh as well as processed samples were analysed for pH, titratable acidity, Brix, total plate count, *E. coli* count, yeast and mold count. Sugarcane without removing the outer peel can be used for the experiments after dipping the canes in boiling water which could reduce the microbial load without affecting the taste of the juice. Preservatives such as potassium metabisulphite can be used for the preservation after acidifying the juice. Experiments are in progress to optimize the addition of preservatives at different stages followed by thermal pasteurization to produce the shelf-stable product in PET bottles with a desired shelf-life of six months.

HEALTH FOODS & NUTRACEUTICALS

Rice bran oil nutraceutical concentrate *(Suresh Kumar G)*

Oryzanol, an active principle of rice bran oil is known to have hypolipidemic property. Rice bran oil concentrate was evaluated for its effect on diabetic nephropathy induced rat model. The optimum concentration was found between 0.1 and 0.3% of nutraceutical concentrates for the diabetic study, which was evident through blood glucose and lipid profile. Diabetic nephropathy (DN) markers were evaluated by glomerular filtration rate (GFR). Histo and immuno histopathology was carried out using PAS stain and collagen IV antibody. Proteins and gene expressions related to lipid and extracellular matrix showed that both 0.1 and 0.3% was effective concentration to treat diabetes. However, β-oxidation studies did not. It concludes that concentrate has the ability to down regulate the expression of transcriptional factor hence reduced the synthesis of lipid but did not alter the β-oxidation related gene expression.

Health foods/ nutraceuticals based on natural ingredients *(Sukumar Debnath)*

High fibre snack food using rice bran

The incorporation of dietary fibre in formulation of traditional snack foods improved their dietary value. A high fibre snack food using specially processed rice bran (SPRB) with negligible silica content with desirable sensory quality was prepared. Maida, SPRB, salt and spices were blended and mixed with water and circular shapes were formed using low pressure extruder and baked using microwave. The effect of incorporation of SPRB at varying levels (5-15%) on the quality characteristics of snack food (papdi) and sensory attributes of the products were evaluated. Results showed that the dietary fiber content was found to increase (13.3-26.1%) significantly with increasing levels of SPRB as compared to control. A slight increase in protein content (10.3-14.4%) was observed in SPRB based snack food in comparison to control. On the basis of sensory characteristics, baked snack food (papdi) with incorporation of up to 10% SPRB was found to be acceptable.

Downstream processing of edible oil from sesame using Three Phase Partitioning (TPP)

The objective of the present study was to extract the oil from sesame using TPP and optimization of the process parameters for extraction using non-carcinogenic solvent. The TPP was carried out by adding t-butanol and salt to the sesame slurry, resulting in the extraction of sesame seed oil into alcohol-rich upper phase. The slurry was pre-treated for the enzymatic action using combination of enzymes cellulase and protease. The efficiency of this extraction process using enzyme is compared with that of the Soxhlet and TPP. The concentrations of t-butanol and salt, and pH were optimized to maximize the yield. The extracted oil was used for preparation of the fried snack food. The sensory evaluation of the product showed that the fried snack product was sensorially acceptable. This simple and effective process can be used to achieve high extraction yields with good oil quality. The process can be applied for large-scale oil extraction from oil seeds using non-carcinogenic solvent.

RTS flavoured beverage from palm jaggery

Palm Jaggery is a traditional Indian sweetener, known for its medicinal properties and higher source of vitamins and minerals. The preparation of palm based ready-to-serve beverage (RTS) with palm jaggery along with a few flavourants viz. lemon, mint, cardamom and ginger was standardised. Sensory profile and consumer acceptance was found satisfactory. Microbial analysis of RTS beverage stored indicated that the beverage was safe for consumption even after 30 days.

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

Kojic acid has been selected as a starting compound to synthesize Nigerloxin, due to its easy availability and reactivity. This is a suitable raw material as expected functionalities of Nigerloxin can be designed through various functional transformations. The hydroxymethyl group of benzyl protected kojic acid was oxidized. The formation of carboxylic acid has been ascertained.

Hydroxymethylation of intermediates was carried out by the reaction paraformaldehyde in the presence of mild base ($KHCO_3$) using ethanol as the solvent. The desired product was obtained, and it was observed that the yield of the product was less (<20%). The progress of reaction was monitored and the final product was confirmed. To continue with the present scheme, the product has to be de-protected. The de-protection of benzyl protected hydroxymethyl kojic acid was carried out with Pd/C and $Pd/BaSO_4$ in DMF under hydrogen pressure of 10 Atm. Reaction was very slow. The hydrogen pressure was increased to 30 Atm and agitated for 3 h. The de-protection of the benzyl group was not seen however, the reduction of double bond was observed. Hence, the de-protection of benzyl group before carrying out the hydroxymethylation (to yield comenic acid) was undertaken.

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

From the current study, it was found that the indigenous isolates of *L. plantarum*- group (LPG) were divergent in relation to adhesion genes (*fbp* and *mub*). The LPG isolates exhibited deletion, duplication, and speciation events in the mucin binding adhesion (MUB) domain repeats, suggest inter-strain diversity. Further, the different strains of LPG from fermented foods harbored the *pln* locus with genetic diversity. The expression of certain genes of *pln* locus suggested the detection of WCFS1, NC8, J23, J51 and E1 type of plantaricin. These indigenous LPG strains were found to have good functional attributes like anti-oxidant, anti-cholesterol, and anti-microbial activity. Because of the presence of these properties, the LPG strains could be a good probiotic starter culture protecting the intestinal mucosal layer from the invading pathogenic microbes through their better adhesion to Caco-2 cell line. The isolates *L. plantarum* subsp. *plantarum* E1 and *L. paraplantarum* MTCC 9483 were able to down-regulate the pro- and/or anti-inflammatory cytokines like TNFα, IL-1, IL-4, TGF-β, IL-8 and IL-10 on inflammatory challenge with LPS (lipopolysaccharide) of *E. coli* and *Listeria monocytogenes* Scott A. Hence, the native isolates have the potential to protect and improve the host health by producing anti-microbial compounds and anti-inflammatory cytokines against the invading pathogens.

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

The effect of overexpression of *tHMG1* gene along with NADPH generating genes, *ZWF1* (cytosolic) and *POS5* (mitochondrial) has been studied for squalene synthesis in *Saccharomyces cerevisiae*. It has been observed that when two copies of *tHMG1* were expressed in dual promoter cassette, squalene content was found to be significantly higher with a yield of 35.7 mg/g DCW which was 1.65-3.06 fold and 16.76-fold higher over the single copy overexpression and wild-type strain, respectively. Studies have been carried out to see the effect of promoters (P_{GAL1}, P_{TEF1} and P_{PGK1}) on *tHMG1* overexpression, and it was observed that the promoter efficiency of P_{GAL1} and P_{TEF1} were similar, whereas P_{PGK} was found to be lower when squalene concentration was considered as response. Overexpression of *ZWF1*, and full length *POS5* has improved squalene to 6.99-fold and 4.25-fold, respectively, when compared to BY4741. Overexpression of *ZWF1* and *POS5* coupled with *tHMG1* overexpression has increased squalene yield to 47.44 and 58.57 mg/g DCW which is a 22.27-fold and 27.49-fold higher yield over the BY4741. It shows that the cytosolic NADPH pool was improved not only by *ZWF1* but also by overexpressing mitochondrial NADH kinase gene, *POS5*. Maximum squalene yield was obtained in strain SK17 whose HMG-CoA reductase activity was observed to be 10.9-fold higher than BY4741. These results suggest that mitochondrial *POS5* and high copy number of *tHMG1* are potential targets for improving squalene synthesis in *S. cerevisiae.*

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

For obtaining an antimicrobial compound producing bacteria, different acidic and alkaline food products obtained from Sikkim, India were screened. These food products include, Gundruk, khalpi, Sinki, Churpi, fermented fish, fermented soyabean, etc. From the study, several spore-forming bacilli were found to exhibit inhibition zone against *Micrococcus luteus* ATCC9341. For mode of action studies, general cell wall reporter as well as subtilin reporter was used. Results indicated that among 45 zone producing cultures, 15 were found to produce antibacterial substance that acts on cell wall. Besides, 10 cultures were found to react with subtilin reporter. In addition, lactic acid bacterial isolates (39 nos) were subjected for their antibacterial activity against *Listeria monocytogenes* Scot-A and *Micrococcus*. Results indicated that most of the bacterial isolates were found to inhibit the growth of *Listeria* suggesting their ability to produce anti-listerial bacteriocin. In addition, six of the nisin producing lactic acid bacteria obtained from fermented foods are being investigated using nisin-specific reporter culture.

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

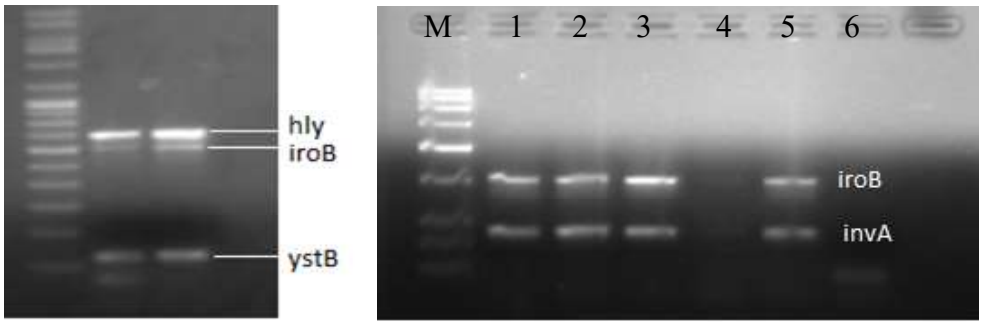
Sequence analysis of fibrinolytic enzymes from *Bacillus* spp. for their diversity was carried out. The diversity of fibrinolytic enzyme among bacilli group was investigated. The alignment of three peptides from *B. amyloliquefaciens* CFR15-protease and two peptides from *B. circulans* were performed using CLUSTAL OMEGA. There were conserved amino acid residues at certain positions in the sequences of above cultures with known fibrinolytic enzymes of other *Bacillus* species in the database. This shows the common evolutionary origin of those enzymes among many *Bacillus* spp. Based on the degenerate oligonucleotide primers designed, the sequenced PCR product showed high similarity. In addition, 32 kDa protease from *Bacillus amyloliquefaciens* CFR15 were purified. Confirmation of fibrinolytic activity of the enzyme and action on different protein substrates were studied. MS/MS analysis of fibrinolytic enzyme CFR15 and fibrin degradation products suggest random cleavage by CFR15 protease. In addition, confirmation of preference of the enzyme towards different chains of fibrin, APTT and PT assays for clotting mechanism was also investigated.

Non-alcoholic vegelactic beverage(s) - 49 Laβev *(Vijayendra SVN)*

The juices extracted from different vegetables, i.e., beetroot, tomato, cucumber and bottle gourd were fermented using a native isolate of *Lactobacillus plantarum.* These non-alcoholic lactic beverages were found to be stable in terms of sensory, microbial and colour stability for 30 days at 5°C. Fermentation increased total betalains by two folds (1.14 mg/ml) in beetroot beverage, 2 fold increase in beta carotene and lycopene in fermented tomato beverage. The lyophilized extracts prepared using fermented bottle gourd, tomato and cucumber juices were found to have antimicrobial activity against *S. aureus, E. coli* and *B. cereus.* All the laβev lactic beverages showed appreciable DPPH radical scavenging activity with an IC_{50} ranging from 0.7-0.9 mg/ml. Fermentation increased the amount of phytonutrients like gallic acid, chlorogenic acid and epigallocatechin in tomato juice, ferulic acid in beet root and syringic acid in cucumber juice. Fermented bottle gourd beverage was found to contain chlorogenic acid and quercetin, which were not present in the fresh juice before fermentation. A cheaper medium using okara as a substrate was standarzied to grow the lactic culture in large volume. Using this medium, a viable cell count of 6.32 x 10^{12} CFU/ml was achieved at the end of a fed-batch fermentation after 50 h. The pulp generated after extracting the juice from beetroot was made into a snack food like beet bar, which had a shelf-life of 50 days in refrigerated condition. It contained 3.8% proteins, crude fiber 2.18%, dietary fiber 11.57% (soluble) and 1.12% (insoluble).

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

Multiplex reverse transcriptase (RT- PCR) is an efficient tool in detecting multiple pathogens in a single reaction and also in differentiating live cells from dead cells. The aim of the study was to optimize RT-PCR technique for the simultaneous detection of the major food borne pathogens and validate using chicken meat samples. Sensitivity of the assay was also evaluated. The technique was standardized using *iroB* gene of *Salmonella enterica* (MTCC 3223 and MTCC 9844), *ystB* gene of *Yersinia enterocolitica* (MTCC 3238) and *hly* gene of *Listeria monocytogenes* (MTCC 657). Brain Heart Infusion Broth (BHI) at 37°C for 16 h was selected as uniform enrichment protocol for the simultaneous growth of the three pathogens. RNA isolation was carried out by a modified protocol using TRIzol and converted to cDNA. Theoretical DNA detection limit for the three organisms was carried



Multiplex PCR for the detection of *hly, iroB* and *ystB* genes using cDNA and PCR amplification of *invA* and *iroB* genes

out by serially diluting (1:10) known concentrations of DNA and subsequently performing PCR. Validation of the standardised technique was carried out by artificial contamination of meat samples using *Salmonella enterica* in different concentrations. Tetrathionate broth was used for the selective enrichment of *Salmonella* from chicken samples and DNA was isolated for PCR. Similarly, SYBR Green I-based real-time quantitative PCR amplification was performed using Step one™ for detection of *Listeria*. Following amplification, a melting curve analysis programme was performed to verify the authenticity of the amplified products by their specific melting temperatures (Tm).

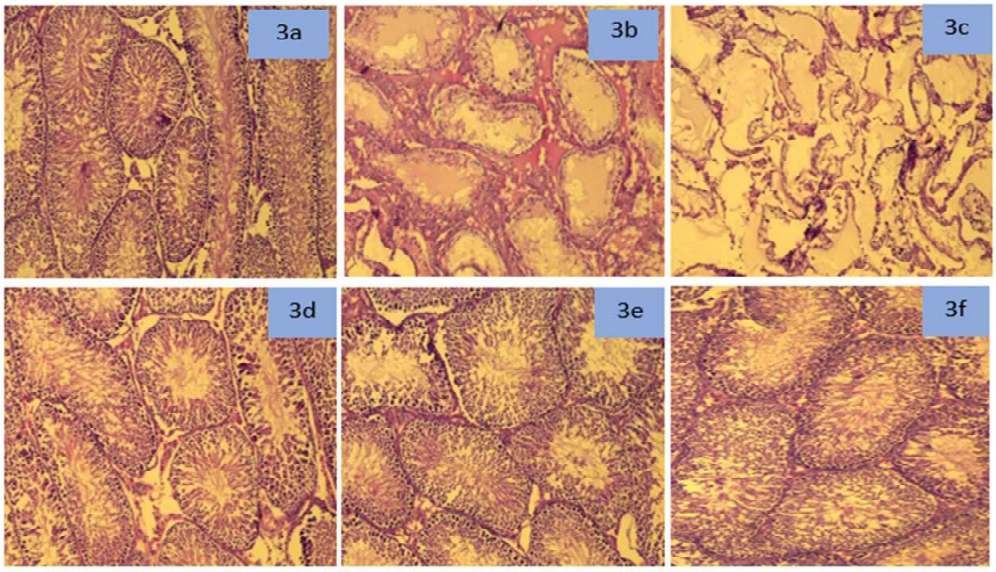
Primers specifically amplified a 606 bp region of the *iroB*, 122 bp of *ystB* and 713 bp of *hly* genes simultaneously at an annealing temperature of 58^{0}C. The PCR technique could detect a DNA concentration of up to 1 ng/ µl for *Salmonella* and *Yersinia* sp., and 0.0025 ng/µl for *Listeria* sp. The multiplex PCR standardized did not show any non-specific reaction with other competing organisms. In the artificially contaminated meat samples, primers specifically amplified a 275 bp and a 606 bp region of the *Salmonella enterica* (MTCC 9844) invasion (*invA*) and fur-regulated (*iroB*) gene respectively at an annealing temperature of 58^{0}C. Absolute quantification of DNA using real time PCR by standard curve method was carried out for *Listeria monocytogenes* hly gene (64 bp).

Proteinaceous material from waste water streams of fish/ meat processing *(Tanaji Kudre)*

The protein rich waste water from fish processing market and slaughter house were collected. The chemical compositions and microbial quality analysis of collected waste water is in progress. The impact of pulse electric field on reduction of microbial load and protein recovery from fish/meat processing wastewater stream are to be evaluated.

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

Spirulina has been established to contain vitamin B_{12} i.e methyl cobalamin and therefore it would be relevant to evaluate *Spirulina* as a source of bioavailable vitamin B_{12}. Studies were carried out for ten weeks with male weanling Wistar rats; the control group a) received AIN 93 diet and other groups received vitamin B_{12} deficient AIN 93 diet as follows: b) without any intervention; supplemented with c) standard vitamin B_{12} ; d) *Spirulina* biomass (32.25 g/kg diet), and e) *Spirulina* biomass (65 g/kg diet). The organ weight profile of rats of all the groups was similar except for the spleen of the vitamin B_{12} deficient group which showed approximately 40% decrease in weight. This may have impact on immunological status of the animals. Further the osmolarity of red blood cells (RBCs) constituting haemoglobin was evaluated. The RBCs of vitamin B_{12}



Testicular histology: (3a) Control showing normal cellular architecture (3b) & (3c) Deficient group clearly indicating severe atrophy and degeneration of seminiferous tubules and clear azoospermia, tubular lumen is filled with debris and the tubular cellular architecture is completely destroyed (3d) Standard B_{12} showing normal cellular architecture and (3e) 1X *Spirulina* & (3f) 2X *Spirulina* groups showing normal cellular architecture with intact tublules with spermatogonia, spermatids and spermatozoa (10X).

deficient group exhibited a high susceptibility to damage, while vitamin B_{12} /*Spirulina* fed groups showed RBC recovery. Results were substantiated with higher plasma homocysteine levels in deficient group (15.106 ± 1.859 μmol/L) correlating with lower vitamin B_{12} in kidney (3.149 ± 0.387 μg/kg) and liver (1.534 ± 0.330 μg/kg). Further lower plasma homocysteine levels in standard B_{12} and *Spirulina* fed groups (8.777 ± 1.00 and 7.334 ± 0.892 μmol/L) correlated with higher vitamin B_{12} in kidney (9.797 ± 1.558 and 10.011 ± 1.322 μg/kg) and liver (5.571 ± 0.598 and 6.666 ± 1.972 μg/kg) respectively. These data illustrate that cobalamins from algae are absorbed by the rat. Histopathological findings of different tissues viz liver, kidney, lungs, spleen and testes showed normal tissue architecture in control, standard B_{12} and *Spirulina* fed groups. Vitamin B_{12} deficient group manifested the atrophic changes in the testes suggesting dietary vitamin B_{12} deficiency and its role in early spermatogenesis. Recovery of testicular architecture in standard B_{12} and *Spirulina* fed groups substantiates the role of vitamin B_{12}. The results clearly showed the bioavailability of vitamin B_{12} from *Spirulina*.

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

Molecular and biochemical screening of transformants (with theobromine synthase invert repeat constructs) was done. Genomic DNA isolated from the regenerated leaves of three pPINC-6 transformed plants and two pCAMBIA1301 transformed plants indicated them to be transgenic since they gave positive for amplification with primers designed for β-glucuronidase gene and the hygromycin resistance gene. One of the plants transformed with pPINC-6 construct showed complete knockdown of caffeine synthase gene and partial knockdown for theobromine synthase when compared to 1301 transformed plant. This plant also showed strong GUS signal. The amplification of promoter from *Xbal* digested genomic DNA from plant showed that the signal retains to the level of undigested DNA indicating methylation protection in the plant due to the RNA directed DNA methylation by the *si*RNA silencing. Overall, the proposed objectives were investigated by developing promoter invert repeat constructs and their transformation into coffee somatic embryos followed by molecular and biochemical confirmation.

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

Studies confirmed that the fruits of *Malphigia glabra* and *Ixora coccinea* are rich in other important phytochemicals such as ascorbic acid 1.7 g, total phenolics 0.97 g, and total flavonoids 0.27 g and total anthocyanin 26 mg per 100 g FW, which are known to contribute to nutraceutical potential. However, the early stage acerola fruits showed highest total phenolics content of about 3.6% with total chlorophyll content of about 5.72 mg/100 g FW. The polyphenol profiling showed that generic acid, synergic acid, epicatechin and synnapic acid as major phenolic acids and mercitin as major flavonoid. The major carotenoids found were luetin and β-carotene. The fruits of *I. coccinea* showed the total phenolics and flavonoids contents of 0.12% and 0.02% respectively which are quite less to acerola fruits whereas the total anthocyanin content was 0.03% which is slightly higher than acerola fruit. The polyphenols characterization showed that synnapic acid, coumaric acid as major compounds and generic acid, ferulic acid and synergic acid as the minor compounds of *I. coccinea* fruits. Similarly, the flavonoids such as mericitin and quercetin were found to be highest in the *I. coccinea* fruits. The major carotenoid present in the ripened fruit was luetin. Acerola fruit powder prepared out of deseeded fruits has the total phenolic content of 9% and total flavonoid content of 0.1% and 18% ascorbic acid.

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

The main objective of the project was to screen the bioactive compounds present in fruits and leaves of *Physalis minima* and *Carissa spinarum.* The screening of the metabolite was carried out for major phenolics, flavanoids and other health beneficial compounds. *C. spinarum* fruits were found to be rich in anthocyanin, resveratrol and vanillic acid. The fruits of *P. minima* showed presence of withanoloids. Further, the compounds from these fruits were fractioned and these fractions alone and with combination were tested for anticancer properties in cell lines. Anthocyanin rich beverage was developed where the pigment was found to be stable. Also, osmo-dried product from *C. spinarum* fruits was prepared which retained its nutrients.

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

Fenugreek germplasms were collected from local market. *In vitro* callus were induced with combination of various auxin and cytokine along with the MS media. For selection of high yielding cell lines cotyledon, hypo cotyledon and roots were taken from all the germplasms and were subjected for callus initiation. The percentage of callus initiation was calculated on 14th day of inoculation. The results showed that in one of the germplasms cotyledon, hypocotyledons and roots produced maximum percentage of initiation of callus with the concentration of BAP+NAA (2.5+0.5 mg/l). However, the cotyledon parts of the all four germplasms provided

higher response with all the five tested growth regulators, than other parts of the explants. Further the callus of various germplasms was screened for diosgenin and 4-hydroxy isoleucine. The higher yielding callus was used for suspension culture. The kinetics for optimization of key metabolites production under various conditions was optimized.

Automation of *Spirulina* cultivation process
(Sarada R)

An indigenous system for automation of *Spirulina* raceway pond has been designed, fabricated and installed. The design philosophy of automation includes online measurement and data logging for pH, temperature, light, DO, and agitation. The control logic includes pH control via CO_2 supplementation along with conventional acid/alkali doses as optional means. The CO_2 supply system includes CO_2 purging based on pH set point, mixing system with air to control CO_2 concentration and flow rate control. Membrane sparger has been provided for enhanced mass transfer of CO_2 into the algal growth medium. The system has been recently installed and commissioned. The initial trials of the system for *Spirulina* cultivation with CO_2 supplementation and without addition of sodium bicarbonate are in progress. During the installation trials of the automation system, the biomass productivity of *Spirulina* was found to be in the range of 80-90 mg/l/d with cultivation medium lacking sodium bicarbonate and supplemented with CO_2.

The *Spirulina* powder faces the challenge of low consumer acceptance as a food ingredient due to its peculiar physico-chemical properties that pose technical and sensorial challenges which put restrictions in its usage as a food ingredient. Two major challenges could be identified as (i) insolubility of *Spirulina* powder in water, milk and other aqueous media such as fruit juices, beverages etc., (ii) a strong unpleasant odour (sometimes described as stench/fishy odour) putting restrictions on quantity that can be incorporated in a food product. In order to overcome these challenges, a novel process for the preparation of 'Soluble Whole Spirulina Powder' has been developed. The soluble whole *Spirulina* powder will facilitate the incorporation and fortification of several food products without compromising on nutritional and sensory properties. The soluble whole *Spirulina* powder paves the way for the development of various sensorially accepted beverages, traditional foods and dairy products for imparting the nutritional benefits of *Spirulina*. Some of the food products which are currently under consideration are '*Spirulina* ready-to-serve beverage', '*Spirulina* yoghurt', '*Spirulina* fortified beverage mix' etc. Preliminary trials on preparation of 'ready-to-serve *Spirulina* beverage' based on 'soluble whole *Spirulina* powder' have been carried out.

High protein ingredients from plant sources
(Jyothi Lakshmi A)

Flaxseed protein isolate (FPI) was extracted from flaxseeds and was characterized for functional properties viz. solubility, fat and water absorption capacity, emulsifying properties. Whole raw flaxseeds were de-mucilaged in distilled water at 55^0C for 3 h and dried for 24 h and pulverized. The hull was separated using sieving and the meal were defatted. Flax seed protein isolate (FPI) was prepared using isoelectric precipitation at pH 4.2 followed by lyophilization. The final yield of protein isolate obtained was 9% w/w with protein content of 82%. The solubility of FPI was higher at alkaline pH with a maximum solubility (~ 90-100%) at pH 12. The water holding capacity and the fat absorption capacity of FPI were 2.35 and 4.5 g/g, respectively. Emulsifying properties viz., emulsifying activity index and the emulsion stability index were found as 50 ± 5 m^2/g and 110 ± 10 h, respectively. Probiotic strains, *Lactobacillus plantarum* (NCIM 2372) and *L. rhamnosus* (NCIM 2125) were encapsulated by preparing sodium alginate beads containing prebiotic β-manno-oligosaccharides (β-MOS) and/or flaxseed protein isolate (FPI). The encapsulation efficiency was studied by optimizing various parameters like sodium alginate concentration, ratio of [FSPI, β-MOS (low and high molecular weight) and FPI + β-MOS (low and high molecular weight)]. Maximum encapsulation efficiency of beads was found at 1:2 ratio of sodium alginate to FPI and 1:2 ratio of sodium alginate to β-MOS (low and high molecular weight) for *L. plantarum* and *L. rhamnosus*. The encapsulation efficiency of *L. plantarum* and *L. rhamnosus* were mostly comparable to each other, except with β-MOS low molecular weight (β-MOS-L) wherein *L. plantarum* showed slightly better encapsulation efficiency (up to 8.03%). Survival of both the *Lactobacillus* strains under concurrent simulated gastric and bile stress was also studied by preparing beads containing FSPI, β-MOS-L, and FSPI + β-MOS-L. *L. plantarum* when encapsulated with β-MOS-L, showed highest 84% survival under simulated gastric stress (after 1.5 h) and 54% survival under simulated bile stress (after 3 h). *L. rhamnosus* when encapsulated with β-MOS-L, showed highest survival (59%, after 1 h) only in simulated gastric stress and did not show any growth under simulated bile stress.

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

Phenol-based ingredients were investigated to fulfill specific requirements of sports personnel. Fatigue is a feeling of extreme physical or mental tiredness. It usually results in deterioration in performance. Carbohydrates and protein combination (BCAA) along with polyphenol rich ingredients were used for improving endurance capacity in the form of a beverage mix and chews.

The two different functional beverage mixes (functional beverage mix with carbohydrates, whey powder and antioxidants and amla based beverage mix) and a chew like toffee product have been formulated and standardized. The developed functional beverage with different flavours and quality characteristics were analysed by sensory evaluation. The added flavour's has great impact on the taste and acceptance of beverages. Clear taste discrimination was observed between the samples.

Animal trials were completed and results showed positive trend. Human trials will be conducted with the developed functional beverage mix. The developed products can be used as anti-fatigue products both by sports personnel and normal subjects for sustenance of energy levels.

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

Antiplatelet aggregation effect of cardamom

Attempts have been made to investigate the anti-platelet aggregation activity of cardamom spice extracts, as source of natural anti-platelet aggregation agents. Cardamom was evaluated for anti-patelet aggregation in rat platelets. Cardamom resin inhibited AA induced platelet aggregation by inhibiting thromboxane B_2 and 12-HETE levels in platelets suggesting that cardamom resin interferes with eicosanoids involved in platelet aggregation. Cardamom resin reduced the formation of thromboxin B_2 (TXB_2) and 12-hydroperoxy eicosa tetraenoicacid (12-HETE) and 12-lipoxygenase activity (12-LOX) in rat platelets in a dose dependent manner. Anti-platelet aggregation activity was found to be dependent on the concentration of the resin and the inducing agent viz., AA, ADP and collagen. Maximum inhibition of platelet aggregation obtained with cardamom resin was 55, 63 and 78% against 3 agonists AA, collagen and ADP respectively and IC_{50} values were 118, 96 and 96 μg/mL respectively. Antiplatelet aggregation property of cardamom resin was further confirmed with the reduced production of TXB_2 and HETE is reported for the first time. Major flavour constituent of cardamom oil, 1-8 cineole induced 59% platelet aggregation at a concentration of 4 μL/mL. Terpenyl acetate, another major flavour component of cardamom oil neither induced nor inhibited platelet aggregation at 100-300 μL/mL. Regular consumption of cardamom resin could have the beneficial effect of preventing the formation platelet aggregation in humans which requires to be further worked upon.

Anti-inflammatory effect of cardamom in experimental animals

Volatile and non-volatile fractions of cardamom were evaluated for anti-inflammatory influence in two sets of Wistar rats by evaluating the carrageenan induced paw edema. In one set of animals, individual groups of rats were orally administered with cardamom oil, cardamom resin, and standard compounds of the volatile cardamom oil fraction as a single dose prior to carrageenan administration (i.p.). Paw inflammation was measured at hourly intervals for 6 h. In another set of animals, individual groups of rats were maintained for 10 days on diets containing cardamom oil and deoiled cardamom powder, and paw edema was induced with carrageenan administration (i.p.) at the end of diet regimen. The extent of paw inflammation was determined at hourly intervals after the injection of carrageenan. Acetone extract (30%) and water extract (31%) showed higher inhibition of the inflammation compared to ibuprofen (22.7%) in oral gavaging studies. In the dietary feeding study, cardamom oil did not show any inhibition of paw inflammation. De-oiled cardamom powder exhibited positive results which indicated that non-volatile compounds present in the deoiled cardamom powder could be responsible for anti-inflammatory effect. The volatile oil and major components of oil viz., terpinyl acetate and 1,8-cineole did not show any positive effect on controlling inflammation. The anti-platelet aggregation effect and anti-inflammatory effect exhibited by cardamom resin and the non-volatile portion of cardamom spice could be due to the cumulative effect of polyphenols and fatty acids and sterols present in resin.

INNOVATIVE FOOD PROCESSING

Spice/ Masala grinder *(Nagaraju VD)*

A small and compact hand operated domestic spice grinder (conceptual model) was designed in which grinding process will take place by (shearing) rubbing action between stones in order to retain the natural flavour and reduce heat generation during grinding process. The performance of the machine was compared with the plate mill, carborundum wheel and conventional mixer grinder for different selected spice ingredients such as coriander, cumin, fenugreek, chilli and pepper. The physical attributes such as moisture, colour, flavour and texture were analysed by sensory and instrumental analysis. Shear force analysis and thermal analysis of different methods of grinding process were studied for selected spices. Instrumental particle size and colour measurement of spices was carried out using particle size and shape analyser and colour measuring instrument by reflectance. The values L*, a* and b* and particle size were recorded respectively. QDA was employed to assess the quality of spices by trained panellists. Among all the ground spice samples, hand operated grinder showed attractive colour. Fabrication of conceptual model of hand operated spice grinder is in the final stage.

Development of speciality products *(Walde SG)*

Commercial preparations of glucose oxidase (GO) and protease (PR) (0.05 and 0.1% addition levels) were tested for their impact on the bread making performance of gluten-free foxtail millet flour. Optimization of gluten free bread was carried out, PR (0.05%) and PR (0.1%) additions proved to be better in terms of sensory and textural quality. Effect of replacement of wheat flour with 0, 10, 20 and 30% WFMF on the rheological characteristics was studied. The results showed an increase in farinograph water absorption, a decrease in stability, decrease in extensograph resistance to extension and extensibility; an increase in amylograph pasting temperature and peak viscosity with the increased addition of WFMF from 0 to 30%. Atta noodles made from atta produced using different techniques have shown significant variations in quality.

Development of micro/ nano structured cellulose materials from bakery wastes and by-product of wheat milling revealed that the bakery wastes used in this study was rich in source of cellulose material. Pumpkin powder incorporated doughnuts had higher carotenoid content. Total phenolic content increased twice when pumpkin powder was incorporated in the doughnut than control. Refined wheat, finger millet and pearl millet flours were blended in different proportions to obtain composite multi-millets flours were studied to know the processing conditions of waffles. The texture (breaking strength in g force) was highest for the control (3699) and least for S1 (2031) (30% finger millet and 20% pearl millet). All the test samples had softer texture than control which is a desired attribute for waffles.

Detection of benzene in food beverages *(Arunkumar P)*

Studies on benzene in food beverages was carried out due to high consumption of food beverages especially among teenagers. The ready to drink fruit juice beverages stored in PET bottles were exposed to sunlight. Samples were withdrawn periodically to check the formation of benzene by GCMS-Headspace analysis. Prior to that benzene standard of different concentrations (1-5 ppb) was analysed by GCMS-Headspace to identify the retention time (8.475) in selected ion monitoring (SIM) mode. The blank analysis was carried out for the sample in SIM mode and no benzene was identified. At the end of the best before date of the sample ~5 ppb of benzene was formed in the sample exposed to sunlight. The study is still in progress for different samples.

Gold nano incorporated biodegradable film

A biodegradable film incorporating gold nanoparticle in starch and gelatin based film was developed. The main objective of the research was to fabricate a biodegradable film using starch, gelatin, glycerol and gold nanoparticle. The film was prepared by wet casting of the aqueous solution containing starch and gelatin as the polymers, distilled water as the solvent, and glycerol as plasticizer. Films were prepared with various

concentration of gold nanoparticle (0.38%, 0.25%) in combination with starch and gelatin. Gold nanoparticle films showed increase in mechanical properties. However, the mechanical properties of control films were less as compared to that of gold nanoparticle. Compared to starch and gelatin based films, gold nanoparticle incorporated films were found to have better heat seal ability.

Self-heating re-usable containers

Self-heating thermos container has a heating module inside the metal can that are attached within the thermos flask. Exothermic reaction by using calcium oxide with some additives, which are non-toxic, safe and eco-friendly was used as the heating source. Heat is generated by shaking the inner container which contains the chemical reagents. It also proves useful in daily life as one can get hot beverages anywhere without the need of a stove, fire, electrical or other power source. Thermos flask is used as the outside container, which prevents the loss or gain of heat energy. It reduces the heat loss to the surrounding and the product temperature is retained for several hours. Amount of heat transfer and percentage of efficiency of heating from the reaction of calcium oxide with water is measured and a comparative analysis was carried out to evaluate the effectiveness of present model by using different types of liquid beverages.

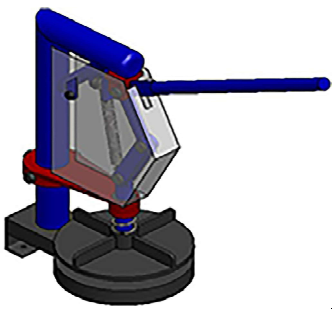
Active packaging system and shelf-life of muffins

Muffin is an individual sized, baked quick bread product. The aim of this project was to extend the shelf-life of muffins without any preservatives as it has only 2-3 days shelf-life. The shelf-life of muffin was increased by a combination of two oxygen scavengers which are zinc based and iron based along with MAP technology. Quality parameters like moisture content, water activity, gas analysis, microbiological content, sensory analysis, colour measurement and texture analysis were done. The muffin with MAP technology was spoiled after 15 days when compared with 27 days with oxygen scavengers. Oxygen scavengers made up of zinc and iron gave good results. Comparatively zinc scavengers extended the shelf-life of muffin while retaining the overall quality of the product.

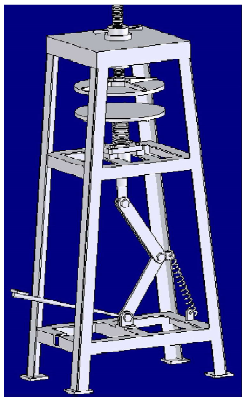
Technological intervention for up gradation of processes/ technologies for grain based products *(Srinivas A)*

A hand operated papad press was designed to produce about 50-60 papads per hour. It consists of fixed and movable plates fixed to a sturdy frame. The movable plate moves parallel to the fixed plate on pressing the handle. Mechanical effort is amplified by the use of toggle mechanism. The gap between the two plates is adjustable to suit individual needs. Papad dough is kept between oil smeared plastic sheets and these sheets are kept between the fixed and movable plates. Upon depressing the handle, the movable plate moves downward and presses the dough, which is formed into a papad. The pressed papad is removed from the sheets and allowed to dry in the sun.

Leg operated papad press was designed for producing 350-400 papads per hour. Depressing the lever by leg amplifies the effort through a toggle mechanism to move the movable plate upwards towards the fixed plate. The gap between the plates can be adjusted to suit requirement of producing papads or *chapatis* or *puris* or *paani puris*. The papad dough (4 nos.) are kept between two oil smeared plastic sheets and these sheets are kept between the two plates. By depressing the lever, the dough gets pressed between the plates thus forming the papads. The papads are then removed from the plastic sheets and spread in the sun for drying prior to packing.



3D model of hand operated papad press



3D model of leg operated papad press

Hand operated pulse dehusker

In order to empower the farmer to not only mill his own pulses to get dhal but also to encourage him to do business by milling the same, the hand operated dhal mill has been designed. This hand operated system can process about 40-50 kg/h. It consists of a truncated cone coated with emery rotating inside a stationary wire mesh cage. The shaft housing this cone can be moved vertically thus adjusting the gap between the rotating emery cone and cage to suit milling of pulses. The system is suitable for pigeon pea (t*ur*), green peas (m*atar*) and Bengal gram (c*hanna*) only. The raw pulse should be soaked in excess water (at ambient temperature) for 60-90 minutes (depending on the pulse and variety). After soaking, the excess water is drained out and the grains are graded (using appropriate sieve) to sort out smaller grains (which have not soaked completely). The big, bolder grains have to be dried in the sun for a day. The smaller grains have to be allowed to soak in excess water for 60 more minutes and then allowed to dry (in a thin layer) in the sun. During drying, the grains have to be mixed every 60-90 minutes, to ensure drying of all grains. After drying, the grains have to be put in a gunny bag and left overnight inside (not open to sky). The following morning, milling has to be done using the Hand Operated Pulse Dehusker (HOPD). The machine works on the principle of abrasion and consists of an emery coated cone fixed onto a vertical shaft. The cone is rotated inside a wire mesh cage with the help of a handle and bevel gear mechanism. Both dehusking and splitting takes place together in the system while aspiration of husk and separation of dhal is done manually by winnowing and sieving respectively.

Pedal operated millet dehuller

Many entrepreneurs and micro enterprise industries have expressed the need for a small scale, manually operated dehusker of millets. Addressing this need, a pedal operated millet dehuller developed earlier was modified. The chassis was changed to a step - through version and a gear train was added to reduce the effort required during pedalling. In addition, the cyclone system was modified for better separation efficiency. A maximum dehulling efficiency for little, foxtail, kodo and proso millets was obtained at 12.8 km/h, 11.3 km/h, 14.5 km/h and 11.3 km/h respectively. Highest dehusking efficiency of 75.21% was obtained for little millet, followed by foxtail millet 67.09%, kodo millet 52.98% and proso millet 51.83% at their respective standardized speeds. A six – speed gear box was fitted to the system to vary the effort by the user. Also, a speedometer indicating the speed of the impeller was fit into the system to indicate the speed at which the operator is pedalling. It was found that the separation efficiencies for kodo millet was 97.14% followed by foxtail millet (95.53%), little millet (93.84%) and proso millet (88.46%).

Corn flakes

Since corn flakes are globally used as breakfast cereals, fortifying the flakes with other cereals can improve the nutritional status of this product. The seed coat fraction from amaranth seed is a good source of protein, dietary fiber and minerals. Thus fortifying corn flour with amaranth seed coat fraction at different concentration was tried for improved nutritional benefits. Accordingly, flakes were prepared and their quality characteristics were studied. It was observed that, with the increase in the substitution level of amaranth seed coat fraction, the nutrient profile of the flakes improved.

RTE maize grits

Maize grains were germinated and the changes in carotenoid content and other physicochemical properties were studied. It was noticed that the extraction of carotenoid content increased upon germination. The grits obtained were treated with hot air to obtain a ready-to-

Schematic model of hand operated pulse dehusker

Pedal operated millet dehuller

eat product which had an expansion ratio of 3.2 and was acceptable when served with milk.

Algae-based value added products *(Sandeep Mudliar)*

Life cycle assessment of microalgae-based CO_2 sequestration facilitated by fresh water microalgae (*Scenedesmus dimorphs*) cultivated in open raceway pond coupled with downstream processing for biodiesel and biogas production was carried out. Total eight possible scenarios were simulated which included upstream scenario of algal cultivation for CO_2 sequestration along with multiple downstream scenarios for biodiesel and biogas production. The downstream processing scenarios for biodiesel production include dewatering technique namely mechanical drying option (MDO) followed by extraction, reaction and purification. Similarly, the downstream processing for biogas production from microalgal slurry incorporated downstream processing with dilute microalgal slurry (post flocculation) and concentrated microalgal slurry (post flocculation and spiral plate centrifugation). These scenarios were also analysed with respect to nutrient addition and extent of nutrient recycling for algal cultivation. The results indicated that algal cultivation energy requirements, biomass productivity and nutrient recycling have major environmental impacts especially with respect to GWP and Eutrophication potential. Further, microalgae-based CO_2 sequestration coupled with biogas is likely to be more sustainable than the biodiesel route and sensitivity analysis with respect to specific energy requirements, algal biomass productivity and net CO_2 sequestration was also analysed.

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

A CFD model predicting the effect of delta wings hydrodynamics and pond geometry on velocity distribution profile and mixing for 1000 L capacity open outdoor raceway pond was developed. CFD model was also developed to predict water velocity profile, gas hold-up profile, interfacial area concentration of air bubble and volumetric mass transfer coefficient in an internal draft-tube air-lift photo-bioreactor. The growth, biomass productivity and biochemical response profile of *Scenedesmus obtusus* was studied in open ponds (under natural light and temperature conditions) and indoor enclosed photo-bioreactor (PBR) system. The effect of hydrodynamic parameters, light intensity and photoperiod on growth and biochemical characteristics was studied in the closed PBR. Additionally, the growth of *Spirulina platensis* in open outdoor raceway was modelled using genetic expression programming (GEP).

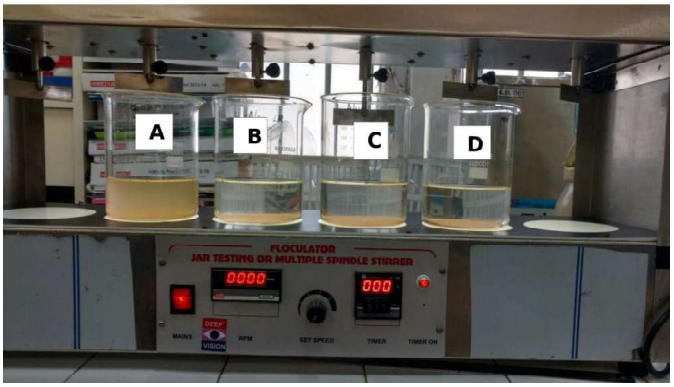
Scale-up and downstream processing of *Morus alba* *(Nandini P Shetty)*

The project aims at identifying the pigments and important metabolites from *Morus alba* and later scaling up their production at bench levels in suspension culture. Different germplasm of *M. alba* were screened for key metabolites resveratrol, anthocyanin and 1-deoxynojirimycin. The best variety which showed the metabolites was used for tissue culture. Identification of nutraceutically important metabolites in different varieties would be of importance for food industry. Even though these fruits are consumed and have been shown to have ethanopharmacological properties, the plants have not been exploited and commercialized due to their non-availability and also lack of research data. The different stages of *Morus alba* fruits grown in Mysuru region were screened for secondary metabolites like phenolic acids, flavonoids - resveratrol and anthocyanin content. The highest total phenolic content, total flavonoid content and total anthocyanin content was found in the matured fruits. The HPLC profiling of fruits showed the presence of gallic acid, chlorogenic acid, resveratrol, rutin, ferulic acid, 1-deoxyneojirimycin, cyanidine-3-glucoside and cyanidine-3-rutinoside as the major secondary metabolites. The project also aimed at improving plant cell culture systems so that the production of high-value compounds is industrially viable. For establishment of callus, various hormone combinations were used for early and higher induction of metabolites. The callus was induced *in vitro* and the metabolite were analysed and quantified for the resveratrol and 1-deoxynojirimycin.

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

The objective of the study was to develop a process for water purification using moringa seed protein. Moringa seed protein isolate (MPI) was prepared from defatted moringa seed flour at optimum conditions. Model turbid water was treated with the moringa seed protein isolate. Quality of the treated water was analyzed and compared with that of water treated with alum, water extract and salt extract of moringa seeds. Residual turbidity was reduced by more than 97% for highly turbid waters on treatment with MPI. MPI treatment did not increase the organic load in treated water when compared to water extract and salt extracts of moringa seeds. The MPI treated water was checked for other quality parameters

like chemical oxygen demand, total dissolved solids, alkalinity, hardness and antimicrobial property. Shelf-life of the treated water was studied for one month and was found safe. MPI can be coupled with other water treating compounds or processes to produce a safe and economic water purifier. Work is under progress for the fabrication of a water purifier using moringa seed protein isolate for application in rural areas. Other application studies showed that MPI can be used as a natural active agent for the treatment of waste water from textile industries.



Color of the mud water is changed to colorless on treatment with MPI (A – Control mud water; B – Crude alum treated mud water; C-Pure alum treated mud water; D- MPI treated mud water)

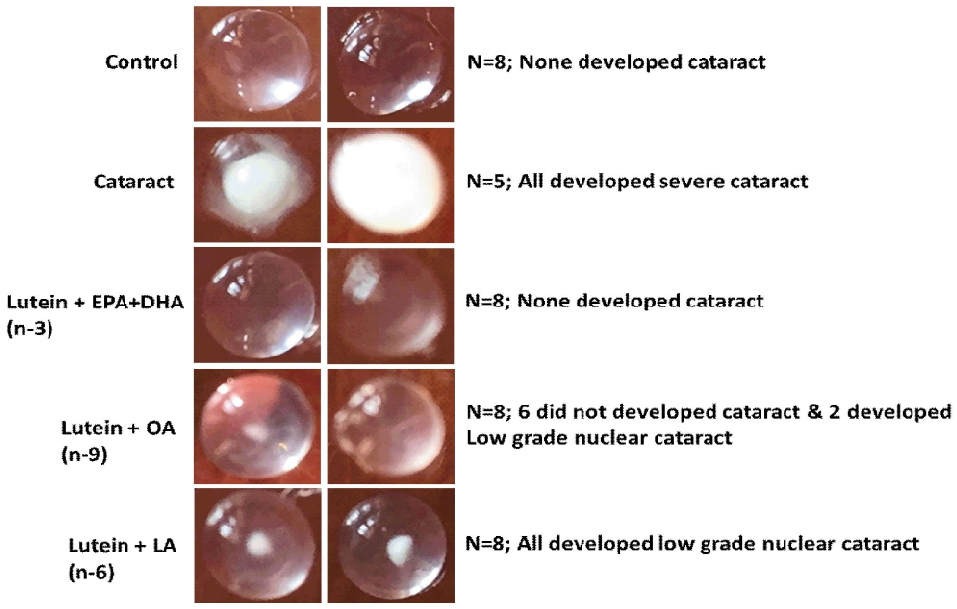
LONG TERM STRATEGIC RESEARCH

Influence of lutein and fatty acids on sodium selenite induced cataract *(Baskaran V)*

Oxidative stress due to diminished antioxidant potential and inflammation is a major factor that affects the modification of lens architecture. In the present study, the effect of lutein and unsaturated fatty acids [linoleic acid (LA 18:2, n-6), eicosapentaenoic acid 20:5, n-3 + docosahexaenoic acid 22:6 n-3 (EPA + DHA) and oleic acid (OA 18:1 n-9)] were studied with respect to its efficacy in modulating cataract formation in rat pups induced with selenite cataract. Results indicate that lutein + EPA/DHA when administered intraperitoneally prevented cataract formation in all rat pups compared to lutein + OA where 2 out of 8 pups developed cataract. In the case of lutein + LA group, all animals developed low grade nuclear cataract. These results were validated by measuring antioxidant enzyme activity and oxidative stress markers in serum and lens samples and inflammatory markers in serum samples. Results obtained indicate that, lutein exhibits an anti-cataract activity in sodium selenite induced cataract in rats and the effect was found to be higher when lutein was administered with EPA+DHA compared to linoleic acid or oleic acid in terms of modulating the biochemical risk factors of cataract. Developing an anticataract food with lutein and n-3 PUFA will be the major deliverable from the research outcome.

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

Galectin-3 binding protein (G3BP) is reported as a ligand for galectin-3. G3BP is a heavily N-glycosylated protein with a molecular mass of 90 kDa and it appears to mediate cell-cell adhesion via bridging galectin-3 molecules on adjacent tumor cells in a carbohydrate-dependent manner. The study addressed expression of G3BP in relation to galectin-3 using cell line/animal models and samples from cancer patients. Data indicated that G3BP expression was negligible in benign tissues, while progresses as and when the disease progresses towards advanced stages. In other words, advanced stage tissues irrespective of the type of origin showed maximum expression along with galectin-3 suggesting that G3BP may be a potential marker for metastasis and can be a good target for the management



Representative of control, diabetic and diabetes + lutein fed rat lens

of metastasis. Further, Biocore analysis revealed that the action of galectin-3 and G3BP is via their interaction with each other, hence, galectin-3 inhibitor can effectively block the same. Role of G3BP and galectin-3 in metastasis *in vitro* and *in vivo* models and modulation by a dietary galectin inhibitor – CRPP, a pectic polysaccharide from carrot (*Daucus carota)* was also addressed. Results revealed the double edged action of CRPP since it was bound with β-carotene. Pectic polysaccharide of CRPP acted as galectin inhibitor, while β-carotene acted as an antioxidant without pro-oxidant effect. The major deliverable from this study is preparation of galactin inhibitor (CRPP).

Cruciferous vegetables derived phytochemicals and ovarian cancer metabolism *(Somashekar BS)*

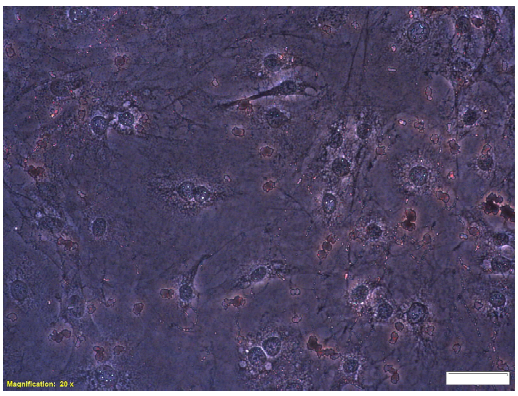
The study utilized ovarian cancer cell model (PA-1) to delineate the chemo-preventive mechanism of dietary phytochemicals derived from cruciferous vegetables Indole-3-Carbinol (I3C) and 3,3'-diindolylmethane (DIM). ^{1}H NMR-based metabolic profiling was carried out on PA-1 untreated and treated cells with varying concentrations of I3C and DIM. Prior to metabolomics study, the cytotoxic potential of I3C and DIM were analysed using MTT assay, which revealed that both the indole phytochemicals inhibit PA-1 cell growth with concentration ranging from 25 μM-200 μM. ^{1}H NMR spectra of polar extracts were used to identify more than thirty metabolites. Further, Principal Component Analysis (PCA) on NMR data revealed clear group separation among untreated and I3C and DIM treated cells. The group separation among I3C and DIM revealed that these two indole phytochemicals have differential mode of chemo-preventive mechanism. I3C and DIM treated PA-1 cells exhibited significantly altered levels of various metabolites involved in hexosamine pathway, energy metabolism, glutaminolysis, membrane choline phospholipid metabolism and osmo-regulatory mechanism. The results clearly indicate that appropriate dose of these phytochemicals could be formulated as functional foods for ovarian cancer management as well as prevention.

Obesity-associated breast cancer and their modulation by phytochemicals *(Ravi Kassiappan)*

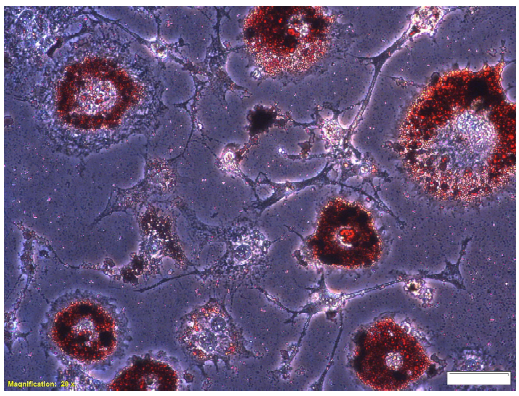
The anti-cancer effects of active ingredients from Indian spices including piperine and cinnamaldehyde on obesity associated breast cancer was studied. To determine IC_{50} for piperine and cinnamaldehyde in cancer cells, MDA-MB 231 (metastatic breast cancer) cells were treated with different concentrations of piperine and cinnamaldehyde for 24, 48 and 72 h. Piperine and cinnamaldehyde were found to significantly inhibit the cancer cell growth. The IC_{50} for piperine and cinnamaldehyde were 79.92 μM and 18.13 μM, respectively. Further, the adipocyte and breast cancer cells co-culture system using 6-well inserts were established. For mature adipocytes, 3T3-L1 pre-adipocytes were cultured with differentiated medium and intracellular lipid content was evaluated with lipophilic dye oil-red. The MDA-MB 231 cells were seeded onto the upper chamber of 0.4 μm pore size transwell system and co-cultivated with or without mature adipocytes. In order to confirm the assays, RNA were extracted from the cells and the gene expressions including leptin, adipokine and MMP-9 by using qRT-PCR were measured.

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

The study demonstrated that diabetes induces inflammatory and fibrotic changes in the lung of diabetic rats with previously developed complications such as



Pre-adipocytes



Mature adipocytes

nephropathy and cataract. These changes were mediated in part through the TGF-β1-activated epithelial-to-mesenchymal transition (EMT) via the activation of both SMAD-dependent and SMAD-independent signaling pathways. Additionally, the study also revealed that glucose restriction promoted the mesenchymal-to-epithelial transition (MET) and substantially reduced the expression levels TGF-β1 and inflammatory, fibrotic and EMT marker genes in cells cultured from the diabetic lung, suggesting that diabetes-induced EMT in the diabetic lung was mediated in part through the effects of hyperglycemia. Furthermore, the study also revealed that the elevated SMAD7 levels in the initial stage of post-diabetes induction and the subsequent reduced SMAD7 levels and concurrent elevated TGF-β1 levels are responsible for the delayed response of the lung to the diabetes-induced pathological effects. Prolonged exposure of diabetic fibroblasts to higher glucose concentration promoted the upregulation of cell proliferation markers such as caveolin, N-cadherin, SIRT3, and SIRT7, suggesting that long-term induction of diabetes may promote cell proliferation. Taken together, the study provides scientific evidence that diabetes also induces long-term pathological effects in the lung that are mediated through inflammatory and fibrotic changes. Furthermore, the study tries to explore the role of microRNAs in diabetes-induced pathological effects in the lung.

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

The liver is the vital organ affected due to obesity, a risk factor for type 2 diabetes causing non-alcoholic fatty liver disease (NAFLD) and emerging as an important cause of liver disease in India. Liver is rich in Cytochrome p450 enzymes involved in xenobiotic function. These enzymes also react with many endogenous substrates and one such substrate is arachidonic acid which is highly up-regulated during metabolic disease conditions. Epoxyeicosatrienoic (EETs) and hydroxyeicosatetraenoic acid (HETEs) are metabolites of Cytochrome P450 arachidonic acid monooxygenase family. In this study, the role played by these eicosanoids in a diet-induced model of NAFLD was investigated and also the effect of quercetin on the modulation of eicosanoids via PPAR nuclear receptors was studied. The results showed that livers from all animals on fast food diet appeared pale, enlarged and showed a significant increase in liver weight. Histological examination showed moderate hepatocellular ballooning, moderate diffuse microvesicular steatosis and infiltration of inflammatory cells. Treatment with low dose (0.1%) and high dose (0.25%) of quercetin reduced the severity of hepatocellular ballooning, moderate diffuse microvesicular steatosis, and infiltration of inflammatory cells. Oral glucose tolerance test showed severe glucose intolerance in fast food diet animals compared to chow diet fed animals. Estimation of liver injury was done by assessing AST, ALT, and ALP, known serum markers of liver injury which were elevated significantly in animals on fast food diet compared to chow-fed animals. Elevated levels of liver TG, increased oxidative stress and decreased glutathione levels were observed in fast food diet animals. Fibrosis was estimated by Mason Trichrome staining for collagen distribution. Animals fed on FFD diet showed moderate-severe collagen deposition. Quercetin treatment decreased collagen deposition significantly. To check if pro-fibrotic and pro-inflammatory pathways are activated in during NAFLD, the gene expression profiles of important genes involved in fibrosis, inflammation and fatty acid transport were analysed. FFD diet caused elevation of TNFα, a proinflammatory cytokine responsible for fibrosis, osteopontin (spp1) gene, a marker for immune cell activation and also FABP4, a gene responsible for fatty acid uptake, transport and metabolism. FFD diet also activated the genes responsible for fibrosis significantly such as TIMP1, ACTA2, COL1A1, COL4A1, and TGFβ. FFD diet completely downregulated the genes of the Cytochrome P450 arachidonic acid pathway, both epoxygenase and hydroxylase enzymes such as CYP 2C11, CYP 2C23, CYP 4A1, CYP 4A2, CYP 4A3, and CYP 4A8.

Natural products and their anti-cancer/ anti-inflammatory properties *(Nawneet K Kurrey)*

The potential of natural products in prevention and treatment of ovarian cancer using *in vitro* (ovarian cancer cell lines) and *in vivo* (laying hen -*Gallus gallus domesticus*) a spontaneous animal model of ovarian cancer was studied. Different parts of the plant of *Ocimum sanctum* (tulasi leaves), *Allium sativum* (garlic bulb) and *Asparagus racemosus* (shatavari root) were procured for extraction using standard protocols. Ovarian cancer PA-1 cells were treated with various concentrations of tulasi extracts (OSEO-2 and 3) to determine the level of cytotoxicity by MTT assay. The extract showed a concentration-dependent significant reduction in cell viability and altered cell morphology in cells. Anti-inflammatory activity was examined by nitric oxide assay using murine macro-phage cells which demonstrated the higher anti-inflammatory activity of extract OSEO-3. Comet assay and DNA fragmentation assay showed the DNA damage and cell death respectively in cells using oil extract of tulasi leaves (OSEO). Prostaglandin-E2 levels were reduced in

ovarian tissues of laying hens which were fed with 167, 334 and 667 mg/kg body weight doses of garlic, tulasi and shatavari (whole extract in the form of capsule) for 21 days.

Ajowan glycoprotein *(Muralikrishna G)*

Ajowan (*Trachyspermum ammi* L.) spice has been used in food preparations and also as a traditional medicine in ayurveda. Although a number of pharmacological activities have been attributed to ajowan, its role in immunomodulation is not known. The main objective of the present study was to examine the macromolecular immunomodulatory components. Macrophage activation was studied by nitric oxide (NO) release, phagocytosis and secretion of pro-inflammatory cytokines as the markers. Ethanol precipitate (fractional) of ajowan aqueous extract was subjected to conventional chromatography (Q Sepharose followed by Bio-Gel P-100). One of the proteins (30.7 kDa; ajowan glycoprotein or Agp) showed effective mitogenic activity towards splenocytes. Agp is a *O*-linked glycoprotein with the glycans contributing to one-third of the molecular mass. It has a high content of glutamic acid, serine, aspartic acid and proline whereas galactose (45.7%), arabinose (34.5%), glucose (7%), mannose (5%) and xylose (4%) are the constituent sugars. Secondary structure analysis indicated that Agp contains 79% α-helices and 21% random coil. Internal sequencing of the tryptic peptides did not show homology with the existing proteins in the database (BLAST). Agp at 1 μg mL^{-1} induced proliferation of B-cell enriched murine splenocytes and activated macrophages in releasing NO and promoted phagocytosis ($p < 0.01$). RAW 264.7 cells produced pro-inflammatory cytokines (IL-12, TNF-α and IFN-γ) at 1 μg mL^{-1} Agp ($p < 0.01$). Deproteinized Agp (dpAgp) failed to elicit activation of murine immune cells, whereas deglycosylated Agp (20 kDa; dgAgp) showed compromised efficiency.

Green gram arabinogalactan protein *(Muralikrishna G)*

The consumption of green gram (*Vigna radiata*) which is rich in dietary fibre and protein is known to enhance the function of immune system. Studies pertaining to the immunomodulatory components of green gram have not been carried out till date. In the present study, various non-starch polysaccharides (cold water, hot water, pectic and alkali soluble i.e., hemicellulose A and B fractions) were isolated from green gram and their immunomodulatory activities were determined using splenocytes and macrophages. Hemicellulose-B was found to be the most effective. A potent immunomodulatory polysaccharide was purified from hemicelluose-B using DEAE cellulose and Sephacryl S-400 columns. Total carbohydrate, uronic acid and protein concentrations and molecular weight of the purified polysaccharide were found to be 75, 10.51% and ~1200 kDa respectively. Monosaccharide composition of the polysaccharide was determined to be arabinose-73%, galactose-8.3%, xylose-7.5% and glucose-6%. The purified polysaccharide induced nitric oxide production and release of cytokines (TNFα and IL6) by macrophage cell line (RAW 264.7) in a dose (10, 50, 100, 200 μg/ml) and time (12, 24, 48 h) dependent manner. The effect of pure polysaccharide on the pinocytic activity of RAW 264.7 cells examined by neutral red uptake showed enhanced effects in the range of 10-250 μg/ml. The pre-treatment of macrophages with anti TLR2, anti TLR4, anti TREM antibodies inhibited the induction of NO, TNFα and IL6 production by the purified polysaccharide (200 μg/ml). These results suggest that the purified acidic polysaccharide from green gram has immunomodulatory effects.

Characterization of α-glucosidase from *Lactobacillus fermentum* *(Muralikrishna G)*

The resistant starch-degrading enzyme (α-glucosidase) from *Lactobacillus fermentum* grown on RS was purified and characterized. The pH and temperature optima were 5.5 and 37°C respectively. The K_m of the purified enzyme in the present study with respect to pNPG was 0.97 mmoles/L. The substrate specificity of the α-glucosidase was tested with other substrates soluble starch, amylopectin and maltooligosachharides (DP 2-7). This enzyme cleaved glucose from maltooligosachharides but failed to release glucose from soluble starch and amylopectin. Polar amino acids like aspartate (11.13%), threonine (10.92%), serine (10.31%) were present in more concentration than the non-polar amino acids like glycine (4.74%) and isoleucine (4.07%). α-Glucosidase activity was enhanced by Ca^{2+} by 39%. α-Glucosidase activity was inhibited by Hg^{2+}, Pb^{2+} by 96% and 58% respectively. EDTA did not show any significant effect on enzyme activity. The blocked N-terminal sequence of α-glucosidase from *Lactobacillus fermentum* were determined by analyzing the peptides derived on lysyl endopeptidase digestion of the enzyme. The sequence of the peptides obtained after digestion was as follows. (A) ala-thr-thr-asp-asp-ala (B) lys-ala-ala-asn-leu-glu. BLAST analysis was performed using the amino acid sequence obtained from the two fragments in order to identify possible homology with the enzymes from other sources. Two fragments exhibited about 92.3% and 90% similarity with the available α-glucosidases isolated from *Lactobacillus* species.

Fortified beverage for improvement of cognitive performance and physical endurance
(Muralikrishna G & Deepa Prakash)

The study was designed to assess the impact of an intervention of hydration and two commercially available beverages in comparison with dehydration on cognitive performance and physical endurance of mice. Hydration status is an important aspect that determines the quality of life as it involves suppression of heat stress, active constituent of cell, mucus lining and also serves as a reactant. Thus, better hydration acts as a protective shield to brain and deep structures. Hence the water intake should be adequate as deficit water consumption will lead to dehydration. The overall study showed that the control group with hydration and beverages has better cognitive performance than the dehydrated groups. However, the dehydrated groups were adapting well to physical endurance tests except in long term endurance like the rotarod test. The commercially available beverages did help alleviate the dehydrated mice groups' cognitive performance and physical endurance. The additional nutrition value of these beverages is also a factor to be considered in their role in improving cognitive performance and physical endurance.

Volatile profiles in rice grain and rice weevil
(Manivannan S)

To elucidate the role of volatile chemicals, the volatile profiles in rice grains (*Oryza sativa*) and in rice weevil (*Sitophilus oryzae*) were investigated and compared with the semiochemical database. A total of 37 and 39 compounds were detected from rice grains and rice weevil respectively. Three new semiochemicals were identified from rice weevil which can be used for the development of semiochemical based insect control devices. Further, the effect of the thermal treatment on rice grains was studied and correlated with preference indices in rice weevil. After 24 h of thermal treatments, the total number of compounds increased to 42. The amount of acid, alcohol, ketone, aldehyde and alkene groups in rice grains increased while alkane groups decreased after the thermal treatment. In addition, the relative concentration of the identified compounds progressively increased or decreased depending on the phytochemical group and the thermal effect. Preference analysis of *S. oryzae* adults on thermal treated grains indicated that preference indices decreased significantly ($P<0.05$) in response to volatile chemical profile changes and olfactory sensation.

Fumigant toxicity and phytochemical residues
(Ezil Vendan S)

Fumigant toxicity of various essential oils were evaluated against rice weevil, *S. oryzae*. The results indicated peppermint oil as a potential bio-fumigant against *S. oryzae* (resulting to 80% mortality). Further, the analysis of physico-chemical properties of the compounds indicated a correlation between polar surface area (PSA) and its residual nature. The residue levels of eugenol were significantly elevated corresponding to its high PSA value in EOs. Compounds with zero PSA value imparted very less or nil residues in treated grains. Though the residues of phytochemicals in treated grains is higher, they belong to the generally recognised as safe (GRAS) status leaving no harmful effect.

Analytical methods for food quality and safety
(Prasanna Vasu & Asha Martin)

Antibiotic residues

A simple, improved cost-effective and eco-friendly and sensitive LC-MS/MS method has been developed for the simultaneous analysis of sulfonamides and nitrofuran metabolites in fish samples antibiotics using ionic liquid aqueous two-phase system (IL-ATPS). The method involves mixing of fish samples (0.2 g) with McIlvaine-EDTA buffer (0.1M, pH 4), IL ([Bmim]BF4) and ammonium sulfate solution (42.0%). In case of nitrofuran metabolite analysis, mixing with IL was performed after 2-nitrobenzaldehyde derivatization. After incubation and centrifugation for phase separation, the upper IL was subjected to LC-MS/MS analysis. Good phase separation and recovery was achieved with ammonium sulfate (≥42%). The 12-min run gave good separation of sulfonamides, while 15 min run gave good separation of nitrofuran metabolites. The LC-MS/MS method showed good linearity in the range of 5-800 ppb ($r^2>0.97$) for sulfonamides (IL-ATPS). The mean recoveries of sulfonamides from the spiked fish samples were 48-90%. The repeatability/ reproducibility (%RSD) was in accordance with the SANCO guidelines (EU regulations), which is <20% for these antibiotics. The mean recoveries of nitrofuran metabolites from the spiked fish samples were 42-124%, with % RSD of <16.4%. Further research has to be carried out to improve the recoveries and % RSD values. The LODs of sulfonamides were 2.5-5 ppb.

Glutamate

A simple extraction protocol for glutamate was optimised and validated. The extraction with water gave better

recovery compared to other extractants tried (0.1M phosphate buffer saline (pH 7.0), 0.1M HCl, and 0.1M sodium carbonate, pH 9.0). After sample extraction and clarification, 20 µl was mixed with 20 µl orthophtahldehyde reagent (OPA) and subjected to HPLC analysis exactly after 2 min. Retention time of glutamic acid was found to be 6.7 in a 15 min gradient run. The HPLC method showed good linearity in the range 0-80 ppb (µg/ml). The recovery of glutamic acid is in the range of 70-99%, with RSD values within 15%. A survey was conducted to determine several commercially available soup and masala mix, and found that masala mix and soup contained high amount of glutamic acids (4.2-6.8 mg/g), while some soup samples contained less amount (0.16-0.26 mg/g), except tomato based soups (0.9 mg/g). Since tomato based soups contain more glutamic acid, some of the fruits and vegetables were checked for its glutamic acid content. Tomato contained high amount (1.5 mg/g) of glutamic acid compared to potato and onion. Mango and cucumber contained least amount of glutamic acid 0.054 and 0.016 mg/g, respectively.

RT-PCR detection of *Salmonella* in food samples *(Asha Martin)*

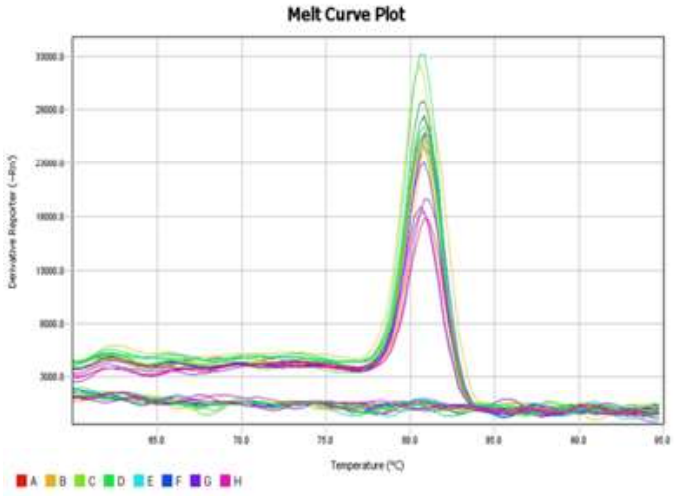
A *Salmonella* specific PCR method has been developed for the detection of *Salmonella* bacterium based on fimbrial sub unit type 1 gene (fimA) (GenBank: M18283.1) with a PCR product size 120 bp. The PCR amplicon was cloned into pJET 1.2/ blunt end cloning vector and named as pFIM. A real-time PCR method was developed and applied to 22 different bacterial culture detection using serially diluted pFIM as standard reference material. Specificity of the method was assessed using 10 MTCC *Salmonella* strains, 10 ATCC non-*Salmonella* strains and 10 bacterial isolates from traditional Indian sweet. The PCR results showed that fimA target primers were specific only to *Salmonella* reference strains. Further, the results were validated using 16S rRNA gene sequencing for all the bacterial strains. The PCR and real time method to detect *Salmonella* is highly specific, robust and reliable for the detection of *Salmonella* in food samples.

Rice bran lipases *(Vijayaraj P)*

The study focusses on the identification of acyl-hydrolases from rice bran by activity based proteome profiling (ABPP) and genome sequence analysis. *In silico* analysis of *Oryza sativa* L. genome revealed that it comprises of an estimated 40,000-60,000 genes with about 466 mb of size in twelve chromosomes. The sequence analysis predicted that there were 73 genes with possible lipase activity and 39 genes with phospholipase activity. Further, the identified lipases were validated by profiling of mRNA expressional level at various stages of germination. The microarray analysis revealed that each lipase was expressed at different time point and depends on its substrate preferences as well as availability. The ABPP of rice bran showed that there were 11 proteins which contained the serine hydrolase domain. The serine hydrolase domain proteins were enriched by immunoprecipitation and sequence were identified by LC-MS/MS. The coding region of the identified proteins was cloned and lipase activity was assessed with purified recombinant protein. Further, the screen of the bioactive molecule from the natural source could control the lipase activity and also retain the other nutrients.

Monoacylglycerol lipase *(Vijayaraj P)*

The study aims to create an integrated platform for the functional characterization of lipid metabolizing enzyme



Melting curves showing a single peak specific to 120 bp amplicon of Fim A gene of *Salmonella*

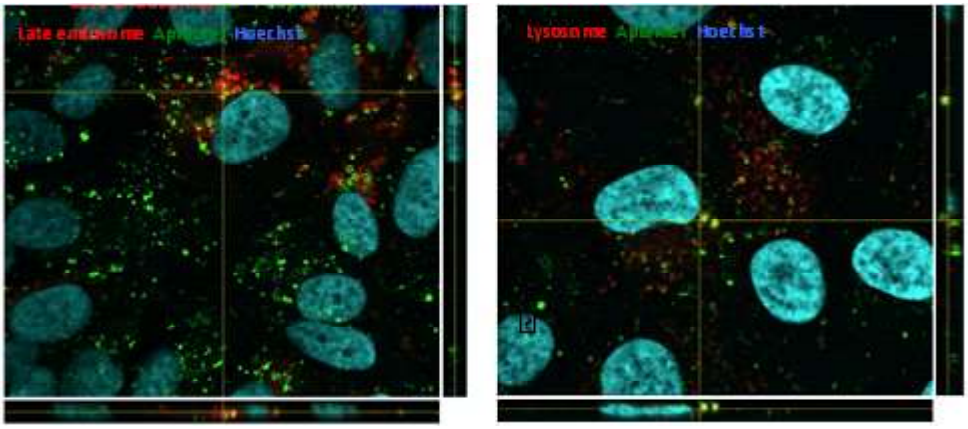
and its therapeutic potentials. The human monoacylglycerol lipase gene was cloned and overexpressed into bacterial expression system. The enzyme assay was performed with Ni^{2+}-NTA purified protein using monoacylglycerol as substrate. The plant/ food sources were identified based on the traditional knowledge and as well as human consumption. So far 20 sources were identified, preserved for the extractions. The sequential extraction was performed with various solvents (nonpolar to polar). The deliverable will be the potent monoacylglycerol inhibitor molecules from food sources for the management as well as prevention of obesity and diabetes.

Lipid biosynthetic enzyme modulators
(Ajay W Tumaney)

Acyl CoA: monoacylglycerol acyltransferase (MGAT) and Acyl CoA: diacylglycerol acyltransferase (DGAT) carry out important enzymatic re-esterification reactions in the MAG pathway in enterocytes for absorption of dietary fats. The aim of the project was to modulate these intestinal acyltransferase enzymes using food based molecules. Potential food leads were shortlisted based on literatures available on foods that have shown delayed fat absorption, prevention of diet induced obesity and increased energy expenditure. Different hydro-ethanolic extracts were prepared from the selected leads. In absence of the regular radio label based assay for acyltransferases, other strategies were utilized to assay MGAT and DGAT activities. Fluorescence label based as well as high resolution mass spectrometry (HRMS) based assays were attempted and standardized using mouse intestinal homogenate. The screening of extracts has been carried out using the HRMS based assay.

Bioactive protein synthesis *in vitro* with cell free platform *(Muniasamy N)*

Development of aptamer conjugation technology for retinal drug targeting was the main aim of the project. Age related macular degeneration (AMD) is a progressive, neurodegenerative disorder that leads to a severe loss of central vision in the elderlies. The health of Retinal Pigment Epithelim (RPE) cells, which plays an important role in maintenance and homeostasis of the retina, is critical for the onset of AMD. These RPE cells undergo high levels of oxidative stress during their lifetime due to the substantial consumption of oxygen, accumulation of lipid peroxidation products from ingested photoreceptor outer segments and constant exposure to light. Chronic exposure to oxidative stress along with decline in lysosomal activity may lead to the death of RPE cells, ultimately leading to AMD. Hence, development of a targeted delivery system to RPE cells is central to prevent the progression of AMD. Intracellular localization of FITC-aptamer conjugate was determined qualitatively by confocal fluorescence imaging. Colocalization of FITC-aptamer with late endosome/ lysosome signal confirmed that FITC-aptamer localized at both the organelles. Colocalization signal was also confirmed by orthogonal section of the image. Localization of the aptamer to lysosome is of significance since the aim is to deliver the aptamer tagged Hsp70 protein to lysosome. It is because during the AMD pathology, Hsp70 protein that is present in the lysosome becomes dysfunctional and is lowly expressed, which results in decrease in capacity of RPE cells to degrade misfolded proteins. The aggregation of these misfolded proteins eventually overwhelms the cellular machinery and leads to cell death, thus, resulting in AMD pathology.



Intracellular localization of FITC-aptamers in ARPE-19 cells

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

The next-generation sequencing (NGS) data obtained for the epididymal tissue of DIO C57BL/6J mice treated with obestatin and Nt8U have been analysed. Few key proteins have been differentially regulated viz. 1) oxidised low-density lipoprotein receptor 1- is upregulated 3 folds by obestatin. This protein is regulated through the cyclic AMP signaling pathway, binds, internalizes and degrades oxidized low-density lipoprotein. 2) arachidonate 15-lipoxygenase is upregulated by 2.3 folds by both obestatin and Nt8U. It inhibits adipose tissue inflammation and subsequent insulin resistance. 3) glycerol kinase-like is upregulated 2 folds by obestatin. It is involved in triglyceride sequestration in the adipose tissue.

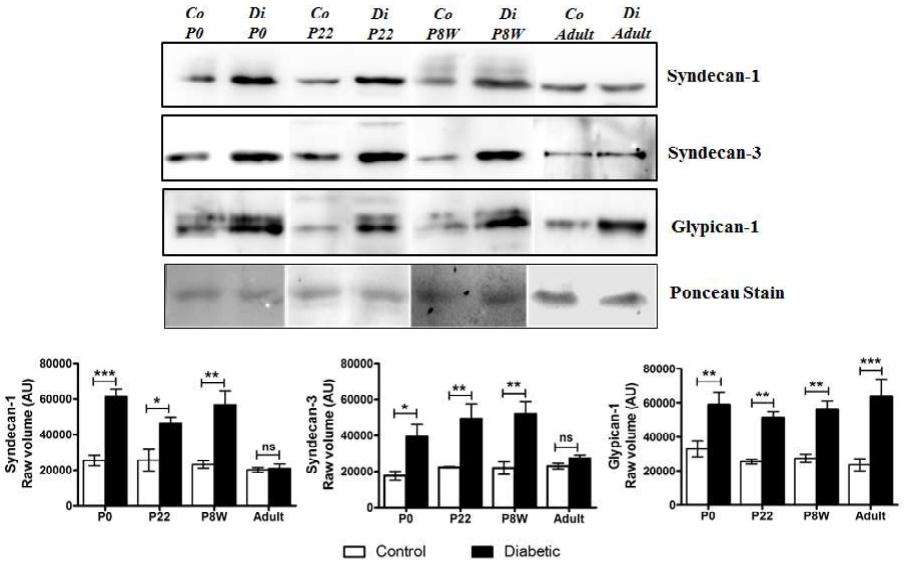
Food-grade terpenes *(Sarma MVRK)*

The maximum theoretical yields with and without cofactor imbalance has been calculated for terpene synthesis. The maximum theoretical yield Y^{E} (γ_S/γ_P) of terpenes were found to be in the range of 0.317-0.331 (g terpene/g glucose) while the theoretical pathway yield Y^{P} were found to be in the range of 0.232-0.317 (g terpene/g glucose). The theoretical yield of terpene with concomitant production of glycerol combined with and without cofactor imbalance ($Y^{P,G}$ and $Y_{Cl}^{P,G}$) was found to be in the range of 0.099-0.239 (g terpene/g glucose) and 0.075-0.102 (g terpene/g glucose) respectively. The latter case signifies the lowest possible theoretical yield achieved in *Saccharomyces cerevisiae*. Studies have been conducted to identify gene knockouts for improvement of precursor molecules for terpene synthesis in *S. cerevisiae* using genome-scale model. Towards this a novel and generic metaheuristic algorithm has been developed which was termed as FOCuS. This hybrid algorithm uses nature-inspired computational procedure to predict gene knockouts. The robustness of this algorithm has been evaluated against several existing knock-out algorithms and it has been found that FOCuS could predict better flux values for the objective functions irrespective of the size of genome-scale models. When FOCuS was evaluated for improvement of terpene precursors' it eventually led to knock out of specific genes in amino acid synthesis pathway.

Maternal diabetes on brain glycosaminoglycans *(Nandini CD)*

Work was continued towards deciphering the changes in brain proteoglycans (PGs) and associated glycosaminoglycans (GAGs) as a result of *in-utero* hyperglycemia. Earlier a marked overexpression of heparan sulfate was observed. The effect of *in-utero* hyperglycemia on heparan sulfate proteoglycans was determined. Syndecans-1 and -3 and glypican-1 were overexpressed in brain of offsprings from diabetic mother. However, in adult diabetic rats, only glypican-1 was overexpressed. The offsprings from diabetic mothers became hyperphagic at the end of 8 wks after birth which can have implications in the long run. The results highlight the likely impact of the *in-utero* exposure of foetus to hyperglycaemic condition on brain GAGs/PGs compared to diabetic.

The influence of bioactives such as quercetin and naringenin on insulin signalling activity in brain in diabetic rats was also determined. The diabetic and non-

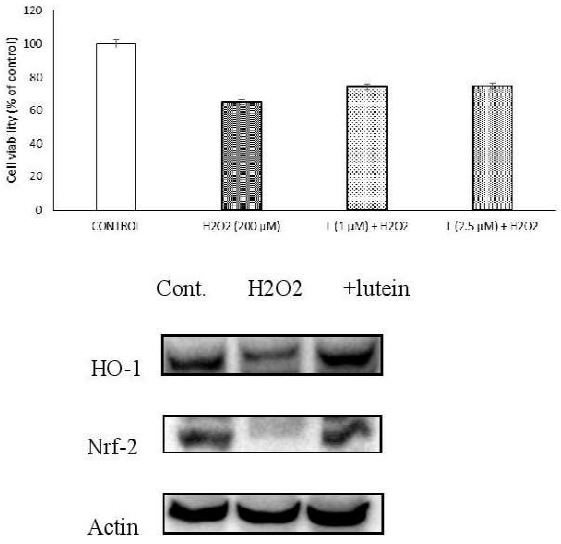


Effect of hyperglycaemia on brain proteoglycans

diabetic rats were subjected to dietary interventions for two months with quercetin, naringenin and berberine supplementation. Results showed that quercetin was most potent among the three and restored low-density lipoprotein receptor-related protein 1 (LRP1) and brain insulin signalling components as well as glucose transporters such as GLUT 1, GLUT 3 and GLUT 4 expression. Berberine and naringenin improved brain IRS 1 expression but showed no significant effect on PI3K and Akt 1 activation. Berberine and naringenin supplementation to diabetic animals also restored GLUT 1 and GLUT 3 expression levels but showed no effect on GLUT 4 expression. It is concluded that quercetin, naringenin and berberine can differentially act through insulin-dependent and -independent mechanisms thereby altering glucose homeostasis in brain during experimental diabetes and bring about beneficial effect.

Screening of marine bioactives *(Ganesan P)*

The possibility of utilizing the marine renewable resource, algae for beneficial health effects was explored. Two marine algal species collected from Pulicat lake, Chennai were identified as *Chaetomorpha* sp. (Green alga) and *Gracillaria* sp. (Red alga). The fresh algal samples were washed, freeze-dried and made into powder for bioactives extraction. The total polyphenol and flavonoid content and the carotenoid profile of both the samples were analysed. Further, lutein purified from *Chaetomorpha* sp. were used to examine its protective effect in stress-induced primary human dermal fibroblast (HDFa) cells. The results showed that lutein protects HDFa cells from H_2O_2-mediated oxidative damage by activating the antioxidant signalling proteins (Nrf-2 and HO-1).



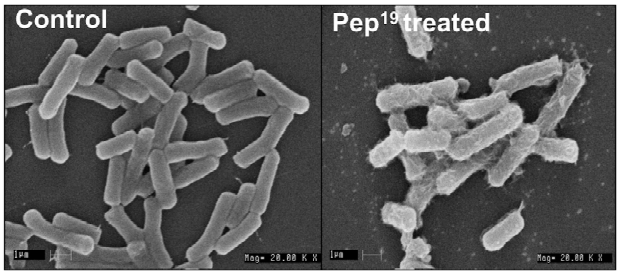
Protective effect of lutein against H_2O_2-mediated cell damage in HDFa cells

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

To overcome the problem of antibiotic resistance, phages were used to treat bacterial infections and were found effective against pathogens. Phage application before food consumption can reduce the risk of food borne diseases. Hence the objective was to isolate novel phages that could be used against major bacterial pathogens. Phage against *E. coli* was isolated from the sewage water after enriching the sewage with the host. Phage isolated was tested against *E. coli* using spot assay and it was confirmed using agar overlay method. The phage was purified using CsCl density gradient method to perform further characterization. Interestingly, isolated phage was found to be working against two food pathogens.

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

Preliminary studies were encouraging to begin a thorough study to target Rel. Similarly, a series of peptides having microbicidal and trypsin inhibition activity were rationally designed. The elements of the design were rationally incorporated based on naturally occurring antimicrobial peptides involving iterative experimental validation of the design elements. Antimicrobial activity of designed peptides were tested against many gram positive and negative bacteria. Among all the designed peptides, Pep^{19} exhibited potent antimicrobial activity

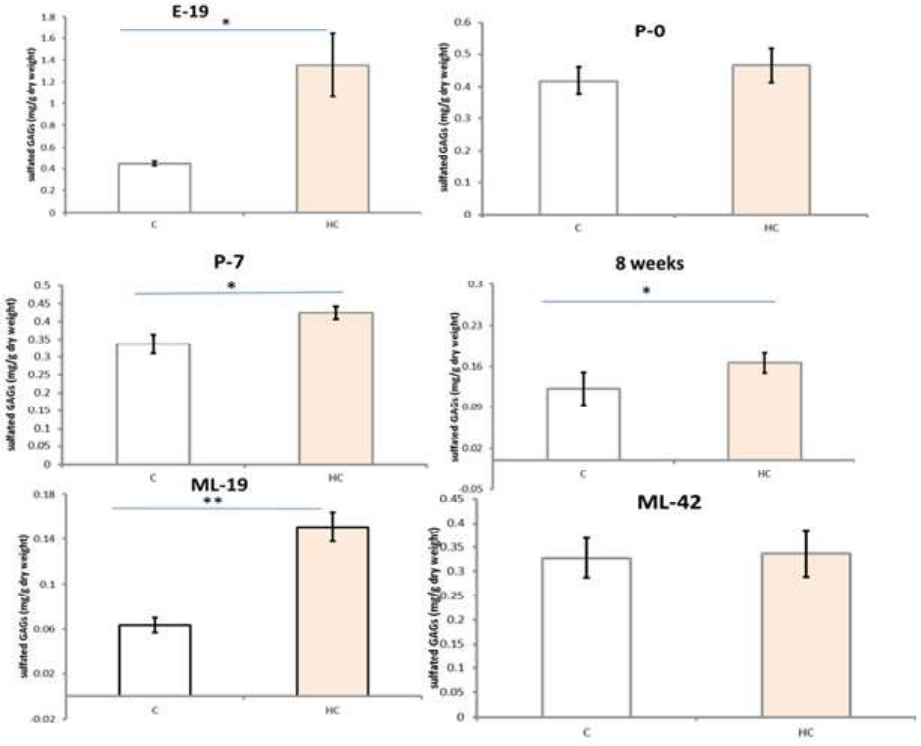


Scanning Electron Microscopy (SEM) images of *B. cereus* treated wiht Pep^{19} at 2X MIC concentration - Cell morphology and membrane integrity of *B. cereus* cells were observed by using SEM after treating the cells with Pep^{19} membrane surface of the peptide treated cells became roughened, lost integrity and leakage of intracellular content was observed. Control cells not treated with the peptides were bright with a smooth surface, membrane was intact and the cells were devoid of such alterations.

against all the microorganisms tested. Results also demonstrated that Pep[19] was more effective against Gram-positive organisms compared to Gram negative organisms. A series of experiments like Scanning Electron Microscopy (SEM), confocal microscopy, propidium iodide uptake assay, live-dead staining and fluorescent probing were performed to confirm their mechanism of action. Stability of the peptides was tested for high temperature and a range of pH. The peptides were found to be stable in most of the conditions examined. Finally, toxicity studies towards human RBC and cell lines indicate that the designed peptides are biocompatible. Also, the applicability of these peptides in several food samples were evaluated and the results were encouraging.

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

The main aim of this project was to elucidate changes in liver glycosaminoglycans (GAGs) as a result of feeding cholesterol in pregnant rats. Liver GAGs are one of the key molecules involved in liporoptein metabolism and are regarded as one of the co-receptors for lipoproteins along with LDL receptors. Furthermore, maternal diet is known to play important roles in growth and development of the organism and its predisposition to various diseases when it reaches adulthood as a result of maternal environment exposure. GAGs isolated from liver of foetus, pups as well as mothers showed quantitative changes in sulfated GAGs. There was a significant increase in levels of GAGs in hypercholesterolemic group compared to the control group. Qualitative analysis of isolated GAGs by cellulose acetate membrane revealed that heparan sulfate was the major GAGs present followed by chondroitin/ dermatan sulfate. Small amounts of hyaluronic acid were also present. Though cellulose acetate membrane electrophoresis were used for determining qualitative changes of GAGs, there were times when separation between the species were not good. Problems were encountered without a proper separation affecting identification of GAG species. The existing method was improvised and GAGs were isolated and estimated using dimethyl-methylene blue (DMMB) dye binding assay. DMMB is known to complex with the dye and bring about metachromasia. It forms a precipitate when left overnight. The precipitate was harvested by centrifugation and decomplexed using guanidium hydrochloride. GAGs were precipitated and taken up for analysis by electrophoresis as well as by HPLC. The samples obtained were much purer with less interference from non-sulfated GAGs such as hyaluronic acid. Electrophoretic analysis gave clear bands which could be deciphered by image J analysis.



Total sulfated glycosaminoglycans from liver at various developmental stages

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

The growth inhibitory potential of β-carotene in human breast cancer (MCF-7) cells was studied. The results of the study showed that β-carotene at physiological concentration sensitizes MCF-7 cells by inhibiting growth and antioxidant signals and by inducing apoptosis. The protein expression studies show that β-carotene at 1 μM concentration effectively decreases the expression of the anti-apoptotic protein, Bcl-2 and PARP and survival protein, NF-kB. It also inhibited the activation of intracellular growth signaling proteins, Akt and ERK1/2. The inhibition of Akt activation by β-carotene results in decreased phosphorylation of Bad. These findings exhibit the key role of β-carotene even at a low physiological concentration in MCF-7 cells which further explains its predominant anti-cancer activity.

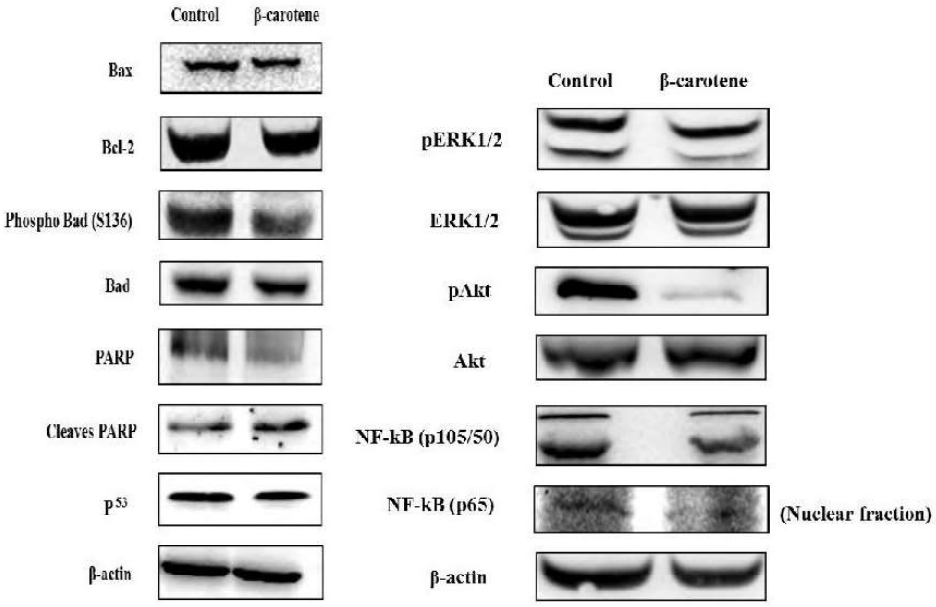
The anti-cancer potential of lutein against human breast cancer (MDA-MB-231) cells was evaluated and the underlying potential molecular targets for its anti-cancer effects were also explored. The results show that purified lutein reduced the viability of MDA-MB-231 cells in a dose dependent manner. This growth inhibitory effect was associated with decreased protein expression of apoptosis markers such as Bcl-2 and PARP, and cell survival markers like pERK1/2 and pAkt and NF-kB. However, the expression of pro-apoptotic marker, Bax did not show any significant change upon lutein treatment.

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

The carotenoids profile of Indian marine algae was studied and their anti-angiogenic potentials using primary human umbilical endothelial (HUVEC) cells as *in vitro* model was examined. The carotenoid profiles of two marine algal species were analysed. Lutein and zeaxanthin was identified as a major carotenoid in *Gracillaria* sp. and *Chaetomorpha* sp., respectively. Since the effect of lutein on angiogenesis is not well understood, the effect of purified lutein was evaluated on HUVECs proliferation, and migration as *in vitro* model assay for angiogenesis. It was found that lutein did not affect the proliferation of endothelial cells, but interestingly it induced endothelial cell migration.

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

The study focuses on the chromosomal segregation of *Mycobacterium smegmatis*. Few of the crucial proteins such as ParA, ParB, ScpA and ScpB involved in chromosomal condensation and segregation have been cloned, overexpressed and purified by metal affinity chromatography. In addition to generation of unmarked deletion mutant of *scpB*, generation of a *scpA* deletion mutant in *M. smegmatis* is under progress. These mutants will be employed to study the growth curve characteristics and segregation of chromosome in *M. smegmatis*. To study the function of SMC, it has been cloned in a pGEX-6P1 vector and standardization of overexpression and purification is under progress.



Effect of β-carotene on apoptosis, proliferation and survival markers in MCF-7 cells

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

FAD synthetase is a bifunctional protein where N-terminal is a FMN adenylyltransferase domain and C terminal is riboflavin kinase domain. The FAD synthetase gene from *H. pylori* have been cloned in an expression vector pET28a and protein of interest have been purified by metal affinity chromatography. In addition, FADS gene from *S. aureus* also has been cloned, overexpressed and purified. Analytical size-exclusion experiments show that protein exists in a monomeric form. Biochemical analysis using TLC based assay indicates that purified SaFADS could convert riboflavin to FMN and FMN to FAD.

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

In connection with *E. coli*'s stress response under oxygen and energy availability, a particular subnetwork involving both protein and sRNA mediated regulation is looked upon. Subtle changes in this motif can bring in drastically different effects on the gene expression. In particular, it is shown that a threshold response in gene expression changes to a bistable response as the regulation on sRNA synthesis or sRNA degradation is altered. The bistable response corresponds to two possible equilibrium states with low and high sRNA concentrations. These results were obtained under deterministic (noise-free) conditions. The gene expression, however, is known to be noisy because of noise associated with various biochemical processes related to transcription, translation, mRNA degradation and also other external perturbations unrelated to the gene. Therefore noise was incorporated in the network models and probability distributions were obtained for concentration levels of proteins and sRNAs. These probability distributions were bimodal with peaks at high and low sRNA concentrations. Probability distributions obtained for different noise strength show that the relative height of the peaks change significantly as the noise strength is increased.

Oil cake rich animal feed *(Mukesh Kapoor)*

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

Probiotics for antigen delivery *(Rajagopal K)*

The whole genome sequence of the commensal bacterium *E. raffinosus* was isolated from a healthy Indian (breast-fed) infant fecal material. Sequencing was performed. A total of 13,777,040 paired end reads (insert size 150 bp) of 131-nucleotide length were obtained. NGS QC tool kit (v. 2.2.1) was used to filter the data for high quality (HQ) (where 70% cut off read length, and 20 as quality cut off score), vector/adaptor-free reads were used for assembly with Velvet (v. 1.2.07). The final assembly contains 193 contigs with a total size of 4207547 bp, and a N50 contig length of 77.065 kbp. Length of the contig's ranged from 200 bp to 201,862 bp with G+C mol % of 39.49%. Gene prediction was performed by PRODIGAL (Prokaryotic Dynamic Programming Gene finding Algorithm, v. 2.60); tRNA was predicted by using with tRNA scan-SE (v. 1.21) and rRNA were predicted using RNAmmer (v. 1.2). Total 4,242 genes were predicted, including 54 tRNA, and 7 rRNA (5S-23S-16S). The annotation of the genome of *Enterococcus raffinosus* reports the presence of a Tn554 element, but lacks the virulent traits such as gelatinase (gelE), and serine proteinase (spr). However, cyto-toxins were observed in the genome of *E. raffinosus*, along with phage infection proteins and Mu like proteins.

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

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

Screening of *A. oryzae* for production of acid protease *(Pushpa S Murthy)*

Exopeptidases catalyze hydrolysis of peptide bonds and the free amino acids formed may function in food as pleasant-tasting flavour compounds or as flavour precursors. Exoproteases from *A. oryzae* which are generally regarded as safe were used for modifying food proteins. Production of exopeptidases (flavourzymes) was through solid-state fermentation from *A. oryzae*. *A. oryzae* strains were isolated, screened and the potential

strain was molecularly identified as *A. oryzae (KX 522630)*. Further, solid state fermentation was performed using wheat bran as a substrate and total proteolytic and acid proteolytic activity were measured. Supplementary to this, the carboxypeptidase activity was assayed using Z-Leu-Tyr as substrate. The biovariables were moisture (50%), temperature (30°C) and fermentation duration (108 h) for efficient carboxy peptidase production. The optimized process yielded $3.2x10^3$ ±100 U/g of total protease, 158±78 U/g of acid protease and $1478.8x10^9$ Kat/ml of carboxy peptidases. Thus, the investigation signifies utilization of wheat bran with the defined starter culture, which play an important role in food processing by protein hydrolysis using specific proteases, changing nutritional, bioactive and functional properties of food proteins and also improve sensory attributes.

Bioactive flavourants using biodegradable polymers and proteins *(Nagarajan S)*

During processing of garlic, alliin gets converted into allicin, diallyl sulfide (DAS), diallyl disulfide (DADS), diallyl trisulfide (DATS) and s-allyl cysteine. Therefore, in order to ascertain the isolation and stability of garlic constituents, it has been subjected to conventional solvent extraction with aqueous ethanol followed by extraction with diethyl ether and chloroform which resulted in lesser yield compared to microwave assisted extraction. Further, on silica gel chromatography, isolated diallyl disulfide {DADS (0.327%)} as major component and other components got decomposed using solvent system chloroform and methanol. Although, microwave extract showed allicin as a major component on LC-MS analysis, DADS also isolated on silica gel-column chromatography with higher yield (2.63%) as characterized by ^1H and ^{13}C NMR spectroscopy. But the total microwave extract on GC and GC-MS analysis, showed at least 13 major compounds such as 3-vinyl-1, 2-dithiacyclohex-5-ene (41.28%) and 3-vinyl-1,2-dithiacyclohex-4-ene (10.17%) along with standard hydrocarbons. These results indicate the need for the application and standardization of selective methods for the isolation of specific components.

Amadori and hynes compounds *(Debasree Chanda)*

Amadori products of D-amino acids (D-alanine, D-valine, D-leucine, D-isoleucine, D-tryptophan, D-arginine, D-lysine, D-phenyl alanine etc) with galactose were accomplished via catalytic method. This reaction study was carried out to understand the effect of optical rotation of starting amino acid on the resultant Amadori products. Amadori products were also achieved from a simple pentose including D-xylose with various amino acids (L-valine, L-leucine, L-tryptophan, L-arginine, L-phenyl alanine etc).

FAST TRACK TRANSLATIONAL PROJECTS

Know-how of the isolation of arabinoxylans from defatted cereal brans *(Muralikrishna G)*

Sequential isolation of calcium hydroxide and 10% sodium hydroxide soluble arabinoxylans from cereal brans and incorporation of the same into various food products is the main objective of the project. In addition to its unique functionality, it can also be utilized to obtain xylo-oligosaccharides (prebiotics) and ferulic acid (antioxidant). Thus, cereal brans can be effectively utilized to obtain bioactive compounds of high commercial value as most of the bran is difficult to dispose. Defatted wheat bran and rice brans (1 kg each) were isolated sequentially with saturated calcium hydroxide, followed by 10% sodium hydroxide to obtain calcium hydroxide as well as alkali soluble (Hemicellulose-A and Hemicellulose-B) arabinoxylans in different yields. Characterization of the above arabinoxylans with respect to their solubility, sugar composition, arabinose-xylose ratio bound phenolic acid and viscosity is under progress.

Development and production of anti-obesity diacylglycerol (DAG) oil *(Malathi Srinivasan)*

Successful production method for DAG oil using an enzymatic *trans*-esterification method at the laboratory scale using microbial lipase was reported earlier. Further work for optimizing the conditions for large scale production of the oil and to improve the 1,3-DAG component of the resultant oil are underway. Also the reaction conditions to get a 45-50% conversion of TAG to DAG were optimized. There has been a global concern on the presence of carcinogenic compounds called glycidyl esters in the commercial DAG oil and the current compound is free from such esters.

Non-thermal processing of liquid foods *(Rastogi NK)*

Initial experiments showed that the high pressure treatment (350 MPa, 50°C, 10 min) of sugarcane juice reduced the total bacterial count by 3.29 log CFU and significant reduction in enzymes (polyphenol oxidase and peroxidase), while no changes were observed in ascorbic acid content. Combination of various hurdle treatments involving ozone treatment, mild heat treatment, nisin, mallic acid, citric acid or ascorbic acid were attempted for the stability of the tender coconut water. The combination of ozone with nisin resulted in significant reduction in total plate count and endogenous enzymes (PPO and POD). Storage studies of stored samples are in progress. Later, these hurdles will be integrated with high pressure treatment for optimal processing.

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

Fruit juices and pulps from grapes, lime, pomegranate, mango, apple, tender coconut were used for the development of carbonated fruit juice beverages. The fruit juice were analysed for the nutritional composition and experiments were conducted to extract the maximum soluble solids. Carbonated fruit juice beverage formulations were developed with increasing fruit juice and pulp content. Fruit juice beverage concentrate were developed for different fruits, which could be used in the carbonated fruit juice dispensing unit. The concentrate from different fruits yielded highly acceptable carbonated fruit juice beverages. A process line for the production of carbonated fruit juice beverages was designed and further studies on the storage and shelf-life of the products are in progress.

PROGRESS UNDER XII PLAN PROJECTS

Biological Sciences Cluster

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

Accelerating ageing in rice

Large scale studies were undertaken to expedite the ageing process in rice. Trials were carried out in a room with facility for modifying the temperature and humidity. Twenty bags of freshly harvested paddy (HDPE woven; 25 kg each) were stacked and stored for accelerating the ageing process. Periodically, at 15 days interval, samples were drawn and milled in laboratory milling equipment. Simultaneously, paddy was stored under ambient conditions and aged naturally for 12 months. Improvement in cooking properties similar to naturally aged rice was noticed within 15 days and there was not much change after 30 days of storage in paddy stored under modified conditions. Elongation percent of the cooked grain showed an increase which was higher than that observed in 12 months naturally aged rice.

In the earlier pilot study wherein storage of freshly harvested paddy was conducted at an elevated temperature (45^0C), without modifying the RH, ageing process was noticed only after 30 days of storage and the process of ageing continued until 45 days of storage.

HPLC analysis of free and bound phenolic acids revealed that the major free phenolic acids were gallic acid, chlorogenic acid, vanillic acid, caffeic acid, p-coumaric acid and ferulic acid, while, ferulic acid, coumaric acid and gallic acids were major phenolic acids detected in bound form. Almost all the phenolic acids were higher in the freshly harvested rice. However, there was marked decrease in the ferulic acid and cholrogenic acid contents in accelerated aged and naturally aged rice. With respect to bound phenolic acids, a corresponding increase in bound form of ferulic acid was noticed in accelerated and naturally aged rice. With respect to free fatty acid (FFA) development, an increase was noticed in aged samples with the naturally aged rice recording the highest value. Changes in FFA are known to take place during storage and their interaction with starch brings about changes in texture and flavor.

Value addition to broken rice

Extruded brown rice: Optimization of conditions of size reduction, moisture conditioning and extrusion conditions like zone temperatures, controls of screw, feeder and pelletizer resulted in mock brown rice with higher nutrient and nutraceutical qualities. Compared to natural brown rice, the extruded brown rice had better cooking, functional and sensory qualities.

Red rice gems through extrusion: Red rice gems which can be used in desserts like payasam, pudding, etc, from brown rice of red rice variety by controlled pulverization, thermal treatment, hydration and heating extrusion were developed.

Ready mix/ batter for uniformly textured *idli*

Different parameters like duration of soaking and fermentation were evaluated during the preparation of

Nutri *idli* (carrot *idli* and moringa leaves *idli*)

idli ready mix. It was found that soaking time of black gram dhal for 7-8 h at ~29-30°C resulted in good fermentation of the batter. Also to prepare *nutri-idli*, some selected vegetables/ leaves (carrot, beetroot, moringa leaves etc) were processed and incorporated into *idli* batter in different quantities. The colour and texture values were recorded and sensory acceptability were carried out. Addition of processed vegetables improved the taste and overall acceptability of *idli*. It was found that the degree of gelatinization of the ready mix was also one of the important quality determinants for textural softness along with other parameters.

Shelf-life extension of South Indian *parotta*

Control *parotta* and *parotta* with RCV (Raisin paste, Citric acid and Vinegar) were prepared using standard procedure. *Parottas* were evaluated for spread ratio, moisture content, shear values, apart from water activity and pH. Storage period of 9 days was fixed for the study based on preliminary data. For storage studies, *parottas* were cooled for 30 min after baking, packed separately in polypropylene pouches (150 gauge) and heat sealed. *Parottas* were stored at room temperature (27 ± 1°C) and relative humidity (65 ± 5%) for 9 days.

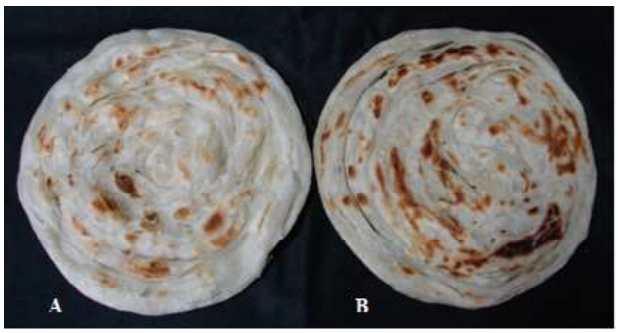
Water absorption decreased from 60-58% with the addition of RCV. The stability, indicating the time (in min) curve at 500 BU, decreased from 6.1 to 5.6. The maximum resistance to extension (R) increased from 555 to 660 BU, and extensibility decreased from 160 to 156 mm with the addition of RCV. Pasting temperature and peak viscosity values also increased with the addition of RCV, indicating that addition of RCV decreased water absorption, dough stability, dough extensibility and increased dough elasticity and swelling capacity of starch during heating.

Addition of RCV decreased the spread ratio and the shear force value indicating improvement in the softness of *parotta*. Addition of RCV decreased a_w from 0.96-0.91, pH from 6.5 to 4.5, increased the sensory scores for texture, number of layers and mouth-feel and hence overall quality score.

Microbial studies showed visible mold growth on 3rd day for control *parotta*, whereas, *parotta* with RCV showed no viable count of mesophilic aerobic bacteria, yeast or molds till 9th day of storage indicating extension of shelf-life of *parotta* by 6 days. Sensory evaluation of *parottas* during storage up to 9 days showed that even though sensory scores for color, hand feel, texture, mouth feel decreased, with a dip in overall quality score from 83 to 75 at the end of 9 days of storage, the product was acceptable.

Whole wheat flour (*Atta*) storage

Bran and germ fractions obtained during roller milling were further subjected to size reduction and heat-treatment (in batches) using microwave. Both treated flour (treated bran and germ along with the endosperm fraction was ground into whole wheat flour) and control flour were subjected to storage study in PET/PE pouch. The flours were evaluated for the physicochemical, rheological and *chapati* making characteristics. Colour values of the control and treated flours showed no significant difference in the L, a and b values, on 7 months storage. Moisture sorption characteristics and dough stability improved in treated flours. Overall sensory quality score decreased with increase in the storage period, from 0 to 7 months. A non-significant change was observed for the tearing strength and pliability of *chapati* during the storage period. Control flour on 4 months storage produced *chapati* with slight rancid aroma which increased further on storage. Similar trend was observed for the eating quality of the control sample on storage. *Chapati* prepared from the flour stored for 4 months showed slight bitter taste, which became very evident for the control sample 5 months onwards. Sensory analysis of treated flour *chapati* samples did not show the bitter taste up to 7 months of storage.



Parotta (A: Control; B: with RCV)

Pectin from mango peel

Mango cv. *Totapuri* is extensively processed into mango pulp. Mango peel is one of the major waste components produced. Extraction of pectin was carried out using different mineral acids viz., HCl, H_2SO_4 and HNO_3. The yield and quality characteristics of the pectin from the dried mango peels indicated that HCl extraction resulted in the maximum yield of pectin (18-20%).

Microwave extraction at different power levels affected the yield, methoxyl content, galacturonic acid and viscosity of pectin. Microwave power levels of 250, 440, 660 and 1000W, with time period ranging from 10-25 min were investigated. Microwave extraction of the mango peel was found to yield maximum pectin within a short time of heating period compared to conventional method of extraction reported earlier. Higher methoxyl content and viscosity were observed in the pectin extracted at 660 and 1000W for 20 minutes. The yield of pectin from mango peel was found to be maximum at microwave power of 1000W for 20 minutes.

Hencos-1-ene extraction from coriander foliage

Coriander foliage contains various bioactive molecules with varied health benefits. Hencos-1-ene was isolated, identified with structural elucidation from coriander foliage. Identification and quantification of Hencos-1-ene were carried out. Structural elucidation was carried out by employing high-resolution mass spectra (HRMS) and 1H, 13C, HMBC, HSQC and TOCSY NMR experiments. A novel, efficient and simple ionic liquid-based microwave-assisted extraction (IL-MAE) was employed for fast extraction of Hencos-1-ene. Various parameters affecting extraction performance at three different levels such as material to solvent ratio (1:10, 1:15 and 1:20), types ([CH3(CH2)3]4NF, [BMIM][PF6], [BMIM][BF4], [C6H5]4P[Br]) and concentration of IL (0.1, 0.5 and 1.0 M), microwave power (200, 500 and 800 W), temperature (50, 70 and 90°C) and extraction time (2, 6 and 10 min) were evaluated. Response surface methodology was applied to determine the influence of parameters and optimal conditions for higher yield of Hencos-1-ene. Under optimal conditions, a maximum yield of 412.8 mg/100g was obtained. Hencos-1-ene showed highest radical scavenging activity of 89.6±0.62% at 200 ppm. The study also confirmed the antimicrobial activity of Hencos-1-ene against *E. coli* and *Salmonella typhimurium*.

Extraction of melatonin

The tryptophan and melatonin content was investigated in Nanjangudu rasabale, Cavendish and silk varieties. Highest content of tryptophan was found in Nanjangudu rasabale, in outer peel (855 μg/100g) and in inner peel (223 μg/100g) whereas in Cavendish, it was 416 μg/100g in the outer peel and 51 μg/100g in inner peel. It was comparatively low in silk banana with 109 μg/100g in the outer peel and 74 μg/100g in the inner peel. Out of all the varieties screened the melatonin was present only in the outer peel of Cavendish and Nanjangudu rasabale with the content 2 μg/100g and 8 μg/100g respectively. Further the stability of serotonin, tryptophan and melatonin were studied at different temperatures (RT, 40, 60 and 80°C) and the content was stable till 40°C after which it degraded completely.

Production of pyrethrins *in vitro*

Present study was aimed at developing a process for augmentation of pyrethrin content in *C. cinerariaefolium* callus and establishing the correlation between early knockdown effects through docking on grain storage insect. *In vitro* seedlings were used as explants to induce callus on MS medium with different concentration of auxins and cytokinins. Pyrethrins extracted from the callus were estimated by RP-HPLC. The concentrations (DW) of cinerin II, pyrethrin II and jasmoline II were quite high in callus grown on solid medium. In callus, total pyrethrin was found to be 17.5 μg/g, which was higher than that found in natural flowers of certain pyrethrum cultivars. Bio-efficacy of pyrethrum extracts of flower and callus on insect *Tribolium* sp., showed higher repellency and early knock-down effect when compared with pure compound pestanal. Further, the rapid knockdown effect of all pyrethrin components was established by molecular docking studies targeting NavMS Sodium Channel Pore receptor docking followed by multiple ligands simultaneous docking (MLSD), performed to investigate the concurrent binding of different combinations of pyrethrin. Among the six pyrethrin components, the pyrethrin I and II were found to be more efficient, binding more firmly to the target, exhibiting higher possibilities of insecticidal effect by an early knockdown mechanism.

Shelf-life extension of fresh fruits and vegetables (mango/ tomato)

Two formulation(s) of stable biochemical fungicides (EC1, EC2) against anthracnose disease in mango fruits [plant fungal pathogen: *Colletotrichum gloeosporioides* Penz] were developed. Formulation (EC1) is in emulsion concentrate form and comprises of plant based volatile bioactive molecules (15% v/v) targeted at the pathogen to completely inhibit spore germination and mycelial growth. Water is the main solvent used to prepare emulsion concentrate and thus this formulation is free from organic solvents. The second formulation (EC2)

developed is in emulsifiable concentrate form and is a blend mixture of plant based volatile bioactive molecules (20% w/w) targeted at complete inhibition of spore germination and mycelial growth. EC2 can ensure uniform spreading and wetting under normal spray and weather conditions. EC2 contains organic solvents and surfactants/ emulsifiers. *In vivo* testing of both formulations in post-harvest treatment on completely matured fruits (var. *Neelum*) showed efficacy of controlling anthracnose.

Edible plant mucilages as surface coating agents

During the molecular studies in coated fruits, it was observed that gene expression levels of polygalacturonase (PG) and xylanase increased during ripening stages (~6-7 folds) and decreased at the final over-ripe stage. On day 7, control fruits showed optimum expression of PG and xylanase, which were ~1.7 folds higher than mucilage coated fruits. The mucilage treated fruits showed optimum expression on 12th day. The treatment with mucilage coating might have precluded the ethylene synthesis and the downstream signalling events such as the synthesis of cell-wall depolymerising genes, during the initial days of ripening. Thus the more abundant transcript would also account for most of the enzymatic activity as observed by the similar trend. Hence, a delay in the ripening of mucilage coated papayas was observed which was corroborated by the ripening parameters such as physiological loss of weight, colour, texture, total soluble solids etc.

After establishing the effect of mucilage coating on shelf-life extension of papaya and the subsequent scale up trials (200 kg, 3 trials), fabrication of cactus de-spiner was undertaken to facilitate large scale production of mucilage from cactus cladode. A semi-auto de-spining unit was developed. The unit has a motor driven rotating drum with multiple blades attached to it to cut spines from the surface of cladode. The cut pieces of cladode kept over a tray are fed manually to the unit wherein the rotating blades remove the spines. De-spined cladode was discharged from the other side. The unit has the height adjustment provision to maintain minimum gap between cladode and blade and effectively remove spines. Trials carried out on the unit have shown more than 90% de-spining efficiency.

Natural pyrethrum as food protectants

The aim was to achieve an effective kill in the test insects with a low cost by exposing them to reduced concentrations of pyrethrum and increasing concentrations of synthetic pyrethroids (cypermethrin/ deltamethrin). Accordingly, 1.2, 1.6 and 2 ml of pyrethrum combined with 300 µl cypermethrin/ deltamethrin concentrations were evaluated for their toxicity on three stored product insects viz., *T. castaneum*, *Rhyzopertha dominica* and *Sitophilus oryzae*. The results revealed that, among the tested combinations, the least LC_{50} value (0.003 mg/cm^2) was recorded in *S. oryzae* with cypermethrin combination exposed for 48 h. On the other hand, deltamethrin combination proved significantly effective in controlling *R. dominica* and *T. castaneum* which recorded LC_{50} values of 0.472 and 0.644 mg/cm^2 concentrations respectively.

Validation of biofume sachets

With trans-anethole as the active constituent, two types of biofume sachets with different adsorbents (Sachet 1 and Sachet 2) were prepared and evaluated for their efficacy against *Sitophilus oryzae* on wheat and *C. chinensis* on green gram under different types of containers (glass, plastic and stainless steel), varying capacities of grain (upto 8 kg for wheat and 4 kg for green gram) and single and multiple doses of the biofumigant. From the studies, it was evident that biofume sachet 1 was more effective than biofume sachet 2 in its efficacy in terms of insecticidal activity,

Cactus cladode de-spiner

oviposition deterrence and F1 generation inhibition properties both in glass and plastic containers.

Oligonucleotide based detection of *Sitophilus oryzae* in food matrix

Sitophilus oryzae (rice weevil) is one of the major insect pests of cereals. Infestation of these insects leads to qualitative and quantitative deterioration of the commodity. Most of the cereals like wheat, rice are used in the form of flour and also for bakery products and biscuits. The flour may contain the remnants of the infested insects when a bulk of cereals is milled. Many of the wheat based bakery products show insect infestation. Hence studies were carried out to develop a molecular based method to detect the remnants of the insect *S. oryzae* in the food matrix like rice flour, wheat flour and wheat based biscuits and cookies using specific primers. Primers were designed for different genes of *Sitophilus* and PCR conditions were optimized for the detection of this insect pest. The DNA isolated from *S. oryzae* spiked cereal based flour and baked foods were checked for matrix interference in PCR analysis.

Value added products from fish and fish by-products

The gelatin solution obtained from the bulk production was subjected to different drying techniques such as, solar drying, tray drying, drum drying, vacuum drying and freeze drying, to obtain gelatine in the form of sheets/ granules/ flakes.

Proximate composition of these gelatins was compared with the control (bovine gelatine). Effect of drying methods on gel strength, content of hydroxyproline and glass transition temperature of the gelatins was also studied. Gelatin obtained from fish acts as a good alternative to mammalian sources like cattle and pigs. This not only eliminates the risk and fear involved with contracting diseases like BSE but also does not require any concerns for halal or kosher, unlike mammals. The skins of warm water fish may be dried and used for gelatin production. This also can reduce the cost of gelatin manufacture in the long run.

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

Morphologically uniform protein-rich selections of quinoa from S9-2 were pooled to derive the homogenous population with desirable qualities. Genetically improved quinoa (*Chenopodium quinoa*) genotype with better yield (600-700 kg/ac), protein content (14.4%) and quality parameters were identified. This can be cultivated in India enabling indigenous availability of the grain crop. The morphological characters of the selected genotype are hexagonal and purple colour stem; green inflorescence which turns to purple in colour at maturity stage. Quinoa matures in 90 to 120 days after sowing. Appropriate agro-technology for quinoa cultivation to obtain high yield per unit area has been developed.

Promising accessions of teff viz., T6 (PI 524439 ENATITE) white grain, containing 12.2% protein and T15 (PI 442114) with brown grain, containing 10.5% protein, were evaluated in pilot scale trials and appropriate agro-technology practices for cultivation were developed to obtain high yield per unit area. Teff matures in 90 to 110 days after sowing and the expected yield is around 250-300 kg per acre and forage can be used as animal feed.

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

The principal objective of the WELFO project was to establish possible relevance of traditional dietary strategies to cardiometabolic disease and general health and to use this knowledge to create functional foods. This would incorporate the identification of food components of traditional dietary interventions for cardiometabolic diseases and extraction of nutraceuticals and bioactive compounds from presumed natural functional foods and screening for efficacy in model systems. Other objectives include the study of microbes as prebiotics for nutritional supplements and selected oligo, polysaccharides as prebiotics.

Food systems/ products with functional ingredients targeted for lifestyle disorders

Wellness rice flour rich in nutraceuticals and GABA was developed to be used as a food ingredient by bioprocessing, milling and thermal treatment. The flour was rich in GABA (improves brain function and reduces blood pressure), g-oryzanol (cholesterol lowering and anti-inflammatory) and polyphenols (antioxidant activity) and can be used for edible purposes.

There is evidence to show the involvement of AMP - activated protein kinase (AMPK) in altered glucosaminoglycans (GAGs) metabolism during diabetic nephropathy. The protective effects of molecules from commonly consumed spices on kidney health in diabetic conditions were studied in animal model. Zerumbone was able to activate AMPK under high glucose conditions. Zerumbone also increased the

phosphorylation of acetyl CoA corboxylase, known AMPK downstream target, which signifies that zerumbone effectively restored the AMPK pathway under high glucose conditions in MDCK cells.

Diet induced obese C57BL/6J mice were treated with obestatin, capsaicin and combination of obestatin + capsaicin. Capsaicin in combination with obestatin was effective in reducing epidydimal fat tissue and serum and epidydimal triglycerides than individual treatment. Genistein did not show any reduction individually and in combination with obestatin, the changes are minimal. Saponins isolated from quinoa seeds administered at 50 mg/kg BW to obese mice and along with HFD feeding to mice significantly reduced weight gain, selected fat depots and lipid parameters in serum. Saponins at 50 mg/kg BW altered the activity of metabolic enzyme and levels of metabolites.

B. breve 142 and *B. longum* 815j, two probiotic cultures isolated from nature were considered for product formulation, based on their potential probiotic properties and inability to produce biogenic amines. Probiotic soy curd with bifidobacteria has been successfully prepared in laboratory trials.

Nutraceuticals and bioactive compounds into functional food ingredients

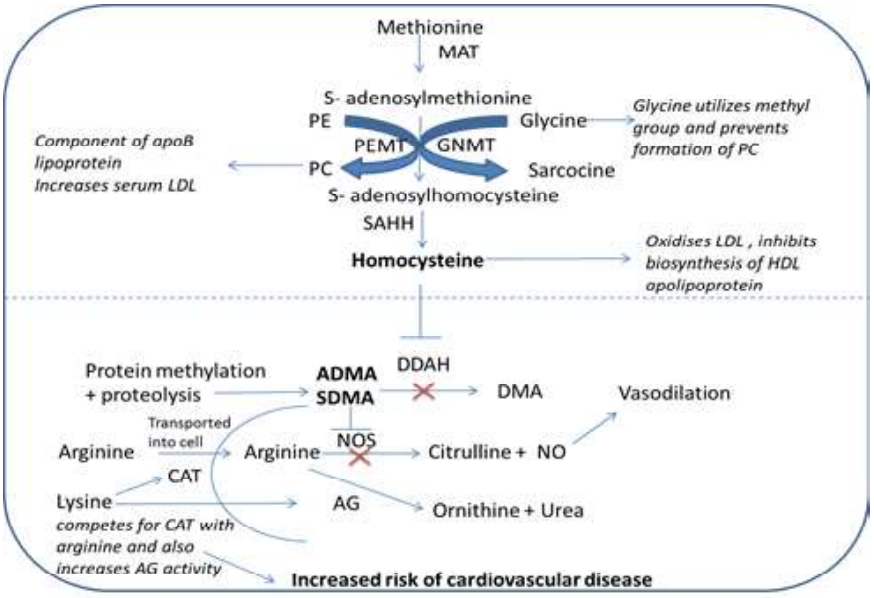
The carbohydrate digestive profile of South Indian foods comprising of the starch fractions digested at different rates was determined. A database for the carbohydrate profiling of Indian foods was created as no authentic database exists on Indian foods. This will help in choice of foods for consumers with diabetes and obesity.

Altering the lysine:arginine and methionine:glycine ratio in diet has an effect on cholesterol levels. The advantage of higher arginine to lysine ratios in diet towards cardiovascular health have been validated through animal experiments in rat model. The mRNA expression levels of hypercholesterolemic markers in liver showed hypocholesterolemic evidence after supplementation of diet with high arginine:lysine ratio.

Cereal brans are generally by-products of the milling industry and do not find edible application. A product with high levels of calcium (~70% RDA in 100 g) has been developed that gives tremendous value addition to the by-product of milling industry. The product also has 10 mg iron and 14 g protein per 100 g.

Extraction of identified nutraceuticals and bioactive compounds

Iron fortified rice that can address the highly prevalent issue of anemia has been developed in the laboratory scale. This can be useful in intervention programmes to address the problem of iron deficient anemia. For developing iron rich rice, paddy was soaked with iron salt (sodium iron EDTA) in water and parboiled under open atmosphere. The parboiled paddy was dried,



Effect of changing ratio of arginine to lysine and methionine to glycine on cardiovascular disease and dyslipidemia markers in rat model

dehusked and milled to obtain iron rich rice. The rice has comparable cooked rice aroma and moderate sweet taste.

Molecules of high values such as zerumbone, catechins were isolated and their derivatives were prepared. Incorporation of zerumbone in functional foods has been successful.

Bioavailability and stability of nutrients/ nutraceuticals

Delivery system for highly fragile nutraceuticals like DHA, EPA and flaxseed oil using nanotechnology were designed at lab scale. Nano-emulsification of DHA can be used as a delivery system to increase the stability. No change in fatty acids profile was observed in nanoemulsions.

Vitamin E is an oily liquid, with poor aqueous solubility and miscibility, which makes poor bioavailability. Spray freeze-dried and freeze-dried microcapsules showed higher dissolution rate than the spray dried microcapsules. *In vivo* data clearly demonstrated the improvement in vitamin E absorption for the spray freeze-dried microcapsules compared to those of spray dried and freeze dried microcapsules.

Formulation of functional food products

a) Tea catechins are valued for their health promoting properties and they are used for chelating iron, boron that will be useful for delivering micronutrients. Both iron and boron catechin complexes may be used as micronutrient fortificants.

b) Fiber content of traditional bakery products was increased by incorporation of fiber and complex carbohydrates by incorporation of chickpea flour, fenugreek and psyllium husk. High fiber bakery products like buns were prepared using by-products such as sugarcane bagasse and banana pseudostem. The products have a good shelf-life and are acceptable to taste. Standardization of process with low sodium bakery and traditional products were carried out. The analysis of residual sodium in low sodium products and storage studies were also carried out.

c) Ready-To-Use (R-T-U) Garden cress (Gc) seed flour was prepared using different drying techniques. Gc seed protein isolate was prepared by standardizing pH, salt concentration and flour to water ratio. From the standardized conditions, 61% of total extractable protein yield was obtained with protein content of 88%. Product has a shelf-life of 4 months under ambient condition and 30 days under accelerated storage condition.

d) *C. elegans* worms were maintained in plates supplemented with green coffee extract (GCE) from egg stage to gravid state through development and then treated with monocrotophos with or without GCE (100 µg/ ml) for 24 h. The extent of dopaminergic neurodegeneration was visualized and quantified in the transgenic strain (BZ555 and NL) along with nonanone assay. GCE significantly alleviated neurodegeneration and rescued AChE activity in MCP-treated worms. Significant neuroprotection by GCE was also evident in BZ555 worms exposed to MCP. Nonanone assay results also showed the rescue of dopamine by GCE. SOD and CAT showed significant increase when treated with GCE against MCP induced alterations.

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

The project was continued with the objectives of working on yeast and plant lipidomes. Under yeast work, the transcriptional regulation pathways involved in various lipid genes were studied and understood clearly for the first time. While working on PHM8 and its regulation, parallel studies were carried upon the RNA polymerase I subunit Rpa12p. This was found to interact with the stress-responsive transcription factor Msn4p to regulate lipid metabolism. Studies were done to confirm that cardiolipin deficiency resulted in TAG accumulation. Further this study led to the annotation of a hitherto putative gene, namely DDL1. This gene was characterized to be a phospholipase with slightly broad substrate specificity. Annotating putative yeast genes and characterizing them biochemically and functionally is a significant achievement. Another yeast gene ATG15 was also found to be a functional lipase and its transcriptional regulation by YAP1 was detailed out. The transcriptional regulation of a lipid phosphatase gene LPPI by a forkhead factor FKH1 and not its isoform FKH2, was also categorically studied and elucidated.

Under plant lipidome, the 18:4 (Stearidonic acid) omega 3 fatty acid rich Himalayan plant Buglossoides was studied at the transcriptome level. While on the one hand, attempts are being made to get a high oil yielding line, at the lab level, the lipid genes are being characterized biochemically. Work on thermogenic foods

using mice models has been carried out to understand the role of white and brown adipose tissue in lipid metabolism.

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

An advanced molecular biology laboratory, including mammalian cell culture and microbial cell culture facility was created. Several projects were initiated to examine food based solutions for type II diabetes.

Inhibition of K_{ATP} channel by phytonutrients

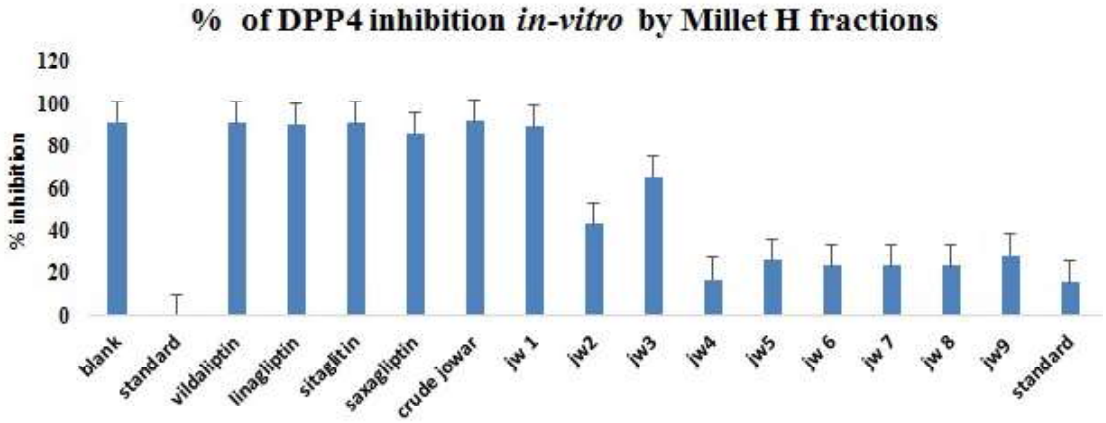
INS-1 cells were screened with bioactive food molecules in order to evaluate their effect on insulin secretion. The treatment of INS-1 cells to various food molecules was performed in a dose dependent manner to optimize for the maximum insulin secretion. Based on screening results, MN-5 was selected for further studies. MN-5 exhibited glucose dependent insulin secretion also known as glucose stimulated insulin secretion (GSIS). Islets isolated from rat pancreas were also treated with MN-5 to observe its effect on potentiation of insulin secretion. Results obtained suggested an increase in the insulin secretion from rat islets through activation of the PKA activity.

Regulatory mechanism of phytonutrients

The project is aimed to attempt a phyto-therapeutic approach to address one of the major post-diabetic complications, diabetic retinopathy (DR) by targeting the outer blood retinal barrier, retinal pigment epithelial cells. The retinal pigment epithelial cells (ARPE-19) were purchased and cultured for this study. Pigments (PGs) isolated and purified from *C. album* were subjected to study their protective effect against glucose-mediated oxidative stress in ARPE-19 cells. Interestingly, PG-1 dose dependently reduced the glucose-mediated intracellular levels of ROS in ARPE-19 cells. This effect was associated with increased protein expression of antioxidant enzymes, HO-1 and SOD-2. Further, PG-1 up-regulated the redox transcription factors, Nrf-2 and NF-kB. Collectively, the findings demonstrate that PG-1 protects retinal pigment epithelial cells from glucose-mediated oxidative stress via activating redox signalling pathways such as Nrf-2 and NF-kB.

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

Naturally occurring bioactive nutritional components present in various foods promote a healthy life and millets are one amongst them. Millet proteins have the potential to be developed as a natural molecule to manage type 2 diabetes (T2D) by inhibiting crucial enzyme such as dipeptidyl peptidase 4 (DPP4). DPP4 inhibitors (DPP4i) are a class of newly developed antidiabetic drugs that extends the half-life of incretin hormones GIP (glucose dependent insulinotropic polypeptide) and GLP-1(glucagon like peptide-1). These hormones promote postprandial insulin secretion. Hence, the newly available therapies for T2D target the pathway of the incretin hormone. Currently, the growing interest among researchers is to challenge incretins to find a



In vitro % DPP4 inhibitory activity of crude jowar and jowar peptides

nutraceutical compound that could modulate this hormone either by inhibiting DPP4 enzyme or by increasing the duration of action of the incretin hormones, studies in this direction may play an important role in the development of natural DPP4 inhibitors with minimal adverse effect. Hence, the aim of the study was to release the bioactive peptides present in cereals/ millets by *in vitro* gastrointestinal sequential digestion using trypsin and pepsin enzyme, purification of bioactive peptides by RP-HPLC and to evaluate their DPP4 inhibitory activity *in vitro* as well as *in situ* using Caco-2 cells. Potential peptides are identified and further validation on animals need to be performed.

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

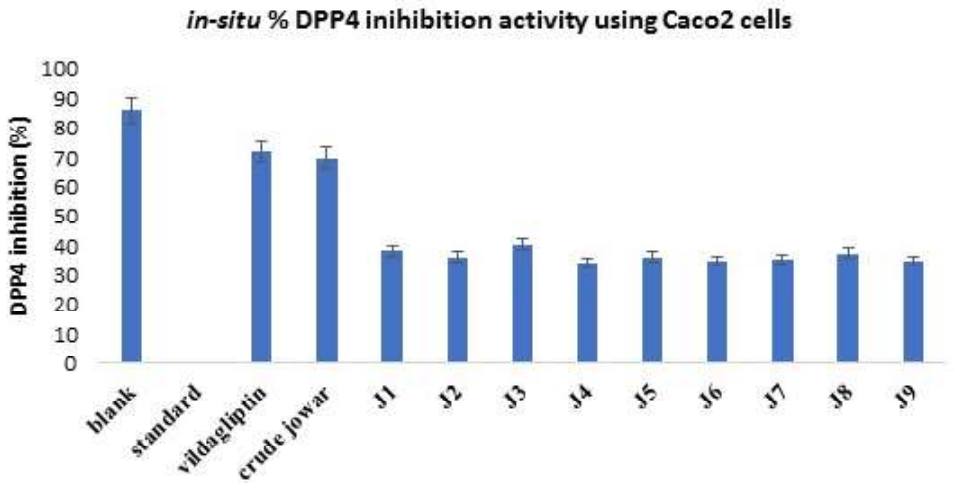
Alpha-glucosidase is an exohydrolase and belongs to glycosyl hydrolase 31 family (EC=3.2.1.20) which cleaves maltose and maltooligosaccharides to liberate glucose. It will be of great significance to study the potential molecules from these millets to control diabetes. The aim of the present work was to use arabinoxylans (AX) and AX derived oligosaccharides (AXOS) from different millets to inhibit the α-glucosidase. Millet bran was used to extract the oligosaccharides. AXOS produced from the water soluble and alkali soluble AX was fractionated using different chromatographic techniques and these were used for the inhibition studies. The results indicated that few fractions of AXOS found to be more potent than the positive drug acarbose. The studies were confirmed both by *in vitro* enzyme inhibition and cell-based assays enzyme inhibitions. These selected AXOS fractions will be explored further at *in vivo* level using diabetic mice models. The potential oligosaccharides from the millet are planned to use for the development of low GI products.

V. New approaches towards understanding of disease dynamics and to accelerate drug discovery (UNDO) *(Bhaskar N)*

The antihyperglycenic nature of horsegram was studied. Effect of the major polyphenol in horsegram, myricetin was analysed on different target enzymes like α-glucosidase, Protein Tyrosinase Phosphatase 1 β and Dipeptidyl Peptidase IV enzymes where myricetin inhibited the enzymes at very low concentrations. The inhibitory activity of myricetin reduced by 20% in the presence of horsegram proteins. Binding studies of myricetin with human serum albumin (HSA), the major carrier protein was carried out. Myricetin decreased the fluorescence intensity of HSA with 60% quenching and Qmax of 69.4%. The binding constant of myricetin for HSA was found to be 9.5 $x10^{-7}$ M with stoichiomety of 1:1. Effect of horsegram proteins on binding interaction of myricetin with HSA was analysed. In the presence of horsegram proteins, myricetin showed decrease in quenching activity i.e 49% with Qmax of 53.1%. The binding constant of myricetin with HSA was increased from 9.5 $x10^{-7}$ M to 2.04 $x10^{-6}$ M in the presence of protein. Thus, protein reduces the affinity of myricetin binding to HSA. Hence, eating whole horsegram could affect the bioavailability and bioactivity of myricetin, a potent anti-glycemic molecule.

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

Exploitation of biomolecules from natural sources with special reference to endangered plants of



In situ % DPP4 inhibition of crude jowar and jowar peptides using Caco-2 cells as DPP-4 source

Asclepiadaceae: D. hamiltonii and *H. indicus* flavour extracts processing followed by their fortification into different food products to impart vanillin related flavour was pursued. Accordingly, microencapsulation method has been employed for DH and HI root powder based water extract, which leads to maltodextrin encapsulated powder which is having its own advantages such as feasibility of using simply in various bakery and milk products, and also the flavour titre values are high. Bioactive compounds such as phytosterols (β-sitosterol) were profiled in both DH and HI root extracts. Subsequently phenolics rich fractions tested for antioxidant potential by DPPH method etc., and also by MTT assay and DAPI assay against cancer cell lines proliferation. A process on flavour preparation using natural extracts of DH and HI was optimized further based on the initial investigations carried out in this during previous year. Both flavour encapsulated powder and flavour concentrates were tried for their efficiency in food formulations such as cookies, cake, shrikhand and both were found to be good.

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

The purified α-galactosidase from *Vigna mungo* was biochemically characterized. The enzyme was stable in a narrow pH range (4-6) by retaining up to 61% residual activity after 15h of incubation at room temperature. The kinetics of thermal deactivation of α-galactosidase between 45 to 51^{0}C revealed 50.5%, 22.4%, 14.86% and 13.4% enzyme activity at 45, 47, 49 and 51^{0}C after 80, 50, 30 and 10 min of incubation respectively. The deactivation energy of α-galactosidase was 108.26 kcal/mol/K while the $t_{1/2}$ at 318, 320, 322 and 324 K was 231, 57.75, 25.66 and 8.56 min, respectively. The values of Gibbs free energy (ΔD), enthalpy (ΔH), and entropy (ΔS) were 22.26-20.52 kcal/mol, 107.6 kcal/mol and 268-269 cal/mol respectively. The purified α-galactosidase was immobilized on magnetic nanoparticles by optimizing the concentration of gluteraldehyde, amount of magnetic nanoparticles (MNP) and the enzyme units. Maximum immobilization of α-galactosidase was obtained by using 500 mM glutaraldehyde, 250 mg MNP and 0.25 U of α-galactosidase. Surfactants like SDS, pluronic F68, tween 80, 85 and CTAB reduced the activity of immobilized enzyme while, tween 20, 40, 60, and triton-x-100 had marginal effect on the immobilized enzyme activity. The effect of metal ions on immobilized enzyme was studied at 1 and 5 mM concentrations. It was found that at 1mM Li^+, Ca^{2+}, Co^{2+}, Fe^{3+} and K^+ stimulated while, Mn^{2+}, Mg^{2+}, Cu^{2+}, Ni^{2+} and Ba^{2+} marginally decreased the immobilized enzyme activity. On the other hand, Mn^{2+}, Mg^{2+}, Cu^{2+}, Ni^{2+}, Li^+, Ca^{2+}, Co^{2+}, Fe^{3+} and Ba^{2+} at 5 mM decreased the activity of immobilized enzyme. Hg^{2+} decreased the enzyme activity at both 1 and 5 mM. The immobilized α-galactosidase was optimally active at pH 4 and 75^{0}C. The immobilized enzyme was stable in pH range (4-6) even after 15 h of incubation at room temperature. Kinetics of thermal deactivation of immobilized α-galactosidase between 67.5 to 75^{0}C revealed 47.5%, 38.3%, 60% and 70% enzyme activity at 67.5, 70, 72.5 and 75^{0}C after 60, 45, 16 and 10 min of incubation, respectively. The deactivation energy of immobilized α-galactosidase was 45.6 kcal/mol/K while the $t_{1/2}$ of immobilized α-galactosidase at 340.5, 343, 345.5 and 348 K was 173.25, 77, 46.2 and 40.76 min, respectively. The values of Gibbs free energy (ΔG), enthalpy (ΔH), and entropy (ΔS) were 23.64-23.18 kcal/mol, 45.6 kcal/mol and 64.5-65.2 cal/mol respectively. Galactose competitively inhibited both free and immobilized α-galactosidase. Reusability experiments of immobilized α-galactosidase showed that enzyme was able to catalyze 10 cycles of repeated substrate hydrolysis. The immobilized α-galactosidase was able to reduce the content of raffinose and stachyose in soymilk. The cytotoxicity analysis using HepG2 cells showed poor toxicity of purified α-galactosidase. Haemagglutination assay of purified α-galactosidase using trypsinized rabbit RBC's showed presence of lectin activity.

The recombinant culture [Hi-Control *Escherichia coli* BL21 (DE3)] harboring manb-1601 plasmid was submitted to MTCC, Institute of Microbial Technology, Chandigarh (MTCC 25101). Colorimetric assays using primary hepatocyte and Hep G2 cell lines were used to evaluate the cellular toxicity of ManB-1601 and results obtained showed that ManB-1601 was non-toxic at 204 ng/ml. Endotoxin evaluation for ManB-1601 was carried out using limulus amebocyte lysate (LAL) assay and results showed <0.25 EU/ml endo-toxin at 20 ng/ml protein concentration.

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

Fulfilling the objective of CSIR network project in developing nutritionally rich food products to combat malnutrition seven nutritional dense food products developed by CFTRI were used for 6-months feeding study to identified children of 12 anganvadi centers of Nanjangud taluk, Mysore district which includes Spirulina chikki, Mango bar, Energy food, Sesame Paste, Rice-Milk Mix, High Protein Rusk and Nutri-sprinkle.

These food products were complemented with regular ICDS program to cater the nutrition needs of malnourished children, in terms of RDA for specific macro- and micro-nutrients such as protein, calcium, iron, zinc, B- group vitamins, vitamin A and calories. Nutrition intervention study was undertaken with support of Women and Child Development Department, Govt. of Karnataka. Around 250 children including severely malnourished children of villages namely, Chamalapura hundi, Heggadahalli, and Ramapura were covered. The program was monitored weekly in all the anganvadi centres. Food products were prepared in-house and distributed to children on a fortnightly basis. The anthropometric and hematological measurements (hemoglobin, ferritin, serum albumin and retinol) of were compared with respective base-line measurements, which showed improvement in weight for age, height for age indices and vitamin A status. The nutrition intervention demonstrated significant positive shift in iron deficient anemia. All the seven food products used in the feeding intervention were highly liked by children.

Chemical Sciences Cluster

IX. Zero Emission Research Initiatives for solid wastes from leather (ZERIS) *(Bhaskar N)*

Fermented delimed leather fleshing as an alternate source of protein in broiler feed formulations: Tannery fleshings (TF) are the major solid wastes resulting from leather processing and are rich in proteins and lipids. Any method that would utilize TF, will help reduce the environment problems associated with the disposal of such organic materials. Earlier, the conditions for deliming TF was optimized and also the safety of the fermented and enzyme hydrolysed delimed-TF was reported through long-term and short-term toxicity assay involving murine model. In this study, the utility value of fermented delimed-TF (FDLF) as a protein source in poultry feed with an aim to establish the commercial utility of FDLF was evaluated.

Broiler chicks (72 nos.; one-day old; 50±5 g) were procured and randomly assigned to six groups (n=12). All the groups were fed a commercial pre-starter diet for a week. After the acclimatization for a week, the groups received different test diets for a period of 6 weeks. Gr I was fed diet with soy as source of protein (control; SM), Gr. II with fish meal as protein source (FM; Positive control), Gr. III & IV received diets with FDLF (10 or 15%) replacing part of soy in the diet as in Gr. I (FDLF-10 & FDLF-15), Gr. V received diet with 10% FDLF replacing part of the fish meal as in Gr. II (FDFM); and Gr VI received a nitrogen-free diet (NF; negative control). Preparation of diets and vaccination schedule for the chicks was done as per the poultry industry protocols. The chicks had *ad-libitum* access to feed and water. Weekly body gain was recorded and, after a total of 7 weeks, blood from chicks of each group were collected and analysed for hematological parameters. The birds were culled as per standard protocol, to collect organs and the carcass for further analysis. All the organs and carcass were stored at -80°C till further analysis. Liver, proventriculus and small intestine were collected and were sectioned for histopathological studies. Meat from different test group was profiled for its proximate composition, fatty acid profile, color and textural properties.

The study revealed significant difference ($p<0.05$) in bodyweight among groups except for soymeal vs fish meal. Fish and FDLF combination fed group gained the maximum bodyweight, whereas nitrogen free diet group had the least body weight. FDLF works in a dose-dependent manner as 10% FDLF fed group gained more body weight compared to 15% FDLF fed group which significantly varied ($p<0.05$). Fish meal diet group recorded slightly higher body weight as compared to soy fed (control) group though it was not significant ($p>0.05$). The serum parameters for all the groups were almost similar ($p>0.05$) except for the nitrogen free diet fed group ($p<0.05$). Proximate analysis and textural analysis of meat did not differ ($p>0.05$) among the groups. Histopathological sections revealed that experimental diet has no effect on the digestive functions of the bird. These results suggest that FDLF can be used as an alternative source of food ingredient in poultry feed formulations.

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

Partial refining of vegetable oils, solvent recovery and separation of value added products using solvent resistant polymeric membranes (SRNF & SRUF): A wide range of composite membranes were developed and the best performing membranes were extensively evaluated for industrial adoption. The comparative analysis showed that the performance of MATES membrane competes with the best of the literature reports taking into consideration holistically all the three vital performance parameters, namely, selectivity, stability and productivity. Subsequently, a plant study was conducted to assess the energy savings with membrane desolventizing vis-a-viz thermal distillation. Under the estimated recirculation conditions (Inlet >37% oil in

miscella) the membrane rejection (>90%) reduced only marginally while the permeate flux reduced to ~10 LMH. The study revealed that the membrane system is expected to recover ~65% of hexane that could be recycled in the extraction plant. Adoption of membrane desolventizing system in a commercial processing plant (300 TPD) would result in energy savings typically to the tune of 1760 MJ/h (~490 kW).

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

Screening of microbial strains for the production of PUFAs enriched oils and development of processes for extraction, characterization and refining of microbial lipids: Search for novel microbial cultures and screening of strains for the PUFAs enriched oils with special reference to GLA was carried out and the evaluation of agro-industrial residues as substrate for the cultivation of microbes were optimized. Total lipid content as well as the fatty acid profiles of these oleaginous microbial cultures was standardized. *Cunninghamella elegans* CFR-C07 (GenBank ANo. KF916583, NCBI) identified as a potent culture which produced maximum biomass of 11.28 g/L (DW), total lipid yield of 38.52% and the concentration of GLA (Gamma Linolenic Acid; $\Delta^{6,9,12}$ C18:3) as 21.72% v/w of the total lipid at 28ºC, 180 rpm and pH 5.5 for 132 hrs. This strain was further subjected to grow at 20ºC to obtain the maximum yield of GLA. The observation indicated that the native isolate *C. elegans* CFR-C07 produced 11.84 g/L (DW) biomass, 29.68% total lipid, 16.62% v/w GLA and surprisingly 1.97% v/w ALA (Alpha Linolenic Acid; $\Delta^{9,12,15}$ C18:3). This was confirmed with GC and GC-MS chromatograms. The growth of this fungus at low temperature (20ºC) altered the biosynthetic pathway and for the production of ω-6 and ω-3 fatty acids, which includes GLA and ALA. Extraction methods and characterization of lipids from this fungus (*C. elegans* CFR07) were standardized. Development of bioprocess in submerged cultures using this selected strain was carried out. Development bioprocess for the microbial production of PUFA at 100-L fermenter at CSIR - NIIST Trivandrum is being carried out and further scale-up for the GLA production is under progress.

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

Encapsulation of cell mass of microbes to maximize viability: Microbial cultures, *Pseudomonas aeruginosa, Pseudomonas pictorum NICM 2077* (NCL) and *Bacillus* sp (CLRI) were encapsulated with different carrier materials using spray drying. The same carrier materials that gave good results with yeast were used for drying of different microorganisms (*Pseudomonas aeruginosa, Pseudomonas pictorum NICM 2077* and *Bacillus* sp) were received from sister laboratories. Drying was carried out with carrier materials one at a time for experiments with different microorganisms. Whey protein, corn starch, and trehalose were used as carrier materials during encapsulation of microbial cells. These encapsulated microbial cells were stored at both refrigerated condition (4°C) and at room temperature (27±2^{0}C) and checked cell survival at regular time intervals (30 days) for a period of 6 months. The encapsulated microbial cell (*Pseudomonas aeruginosa*) was analysed for moisture content, micro structure, particle size, and flow properties.

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