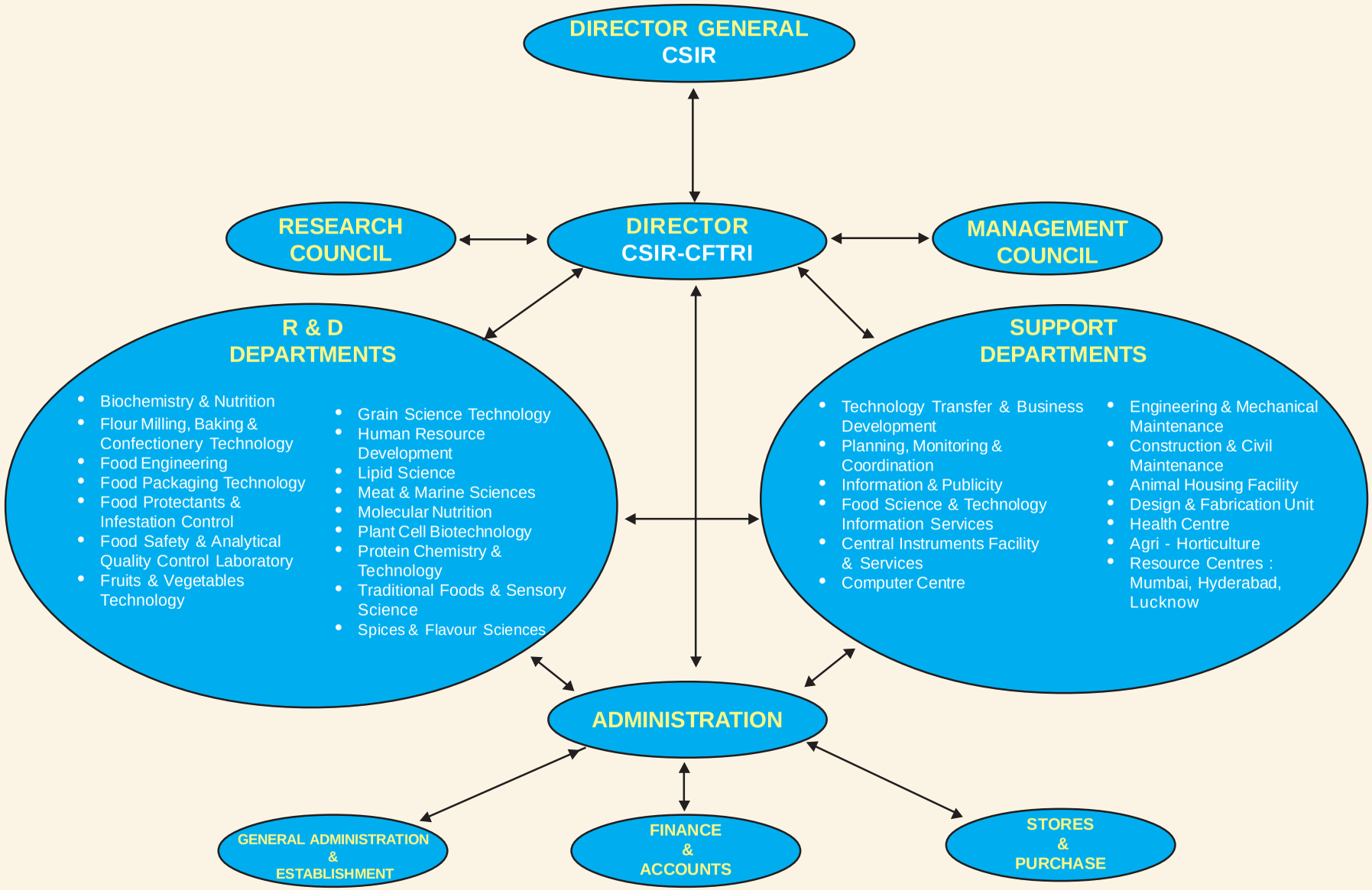
PERFORMANCE REPORT

2014-15

CSIR - Central Food Technological Research Institute
Mysuru - 570 020, India

ORGANISATION CHART OF CSIR-CFTRI



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

Published by :

Director
CSIR-Central Food Technological Research Institute
Mysuru, India

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From Director's Desk . . . . .

It is another proud moment for me to present the outcome of our Institute's research programs for the period 2014-15.

Our achievements were no doubt possible due to the collective efforts of the entire R&D community of the Institute, ably supported by our non-scientific staff. A vibrant and creative CSIR-CFTRI has been achieved by the steadfast and passionate involvement of Team CFTRI.

Our XII Five Year plan projects - AGROPATHY, WELFO, LIPIC and NUTRI-ARM, are geared up with their deliverables. These projects have been very successful as measured by the yardstick of publications in high impact, peer reviewed journals and by the innovative technology outcomes.

Being a premier food research laboratory in the country, CSIR-CFTRI has attracted many institutions to partner with it in furthering the R&D in the area of Food Science and Technology. This year saw the collaborations with Karnataka Govt. for establishing a Nutra-Phyto Incubation Centre and Common Instrumentation facility (NPIC-CIF) on campus; a MoU with PCPCL, a farmer's cooperative in Palakkad, for marketing Coconut Neera in PET bottles. We have also signed a MoU with the Food Safety Commisionerate of Kerala, to help them upgrade the analytical laboratory and strengthen food safety in their state.

Human resource development department has seen a rising increase in the number of students joining our M.Sc. (Food Technology), Certificate course in Milling Technology and Integrated M.Sc.-Ph.D programme (Nutrition Biology). The Ph.D programs under AcSIR and Mysore University are monitored for high quality and best standards. CSIR-CFTRI also signed a MoU with the Indian Institute of Crop Processing Technology (IICPT), Thanjavur, to collaborate and synergise their efforts in curriculum development. As part of the continuing education programme, Short Term Courses and customized training programmes are offered to empower entrepreneurs and industry personnel.

The Institute continued to show its commitment towards the farming community, by organizing an All India Farmers Empowering Workshop and many other awareness programmes conducted in association with agencies like the Ministry of MSME, Govt. of India. Keeping in mind the Dehradun Declaration by the Hon'ble Minister for S&T earlier in June this year, we have focused on societal development, resulting in beneficiaries to the tune of several thousand farmers and several hundred anganwadi children. As in the previous years, OPEN DAYS were organised that have drawn a good number of visitors and students for first hand interaction with scientists.

Overall, it was a fulfilling year in terms of academic and societal accomplishments. It is my duty to acknowledge the support received from CSIR, New Delhi; the guidance from the Research Council and Management Council of the Institute and various funding organizations and Industries. I wish to thank the staff and students of the Institute for their zealous and relentless efforts in making this success possible every time.

I look forward to a more productive year ahead!

(Sd/-)
Prof. Ram Rajasekharan
Director
CSIR-Central Food Technological Research Institute, Mysuru

Date: 29 October 2015
Place: Mysuru

Achievements at a glance

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Achievements in Brief

1. Research Papers Published

SCI Papers

1 Aduja Naik, Venu G.V., Maya Prakash, Raghavarao K.S.M.S., Dehydration of coconut skim milk and evaluation of functional properties, CyTA - J. Food, 2014, 12(3), 227-234

2 Akitha Devi M.K., Giridhar P., Isoflavone augmentation in soybean cell cultures is optimized using response surface methodology, J. Agric. Food Chem., 2014, 62, 3143-3149

3 Akitha Devi M.K., Giridhar P., Variations in physiological response, lipid peroxidation, antioxidant enzyme activities, proline and isoflavones content in soybean varieties subjected to drought stress, Proc. Nat. Acad. Sci., India, Sect. B - Biol. Sci., 2015, 85(1), 35-44

4 Amit K. Das, Sreerama Y.N., Vasudeva Singh, Diversity in phytochemical composition and antioxidant capacity of dent, flint and specialty corns, Cereal Chem., 2014, 91(6), 639-645

5 Amit Kumar T, Ashish D., Manish Kumar P, Namrata R., Priyanka G., Shakir Ali, Manjunatha Prabhu B.H., Hari Narayan K., Ratan Singh R., Shio Kumar S., Shivali D., Bhaskar N., Durga Prasad M., Attenuated neuroprotective effect of riboflavin under UV-B irradiation via miR-203/c-Jun signaling pathway in vivo and in vitro, J. Biomed. Sci., 2014, 21, 39

6 Amitha V., Shylaja M. Dharmesh, Nalini M.S., Fungal endophytes from the culinary herbs and their antioxidant activity, Int. J. Current Res., 2014, 6(8), 7996-8002

7 Amrutha Kala A.L., Studies on saturated and trans fatty acids composition of few commercial brands of biscuits sold in Indian market, J. Food Sci. Technol., 2014, 51(11), 3520-3526

8 Anindya Basu, Sarma Mutturi, Prapulla S.G, Modeling of enzymatic production of isomaltooligosaccharides: A mechanistic approach, Catalysis Sci. Technol., 2015, 5(5), 2945-2958

9 Anushi Sharma, Joseph G.S., Singh R.P, Antioxidant and antiplatelet aggregation properties of bark extracts of Garcinia pedunculata and Garcinia cowa, J. Food Sci. Technol., 2014, 51(8), 1626-1631

10 Anwesha Sarkar, Purnima Kaul Tiku, Evaluation of tomato processing by-products: A comparative study in a pilot scale setup, J. Food Process Eng., 2014, 37, 299-307

11 Aprajeeta J., Gopirajah R., Anandharamakrishnan C., Shrinkage and porosity effects on heat and mass transfer during potato drying, J. Food Eng., 2015, 144, 119-128

12 Arunkumar R., Harish Prashanth K.V., Manabe Y, Hirata T., Sugawara T., Shylaja M. Dharmesh, Baskaran V., Biodegradable poly (lactic-co-glycolic acid)-polyethylene nanocapsules: An efficient carrier for improved solubility, bioavailability and anticancer property of lutein, J. Pharm. Sci., 2015, 104, 2085-2093

13 Ashwini Bellary N., Rastogi N.K., Effect of selected pretreatments on impregnation of curcuminoids and their influence on physico-chemical properties of raw banana slices, Food Bioprocess Technol., 2014, 7(10), 2803-2812

14 Bharath Kumar S., Prabhasankar P, A study on noodle dough rheology and product quality characteristics of fresh and dried noodles as influenced by low glycemic index ingredient, J. Food Sci. Technol., 2015, 52(3), 1404-1413

15 Bharath Kumar S., Prabhasankar P, A study on starch profile of rajma bean (Phaseolus vulgaris) incorporated noodle dough and its functional characteristics, Food Chem., 2015, 180, 124-132

16 Bhowal S., Priyanka B.S., Rastogi N.K., Mixed reverse micelles facilitated downstream processing of lipase involving water-oil-water liquid emulsion membrane, Biotechnol. Prog., 2014, 30(5), 1084-1092

17 Binduheva U., Negi P.S., Efficacy of cinnamon oil to prolong the shelf-life of pasteurised, acidified and ambient stored papaya pulp, Acta Aliment., 2014, 43(3), 378-386

18 Chaitali Sen Gupta, Milind, Jeyarani T., Jyotsna Rajiv, Rheology, fatty acid profile and quality characteristics of nutrient enriched pizza base, J. Food Sci. Technol., 2015, 52(5), 2926-2933

19 Chakkaravarthi A., Nagaprabha P., Punil Kumar H.N., Baby Latha R., Suvendu Bhattacharya, Jilebi 3: Effect of frying conditions on physical characteristics, J. Food Sci. Technol., 2014, 51(5), 865-874

20 Chalamaiah M., Hemalatha R., Jyothirmayi T, Prakash Diwan V., Uday Kumar P., Nimgulkar C., Dinesh Kumar B., Immunomodulatory effects of protein hydrolysates from rohu (Labeo rohita) egg (roe) in BALB/c mice, Food Res. Int., 2014, 62(1), 1054-1061

21 Chalamaiah M., Hemalatha R., Jyothirmayi T, Prakash V. Diwan, Bhaskarachary K., Vajreswari A., Ramesh Kumar R., Dinesh Kumar B., Chemical composition and immunomodulatory effects of enzymatic protein hydrolysates from common carp (Cyprinus carpio) egg, Nutrition, 2015, 31, 388-398

22 Chandrasekhar J., Sonika G., Madhusudhan M.C., Raghavarao K.S.M.S., Differential partitioning of betacyanins and betaxanthins employing aqueous two phase extraction, J. Food Eng., 2015, 144, 156-163

23 Chhanwal N., Anandharamakrishnan C., Temperature and moisture based modeling for prediction of starch gelatinization and crumb softness during bread baking process, J. Texture Stud., 2014, 45, 462-476

24 Deepa C., Umesh Hebbar H., Micronization of maize flour: Process optimization and product quality, J. Cereal Sci., 2014, 60, 569-575

25 Divya K., Ramalakshmi K., Pushpa S. Murthy, Jagan Mohan Rao L., Volatile oils from Ferula asafoetida varieties and their antimicrobial activity, LW T-Food Sci. Technol., 2014, 59(2), 774-779

26 Divyashri G., Murty V.R., Prapulla S.G., Probiotic-mediated biotransformation of monosodium glutamate to gamma-aminobutyric acid: Differential production in complex and minimal media and kinetic modelling, Ann. Microbiol., 2014, 64, 229-237

27 Divyashri G., Prapulla S.G, An insight into kinetics and thermodynamics of gamma-aminobutyric acid production by Enterococcus faecium CFR 3003 in batch fermentation, Ann. Microbiol., 2015, 65(2), 1109-1118

28 Divyashri G., Prapulla S.G., Mass transfer characterization of gamma-aminobutyric acid production by Enterococcus faecium CFR 3003: Encapsulation improves its survival under simulated gastro-intestinal conditions, Bioprocess Biosyst. Eng., 2015, 38, 569-574

29 Fazal E., Pushpa S. Murthy, Akhilender Naidu K., Maheshwaraiah A., Nagarajan S., Sudha B.S., Microwave assisted synthesis and biological evaluation of potential quinoline-2-carboxylates of aromatic compounds, Indo American J. Pharm. Res.(OA), 2015, 5(2), 625-634

30 Gadkari P.V., Manohar B., Extraction of catechins from decaffeinated green tea for development of nanoemulsion using palm oil and sunflower oil based lipid carrier systems, J. Food Eng., 2015, 147, 14-23

31 Gayathri Balakrishnan, Renu Agrawal, Antioxidant activity and fatty acid profile of fermented milk prepared by Pediococcus pentosaceus, J. Food Sci. Technol., 2014, 51(12), 4138-4142

32 Gondi M., Basha S.K., Bhaskar J.J., Salimath P.V, Prasada Rao U.J.S., Anti-diabetic effect of dietary mango (Mangifera indica L.) peel in streptozotocin-induced diabetic rats, J. Sci. Food Agric., 2015, 95(5), 991-999

33 Gunashree B.S., Selva Kumar R., Roobini R., Venkateswaran G., Nutrients and antinutrients of ragi and wheat as influenced by traditional processes, Int. J. Curr. Microbiol. Appl. Sci., 2014, 3(7), 720-736

34 Hariprasad P., Vipin A.V., Karuna S., Raksha R.K., Venkateswaran G., Natural aflatoxin uptake by sugarcane (Saccharum officinaurum L.) and its persistence in jaggery, Environ. Sci. Pollut. Res., 2015, 22(8), 6246-6253

35 Henry D.E., Prakash M. Halami, Prapulla S.G, Lactobacillus plantarum MCC2034, a novel isolate from traditional Indian lactic fermented preparation: Molecular identification and evaluation of its in vitro probiotic potential, J. Microbiol. Biotech. Food Sci., 2015, 4(4), 328-331

36 Hithamani G., Srinivasan K., Bioaccessibility of polyphenols from wheat (Triticum aestivum) sorghum (Sorghum bicolor), green gram (Vigna radiata) and chickpea (Cicer arietinum) as influenced by domestic food processing, J. Agric. Food Chem., 2014, 62, 11170-11179

37 Hithamani G., Srinivasan K., Effect of domestic processing on the polyphenol content and bioaccessibility in finger millet (Eleusine coracana) and pearl millet (Pennisetum glaucum), Food Chem., 2014, 164, 55-62

38 Hundre S.Y., Karthik P, Anandharamakrishnan C., Effect of whey protein isolate and beta-cyclodextrin wall systems on stability of microencapsulated vanillin by spray-freeze drying method, Food Chem.,2015, 174, 16-24

39 Indrani D., Milind, Sakhare S.D., Inamdar A.A., Venkateswara Rao G., Development of protein and fiber enriched breads by supplementation of roller milled fractions of green gram, J. Food Sci. Technol., 2015, 52(1), 415-422

40 Jadhav Kisan B., Sashikumar S., Hari Prasad, Apurva Kumar R.J., Revanappa B., Janagoudar B.S., Rajini P.S., Comparative responses of acetylcholinesterase (AChE) of rat brain and model

invertebrate Caenorhabiditis elegans in vitro, Appl. Biol. Res., 2014, 16(2), 169-175

41 Jamuna J.B., Nandini C.D., Feeding of banana flower and pseudostem to diabetic rats results in modulation of renal GLUTs, TGFβ, PKC and extracellular matrix components, Nutr. Metab. Cardiovasc. Dis., 2014, 24, 623-631

42 Jeyarani T., Banerjee T., Ravi R., Gopalakrishna A.G., Omega-3 fatty acids enriched chocolate spreads using soybean and coconut oils, J. Food Sci. Technol., 2015, 52(2), 1082-1088

43 Jyotsna R., Milind, Sakhare S.D., Inamdar A.A., Venkateswara Rao G., Effect of green gram semolina (Phaseolus aureus) on the rheology, nutrition, microstructure and quality characteristics of high protein pasta, J. Food Process. Pres., 2014, 38, 1965-1972

44 Kathiresan S., Chandrashekar A., Ravishankar G.A., Sarada R., Regulation of astaxanthin and its intermediates through cloning and genetic transformation of β-carotene ketolase in Haematococcus pluvialis, J. Biotechnol., 2015, 196-197, 33-41

45 Kavitha B.C., Shylaja M. Dharmesh, Effect of various cooking processes on antioxidants of potato (Solanum tuberosum), J. Pharmacy Res., 2014, 8(8),1148-1157

46 Koushika Maiya G., Shwetha B.G., Indrani D., Effect of barley flour on rheological characteristics of dough, organoleptic, nutritional and storage characteristics of South Indian parotta, Food Sci. Technol. Int., 2015, 21(1), 24-32

47 Krishna Murthy T.P., Manohar B., Optimization of supercritical carbon dioxide extraction of phenolic compounds from mango ginger rhizome (Curcuma amada Roxb.) using response surface methodology, J. Biomed. Biotechnol., 2014, 2(1), 14-19

48 Kumudha A., Sarada R., Effect of different extraction methods on vitamin B_{12} from the blue green algae, Spirulina platensis, Pharmaceutica Analytica Acta, 2015, 6(2)

49 Kumudha A., Selvakumar S., Dilshad P, Vaidyanathan G., Thakur M.S., Sarada R., Methylcobalamin – a form of vitamin B_{12} identified and characterised in Chlorella vulgaris, Food Chem., 2015, 170, 316-320

50 Mahendra Kumar C., Sridevi Annapurna Singh, Bioactive lignans from sesame (Sesamum indicum L.): Evaluation of their antioxidant and antibacterial effects for food applications, J. Food Sci. Technol., 2015, 52(5), 2934-2941

51 Maheswaraiah A., Jaganmohan Rao L., Akhilender Naidu K., Anti-platelet activity of water dispersible curcuminoids in rat platelets, Phytotheraphy Res., 2015, 29, 450-458

52 Mohammad Imtiyaj Khan, Giridhar P., Enhanced chemical stability, chromatic properties and regeneration of betalains in Rivina humilis L. berry juice, LWT-Food Sci. Technol., 2014, 58(2), 649-657

53 Mohammad Imtiyaj Khan, Giridhar P, The berries of Santalum album L. as a new source of cyanidin-3-glucoside and chemical profiling during different stages of berry development, Proc. Nat. Acad. Sci., India, Sect. B - Biol. Sci., 2014, 84(3), 689-694

54 Mohammad Imtiyaj Khan, Sri Harsha P.S.C., Chauhan A.S., Vijayendra S.V.N., Asha M.R., Giridhar P., Betalains rich Rivina humilis L. berry extract as natural colorant in product (fruit spread and RTS beverage) development, J. Food Sci. Technol., 2014, 52(3), 1808-1813

55 Mohan Kumar N.S., Vijay Kishore, Manonmani H.K., Chemical modification of L-asparaginase from Cladosporium sp. for improved activity and thermal stability, Preparative Biochem. Biotechnol., 2014, 44, 433-450

56 Muhammed M.A., Bindu B.S.C., Jini R., Harish Prashanth K.V., Bhaskar N., Evaluation of different DNA extraction methods for the detection of adulteration in raw and processed meat through polymerase chain reaction - restriction fragment length polymorphism (PCR-RFLP), J. Food Sci. Technol., 2015, 52(1), 514-520

57 Muhammed M.A., Domendra D., Muthukumar S.P, Sakhare P.Z., Bhaskar N., Effects of fermentatively recovered fish waste lipids on the growth and composition of broiler meat, British Poult. Sci., 2015, 56(1), 79-87

58 Mukthamba P., Srinivasan K., Beneficial hypolipidemic influence of a combination of dietary fenugreek (Trigonella foenum-graecum) seeds and garlic (Allium sativum) in induced hypercholesterolemic rats, Eur. Food Res. Technol., 2015, 240, 1049-1058

59 Nagaprabha P., Sila Bhattacharya, Effect of concentration and cations on texture of green gram (Vigna radiate L.) gels, Int. J. Food Properties, 2015, 18, 1865-1875

60 Nagaraj S., Raghavan A.V., Sudha N. Rao, Uma V. Manjappara, Obestatin and Nt8U influence glycerolipid metabolism and PPAR gamma signaling in mice, Int. J. Biochem. Cell Biol. (OA), 2014, 53, 414-422

61 Nagaraju V.D., Sridhar B.S., Hydrodynamics and heat transfer characteristics of draft tube spouted bed roasting of groundnuts (Arachis hypogeae), Int. J. Scientific Technol. Res., 2014, 3(7), 178-186

62 Nandini K., Srinivas P., Bettadaiah B.K., RuO_4 Catalyzed dihydroxylation for the synthesis of mixed medium-chain triacylglycerols, Tetrahedron Lett., 2015, 56, 2704-2706

63 Neelam Rawat, Indrani D., Effect of ingredients on rheological, nutritional and quality characteristics of fibre and protein enriched baked energy bars, J. Food Sci. Technol., 2015, 52(5), 3006-3013

64 Nidheesh T, Anil Kumar P.K., Elakkiyaselvi V, Maheswari K., Suresh P.V., Statistical optimization of solid state fermentation conditions for the enhanced production of thermoactive chitinases by mesophilic soil fungi using response surface methodology and their application in the reclamation of shrimp processing by-products, Ann. Microbiol., 2014, 64(2), 671-681

65 Nidheesh T., Gaurav Kumar P., Suresh P.V, Chitooligomers preparation by chitosanase produced under solid state fermentation using shrimp by-products as substrate, Carbohydr. Polym., 2015, 121, 1-9

66 Nidheesh T.,Gaurav Kumar P., Suresh P.V, Enzymatic degradation of chitosan and production of D-glucosamine by solid substrate fermentation of exo-β-D-glucosaminidase (exochitosanase) by Penicillium decumbens CFRNT15, Int. Biodeter. Biodegr., 2015, 97, 97-106

67 Nidhi B., Mamatha B.S., Baskaran V., Olive oil improves the intestinal absorption and bioavailability of lutein in lutein-deficient mice, Eur. J. Nutr., 2014, 53,117-126

68 Nidhi B., Ramaprasad T.R., Baskaran V., Dietary fatty acid determines the intestinal absorption of lutein in lutein deficient mice, Food Res. Int., 2014, 64, 256-263

69 Nidhi B., Sharavana G., Ramaprasad T.R., Baskaran V., Lutein derived fragments exhibit higher antioxidant and anti-inflammatory properties than lutein in lipopolysaccharide induced inflammation in rats, Food Funct., 2015, 6, 450-460

70 Padma Ishwarya S., Anandharamakrishnan C., Spray-freeze-drying approach for soluble coffee processing and its effect on quality characteristics, J. Food Eng., 2015, 149, 171-180

71 Padmaja R.J., Akshath U.S., Abhijith K.S., Prakash M. Halami, Thakur M.S., Gold nanoparticle-based immunodetection of Staphylococcus aureus leukotoxin M/F'-PV in subclinical samples of bovine mastitis, Anal. Methods, 2014, 6, 5214-5220

72 Padmaja R.J., Prakash M. Halami, Immunogenicity of Staphylococcus aureus LukM/F'-PV recombinant subunits: Validation of diagnostic potential and evaluation of protective efficacy in vitro, Vet. Microbiol., 2014, 170, 358-367

73 Pallavi B.V., Chetana R., Ravi R., Yella Reddy S., Moisture sorption curves of fruit and nut cereal bar prepared with sugar and sugar substitutes, J. Food Sci. Technol., 2015, 52(3), 1663-1669

74 Pradeep H., Shashikumar S., Rajini P.S., Rajanikant G.K, Anti-parkinsonian efficacy of target-specific GSK3β inhibitors demonstrated in Caenorhabiditis elegans, Med. Chem. Res., 2014, 23, 5263-5268

75 Pradeep P.M., Sreerama Y.N., Impact of processing on the phenolic profiles of small millets: Evaluation of their antioxidant and enzyme inhibitory properties associated with hyperglycemia, Food Chem., 2015, 169, 455-463

76 Pradeep P.M., Usha Dharmaraj, Sathyendra Rao B.V, Amudha Senthil, Vijayalakshmi N.S., Malleshi N.G., Vasudeva Singh, Formulation and nutritional evaluation of multigrain ready-to-eat snack mix from minor cereals, J. Food Sci. Technol., 2014, 51(12), 3812-3820

77 Prasanna Anjaneya Reddy L., Narasimha Reddy B., Bhakshu M.D.L., Venkata Ratnam K., Veeranjaneya Reddy L., Chemical composition, antimicrobial and antioxidant activities of essential oils from leaves and fruits of Commiphora caudata Engl., Int. J. Pharmacognosy Phytochemical Res., 2015, 7(1), 38-44

78 Prasanna Anjaneya Reddy L., Venkata Ratnam K., Bhakshu M.D.L., Narasimha Reddy B., Veeranjaneya Reddy L., Chemical profile, antioxidant and antimicrobial activity of essential oils from Boswellia ovalifoliolata Bal et. Henry, Int. J. Pharma. Clinical Res., 2015, 7(1), 96-101

79 Prasanth Kumar P.K., Gopala Krishna A.G., Impact of different deacidification methods on quality characteristics and composition of olein and stearin

in crude red palm oil, J. Oleo Sci., 2014, 63(12), 1209-1221

80 Prasanth Kumar P.K., Gopala Krishna A.G, Physico-chemical characteristics and nutraceutical distribution of crude palm oil and its fractions, Grasas y Aceites, 2014, 65(2), e018

81 Prasanth Kumar P.K., Gopala Krishna A.G, Physico-chemical characteristics of commercial coconut oils produced in India, Grasas y Aceites, 2015, 66(1), e062

82 Prasanth Kumar P.K., Sai Manohar R., Indiramma A.R., Gopala Krishna A.G., Stability of oryzanol fortified biscuits on storage, J. Food Sci. Technol., 2014, 51(10), 2552-2559

83 Preeti C., Prasanth Kumar P.K., Ramesh H.P, Lokesh B.R., Gopala Krishna A.G., Hypolipidemic effect of oryzanol concentrate and low temperature extracted crude rice bran oil in experimental male wistar rats, J. Food Sci. Technol., 2014, 51(7), 1278-1285

84 Radha Pujari, Natesh Kumar, Suhas Ballal, Sachin M. Eligar, Anupama S., Ganapathi Bhat, Bale M.S., Shashikala R.I., Padma Shastry, Rhizoctonia bataticola lectin (RBL) induces phenotypic and functional characteristics of macrophages in THP-1 cells and human monocytes, Immunol. Lett., 2015, 163, 163-172

85 Raghavendra C.K., Srinivasan K., Anti-cholelithogenic effect of dietary tender cluster beans (Cyamopsis tetragonoloba) on the formation of cholesterol gallstones in mice, Appl. Physiol. Nutr. Metab., 2014, 39, 152-157

86 Raghavendra C.K., Srinivasan K., Influence of dietary tender cluster beans (Cyamopsis tetragonoloba) on biliary proteins, bile acid synthesis and cholesterol crystal growth in rat bile, Steroids, 2015, 94, 21-30

87 Raja Rajan R.G., Gopala Krishna A.G, A simple method for purification of deodorizer distillate from Indian rice (Oryza sativa) bran oil and preparation of phytosterols, Grasas y Aceites, 2014, 65(4), e050

88 Raja Rajeshwari, Manisha Guha, Jayadeep A., Sathyendra Rao B.V., Effect of alkaline cooking on proximate, phenolics and antioxidant activity of foxtail millet (Setaria italica) World Appl. Sci. J., 2015, 33(1), 146-152

89 Rajagopal K., Chandana T.G., Praveen K. Singh, Diffusion, frowning and smiling of low molecular weight protein bands: A simple, rapid and efficient solution, Int. J. Pept. Res. Ther., 2015, 21, 7-11

90 Rajam R., Anandharamakrishnan C., Microencapsulation of Lactobacillus plantarum (MTCC 5422) with fructooligosaccharide as wall material by spray drying, LW T-Food Sci. Technol., 2015, 60(2), 773-780

91 Rajesh Devisetti, Sreerama Y.N., Sila Bhattacharya, Nutrients and antinutrients in foxtail and proso millet milled fractions: Evaluation of their flour functionality, LW T-Food Sci. Technol., 2014, 59, 889-895

92 Raju Nagaraju, Apurva Kumar R.J., Rajini P.S., The organophosphorus insecticide, monocrotophos possesses the propensity to induce insulin resistance in rats on chronic exposure, J. Diabetes, 2015, 7, 47-59

93 Ramesh K. Saini, Harish Prashanth K.V., Nandini P. Shetty, Giridhar P., Elicitors, SA and MJ enhance carotenoids and tocopherol biosynthesis and expression of antioxidant related genes in Moringa oleifera Lam. leaves, Acta Physiologiae Plantarum, 2014, 36, 2695-2704

94 Ramesh K. Saini, Manoj P., Nandini P. Shetty, Srinivasan K., Giridhar P., Dietary iron supplements and Moringa oleifera leaves influence the liver hepcidin messenger RNA expression and biochemical indices of iron status in rats, Nutr. Res., 2014, 34(7), 630-638

95 Ramesh K. Saini, Nandini P. Shetty, Giridhar P, Carotenoid content in vegetative and reproductive parts of commercially grown Moringa oleifera Lam. cultivars from India by LC-APCI-MS, Eur. Food Res. Technol., 2014, 238(6), 971-978

96 Ramesh K. Saini, Nandini P. Shetty, Giridhar P, GC-FID/MS analysis of fatty acids in Indian cultivars of Moringa oleifera: Potential sources of PUFA, J. Am. Oil Chem. Soc., 2014, 91(6), 1029-1034

97 Ramesh K. Saini, Nandini P. Shetty, Maya Prakash, Giridhar P., Effect of dehydration methods on retention of carotenoids, tocopherols, ascorbic acid and antioxidant activity in Moringa oleifera leaves and preparation of a RTE product, J. Food Sci. Technol., 2014, 51(9), 2176-2182

98 Ravi H., Baskaran V., Biodegradable chitosan-glycolipid hybrid nanogels: A novel approach to encapsulate fucoxanthin for improved stability and bioavailability, Food Hydrocolloids, 2015, 43, 717-725

99 Rekha B., Lokesh B.R., Gopala Krishna A.G, Chemistry of color fixation in crude, physically refined and chemically refined rice bran oils upon

heating, J. Am. Oil Chem. Soc., 2014, 91, 1665-1676

100 Revanappa S.B., Nandini C.D. Salimath P.V, Structural variations of arabinoxylans extracted from different wheat (Triticum aestivum) cultivars in relation to chapati quality, Food Hydrocolloids, 2015, 43, 736-742

101 Revanappa S.B., Salimath P.V., Prasada Rao U.J.S., Effect of peroxidase on textural quality of dough and arabinoxylan characteristics isolated from whole wheat flour dough, Int. J. Food Properties, 2014, 17, 2131-2141

102 Ritika Mathur, Nivya P.N., Basavaraj K., Pushpa S. Murthy, Bioprocess of robusta cherry coffee with polyphenol oxidase and quality enhancement, Eur. Food Res. Technol., 2015, 240, 319-325

103 Roopashri A.N., Varadaraj M.C.,Hydrolysis of flatulence causing oligosaccharides by α-D-galactosidase of a probiotic Lactobacillus plantarum MTCC 5422 in selected legume flours and elaboration of probiotic attributes in soy-based fermented product, Eur. Food Res. Technol., 2014, 239, 99-115

104 Ruthu, Pushpa S. Murthy, Amit K.R.,Bhaskar N., Fermentative recovery of lipids and proteins from freshwater fish head waste with reference to antimicrobial and antioxidant properties of protein hydrolysate, J. Food Sci. Technol., 2014, 51(9), 1884-1892

105 Sakhare S.D., Inamdar A.A., Indrani D., Kiran M.H.M., Venkateswara Rao G., Physicochemical and microstructure analysis of flour mill streams and milled products, J. Food Sci. Technol., 2015, 52(1), 407-414

106 Sakhare S.D., Inamdar A.A., Shwetha B.G., Indrani D., Venkateswara Rao G., Roller milling fractionation of green gram (Vigna radiata): Optimization of milling conditions and chemical characterization of millstreams, J. Food Sci. Technol., 2014, 51(12), 3854-3861

107 Sakhare S.D., Inamdar A.A., Soumya C., Indrani D., Venkateswara Rao G., Effect of flour particle size on microstructural, rheological and physico-sensory characteristics of bread and South Indian parotta, J. Food Sci. Technol., 2014, 51(12), 4108-4113

108 Sakhare S.D., Inamdar A.A., The cumulative ash curve: A best tool to evaluate complete mill performance, J. Food Sci. Technol., 2014, 51(4), 795-799

109 Sakhare S.D., Indrani D., Inamdar A.A., Shwetha B.G., Venkateswara Rao G., Chemical, rheological and bread making characteristics of bran duster flours from roller flourmills, J. Food Sci. Technol., 2014, 51(10), 2699-2705

110 Santosh Kumar S.C., Vijendra Kumar N., Srinivas P., Bettadaiah B.K., A convenient practical synthesis of alkyl and aryl oxime esters, Synthesis, 2014, 46, 1847-1852

111 Sarat Chandra T., Mudliar S.N., Vidyashankar S., Mukherji S., Sarada R., Krishnamurthi K., Chauhan V.S., Defatted algal biomass as a non-conventional low-cost adsorbent: Surface characterization and methylene blue adsorption characteristics, Bioresource Technol., 2015, 184, 395-404

112 Sashikala V.B., Sreerama Y.N., Pratape V.M., Narasimha H.V., Effect of thermal processing on protein solubility of green gram (Phaseolus aureus) legume cultivars, J. Food Sci. Technol., 2015, 52(3), 1552-1560

113 Satheesh Babu S., Mohandass C., Vijayaraj A.S., Mohan A. Dhale, Detoxification and colour removal of Congo red by a novel Dietzia sp. (DTS26) - a microcosm approach. Ecotox. Environ. Safety, 2015, 114, 52-60

114 Sathiya Mala K., Prabhakara Rao P.G, Prabhavathy M.B., Satyanarayana A., Studies on application of annatto (Bixa orellena L.) dye formulations in dairy products, J. Food Sci. Technol., 2015, 52(2), 912-919

115 Sathya T.A., Mahejibin Khan, Diversity of glycosyl hydrolase enzymes from metagenome and their application in food industry, J. Food Sci., 2014, 79(11), R2149–R2156

116 Savanur M.A., Sachin M. Eligar, Radha Pujari, Chen Chen, Pravin M., Anita B., Padma S., Arvind I., Rajiv D.K., Bale M.S., Jonathan M.R., Lu-Gang Y, Shashikala R.I., Sclerotium rolfsii lectin induces stronger inhibition of proliferation in human breast cancer cells than normal human mammary epithelial cells by induction of cell apoptosis, PLoS One, 2014, 9(11), e110107

117 Sharath B.S., Mohankumar B.V., Somashekar D., Bio-detoxification of phorbol esters and other anti-nutrients of Jatropha curcas seed cake by fungal cultures using solid-state fermentation, Appl. Biochem. Biotechnol., 2014, 172, 2747-2757

118 Shibin Mohanan, Satyanarayana K.V., Sridevi V, Kalpashree Gowda, Giridhar P., Chandrashekar A, Ravishankar G.A., Evaluating the effect and

effectiveness of different constructs with a conserved sequence for silencing of Coffea canephora N-methyltransferases, J. Plant Biochem. Biotechnol., 2014, 23(4), 399-409

119 Shipra Sharma, Suvendu Bhattacharya, Flow behaviour of gellan sol with selected cations, J. Food Sci. Technol., 2015, 52(2), 1233-1237

120 Shipra Sharma, Suvendu Bhattacharya, Strain and strain rate dependence of gellan, agar and gellan-agar gels, J. Food Eng., 2014, 141, 93-98

121 Shivli Srivastava, Sakhare S.D., Indrani D., Preparation of multigrain semolina blend for upma – its formulation, rheology, physico-chemical, textural and nutritional characteristics, J. Texture Studies, 2014, 45, 452-461

122 Shobharani P., Prakash M. Halami., Cellular fatty acid profile and H+-ATPase activity to assess acid tolerance of Bacillus sp. for potential probiotic functional attributes, Appl. Microbiol. Biotechnol., 2014, 98, 9045-9058

123 Shubha J.R., Praveena Bhatt, Plectranthus amboinicus leaves stimulate growth of probiotic L. plantarum: Evidence for ethnobotanical use in diarrhea, J. Ethnopharmcol., 2015, 166, 220-227

124 Shweta Tewari, Ramalakshmi K., Laxmi M., Jagan Mohan Rao L., Microwave-assisted extraction of inulin from chicory roots using response surface methodology, J. Nutr. Food Sci., 2015, 5(1), 1-7

125 Sinjitha S. Nambiar, Nandini P. Shetty, Antioxidant and atherogenic foam cell prevention ability of methanol and aqueous extract of Emblica officinalis fruits and its effect on CD36 and ABCA1 gene expression in RAW 264.7 macrophage cell line, J. Food Biochem., 2014, 38(6), 563-574

126 Sinjitha S. Nambiar, Nandini P. Shetty, Praveena Bhatt, Bhagyalakshmi N., Inhibition of LDL oxidation and oxidized LDL-induced foam cell formation in RAW 264.7 cells show anti-atherogenic properties of a foliar methanol extract of Scoparia dulcis, Pharmacognosy Magazine, 2014, 10(38), 240-248

127 Sistla Srinivas, Purnima Kaul Tiku, Reaction kinetics of the invertase from yeast (S. cerevisiae), Food Biophys., 2014, 9, 179-183

128 Snehal Doke, Manisha Guha, Identification of extraction conditions for determination of phenolic contents of garden cress seed (Lepidium sativum L.) and its milled fractions, Food Anal. Method., 2015, 8, 1053-1057

129 Snigdha M., Hariprasad P., Venkateswaran G, Transport via xylem and accumulation of aflatoxin in seeds of groundnut plant, Chemosphere, 2015, 119, 524-529

130 Sonar N.R., Prakash M. Halami, Phenotypic identification and technological attributes of native lactic acid bacteria present in fermented bamboo shoot products from North-East India, J. Food Sci. Technol., 2014, 51(12), 4143-4148

131 Sowmya R., Ravikumar T.M., Vivek R., Rathinaraj K., Sachindra N.M., Optimization of enzymatic hydrolysis of shrimp waste for recovery of antioxidant activity rich protein isolate, J. Food Sci. Technol., 2014, 51(11), 3199-3207

132 Sowmya R., Sachindra N.M., Protective effect of shrimp carotenoids against ammonia stress in common carp, Cyprinus carpio, Ecotoxicol. Environ. Safety, 2014, 107, 207-213

133 Sreedhar R.V., Priya Kumari, Rupwate S.D., Ram Rajasekharan, Malathi Srinivasan, Exploring triacylglycerol biosynthetic pathway in developing seeds of chia (Salvia hispanica L.): A transcriptomic approach, PLoS ONE, 2015, 10(4), e0123580

134 Sridevi V., Giridhar P., Establishment of somaclonal variants of robusta coffee with reduced levels of cafestol and kahweol, In Vitro Cell. Dev. Biol.-Plant, 2014, 50(5), 618-626

135 Sridhar B.S., Sommer K., Mathematical modelling of grinding kinetics of food particulates, Food Bioprod. Process., 2015, 94, 392-397

136 Sruthi G.K., Sila Bhattacharya, Fermentation of blackgram paste: Time-dependent rheological characteristics, modelling and quality attributes of a traditional snack, Int. J. Food Sci. Technol., 2014, 49, 2214-2222

137 Sudha M.L., Chetana R., Yella Reddy S., Effect of microencapsulated fat powders on rheological characteristics of biscuit dough and quality of biscuits, J. Food Sci. Technol., 2014, 51(12), 3984-3990

138 Sudha M.L., Rajeswari G., Venkateswara Rao G, Chemical composition, rheological quality characteristics and storage stability of buns enriched with coriander and curry leaves, J. Food Sci. Technol., 2014, 51(12), 3785-3793

139 Sudha M.L., Sushma W. Eipson, Hafeeza Khanum, Madhava Naidu M., Venkateswara Rao G., Effect of normal/dehydrated greens on the rheological, microstructural, nutritional and quality characteristics of paratha - an Indian flat bread, J. Food Sci. Technol., 2015, 52(2), 840-848

140 Sunil L., Vanitha Reddy P., Gopala Krishna A.G, Asna Urooj, Retention of natural antioxidants of blends of groundnut and sunflower oils with minor oils during storage and frying, J. Food Sci. Technol., 2015, 52(2), 849-857

141 Suresh Kumar G., Gopala Krishna A.G., Studies on the nurtraceuticals composition of wheat derived oils, wheat bran oil and wheat germ oil, J. Food Sci. Technol., 2015, 52(2),1145-1151

142 Suresh P.V., Sakhare P.Z., Sachindra N.M., Prakash M. Halami, Extracellular chitin deacetylase production in solid state fermentation by native soil isolates of Penicillium monoverticillium and Fusarium oxysporum, J. Food Sci. Technol., 2014, 51(8), 1594-1599

143 Suresha B.S., Srinivasan K., Fungal metabolite nigerloxin ameliorates diabetic nephropathy and gentamicin-induced renal oxidative stress in experimental rats, Naunyn Schmiedeberg's Arch. Pharmacol., 2014, 387, 849-859

144 Susanna S., Prabhasankar P., Development of hypoimmunogenic pasta and its immunochemical validation with celiac disease patient's sera, LWT- Food Sci. Technol., 2015, 62, 333-340

145 Susanna S., Prabhasankar P., Effect of different enzymes on immunogenicity of pasta, Food Agricul. Immunol., 2015, 26(2), 231-247

146 Swarnalatha G.V., Namratha S. Hegde, Chauhan V.S., Sarada R., The effect of carbon dioxide rich environment on carbonic anhydrase activity, growth and metabolite production in indigenous freshwater microalgae, Algal Res., 2015, 9, 151-159

147 Tulse S.B., Reshma V., Inamdar A.A., Sakhare S.D., Studies on multigrain milling and its effects on physical, chemical and rheology characteristics of milled streams, J. Cereal Sci., 2014, 60, 361-367

148 Umesha S.S., Akhilender Naidu K., Antioxidants and antioxidant enzymes status of rats fed on n-3 PUFA rich garden cress (Lepidium sativum L.) seed oil and its blended oils, J. Food Sci. Technol., 2015, 52(4), 1993-2002

149 Usha Dharmaraj, Meera M.S., Yella Reddy S., Malleshi N.G., Influence of hydrothermal processing on functional properties and grain morphology of finger millet, J. Food Sci. Technol., 2015, 52(3), 1361-1371

150 Vandana Joshi, Prachi Thatte, Jamuna Prakash, Jyothi Lakshmi A., Effect of oilseed protein concentrates and exogenous amino acids on the dialysability of iron and zinc, LWT - Food Sci. Technol., 2014, 59, 540-546

151 Varnashree B.S., Nagarajan S., Effect of various drying methods on flavour characteristics and physicochemical properties of dried curry leaves (Murraya koenigii L. Spreng), Drying Technol., 2014, 32, 882-890

152 Vasantha K.Y., Murugesh C.S., Sattur A.P., A tyrosinase inhibitor from Aspergillus niger, J. Food Sci. Technol., 2014, 51(10), 2877-2880

153 Veena R., Indira T.N., Sila Bhattacharya, Effect of roasting on rheological and functional properties of sorghum flour,Food Sci. Technol. Int., 2014, 20(8), 579-589

154 Vemana Gowd, Nandini C.D., Erythrocytes in the combined milieu of high glucose and high cholesterol shows glycosaminoglycan-dependent cytoadherence to extracellular matrix components, Int. J. Biol. Macromol., 2015, 73, 182-188

155 Vijayaraj P., Chinnarasu Sivaprakasam, Vishnu Varthini L., Mary Sarkar, Vasanthi Nachiappan, In vitro exposure of tobacco specific nitrosamines decreases the rat lung phospholipids by enhanced phospholipase A2 activity, Toxicol. in Vitro, 2014, 28, 1097-1105

156 Vishnu Varthini L., Selvaraju K., Malathi Srinivasan, Vasanthi Nachiappan, ROG1 encodes a monoacylglycerol lipase in Saccharomyces cerevisiae, FEBS Lett., 2015, 589(1), 23-30

157 Vishwanath S.V., Purnima Kaul Tiku, Antihypertensive peptides derived from soy protein by fermentation, Int. J. Pept. Res. Ther., 2014, 20(2), 161-168

158 Vishwanathan K.H., Subramanian R., Particle size characteristics of ground soy and red gram, Int. J. Food Properties, 2014, 17(7), 1469-1481

159 Vismaya, Rajini P.S., Oral exposure to the organophosphorus insecticide, monocrotophos induces intestinal dysfunction in rats, Food Chem. Toxicol., 2014, 71, 236-243

160 Vrinda R., Goveas L.C., Maya Prakash, Prakash M. Halami, Bhaskar N., Optimization of conditions for probiotic curd formulation by Enterococcus faecium MTCC 5695 with probiotic properties using response surface methodology, J. Food Sci. Technol., 2014, 51(11), 3050-3060

161 Vrinda R., Goveas L.C., Prakash M. Halami., Bhaskar N., Kinetic modeling, production and characterization of an acidic lipase produced by Enterococcus durans NCIM5427 from fish waste, J. Food Sci. Technol., 2015, 52(3), 1328-1338

Non-SCI

1 Avinash Kumar, Simmi P.S., Gyanendra Kumar, Giridhar P., RP-HPLC and transcript profile indicate increased leaf caffeine in Coffea canephora plants by light, J. Biol. Earth Sci., 2015, 5(1), 1-9

2 Balaswamy K., Prabhakara Rao P., Narsing Rao G., Nagender A., Satyanarayana A., Production of low calorie ready-to-serve fruit beverages using a natural sweetener, stevia (Stevia rebaudiana L.), Focusing on Modern Food Industry (FMFI), 2014, 3, 2014

3 Deepthi D., Shubha Jayaram, Savitha M.R., Manjunath S.N., Sreenivas N., Shylaja M. Dharmesh, Serum zinc levels in children hospitalized with pneumonia: A case control study, J. Evidence Based Med. Healthcare, 2014, 1(12), 1553-1558

4 Desai S.V., Varadaraj M.C.,Growth kinetics of a native toxigenic isolate of Bacillus cereus under the influence of incubation temperature, pH and sodium chloride in broth system, British Microbiol. Res. J, 2014, 4(11), 1267-1284

5 Ganesan K., Suresh Kumar K., Subba Rao P.V, Tsukui Y.,Bhaskar N., Hosokawa M., Miyashita K., Studies on chemical composition of three species of Enteromorpha, Biomedicine Preventive Nutr., 2014, 4, 365-369

6 Gopirajah R., Anandharamakrishnan C., Methods integrating physical mechanisms underlying the food digestion and release of nutrients in human stomach, J. Nutr. Nutritional Epidemiology, 2014, 1(1), 1-13

7 Guruprasad B.R., Akmal Pasha, Assessment of repellency and insecticidal activity of Ajuga parviflora(Benth) and Trichilia connaroides (W&A) leafextracts against stored product insects, J. Entomol. Zool. Stud. (OA), 2014, 2(4), 221-226

8 Hema Panwar, Manisha Guha, Effect of processing on nutraceutical properties of garden cress (Lepidium sativum L.) seeds, Int. J. Pharm. Pharm. Sci.(OA), 2014, 6(7), 315-318

9 Henry D.E., Prapulla S.G., Exopolysaccharide producing lactic acid bacterium from traditional lactic fermented preparations: Screening, biosynthesis dynamics, compositional analysis of exopolysaccharide and evaluation of its probiotic potential, Annals Food Sci. Technol., 2014, 15(2), 336-344

10 Jyotsna R., Soumya C., Chemical, rheological and nutritional qualities of sugar snap cookies as influenced by the addition of multigrain, J. Food Measurement Characterization, 2015, 9, 135-142

11 Lohith K., Anu Appaiah K.A., In vitro probiotic characterization of yeasts of food and environmental origin, Int. J. Probiotics & Prebiotics, 2014, 9(3), 87-92

12 Math R.G., Nagender A., Sameera Nayani, Satyanarayana A., Continuous microwave processing and preservation of acidic and non-acidic juice blends, Int. J. Agric. Food Sci. Technol., 2014, 5(2), 81-90

13 Nimisha S.M., Chauhan A.S., Rekha M.N., Negi P.S., Nusrath N., Asha M.R., Composition of edible portion of tender bamboo shoot (TBS) and development of various candies with and without incorporation of ginger and pineapple flavours, American J. Nutr. Food Sci., 2015, 2(1), 7-15

14 Prabhakara Rao P., Narsing Rao G., Madhavi M., Balaswamy K., Satyanarayana A., Studies on effect of light source on the stability and in vitro antioxidant activity of dyes and extracts from annatto (Bixa orellana L.) seed, J. Food Pharm. Sci., 2014, 2, 68-74

15 Rajagopal K., Praveen K. Singh, Rajesh Kumar, Kaneez Fatima Siddiqui, CTAB-mediated, single-step preparation of competent Escherichia coli, Bifidobacterium sp. and Kluyveromyces lactis cells, Meta Gene, 2014, 2, 807-818

16 Sathiya Mala K., Prabhakara Rao P.G., Narsing Rao G., Satyanarayana A., Nutritional quality and storage stability of chikki prepared using pumpkin seed, flaxseed, oats and peanuts, Indian J. Traditional Knowledge, 2015, 1(1),118-123

17 Shakuntala S., Praseeda M., MuralikrishnaG, Pectic oligosaccharides derived from chickpea (Cicer arietinum L.) husk and elucidation of their role in prebiotic and antioxidant activities, Trends Carbo. Res., 2014, 6(4), 29-36

18 Shamala T.R., Rohinishree Y.S., Vijayendra S.V.N., Biosynthesis of multiple biopolymers by Sinorhizobium meliloti CFR 14 in high cell density cultures through fed batch fermentation, Biocatal. Agricult. Biotechnol., 2014, 3, 316-322

19 Shashirekha M.N., Shylaja M. Dharmesh, Shivaleela V.B., Mallikarjuna S.E., Rajarathnam S., Health and wellness product from mangosteen (Garcinia mangostana L.) rind: Bioactive potentials,Int. J. Biotechnol. Wellness Ind., 2014, 3, 111-120

20 Shubhra P., Srinivasan K., Weight reducing potential of dietary tender cluster bean (Cyamopsis tetragonoloba) in high-fat fed rats, Ind. J. Nutr. Dietet., 2014, 51, 236-251

21 Sonar N.R., Vijayendra S.V.N., Prakash M., Saikia M., Tamang J.P., Prakash M. Halami, Nutritional and functional profile of traditional fermented bamboo shoot based products from Arunachal Pradesh and Manipur states of India, Int. Food Res. J., 2015, 22(2), 795-804

22 Sridevi V., Giridhar P., Changes in caffeine content during fruit development in Coffea canephora P. ex. Fr. grown at different elevations, J. Biol. Earth Sci., 2014, 4(2), B168-B175

23 Srividya D., Chandra Prakash S.V., Shylaja M. Dharmesh, Renu Agrawal, Anti-Shigella dysenteriae activity by probiotic lactic acid bacteria (Pediococcus pentosaceus): An in vitro study, J. Microbiol. Biotechnol. Food Sci., 2015, 4, 317-320

24 Suresh Kumar G., Salimath P.V., Effect of spent turmeric on kidney glycoconjugates in streptozotocin-induced diabetic rats, J. Diabetes Metabolic Disorders, 2014, 13, 1-9

25 Usha Dharmaraj, Ravi R., Malleshi N.G., Cooking characteristics and sensory qualities of decorticated finger millet (Eleusine coracana), J. Culinary Sci. Technol., 2014, 12(3), 215-228

26 Vaibhav B. Porwal, Bharath Kumar S., Madhumathi R., Prabhasankar P., Influence of health based ingredient and its hydrocolloid blends on noodle processing, J. Food Measurement Characterization, 2014, 8, 283-295

27 Vasantha K.Y., Murugesh C.S., Sattur A.P., Use of extracts cluster analysis (ExCLAN) to rapidly screen for enzyme inhibitors in microbial fermented extracts, Int. J Bioassays (OA), 2014, 3(4), 1990-1993

28 Vasantha K.Y., Saleem Javeed, Chakradhar D., Sattur A.P., Effect of inoculum morphology on production of nigerloxin by solid state fermentation, J. Yeast Fungal Res.(OA), 2014, 5(4), 50-57

29 Veenashri B.R., Muralikrishna G., Inhibition of α-amylase and α-glucosidase by various compounds isolated from finger millet (Eleusine coracana) bran, Trends Carbo. Res., 2014, 6(4), 10-16

30 Vijaykrishnaraj M., Bharath Kumar S., Prabhasankar P., Green mussel (Perna canaliculus) as a marine ingredient to enrich gluten free pasta: Product quality, microstructure and biofunctional evaluation, J. Food Measurement Characterization, 2015, 9, 76-85

Reviews, Book Chapters & Papers in Proceedings

Reviews

1 Anu Bhushani J., Anandharamakrishnan C., Electrospinning and electrospraying techniques: Potential food based applications, Trends Food Sci. Technol., 2014, 38, 21-33

2 Bhaskar B., Ramesh Kumar P., Genetically Modified (GM) crops face an uncertain future in India: Bt Brinjal appraisal - a perspective, Ann. Plant Sci., 2015, 4(2), 960-975

3 Gadkari P.V., Manohar B., Catechins - sources, extraction and encapsulation: A review, Food Bioproducts Processing, 2015, 93, 122-138

4 Inamdar A.A., Suresh D.S., Application of colour sorter in wheat milling, Int. Food Res. J., 2014, 21(6), 2083-2089

5 Neelam Rawat, Indrani D., Functional ingredients for wheat based bakery, traditional, pasta and other food products- A review, Food Rev. Int., 2015, 31(2), 125-146

6 Padma Ishwarya S., Anandharamakrishnan C., Stapley A.G.F., Spray-freeze-drying: A novel process for the drying of foods and bioproducts, Trends Food Sci. Technol., 2015, 41, 161-181

7 Parimala K.R., Sudha M.L., Wheat-based traditional flat breads of India, Critical Rev. Food Sci. Nutr., 2015, 55(1), 67-81

8 Prasanna Vasu, Antibiotic residues in foods - analysis and challenges, Spinco Biotech Cutting Edge, September 2014, 7-12

9 Shashidhar G.M., Giridhar P., Manohar B., Functional polysaccharides from medicinal mushroom Cordyceps sinensis as a potent food supplement: Extraction, characterization and therapeutic potentials - a systematic review, RSC Advances, 2015, 5, 16050-16066

10 Shashirekha M.N., Mallikarjuna S.E., Rajarathnam S., Status of bioactive compounds in foods, with focus on fruits and vegetables, Critical Rev. Food Sci. Nutr., 2015, 55(10), 1324-1339

11 Vijayendra S.V.N., Shamala T.R., Film forming microbial biopolymers for commercial applications - A review, Critical Rev. Biotechnol., 2014, 34(4), 338-357

Book Chapters

1 Alok Kumar Srivastava, Manisha Guha, Veenu Sangwan, Food additives and health, In: Herbaceous plants as natural protective foods, Ed: Rana M.K., Published by: Scientific Publisher, Jodhpur, 2014, 451-458

2 Bhowal S., Priyanka B.S., Nandini K.E., Rastogi N.K., Ways and means for the downstream processing of lipase, In: Biotechnology Vol. 12: Bioprocess engineering, Ed: Shishir Sinha, Published by: Studium Press LLC, Houstan, USA, 2014, 408-433

3 Cassano A., Basile A., Rastogi N.K., Membrane technologies for water treatment and reuse in the food and beverage industries, In: Advances in membrane technologies for water treatment: Materials, processes and applications, Ed: Basile, A., Cassano, A., Rastogi, N.K., Published by: Woodhead Publishing Ltd., UK, 2015, 551-580

4 Chakkaravarthi A., Suvendu Bhattacharya, Size reduction practices in food processing, In: Conventional and advanced food processing technologies, Ed: Suvendu Bhattacharya, Published by: Wiley-Blackwell, UK, 2015, 33-50

5 Chanukya B.S., Rastogi N.K., Downstream processing of organic acids by involving liquid membranes by, In: Biotechnology Vol. 12: Bioprocess engineering, Ed: Shishir Sinha, Published by: Studium Press LLC, Houstan, USA, 2014, 384-407

6 Dubey R.K., Suvendu Bhattacharya, Extrusion processing of foods, In: Conventional and advanced food processing technologies, Ed: Suvendu Bhattacharya, Published by: Wiley-Blackwell, UK, 2015, 75-97

7 Gopirajah R., Parthasarathi S., Anandharamakrishnan C., Computational modeling techniques for drying of food products, In: Drying technologies for foods: Fundamentals and applications, Ed: Nema P.K., Kaur B.P., Mujumdar A.S., Published by: NIPA, New Delhi, 2015, 319-345

8 Mahendrakar N.S., Rathina Raj K., Fishery byproducts: Fish byproduct silage, In: Fish processing byproducts: Quality evaluation and applications, Ed: Sachindra N.M., Mahendrakar N.S., Published by: Studium Press LLc, USA, 2015, 347-382

9 Manisha Guha, Sreerama Y.N., Malleshi N.G, Influence of processing on nutraceuticals of little millet (Panicum sumatrense), In: Processing and impact on active components in food, Ed: Preedy V.R., Published by: Elsevier USA, 2015, 353-360

10 Mathen Mathew, Fish oils: Production and quality aspects, In: Fish processing byproducts: Quality assessment and applications, Ed: Sachindra N.M., Mahendrakar N.S., Published by: Studium Press LLc, USA, 2015, 77-106

11 Muralikrishna G., Lyned D. Lasrado, Non-starch polysaccharides from food grains: Their structure and health implications, Ed: Noureddine Benkeblia, Published by: CRC Press Taylor & Francis, 2014, 209-231

12 Murugesh C.S., Subramanian R., Applications of enzymes in processing green tea beverages, In: Processing and impact on antioxidants in beverages, Ed: Preedy V.R., Published by: Elsevier, London, UK, 2014, 99-108

13 Nayak C.A., Rastogi N.K., Anthocyanin from Garcinia indica choisy: A potential source for natural colorant, In: Recent progress in medicinal plants Vol. 39: Biotechnology and genetic engineering, Ed: P. Ananda Kumar, J.N. Govil, Published by: Studium Press LLC, Houstan, USA, 2014

14 Nidheesh T., Suresh P.V., Functional polysaccharides from shellfish byproducts, In: Fish processing byproducts: Quality assessment and applications, Ed: Sachindra N.M., Mahendrakar N.S., Published by: Studium Press LLc, USA, 2015, 299-345

15 Prasada Rao U.J.S., Hemalatha M.S., Enzymes, In: Bakery products: Science and technology, Ed: Zhou W., Hui Y.H., De Leyn I., Pagani M.A., Rosell C.M., Selman J.D., Therdthai N., Published by: Wiley Blackwell, NJ, USA, 2014, 275-294

16 Priyanka B.S., Rastogi N.K., Tiwari B.K., Opportunities and challenges in the application of ozone in food processing, In: Emerging technologies in food processing, Ed: Da-Wen Sun, Second Edition, Published by: Academic Press, Elsevier, London, UK, 2014, 335-358

17 Rastogi N.K., Cassano A., Basile A., Water treatment by reverse and forward osmosis, In: Advances in membrane technologies for water treatment: Materials, processes and applications, Ed: BasileA., Cassano A., Rastogi N.K., Published by: Woodhead Publishing Ltd., UK, 2015, 129-154

18 Rastogi N.K., Infrared heating of foods and its combination with electron beam processing, In: Electron beam pasteurization and complementary food processing technologies, Ed: Suresh Pillai, Shima Shayanfar, Nell Holden, Published by: Woodhead Publishing Ltd., UK, 2013, 61-82

19 Rastogi N.K., Raghavarao K.S.M.S., Niranjan K., Recent developments in osmotic dehydration, In: Emerging technologies in food processing, Ed: Da-Wen Sun, Second Edition, Published by: Academic Press, Elsevier, London, UK., 2014, 181-212

20 Sachindra N.M., Mahendrakar N.S., Fishery byproducts: An overview, In: Fish processing byproducts: Quality evaluation and applications, Ed: Sachindra N.M., Mahendrakar N.S., Published by: Studium Press LLc, USA, 2015, 1-11

21 Shanthilal J., Suvendu Bhattacharya, Nanoparticles and nanotechnology in food In: Conventional and advanced food processing technologies, Ed: Suvendu Bhattacharya, Published by: Wiley-Blackwell, UK, 2015, 567-593

22 Shanthilal J., Suvendu Bhattacharya, The process of gelling, In: Conventional and advanced food processing technologies, Ed: Suvendu Bhattacharya, Published by: Wiley-Blackwell, UK, 2015, 99-114

23 Siddeswari S., Suvendu Bhattacharya, Instantization and agglomeration of foods, In: Conventional and advanced food processing technologies, Ed: Suvendu Bhattacharya, Published by: Wiley-Blackwell, UK, 2015, 313-336

24 Sila Bhattacharya, Roasting and toasting operations in food process engineering and applications, In: Conventional and advanced food processing technologies, Ed: Suvendu Bhattacharya, Published by: Wiley-Blackwell, UK, 2015, 221-247

25 Sowmya R., Sachindra N.M., Carotenoids from fishery resources, In: Fish processing byproducts: Quality evaluation and applications, Ed: Sachindra N.M., Mahendrakar N.S., Published by: Studium Press LLc, USA, 2015, 268-293

26 Srinivasan K., Health beneficial effects of turmeric (Curcuma longa) and ginger (Zingiber officinale) In: Functional foods, Ed: Dhiraj Vattem, Published by: DE Stech Publications Inc., Lancaster, PA, USA, 2015, 401-419

27 Srinivasan K., The role of herbs and spices - in health and longevity and in disease, In: Antioxidants in health and disease - myths or scientific evidence, Ed: Antonis Zampelas, Renata Micha, Published by: CRC Press, USA, 2015, 293-312

28 Thumu S.C.R., Prakash M. Halami, Mechanism of cross resistance and inducible resistance to antibiotics by lactic acid bacteria, In: Current research in biochemistry and microbiology, Ed: Deshmukh A.M., Jawalikar J.D., Wakte P.S., Published by: Oxford Book Company, Jaipur, 2015, 1-19

29 Umesh Hebbar H., Advances in food technologies in relation to youth and enterprise, In: Family farming and rural economic development, Ed: Choudhary M.L., Aditya, Published by: New India Publishing Agency, New Delhi, 2014, 313-315

Proceedings

1 Kamlesh Yadav, Neelima Singh, Ram Rajasekharan, The PHO4 transcription factor regulates triacylglycerol metabolism under low phosphate conditions in Saccharomyces cerevisiae, March 28-April 1, 2015 Experimental Biology Annual Meeting, Boston, MA, USA. Published in: The FASEB Journal, April 2015, 29(1 Suppl.), 715.38

2 Kanagavijayan D., Malathi Srinivasan, Ram Rajasekharan, Aging yeast cells are fat! March 28-April 1, 2015 Experimental Biology Annual Meeting, Boston, MA, USA. Published in: The FASEB Journal, April 2015, 29(1 Suppl.), 715.47

3 Praveen Srivastava, Appu Rao A.G., Mukesh Kapoor, Structural insights into the thermal stability of endo-mannanase belonging to family 26 from Bacillus sp. CFR1601, 2014, Experimental Biology Annual Meeting, San Diego, USA. Published in: The FASEB Journal, April 2014, 28(1 Suppl.), 580.2

Books Published

1 Compendium on Agri-business, published by: CSIR-CFTRI, 2015, 1-95

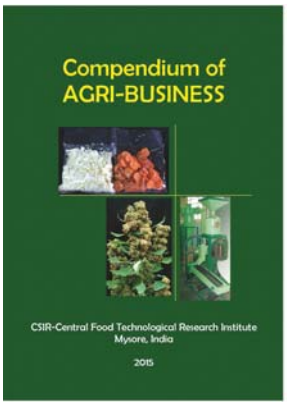
- Empowering the farming community with innovative agri-business models, Ram Rajasekharan, 1-5
- Grain based technologies for rural sector, Srinivas A., Sathyendra Rao B.V., 6-12
- Fruit and vegetable technologies for rural food industry, Ng. Iboyaima Singh, Revathy Baskaran, 13-22
- Bakery products adaptable for rural food processing, Indrani D., Sai Manohar R., 23-28

- Technologies for spice processing in the rural sector, Srinivas P., Sowbhagya H.B., 29-34
- New oil seed varieties for cultivation, Ram Rajasekharan, Malathi Srinivasan, Sreedhar R.V., 35-38
- Super food grain crop for cultivation, Ram Rajasekharan, Malathi Srinivasan, Ramesh Kumar R., Sreedhar R.V., Prasanna Anjaneya Reddy L., 39-42
- Success stories in establishing rural enterprises, Vijayanand P., 43-46
- Food packaging for rural food products, Rajesh S. Matche, 47-54
- Traditional food products for rural enterprises, Chetana R., 55-58
- Value added traditional products from beaten rice (CHIRA) for rural folks, Baby Latha R., 59-61
- Oilseed technologies for rural industries, Sindhu Kanya T.C., 62-67
- Meat products processing in the rural sector, Modi V.K., 68-73
- Engineering requirements for SMEs, Subramanian R., 74-82
- Requirements for establishing rural enterprises, Gupta P.K., 83-86

2 CSIR-CFTRI Research profile, Published by: CSIR-CFTRI, 2014, 1-199

3 Fish processing byproducts: Quality assessment and applications, Edited by: Sachindra N.M., Mahendrakar N.S., Published by: Studium Press LLc, USA, 2015

4 Technologies for SMEs in food processing, Published by: CSIR-CFTRI, 2014, 1-45



2. Patents filed

- A process for the preparation of composite multigrain granules from cereals, pulses and millets
- A device for a continuous separation of fish bone and meat.
- A Process for preparation of neutraceutical beverage from cactus (opuntia dillenii) stem (cladode) and fruit (cactus pear)
- A process for the preparation of dry chilli and powder from fresh red chilli (capsicum annum L.)
- A process for the preparation of protein isolate from defatted moringa seed meal flour
- An improved process for the preparation of curcuminoids from turmeric (Curcuma longa L.) oleoresin
- An improved process for the preparation of Zerumbone crystals from shampoo ginger (Zingiber Zerumbet)
- Table top continuous wet cum dry grinder

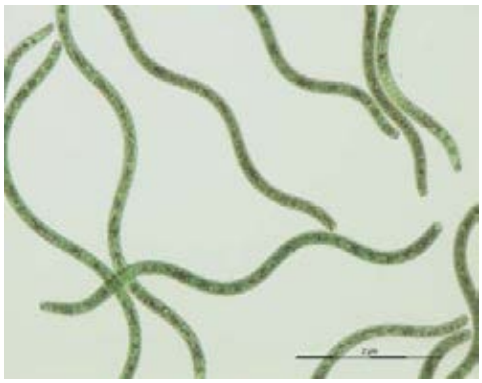
3. Processes released for commercial exploitation

Fifty seven processes were released for commercial exploitation to 89 parties and forty processes were demonstrated to 60 licensees. Details are given below:

- Bar cake
- Bland soy protein concentrate
- Bombay halwa mix
- Bottling of sugarcane juice
- Chikki / nutra chikki (3 formulations)
- Chocolate pasta
- Coffee concentrate

- Compounded asafoetida
- Date syrup concentrate
- Deep fat fried & flavoured cashew kernels
- Dry roasted and flavoured cashew kernel
- Egg wafers
- Eggless cake premix
- Energy food: New formulation
- Fermented and dehydrated ready mixes for idli dosa batter
- Fruit dehydration: Banana
- Fruit jams & jellies: Preparation
- Fruit syrups and squashes
- Fruits & vegetables dehydration: grapes, banana, onion, potato, peas & green chillies
- Fruits & vegetables: Canning
- Garlic paste
- Ginger paste
- Gravy paste for different Indian cuisine
- Groundnut (peanut) butter
- High protein biscuits
- Instant gravy mixes: Dehydrated (11 formulations)
- Instant payasam mix
- Instant traditional food: Sambar
- Layered parotta (South Indian)
- Making superior quality white pepper
- Malted weaning food
- Milk chocolate
- Modified atmosphere packaging of minimally processed vegetables
- Mustard/ rape seed integrated processing
- Mutton pickle
- Online fortification of atta (whole wheat flour) / maida (refined wheat flour)
- Orange flavour concentrate for manufacturing of soft beverage
- Oyster mushroom-dehydration
- Pomogranate juice & products
- Preparation of cereal bar
- Processed besan (bengal gram flour) for sev and boondi preparation
- Processing of cocoa (theobroma cocoa pods to dried cocoa beans)
- Processing of cocoa beans to: Cocoa mass, cocoa butter, cocoa powder
- Production of soya protein hydrolysate
- Production of turmeric powder from fresh turmeric rhizome
- Pulse based papads
- Ready mix: Dosa
- Ready mix: Jamun
- Ready-to-eat low fat maize snack from milled maize grits
- Ready-to-eat snack mix from puffed coarse cereals and legumes
- RTS fruit juices and beverages
- Rural based biotechnological production of spirulina
- Shelf stable chapati
- Tamarind candy
- Tomato products
- Tutti fruity (papaya / carrot)
- Virgin coconut oil

Raceway pond for spirulina cultivation



Spirulina - A microscopic view

4. New processes ready for commercial exploitation

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

- Preparation of beverage mix from malted ragi
- A process for the preparation of gluten free bakery products
- Roller milling process for fenugreek fiber and gum
- Sesame based nutritious supplement
- Roasted and flavoured cashew kernel
- Multigrain cereal-legume bar and puffed rice bar
- Spirulina-choco bar and spirulina-cereal bar
- Nutra chikki with added spirulina
- Dhal based nutritional supplement for foods
- Fortified mango bar
- Rice-milk mix
- Dehydration of dill greens
- Apple pomace powder for enrichment of bakery products (bun, muffin, cookies)
- An improved process for chilli oleoresin
- Ginger beverage
- Multigrain instant semolina
- A device for continuous separation of fish bone and meat

Rice-milk mix

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

	Type of project	No. of completed projects	New projects under-taken	Total no. of projects carried out
•	Consultancy	3	3	7
•	Sponsored	8	12	30
•	Grant-in-Aid	24	27	87

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

	Academic Programme	Degree/Certificate Awarded
•	M.Sc. (Food Technology)	25
•	Certificate course in Milling	24
•	Short-term courses (35 Nos.)	644

Nutra-chikki with added spirulina

Spirulina nutri chikki

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

- DST Stakeholders Meet (August 5-6, 2014)

CSIR-CFTRI organised Stakeholders Meet during Aug. 5-6, 2014 sponsored by International Multilateral & Regional Cooperation Division, DST, Govt. of India, New Delhi for the preparation of joint R&D proposals in the area of food science & technology in collaboration with ASEAN countries. Along with subject experts, representatives from NABI (Mohali), CIPHET (Punjab), NIN (Hyderabad), IICPT (Thanjavur), NIFTEM (Sonapet) including the DST team attended the deliberations. Prof. Ram Rajasekharan, Director, CSIR-CFTRI chaired various technical sessions.

Inaugural session of the DST Stakeholders meet in progress

- Hindi Fortnight Celebration (September 8-16, 2014)

Hindi Fortnight was celebrated by CSIR-CFTRI from 08.09.2014 to 22.09.2014. Prof. Ram Rajasekharan, Director, CSIR-CFTRI inaugurated the function on 8th September 2014. A variety of competitions in Hindi were conducted for the employees and research students of the Institute during the fortnight. Prizes to the winners of the competitions were distributed by the Shri Ishwar Chandra Mishra, Asst. Director, Central Translation Bureau, Bangalore in the valedictory function held on 22nd September 2014.

Inauguration of Hindi Fortnight celebration by Director, CSIR-CFTRI

- CSIR Foundation Day (September 26, 2014)

CSIR Foundation Day was celebrated on September 26, 2014 at CFTRI. The CSIR Foundation day and Open Days was inaugurated by His Holiness Jagadguru Sri Shivarathri Deshikendra Mahaswamiji, (Jagadguru Sri Veerasimhasana Mahasamsthana Math, Suttur Srikshetra and Hon. President, JSS Mahavidyapeetha, Mysore). Prof. Ram Rajasekharan, Director, CSIR-CFTRI presided for the events. The Chief guest gave prizes to school children who participated in various competitions.

Inauguration of the event by Chief Guest at the venue

The Institute kept its doors open to General Public, students from various schools, colleges, universities and entrepreneurs on 26th and 27th of September 2014. During this time, research activities of all the departments of CFTRI were displayed and also novel machineries & products developed by the Institute were demonstrated. The programme received wide public appreciation and attracted nearly 20,000 visitors. The new building of the Molecular Nutrition department was also inaugurated by the chief guest.

Product display during the open day celebration

- MoU Signing with Palakkad Coconut Production Company Limited (PCPCL) aimed at protecting the interests of coconut farmers (September 26, 2014)

CSIR-Central Food Technological Research Institute, Mysore signed an MoU with Palakkad Coconut Production Company Limited (PCPCL), a co-operative federation formed under the aegis of Coconut Development Board, aimed at protecting the interests of coconut farmers. Under this agreement, CSIR-CFTRI will help this farmers' cooperative body in bottling of Neera in PET bottles for large scale marketing across the country. The MoU documents were exchanged by Prof. Ram Rajasekharan, Director, CSIR-CFTRI and Shri Vinod Kumar, Chairman, PCPCL in a function organized in the sideline of CSIR Foundation Day.

Exchange of MoU document

- All India Farmers Empowering Workshop (October 17, 2014)

Organizing "All India Farmers Empowering Workshop" at CSIR-CFTRI, during October 17, 2014. About 120 farmers across India attended the one day event.

Inaguration of the All India Farmers Empowering workshop

- CSIR-CFTRI Foundation Day (October 21, 2014)

CFTRI Foundation Day was celebrated on October 21, 2014. A Memorandum of Association (MOA) between CFTRI and Dept. of IT, BT and S&T, Govt. of Karnataka for establishing a Nutra-Phyto Incubation Centre and Common Instrumentation facility (NPIC-CIF) was signed on the occasion. The event was being graced by His Holiness Paramapujya Jagadguru Sri Nirmalanandanath Mahaswamji of Sri Adichunchanagiri Mahasamsthana Math. The other dignitaries for the event included Capt. Ganesh Karnik, Chief Whip of Opposition, Karnataka Legislative Council and Ms. Tanusree Deb Barma, Managing Director, KBITS, Govt. of Karnataka. Sri Nirmalanandanath Mahaswamji, who was the chief Guest for the foundation day gave away CFTRI Annual awards to employees in different categories.

CSIR-CFTRI Foundation day inauguration by the Chief Guest

Awardees with dignitaries of the function

- CSIR-CFTRI signs MoA with Govt. of Karnataka for establishing a Nutra-Phyto Incubation Centre (October 21, 2014)

CSIR-CFTRI, Mysore, signed a Memorandum of Association (MoA) with Karnataka Biotechnology & Information Technology Services (KBITS), Dept. of IT, BT and S&T, Govt. of Karnataka for establishing a Nutra-Phyto Incubation Centre and Common Instrumentation facility (NPIC-CIF) in the project mode at its campus for the betterment of Industries in the areas of nutraceuticals and functional foods. The proposed facility would facilitate discovery and development of new products/innovative technologies by establishing world-class laboratories, Pilot Plant facilities, analytical testing and safety studies for promoting entrepreneurs, SHGs and SMEs. The facility would be also made available to farmers for primary and secondary processing of agri-produce for the value addition.

The NPIC-CIF would be transformed as a world-class hub to catalyse research and innovations.

Prof. Ram Rajasekharan, Director, CSIR-CFTRI exchanged the MoA with Ms. Tanusree Deb Barma, IAS, Director, Dept. of IT, BT and S&T and MD, KBITS, Govt. of Karnataka in a function held on CSIR-CFTRI Foundation Day (Oct. 21, 2014) at Mysore.

- CSIR-CFTRI organises one day workshop for SMEs in Nasik under CSIR MSME Initiatives (February 27, 2015)

CSIR-CFTRI conducted one-day workshop entitled "Value Addition to Agri-resources for SMEs in Food Sector" in collaboration with Udyogwardhini Shikshan Sanstha, a Nasik based organisation involved in training young professionals for setting up new business, at Nasik on February 27, 2015. The programme was coordinated under the banner of CSIR MSME Initiative supported by Department of MSME, Govt. of India, New Delhi. Focus of the meet was for upgradation in terms of product/ technology/ skill base and productivity enhancement in the MSME sector. Lectures were arranged on various topics on processing of agri-horti resources relevant to the region by scientists of CSIR-CFTRI. A total of 212 prospective entrepreneurs participated in the event. The participants expressed their interest to have similar workshops in the topics related to shelf-life extension of pomegranate, custard apple, sapota, guava; technologies for value addition to red onion, guava, mosambi, fig, grapes and vegetables grown in that part of the region. Prof. Ram Rajasekharan, Director, CSIR-CFTRI in his message stated that, "It has been our desire that CSIR-CFTRI's knowledgebase should provide the base for establishing many sustainable business enterprises in the country".

Exchange of MoA document on CSIR-CFTRI Foundation day function

Inaugural function of the workshop at Nasik under CSIR MSME Initiative

8. Awards and Recognitions

a) Ph.D. Degree awarded

Shibin Mohanan N (Molecular characterization of transformants of coffea canephora pierre for lowered caffeine)

Ramesh Kumar Saini (Studies on the enhancement of carotenoids, folic acid, iron and their bioavailability in Moringa oleifera and in vitro propagation)

Leelaja BC (Investigations on selected enzyme Systems in Caenorhabditis elegans in response to representative insecticides of different classes)

Singdha M (Uptake of aflatoxin from rhizosphere and rhizoplane and accumulation by groundnut plants)

Susanna (Development of modified gluten pasta)

Denny Joseph KM (Interactive neuroprotective strategies employing phytochemicls and Omega-3 fatty acids)

Vrinda Ramakrishnan (Characterization of lipase from lactic acid bacteria isolated from fish processing waste)

Sathya Prasad N (Therapeutic propensity of selected spice actives against experimentally induced neuropathy)

Anbarasu K (Characterization of aspergillus carbonarius mutant in relation to carotenoid production and its application)

Shankar Shetty Umesha (Studies on bioactive compounds and nutritional evaluation of n-3 Fatty acid rich garden cress (Lepidiumsativum L.) seed oil)

Girish Chandran (Mechanisms underlying the neuromodulatory properties of selaginella and its flavonoids in cell and animal models of neurodegeneration)

Abhijith KS (Studies on gold nanoparticles for application in detection of aflatoxins in selected food commodities)

Devavratha H Rao (Molecular characterization of an enzymatic D-galactose specific lectin from field bean (Dolichos lablab) seeds)

Chougala M B (Effect of dietary antioxidants on Advanced glycation end products (AGEs) related complications during diabetic nephropathy in rats)

Surya Chandra Rao (Studies on erythromycin resistance in lactic acid bacteria from fermented foods)

Vinod Kumar (Molecular engineering of the horsegram (dolichosbiflorus) seed bowman-birk inhibitor: Implications of the disulfide framework on functionality)

Shaheen Jafri Ali (Propensity of monocrotophos, an organophosphorus insecticide, to elicit and augment dopaminergic neuronal dysfunctions in animal models of parkinson's disease)

Chandra Sekhar Jampani (Adsorption and liquid-liquid extraction for the downstream processing of anthocyanins)

Divya P (Molecular analysis of carotenoids expression from Coriandrum Sativum L. and regulation of expression of pathway genes)

Nidhi Bhatiwada (Studies on digestive stability and metabolism of lutein in mice)

Mohan Kumar NS (Production, purification and characterization of fungal L-asparaginase)

Sugasini D (Effect of encapsulated linseed oil to enrich cardiac and brain lipids with omega-3 fatty acid in rats)

Ashok Kumar HG (Biochemical and immunological characterization of the major allergen from sapodilla fruit (Manilkarazapota))

b) Individual Awards

Award Title	Instituted by	Awardee
• Laljee Godhoo Smarak Nidhi Award 2013	Association of Food Scientists and Technologists (India), Mysore	Prakash M Halami
• Laljee Godhoo Smarak Nidhi Award 2013	Association of Food Scientists and Technologists (India), Mysore	Negi PS

c) Recongnitions by Academies

Recognition	Instituted by	Awardee
• Prof. G.S. Bains Lifetime achievement award	Association of Food Scientists and Technologists (India), Mysore	Indrani D
• Fellow	Association of Food Scientists and Technologists (India), Mysore	Modi VK
• Fellow	AP Academy of Science, India (APAS, 2015)	Raghavarao KSMS
• Fellow	Academy of Food Scientists and Technologists, India (FAFST, 2012)	Raghavarao KSMS

d) Other Recognitions

Fellowship / Programme	Awardee	Host Institute / Agency
• Chairman	Asha Martin	Test methods for food products sectional committee, FAD 28 of BIS, Govt. of India
• Principal Member	Asha Martin	Food hyginene, safety management and other systems, FAD 15 of BIS, Govt. of India
• Food Safety Expert Science	Asha Martin	Safety Parliament organised by National Council of Museums, Ministry of Culture, Govt. of India
• Chairman	Anu Appaiah KA	Alcoholic sub committee (FAD 14:1), BIS, Govt. of India
• Member	Sindhu Kanya TC	Oils & oilseeds sectional committee, FAD 13, BIS, Govt. of India
• Member	Anu Appaiah KA	Expert committee on alcoholic beverages, FSSAI, Govt. of India
• Member	Anu Appaiah KA	Scientific panel on pesticides and antibiotic residues, FSSAI, Govt. of India
• Alternate Member	Vanajakshi V	Drinks and drinking water sectional committee, FAD 14, BIS, Govt. of India
• UAA-ICT Distinguished Alumnus Award (Research Category)	Raghavarao KSMS	Institute of Chemical Technology, Mumbai (2014-15)
• Member of the sub expert committee	Sindhu Kanya TC	Evaluation of project proposals on "Women and Nutrition Programme" of DST
• Member - State level empowered committee	Gothwal PP	Appraisal of new food processing industry proposals, Department of Horticulture and Food Processing, Govt. of Uttar Pradesh
• Member	Prabhasankar P	APEDA Task force, New Delhi

e) Other Awards

Recognition	Instituted by	Awardee
• Indira Gandhi Sadbhavana Gold Medal award	Global Economic Progress and Research Association (GEPRA), New Delhi	Sukumar Debnath
• Special Recognition Award for the project "Studies on the preservation of vegetable juices by microwave heating and development of prototype model of continuous microwave pasteurization/ sterilization system	Society for Educational and Scientific Research (SERB) during International conference on Biosciences: State of the advancements, Kumarakom, Kerala	Math R.G.

f) CFTRI Annual Awards 2013-14

On the occasion of CSIR-CFTRI Foundation Day on October 21, 2014, CFTRI Annual awards were presented to the exemplary performance of staff and students for the year 2013-14. Details of the recipients are given below:

- Best Research Paper Published by Staff

  Basic Research:

  - Dr. (Mrs.) Asha Martin, Food Safety & Analytical Quality Control Laboratory

  Applied Research:

  - Dr. C. Anandharamakrishnan, Food Engineering Department

- Best Award for Societal Contribution
  - Amla Candy - Fruit & Vegetable Technology

- Individual Awards for Scientific and Technical Contributions

  Group IV:

  - Dr. Prakash M Halami, Microbiology & Fermentation Technology

  Group III:

  - Dr. R. Ravi, Traditional Foods & Sensory Science

- Individual Awards for Technical Contributions

  Group III:

  - Mr. K. Vatcharavelu, Central Instrumentation Facility & Services

- Individual Awards for Best Support Staff

  Group II:

  - Mr. Umapathy H, Central Instrumentation Facility & Services

  Group I:

  - Mr. Subbraraya N, Food Protectants & Infestation Control Department

- Best Contribution Award for General Administration, Finance & Accounts and Stores & Purchase

  - Mrs. Padmavathi HR, General Administraion
  - Mr. Rajamallu M, Finance and Accounts
  - Mr. Somaiah PT, Stores and Purchase

- Best Student Award
  - Ms. Zarkar Geeta Chandrakant, M.Sc. (Food Technology) Programme
  - Ms. Sugasini, Senior Research Fellow, Traditional Foods & Sensory Science
  - Mr. Vasant Raghavan, Senior Research Fellow, Microbiology & Fermentation Technology

- Best Research Publication Award for Project Assistants
  - Mr. Saravan Kumar S, Plant Cell Biotechnology

- Special Outstanding Award

  Combined Award for Administration, Finance & Accounts and Stores & Purchase for saving Service Tax for the Institute with Special Reference: Dr.Alok Kumar Srivastava, Dr. Lalitha R Gowda, Mr.Aruna Kumar (FS&AQCL); Mr. Thomas Kuriakose, Mr. Shenbaganathan, Mr.Anil G Revankar, Mr.Abhigna (S&P); Mr.Anish Pasha, Mr. V K Ravi, Mr. Naushad Basha (F&A); Mr. S Rajappa (Administration)

g) Best Research Papers / Posters awards

I. 23rd ICFOST, NIFTEM campus, Kundli, Haryana, December 13- 14, 2014

- Savita K.R., Yogesh D., Halami P.M., Effect of tryptophan on protease activity from Bacillus spp (BCF3)
- Sourav Kumar, Efficient online round grain separator for roller flour mills and grain processing industry
- Girish K. Ghiwari, Nagaraju V.D., Sridhar B.S., Development of a multispouted bed Roasting (MSBR) technology for value added processing of Makhana (EURYALE FEROX SALISB) seeds
- Shivakumar M., Nagaraju V.D., Design and Development of compact spouted bed roaster (CSBR) for coffee bean
- Padma Ishwarya S., Anandharamakrishnan C., Bubble growth during the bread baking process
- Manivannan S., Kiran S., John Kiran, Catalase activity in phosphine-resistant strains of Oryzaephilus

II. Research Papers / Posters awards in other seminars

- Anand Prakash, Prabhudev S.H., Vijayalakshmi M.R., Maya Prakash, Revathy Baskaran, Nutri-ketchup from acerola and tomato: Implication of blending and processing on phytonutrients, PFFCSFP 2015, JSS College, Ooty Road, Mysore February 20- 21, 2015 (Second prize)
- Hameeda Banu N Itagi, Pradeep S.R., Vasudeva Singh, Srinivasan K., Jayadeep A., Beneficial influence of phosphorylated parboiled dehusked red rice flour (oryza sativa L) in streptozotocin-induced diabetic rats, 4th International Rice Congress, Bangkok, Thailand, 27 October - 1 November 2014 (Young Rice Scientist Award)
- Santhosh R., Vadivelan G., Venkateswaran G, Production of omega-6 and omega-3 fatty acids under cold temperature from native isolate, Cunninghamella elegans CFR-C07 and its health benefit, DAE-BRNS Life sciences symposium (LSS-2015), BARC, Mumbai, February 3-5, 2015
- Vadivelan G., Santhosh R., Muthukumar S.P, Venkateswaran G., Impact of fungal biomass containing omega-3 fatty acids as feed supplementation on chicken eggs, 55th Annual Conference on Empowering Mankind with Microbial Technologies (AMI - EMMT-2014), Tamil Nadu Agricultural University, Coimbatore, November 12-14, 2014

- Aishwarya S., Devi S.M., Halami P.M., Molecular typing of diverse L. plantarum cultures isolated from fermented vegetables by species-specific PCR and RAPD profiling, National symposium on Microbes and Human Welfare, JSS college, Ooty road, Mysore, March 23-24, 2015
- Indrakshi Paul, Matche R.S., Antimicrobial activity and physico-mechanical properties of curcumin, nanocurcumin and chilli extract incorporated in methylcellulose film, POLYCON'2014, 6th National Conference on Advances in Polymeric Materials, Mysore, April 16-17, 2014 (Best oral presentation award)
- Urvi Ashwin Thakkar, Matche R.S., Milk spoilage and development of time temperature indicator for milk, POLYCON'2014, 6th National Conference on Advances in Polymeric Materials, Mysore, April 16-17, 2014 (Best oral presentation award)
- Mallikarjun S.E., Dharmesh S.M., Galectin-3 blockade by swallow root (Decalepis hamiltonii) saccharide resulted in cancer cell death via modulation of surviving and inflammatory cytokines, IACR- 2015, Jaipur, February 19-21, 2015
- Mane S.D., Naidu K.A., Anti-proliferative effect of ascorbyl stearate, a food additive, on cervical cancer cells by modulation of cell signaling pathways, DAE-BRNS Life Sciences Symposium on Advances in Microbiology of Food, Agriculture, Health and Environment, BARC, Mumbai, February 3-5, 2015
- Sukumar Debnath, Praneeth Juvvi, Chakkaravarthi A., Emerging technique for healthier frying for production of reduced-fat red beet root (beta valgaris) chips, 3S, Jadavpur University, February 27 - March 1, 2015 (Second Prize)
- Praneeth Juvvi, Prarthana Dutta, Dipankar Kalitha, Charu Lata Mahanta, Sukumar Debnath, Effect of vacuum on changes in quality attributes during production of fried healthy eggplant chips, National Seminar cum workshop (IPFP 2015), Tezpur University, March 27-28, 2015 (Third Prize)

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

- Journal of Food Science and Technology Spinger Verlag (Madhava Naidu M, Rajini P.S., Anandharamakrishnan C, Prabhasankar P, Sridevi Annapurna Singh)
- Indian Journal of Microbiology (Venkateswaran G)
- Indian Food Industry Mag (Anu Appaiah K.A., Vijayendra S.V.N., Jayadeep A, Umesh Hebbar H, Suresh D Sakhare)
- Innovative Food Science and Emerging Technologies, Elsevier (Rastogi N.K.)
- International Journal of Genuine Traditional Medicine published by Association of Humanitas Medicine, Republic of Korea (Negi P.S.)

i) Editorial Boards

- Blue Biotechnology, Nova Publishers, USA (Prabhasankar P)
- Research and Reviews: Journal of Food Science and Technology (Prabhasankar P)
- International Journal of Immunology (Prabhasankar P)
- Journal of Molecular and Genetic Medicine, Omics Publishing Group, Foster City, USA (Negi PS)
- SOA Journal of Organic and Biomolecular Chemistry, Research Signpost, India (Negi PS)
- International Journal of Peptide Research (Rajgopal K)
- Pharmacognosy Magazine (Suresh Kumar G)
- Journal of Food Science and Engineering, David Publishing Company, Libertyvilles, USA (Anandharamakrishnan C)
- Food Science Journal, Academy Science Society (Anandharamakrishnan C)
- Journal of Nutrition and Nutritional Epidemiology (Anandharamakrishnan C)
- International Journals of Applied Nanotechnology (Anandharamakrishnan C)
- Computational Biology Journal (Anandharamakrishnan C)
- Journal of Membrane Science & Technology, Omics Publishing group (Rastogi NK)
- International Journal of Food Science and Nutrition Engineering, Scientific & Academic Publishing Co. Rosemead, USA (Rajesh S Matche)
- International Journal of Agriculture Food Science & Technology (IJAFST), Research India Publications, Delhi (Rajesh S Matche)
- International Journal of Knowledge Management and Information Technology (IJKMIT), Research India Publications, Delhi (Rajesh S Matche)

9. Participation in Exhibitions

- TSRD Expo-2014: Organized by CSIR-AMPRI, Bhopal & MPCST, Bhopal, July 4-5, 2014
- 10th Government achievements & schemes expo-2014: Organized by NNS Media Group, New Delhi, July 25-27, 2014
- Agri-Tech India-2014: Organized by Media Today Pvt. Ltd, Bangalore, August 22-24, 2014
- World Coconut Day: Organized by Coconut Development Board, Bangalore, September 2, 2014
- Agri Tech 2014: Organized by CII (Northern Hqs.), Ministry of Agriculture & Ministry of Food Processing Industries, Chandigarh, November 22-25, 2014
- FOODBIZ INDIA 2014: Organized by Andhra Pradesh Technology Development & Promotion Centre (APTDC), Hyderabad, August 8, 2014
- 3rd FOOD FEST 2014: Key2Green, Pvt. Ltd., New Delhi, October 10-12, 2014
- Exhibition based on CFTRI Technologies: Organised by Uttar Pradesh Khadi Village Industry Board, Govt. of UP, Lucknow, February 4-5, 2015
- Exhibition based on CFTRI Technologies: Organized by CFTRI Resource Centre, Lucknow, September 9, 2014
- Agrowon Agri-Expo 2014: Organised by Agrowon, Pune, November 12-16, 2014

10. EDP Participation / Conducted

Programme	Place	Organized by	Date
Entrepreneurship Development Program about CFTRI Technologies	Lucknow	Resource Centre, Lucknow	April 2, 4, & 10, 2014 Aug. 22, 2014 Sept. 19, & 27, 2014 Nov. 14, 2014 Jan. 19, 2015 Feb. 13, 2015
Entrepreneurship Development Program	Hyderabad	Osmania University	July 1, 2014
Entrepreneurship Development in Food Processing	Hyderabad	NIMSME	July 10, 2014
EDP Programme on Food Processing	Vijayawada	ALEAP, Vijayawada	Sept. 15, 2014
Workshop on "Chintana-Mantana" on Agro and food based industries	Mandya	Mandya Zilla Abhivrudhi Vedike, Mandya	Oct. 11-12, 2014
Technology clinic on Agriculture-food processing	Kalpetta, Waynad, Kerala	Development of Industries and Commerce, Govt. of Kerala	Oct. 16-17, 2014

Programme	Place	Organized by	Date
Technology clinic on Food processing, plastic recycling, product development and textiles	Kannur, Kerala	Department of Industries and Commerce, Govt.of Kerala	Nov. 19-20, 2014
EDP programme	Hyderabad	DSR and NIMSME, Hyderabad	Nov. 28, 2014
International programme on Planning and promotion of Agro Food Enterprises	Hyderabad	NIMSME	Feb. 11, 2015
Technology awareness programme on food processing	Gadag	Department of Industries and Commerce, Govt. of Karnataka, Karnataka Technology Upgradation Conucil, District Industries Centre (Gadag), CSIR-CFTRI and Karnataka Rural Development Bank (Dharwad)	Feb. 27, 2015

11. Support Department Activities

Access to around 4183 e-journals was provided by the library to the staff and students through the CSIR network. Also access to citation and full-text databases such as Web of Science, Derwent Innovation Index and Questel Patent database was facilitated.

The Central Instrument Facility & Services department has installed new instruments such as Differential Scanning Calorimeter,Agilent GC-MS, ABSCIEX UPLC-HRMS, Water preparative HPLC and Thermo Flash 2000 N/protein Analyser for the benefit of the R&D departments. In-house training to research scholars and short term courses were also organized.

Information & Publicity department conducted guided tours for 145 groups totaling 3980 visitors comprising of students, entrepreneurs, farmers, officials and foreign visitors. The department issued 10 press releases, organized two press conferences and provided media coverage to two technologies developed in the institute.

The institute network was strengthened with state-of-art Unified Threat Management (UTM) appliance to provide virus and spam free communication to users. Secure and safe mail service was extended through NIC. Software such as COMSOL, SYSSTAT and SIGMAPLOT were procured and associated training programmes were organised. Preliminary steps with regard to Aadhar Enabled Biometric Attendance System (AEBAS) were initiated and Intranet applications like online attendance system for students, Pilot Plant Management System (PPMS) and Indent Management System (IMS) were developed.

12. About CSIR-800 Activities

- All India Farmers Empowering Workshop:

Under CSIR-800 programme an “All India farmers Empowering Workshop” was held at CSIR-CFTRI, on 17th October 2014 in collaboration with All India Sugarcane Farmers Association. The event was organized to empower the farming community across the nation for popularising the technologies developed by CSIR-CFTRI.

A total of 120 farmers from different states participated in the workshop. The technologies such as sugarcane juice, Virgin coconut oil and Dhal milling were demonstrated in three batches. Using the CSIR-CFTRI technologies, sugar cane juice can be preserved upto four months in glass bottles. Similarly, Virgin coconut oil has a characteristic flavor and high nutritional value which could help the farmers for exploring national and international market. Dhal milling can help the farmers for efficient and quick milling of pulses.

On this occasion, a souvenir covering twenty of the selected technologies developed at CSIR-CFTRI were released. Details of the technologies were made in Kannada, Hindi and English to enable better understanding to the farmers. Also new varieties of Chia and Quinoa were released by Prof. Ram Rajasekharan, Director, CSIR-CFTRI. The new variety can help the farmers for alternative crop farming and also intercropping. The high yielding varieties are called "Super Food", which are nutritious and important for curing dietary disorders and combating malnutrition. They are rich in protein, high fibre, iron, magnesium and riboflavin.

The programme had dignitaries representing various sectors, Dr.Vishakant, MD, Karnataka State Agricultural Produce Processing and Export Corporation Limited, Govt. of Karnataka; Sri Aravamudan, Joint Director, NABARD (Bangalore region) and Sri Kurbur Shanta Kumar, President, Indian Sugarcane Farmers Association, New Delhi. Prof. Ram Rajasekharan, Director, CFTRI presided the function and Dr. Renu Agrawal, Chief Scientist and Coordinator, CSIR-800 coordinated the programme.

Interaction with banking officials in progress

Release of new seed varieties to farmers

- Empowering Karnataka Rural bakers with CSIR-CFTRI Technologies:

CSIR-CFTRI conducted one day workshop on February 20th 2015 for the benefit of rural bakers of Karnataka. A total of 27 rural bakers of Karnataka participated in the workshop. The event was organized to empower the rural bakers with CSIR-CFTRI technologies and to provide them insight on baking aspects. Participants visited the pilot wheat mill in the Institute to get information regarding the processing of wheat to wheat milled products. Various bakery products namely breads, buns, cookies and cakes were demonstrated. Participants had hands on experience during the demonstration. Hybrid oven and optimization of baking through computational modeling was also shown.

Demonstration in progress for Karnataka Rural Bakers at CSIR-CFTRI

Demonstration of sugarcane bottling process to farmers

Workshop for specially-abled children under progress

Progress Under R&D Projects

VALUE ADDITION TO AGRICULTURAL RESOURCES

Botanical extract infused freshness keeper (Matche RS)

Botanical extract infused freshness keeper was placed inside pouches to store litchis, green beans and fenugreek leaves for extending the freshness. It was observed that there was about two-fold increase in the keeping quality (shelf-life) of beans, litchi and leafy vegetables both at room temperature as well as refrigerated conditions.

Leafy without and with freshness keeper after 2 days

Litchi fruit without and with fresh-keeper after 2 days

Ethylene scavenger

Short shelf-life is one of the major problems in fresh produce retail. Conditions in Indian mandisare very close to ripening chambers (25°C temp and 100-150 ppm ethylene). Also, in refrigerators discoloration of vegetables takes place due to excess ethylene. Work on development of ethylene scavenger using industrial byproduct was initiated to increase shelf-life of ethylene sensitive fruits and vegetables.

With scavenger and without scavenger

Self-heating packaging cans

Design and development of the polymeric based self-heating cans was undertaken. About 200 ml of beverages contained in the can can be heated by 60°C (e.g. 30°C to 90°C) in about 8 min, after activation without any external energy sources.

Biodegradable coating for leaf plates

There are more than 15,000 leaf cup making machines in India producing more than 1000 billion plates per year. Problem is the water absorption and fungal growth. Work was initiated on developing biodegradable food grade coating.

Ganoderma sp. for pharmaceutical applications (Manonmani HK)

Different media such as Potato Dextrose Broth (PDB), Yeast Extract Broth (YEB), Malt Extract Broth (MEB), Czapek Dox Broth (CDB), were used to screen for the

Ganoderma mycelialbiomass production. PDB was the best liquid medium with dry weight of mycelia of 1g for 100 mL broth followed by YEB with 0.75g mycelia for 100 mL broth for Ganoderma lucidum MTCC1039. Growth of Ganoderma proelongum MTCC 8442 in PDB yielded 1.2 g (dry wt.) mycelia. Significant growth was not found in other media tested. Different solid substrates such as wheat bran, paddy straw, saw dust, ragi straw and wood chips in different permutations and combinations were tested for biomass production by SSF. Spawn culture was produced on wheat bran (taken in 250 mL Erlenmeyer flasks) moistened with peptone water at 65%. The flasks were incubated at 30°C for 7 days. Spawn culture of Ganoderma lucidum MTCC 1039 was further cultivated in polypropylene bags using optimized substrates. Formation of antler took further 10-12 days. The emerging antlers were reddish brown in color. Growth was slow, yet noticeable from day-to-day. Cap formation took another 15-17 days. This whole process of cultivation needed 70-80 days to harvest first mature crop. Both mycelial and fruiting body extracts were assayed for antimicrobial activity against 7 food borne bacterial pathogens E.coli MTCC 729, Bacillus cereus MTCC 1272, Staphylococcus aureus MTCC 96, Streptococcus pneumoniae MTCC 655, Salmonella paratyphi MTCC 735, Listeria monocytogenes MTCC 1143, Yersinia enterocolitica MTCC 859. Fruiting body extracts had better antimicrobial activity compared to mycelial extracts.

Freshness of fruits and vegetables (Prasanna Vasu)

The study was aimed at investigating and identifying the natural inhibitor of pectin methyl esterase (PME), which can be used to inhibit textural softening in fruits and vegetables. Among the different natural inhibitors tried, black tea extract (polyphenols) has shown significant PME inhibition. . Pure black tea and green tea crude extracts (20 mg/ml) showed significant inhibition of PME activity in papaya discs (in vivo), after 2 h of incubation.

Papaya PME was partially purified by cation exchange chromatography, and studied the inhibition profile of partially purified papaya PME (0.28 mg/ml protein) using pure black tea and green tea extracts. Results showed that pure black tea extract (equivalent to 0.318 mg polyphenols) completely inhibited pure papaya PME activity (5018.4 U/min). Further characterization is in progress.

Furthermore, the PME activity in different ripening stages of tomato was studied and found that maximum activity is at unripe stage (96,132 U/min/g fresh weight, using spectrophotometric PME assay). Inhibition studies of tomato PME activity using natural inhibitors is under progress.

Functional attributes of banana pseudo stem, green tamarind and wild apple
(Aradhya SM & Ng. Iboyaima Singh)

Banana pseudostem anti-ulcerative property: The anti-ulcerative property of banana pseudostem juice was investigated at different concentrations in Wistar rats. Animals were served with the juice for a specific period, and the level of protection against ulcer induction by the drugs will be observed using different biochemical and histochemical methods. Feeding trials are in progress.

Banana pseudostem powder: Trials were undertaken to develop banana pseudostem powder free of discoloration. The stem was dried whole in a cabinet drier with pre-treatments and powdered. Powder was also prepared from juice after extraction and concentration followed by spray drying. The powder extracted was of good colour but found to be slightly hygroscopic.

Banana pseudostem juice and beverages: Enzymatic browning is the main problem associated with juice extracted from banana pseudostem. Extraction methods were standardized without much browning of juice. The juice extracted was used for development of ready-to-serve beverages.

Banana pseudostem milk: Thin slices of banana pseudostem were cooked, thick juice extracted and blended with sugar, protein and oil to get milk. The product was acceptable in colour,taste and aroma but

Prevention of browning in banana Pseudostem juice

Banana Pseudostem juices

serum separation occurred during storage. Studies on stabilization are in progress.

Influence of storage conditions on the extension of the storage life of fresh tamarind: The objective was optimization of pre-treatments and storage conditions for shelf-life extension and post-harvest quality maintenance of fresh tamarind. Optimally matured fresh pods of tamarind (6.96^{0}bx) (var.local) were pre-treated with solutions of calcium propionate (0.25 and 0.5% levels) and phenyl acetaldehyde (500 ppm) as dip treatments for 30 minutes and stored at LT (6±1^{0}C; 90-95% RH) and at RT (25±1^{0}C; 75-80% RH) storage conditions. These fruits were periodically analyzed for changes in various physiological and physico-chemical quality attributes. Results on RT and LT storage studies indicated that tamarind responded very well to calcium propionate at 0.25% and 0.5% in terms of retention of fruit quality (color, texture, ascorbic acid and other quality parameters) with effective storage life of 28 days at optimum LT storage conditions as against 14 and 7 days in untreated controls in LT and RT storage conditions, respectively.

Determination of compositional characteristics of green tamarind and development of green tamarind beverage, bar and dehydrated powder: Freshly harvested green tamarind (GT) pods were sorted, fibrous portion removed and used for further experiments. Tamarind pods were washed in water and pulp, peel and seeds were separated. These components were analysed for their chemical compositions. Various pre-treatments were conducted to control browning in green tamarind pods during crushing and pulp extraction. Crushed material from whole pods and pulp was found to contain a high amount of acid ranging from 4.2% to 4.7%, respectively. The effect of pre-treatments on the different parts of fruit was determined for total phenolic and flavonoid contents. The data indicated that total phenolic content was observed maximum (1929 mg/100g) in freshly harvested tamarind pods followed by tamarind peels (1293 mg/100g). The flavonoids content in the blanched GT peel was found to be 329.27 mg/100 g followed by blanched seeds (191.42mg/100g). The whole green tamarind powder developed after pretreatment had a highly acceptable light creamish colour, whereas, control sample had dark brown colour. RTS beverages developed from green tamarind pulp were highly acceptable with respect to sensory quality parameters. The products were analysed for chemical parameters. Preliminary studies were also conducted to develop "green tamarind bar". Further work on storage and use of these products in culinary preparations as acidulants are in progress.

Wild apple: Proximate composition of wild apple (Docynia indica) and its polyphenol contents were determined. It was found that the fruit contains 81.8% moisture, 0.2% fat, 0.5% protein, 2.1% crude fibre, 0.3% ash, 15.1% carbohydrates, 2-2.5% acidity , 3.4 pH, 14-15% TSS, 8-9% total sugar, 30-35 mg% vitamin C, 11.5 mg% Ca, 44.5 mg% K and 6.4 mg% P.

Antibacterial activity: The antibacterial activity of various D. indica extracts was determined by broth dilution assay against gram positive (Staphylococcus aureus, Bacillus cereus and Listeria innocua) and gram negative bacteria (Escherichia coli, Pseudomonas aeruginosa and Yersinia enterocolitica). The results showed that MAW (methanol: acetic acid: water) extract was most effective as it showed least MIC values (1.57-3.92 mg/L) and its effectiveness increased after extraction with KMS treatment (0.78-1.57 mg/L). Water extract of peel also showed good activity against S. aureus and Y. enterocolitica (MIC values of 1 mg/L).

Phenolic and flavonoid content was examined in fresh fruit, mature and immature fruit and KMS treated fruit powder. The highest concentration of phenolics was measured in methanolic, acetone and MAW extracts.

The DPPH radical scavenging activity indicates that the scavenging activity of five extract decreased in order methanol>acetone> MAW>ethanol>water extract at same reaction time.

Wild apple preserve

Wild apple candy

Development of value added products like dried slices, candy, preserve, IMF and juice were carried out. Further optimization process is in progress.

Wild apple fruit

Dried wild apple slices

Shelf-life extension of mangoes

Development of pre and post-harvest protocol for mango vars. Dasheri and Langra for export by ship: Dasheri and Langra mango orchards was visited for physical inspection of the mango trees for disease status and orchard hygiene was carried out. Two pre-harvest sprays with fungicide and pesticides before blooming and after fruit set were provided at State Govt. Horticulture Garden HTTC, Lucknow.Also third pre-harvest spray depending upon the disease status of fruit, plant and orchard hygiene was carried out.

Composite processed fruit products (Shashirekha MN)

Composite formulations were evolved based on mango, banana, papaya, bitter orange, pomelo fruit juices, besides supplementation with xanthone extract from mangosteen fruit exocarp. Components such as β-carotene, ascorbic acid, limonin, naringin, hesperidin, and xanthone(s) were regularly monitored during storage. The developed composite processed fruit products had sensorial acceptance with a stable storage life of ~6 months at room temperature and was found microbiologically safe. The bio-active components were retained in the stored products and the loss was within 15% at the end of storage period.

Preliminary studies undertaken with the fruits of bitter orange and pomelo using different fractions (as many as 15 fractions) of fruit have showed positive results on anti-diabetic and anti-obesity properties.

Value addition to small millets (Sathyendra Rao BV)

Heat processing reduced the development of FFA but processed polished millet was susceptible to oxidative rancidity. Also, heat treatment did not completely inactivate the lipase. Heat modification improved the cooking characteristics of polished kodo millet. Resistant starch content increased with a corresponding increase in slow digestible starch. Heat modification also had a significant effect on gel strength and pasting properties.

Pressure steamed, steamed and roasted kodo millet flour significantly increased extractable and decreased non-extractable and hydrolysable polyphenols. The methanolic extracts from processed kodo millet flour showed significantly high antioxidant activities against DPPH radical scavenging, TAC, reducing power and lower activity of *HO and O_2 radical scavenging and Fe^{++} chelating power.

Preparation of edible flour from the millet using roller milling technology avoiding the dehusking step was explored. Work indicates the potential for preparation of protein-rich and fiber-rich fractions from foxtail millet.

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

In order to develop an oxygen scavenging system, studies were carried out on encapsulation of ascorbic acid (AA) using alginate and gelatin as wall materials. AA was encapsulated by homogenizing its solution along with alginate solution and preparing the alginate beads by dropping the homogenate to calcium chloride solution and drying the resultant beads. However, the recovery of ascorbic acid from the dried bead was very poor (less than 5%). For encapsulating in gelatin, the AA solution was homogenized with gelatin solution and glycerol, dried and powdered. The recovery of AA from gelatin encapsulated powder was around 70%. In order to study the oxygen scavenging capacity of gelatin encapsulated AA (GEAA), GEAA was mixed with equal quantity of ferrous sulfate as catalyst and sodium bicarbonate as alkaline salt and exposed to high humidity and ascorbic degradation was used as indicator of oxygen scavenging capacity. AA content in the mixture was determined periodically.AA content gradually decreased and at the end of 24 h the AA content was 16-40% of original. AA degradation was higher at higher RH (>75%). However, AA degradation needs to be correlated with reduction in oxygen levels and the study has been initiated on

determining the oxygen levels in the packs in presence of the oxygen scavenger.

To develop an egg coating system, mature Aloe vera leaves were used for mucilage extraction. Homogenized gel was filtered using muslin cloth to remove fibers and the gel was diluted with water at different ratios, glycerol and polyethylene glycol 400 were mixed with the gel as plasticizers. The solution obtained was used for coating the eggs and the coated eggs were stored at ambient temperature for four weeks. Periodical sampling revealed that aloe:water (1:3) with 1% glycerol combination had retained the egg quality up to two weeks, better than any other combination.

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

Studies on bioactive components, polyphenol content and antioxidant activity were investigated in different rice bran varieties. Bran from non-pigmented (IR-64) and pigmented (Jyothi and Njavara) were obtained by milling and tested for polyphenolic content, total flavonoid content and bioactivity assays in extracts. The pigmented variety showed 8-9 times higher solublility as well as bound polyphenols than non-pigmented variety. Flavonoid content was 3 times higher in pigmented rice bran than in non-pigmented. Pigmented variety Njavara showed the highest potency of scavenging DPPH radical followed by Jyothi and IR-64. Jyothi showed highest reducing power by FRAP method followed by Njavara and IR-64. Pigmented varieties also showed high polyphenol content and total antioxidant activity. Studies on the effect of irradiation on bioactive components in rice bran are in progress.

Irradiation of turmeric rhizomes (Madhava Naidu M)

Irradiation of turmeric rhizome and powder was conducted at different doses (0-10 kGY) using Co^{60} batch irradiation unit to make it safe for human consumption. Colour of irradiated turmeric powder showed marginal changes in colour parameters such as hue, chroma and brightness. The extracted colour (curcumin), oleoresin and volatiles were also determined and were subjected to further analysis using GC and GC/MS to ascertain the effect of irradiation on volatile oil constituents. The microbial load decreased from 10^6/g to about 3×10^2/g at a dose rate of 10 kGY while pathogens (coliform) were eliminated at dose rate of 6 kGY.

Fish processing waste oil for biodiesel production (Tanaji Kudre)

Fish oil for biodiesel production was recovered from fresh water fish wastes (viscera, head, maw, skins, frame etc.) using three different methods such as wet reduction (cooked at 70°C for 45 min), solvent extraction (n-hexane, 1:5 v/v) and acid ensilage (5% formic acid, 2% NaCl). The highest oil yield was obtained by wet reduction method in which minced fish wastes were added with water (1:1 w/w) and cooked at 70°C for 45 min. Upper layer containing oil was separated by centrifugation. Moisture content and free fatty acid content of oils recovered by wet reduction, acid ensilage and solvent extraction were 0.5%, 0.3%, 0.2% and 23.4%, 18.2%, 12.0%, respectively. Prior to biodiesel production, oil was neutralized to reduce free fatty acid content. Oil recovered by wet reduction was used for biodiesel production through trans-esterification reaction using methanol (reactant) and KOH (catalyst). Optimal conditions for biodiesel production including temperature (45-70°C), catalyst concentration (0.5% -2.0%, KOH, w/w), molar ratio-methanol to oil (0.25:1-3:1, v/v) and reaction time (30-180 min) were investigated. The study revealed that, 0.75% KOH (w/w) of oil; 0.5:1 methanol to oil molar ratio; reaction temperature of 55°C and duration of 60 min are the optimal conditions for maximum biodiesel production.

Chicken liver hydrolysates (Bhaskar N, Modi VK & Sakhare PZ)

The chicken liver hydrolysates (CLH) prepared fermentatively and by enzymatic hydrolysis exhibited anti-oxidative and anti-bacterial properties. The CLH prepared had iron content (mg/100g) ranging from 16.1 to 17.1. In-vitro bioavailability assay of iron revealed 18-22% to be available for absorption. Attempt was made to prepare a carrier material for delivering CLH in the form of gelatin prepared from chicken feet, another poultry processing byproduct. Functional properties and chemical characterization of CLH and gelatin were also investigated. Protein solubility of both hydrolysates (CLH) was in excess of 95% over a wide pH range (2-10). Emulsifying Activity Index (EAI) and Emulsion Stability Index (ESI) of both the hydrolysates over a wide pH (2-10) were found to be in the range of 58-86%, indicating the utility value of these CLH in preparing a stable emulsion. Both hydrolysates showed dose dependent increase in ACE inhibitory activity which varied between 64 and 88% dose dependence, depending on the concentration of hydrolysates. Amino acid profile revealed alanine, glycine, valine, leucine and proline to be the major amino acids in both the hydrolysates; while, the fatty acid profile indicated palmitic acid followed by stearic acid as the major saturated fatty acid with elaidic acid and linoleic acid to be the major unsaturated fatty acids.

Conditions for gelatin extraction from chicken feet were optimized for preparing gelatin for use as a carrier for the protein and iron rich CLH as an ingredient in some product formulations. The bloom strength of gelatin extracted from chicken feet ranged between 155-200 g. The amino acid composition of gelatin showed the presence of >30% of glycine and 15-17% of amino acids (proline and hydroxy-proline). The gelatin had 4-9 g of hydroxy-proline per 100g of sample. Viscoelastic property (flow behavior and frequency sweep) of gelatin revealed that the gelatin prepared from chicken forms a strong gel network indicating its potential for utilization as a binding material in case of free flowing products. With these good functional properties of gelatin the hydrolysates were evaluated for their role as ingredient in select food systems like wheat flour and jelly type products. Characterizing the products fortified with iron and protein rich CLH are in progress.

Further, reversion of induced anaemia in mice model (female albino mice) by CLH was also evaluated. These in-vivo experiments are in progress and the effect of CLH on reversal of anaemia in mice will be evaluated Also the possible correlation between antioxidant status of the animal as a function of feeding CLH will be explored.

Chitosan based coating formulation
(Harish Prashanth KV)

Study was conducted to investigate the effect of chitosan based formulation on different quality parameters (biochemical and organoleptic) for shelf-life extension of mangoes. Standardized chitosan-based coating (with additives) was used to delay ripening and an extended shelf-life of Alphonso mangoes stored at room temperature (27±2°C) for 13 days was achieved. Samples were taken at regular intervals for analysis and compared with control fruits. Prepared chitosan formulation enhanced the total soluble solids and carotenoid content and decreased the titratable acidity. Coating application decreased the incidence of microbial spoilage of fruits. Changes in the sensory qualities of taste, colour and odour were also evaluated. The data revealed that applying a chitosan coating effectively prolongs the quality and improves the sensory attributes with the extension of the shelf-life of mango.

Texturized egg products (Modi VK)

The compatibility of egg liquid, egg albumen and egg yolk was studied for the development of novel cooked egg sausage. Liquid egg contents were mixed with optimized quantities of lipid and binders to obtain a texturized stable emulsion. The egg sausages were processed using synthetic casings for further quality evaluations. A 100% Water Holding Capacity (WHC) and thermal stability of cooked emulsion was recorded in all the three types of sausages. An average shear force 2.89±0.13N Whole Egg Sausage (WES), 8.00±0.51N Egg Albumin Sausage (EAS) and 6.6±0.15N Egg Yolk Sausage (EYS) was noticed indicating the EAS had the optimum emulsion characteristics and textural properties of the product. In another study, emulsions for the preparation of egg sausage was made by using different levels of egg liquid 50%+chicken meat 25%, (T-I); egg liquid 57.5%+chicken meat 17.5%, (T-II); egg liquid 65%+chicken meat 10%, (T-III). The nutritional characteristics with respect to minerals, cholesterol, phosphatidylcholine and fatty acids were studied in all the types of sausages. The difference in structural variations in sausage was studied with the help of Scanning Electron Microscopy (SEM) and correlated with rheological properties of emulsion. Calcium (30.86±0.01 mg/100 gm) and iron (0.87±0.01 mg/100 gm) were higher in T-III sausage compared to T-I and T-II. Similarly phosphatidylcholine, considered an important nutrient was more (286.82±0.5 mg/100 gm) in T-III sausage. The cholesterol content in T-I, II and III sausage was found to be 192.15±2.3, 193±3.2 and 193.65±0.4 mg/100 gm, respectively. Essential fatty acids, oleic acid and á-linoleic acid were present in the all the three types of sausages. Maximum antioxidant properties measured by free radical antioxidant property, diphenyl picryil hydrazyal and total phenolic compounds were 19.56 ± 2.4 (T-I), 0.24 ± 0.1(T-II), and 1.86 ± 0.3(T-III), respectively.The products were stored at frozen condition (-18°C) and quality characteristics were studied for six months by microbial analysis, colour measurement, texture profile analysis, rheological study, electron micrograph and Fourier transform infrared spectroscopy (FTIR).

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

Traditional products such as halwa, vadiams, boorelu and confectionery items such as toffees were prepared using foxtail millet, bajra, finger millet and jowar in combination with rice, corn and sago flour either fully or by partial replacement of cereals for better utilisation of millets and also to avail their nutritional benefits. Halwa was prepared using foxtail millet (Setaria italica) and bajra (Pennisetum typhoideum) flours. Fryums (vadiams) were prepared using flours from finger millet (Eleusine coracana), jowar (Sorghum vulgare), foxtail millet, bajra, corn (Zea mays), rice (Oryza sativa) independently as well as in combination with sago. Traditional food of Andhra Pradesh, Boorelu was prepared using foxtail

millet flour and bajra flour in place of rice flour, namely sajja boorelu and korra boorelu, which have scored over traditional rice boorelu. The products prepared with millets had good crude fibre as they were prepared from whole grains and were found acceptable.

Vegetable pastes (Jyothirmayi T)

Work has been taken up on the popular acidic leafy vegetables of Andhra Pradesh such as Hibiscus cannabis (gongura) and Rumex vesicarius (chukka kura) for value addition and preparation of shelf stable products. The fresh leaves were analysed for various parameters and acidity of dehydrated gongura was 14.8% and chukka kura, 11.1%. Dehydrated leaf powders from both the leafy vegetables were produced to utilise as sprinkling powders for fried foods and chats. An attempt was also made to prepare shelf stable ready to eat chutney (an intermediate moisture paste) from gongura, which was stored in glass bottles with 350 ppm benzoic acid. The chutney was acceptable and stable for 3 months against 1-2 days storage life of traditional chutney. Preparation of chukka kura paste for culinary applications is under progress.

Value added products from pumpkin (Sathiya Mala K)

The study is aimed at the development of carotene rich extruded products like vermicelli, pasta, noodle and flakes by utilising pumpkin powder/pulp. Studies were initiated to evaluate the effect of different pre-treatments on the quality characteristics of pumpkin powder and β-carotene retention during drying and storage. All the pre-treated and control samples were dried in a tray drier at 55 ± 5°C for 16 h. Dried slices were pulverized into flour and stored in MPE pouches prior to further analysis. The powders were analysed for proximate parameters including β-carotene, colour, dietary fibre and antioxidant activity. It was observed that among all the pre-treated samples, better retention of â-carotene was found in the sample with blanching for 3 min followed by dipping in 0.2% KMS for 45 min. Storage studies are under progress.

Pumpkin powder was also prepared by foam mat drying to prevent losses in â-carotene as a result of faster drying. Tween 80 at 1% was found to be the best suited for the purpose. As the pumpkin flour has shown good flavour, sweetness and deep yellow-orange colour apart from β-carotene, an attempt was made to develop wholesome and nutritious muffins. Wheat flour was substituted with different levels of pumpkin powder for preparation of muffins and sensory analysis revealed that at 20% substitution product was acceptable.

Processed products from underutilized fruits/ vegetables (Gothwal PP)

Wild plum fruits were washed in running water to remove adhered dust and dirt particles. Pulp was obtained by passing through a pulper and the pulp was preserved by sulphiting and heat processing for further use. For making the juice, pulp was treated with pectic enzyme concentrate to 4 h at 40ºC. The enzyme treated pulp was subjected to juice extraction through filtration to get the clear juice. The juice was pasteurized and preserved by sulphiting and filled in sterilized glass bottles capped, labeled and stored. For making the drink with 10% pulp, extracted pulp was mixed with cane sugar, water, citric acid, flavor and color by keeping the particular ratio of TSS/acidity. The prepared drink was heated to 90ºC, filled hot into a narrow mouthed glass bottles, capped and stored. For the preparation of RTS beverage, nectar and squash various combinations were tried. A combination having 12.5 to 25% juice content, TSS 16 to 45º Brix, acidity 0.40 to 1.20% and red cherry color at 25 ppm was found to be the most favored blend. The final products were heated to 90ºC, filled hot into a narrow mouthed glass bottles, capped and stored for further study. For the preparation of herbal jam, wild plum pulp was mixed with sugar, citric acid and ground herbal mixture consisting of several components such as safed musali, dried anjeer, lajwanthi, dasmula, bala, neelkamal, yashtimadhu, ashwagandha, pippali, nagkesar, dalchini etc., and heated in a steam jacketed pan with constant stirring and cooked till TSS reached to 70º Brix or till it gets set. Since the level of pectin is very high in wild plum no pectin was added in the herbal jam. Wild plum pomace after pretreatments such as blanching (boiling at 95°C for 5 min followed by cooling) and drying (in mechanical dehydrator at 50±2°C) was used for extraction of pectin using different extraction and precipitation methods. For optimization of pretreatment of wild plum pomace, acid extraction followed by alcoholic precipitation method was followed.

The storage studies of these products at room temperature, 7°C and 37°C indicates that products stored at RT showed no significant changes with respect to moisture, TSS, acidity and total sugar after 90 days of storage. Similar observation were noticed at 7°C and 37°C. More cloudiness are formed in drink with 10% pulp stored in all stored temperatures. The colour of pectin became brown due to Maillard browning reaction during storage. The products were evaluated for sensory attributes.

Value added products from kokum (Garcinia Indica) (Badgujar PM)

Scale-up studies of kokum paste and kokum beverage base/ paste preserve with different sweeteners were conducted.

HEALTH FOODS & NUTRACEUTICALS

Modulating age related macular degeneration (Baskaran V)

The objective of the study was to find out the comparative antioxidant effect of astaxanthin and fucoxanthin against lutein in lutein deficient rat model. Groups of lutein deficient rats were gavaged orally (200 µ/day) for 14 days with β-carotene, lutein, astaxanthin or fucoxanthin. Group received groundnut oil with no carotenoids served as control. Lipid peroxidation was suppressed ($p<0.05$) in plasma and liver on feeding β-carotene (15 and 39%), astaxanthin (24 and 50%), fucoxanthin (35 and 30%) and lutein (10 and 37%) compared to control. Similarly, SOD activity in plasma and liver were decreased in β-carotene (8 and 23%), astaxanthin (55 and 54%) fucoxanthin (31 and 50%) or lutein (12 and 29%) fed groups compared to control. Whereas, catalase activity in plasma and liver increased in β-carotene (5 and 30%), astaxanthin (63 and 68%), fucoxanthin (36 and 70%) or lutein (19 and 63%) fed groups compared to control. Glutathione reductase activity in plasma and liver was elevated on feeding β-carotene (23 and 63%), astaxanthin (32 and 130%) fucoxanthin (48 and 106%) or lutein (36 and 54%) compared to control. Fatty acid profile showed significant decrease in saturated fatty acids (15 to 21%) and an increase in unsaturated fatty acids (30-42%) when compared to control group. These results indicate astaxanthin and fucoxanthin are as much potent antioxidant as lutein.

Value-added products from moringa leaves (Baskaran V)

The solubility of commercial moringa leaf powder was in the range 10-15% whereas, for laboratory processed samples solubility was in the range of 45-55%. Hence laboratory processed moringa leaf powder was used for preparation of protein concentrate by ultrafiltration. Solubility of moringa leaf powder could be enhanced up to 70% after treatment with proteases. However, treatment with alcalase requires basic pH of 7.8. This results in dark brown color protein concentrate after ultrafiltration due to interaction with phenolics. In order to minimize the interaction, digestion with acidic pH of 1.5-2.0 was followed by using pepsin. The color of the concentrate produced by ultrafiltration after treatment with pepsin was light brown. The protein rich extract obtained from laboratory processed moringa leaf powder was subjected to ultrafiltration using 25 kDa MWCO membranes. The retentate was subjected to 100% diafiltration. The permeate composite was subjected to ultrafiltration using 10 kDa MWCO membrane. The retentate was subjected to 50% diafiltration.

The protein content of the dried retentate and composite permeate obtained using 25 kDa membrane was 57.28 and 29.19%, respectively whereas, the protein content of the dried retentate and composite permeate obtained using 10 kDa membrane was 40.02 and 26.8%, respectively.The study revealed that moringa leaf protein can be concentrated up to 57%, by ultrafiltration of the protein rich fraction obtained by pepsin treatment. From the study it was observed that even after using 25 kDa MWCO membranes, considerable amount (60%) of protein goes to permeate. The permeation of the protein can be prevented by controlling the extent of hydrolysis. Moringa leaf proteins concentrates prepared by ultrafiltration were limiting with respect to sulphur containing amino acids.

Health beneficial physiological effects of cardamom (Sowbhagya HB)

Cardamom, Coorg variety was selected to study the health benefits viz., anti-cholesterol, hyper-lipidemic in blood, heart and liver in male Wistar rats. The Coorg variety cardamom had volatile oil content of 7% by steam distillation and 9% by hydro distillation. Steam distilled cardamom oil was used in the study. The study was conducted in two groups (i) normal diet and (2) high cholesterol diet. Cardamom powder was incorporated in the diet at 5% level, and cardamom oil 0.35% (equivalent to 5% cardamom powder) and deoiled cardamom powder at a concentration of 5%. The rats were fed with the diet for a period of 56 days. Rats were grouped into 8 groups of 3 each in a group. At the end of 56 days, animals were sacrificed and blood, liver, heart samples were collected and stored at 4°C. The blood

samples were analysed for HDL, LDL, cholesterol and triglycerides.

Hypercholesterolemia was induced by feeding a high 0.5% cholesterol diet for 8 weeks with dietary interventions using (a) cardamom powder at 5% level, (b) cardamom oil incorporated 0.35% level (equivalent to 5% cardamom powder), and (c) deoiled cardamom powder added at 5% level. Significant reduction in the serum total cholesterol (31%) and LDL cholesterol (44%) was observed by oral administration of cardamom oil in induced hypercholesteromic rats accompanied by a marked decrease in serum triglycerides by 42%. Cholesterol content of cardiac muscle was beneficially lowered by 39% with administration of cardamom oil in induced hypercholesteromic rats. Liver triglycerides content was reduced by 33%. Cardamom oil was more effective than the cardamom powder. Incorporation of cardamom oil/powder in diet did not alter the pattern of feed consumption in rats. Thus, present animal study has evidenced the potential of cardamom oil in restoring the alteration in lipid homeostasis in conditions of hypercholesterolemia.

Functionally improved bakery, traditional and pasta products (Sai Manohar R & Prabhasankar P)

Garden cress seed (GC) flour was used as a source of ω-3 fatty acid. Blends of 5 and 10% replacement of whole wheat flour with GC flour were analysed for moisture, falling number, SDS sedimentation. Farinograph characteristics of these blends were determined.

Water chestnut were procured from Maharashtra and studied for their physico-chemical characteristics. The entire lot was divided into three categories, viz., under matured, matured and over matured which varied their average weight from 9.5 to 14.2 g; average value varied from 9.5 to 12.5 ml and density in the range of 0.995 to 1.137. The peeled water chestnut kernel varied with its weight from 7.24 to 10.162 g from under matured to over matured; average volume varied from 7.20 ml to 9.95 ml and density varied from 1.006 to 1.021. The average thickness of under matured, matured and over matured was 12.86, 14.27 and 14.88 and L/h ratio was 1.168, 1.136 and 1.094, respectively. The chemical compositions of peeled water chestnut kernels were determined for their moisture, ash, total sugar, reducing sugar, acidity fat and protein. The farinographic and extensographic studies were carried out for the blends of wheat flour with water chestnut flour by replacing in proportion of 5 to 25%. The cookies were prepared with the same blend of wheat flour and water chestnut flour.

Two varieties of whole wheat flour samples having protein content of 10.6% and 12.4% were subjected to dry and moist heat conditions. Treated and untreated samples were analysed for chemical, rheological, immunological and baking characteristics. Dry heat treated flours had higher values of falling number and SDS sedimentation values whereas, processing by moist heat decreased the same. Water absorption decreased from 75.4 to 56.7% and the dough development time increased from 3.3 to 11.9 min. The peak viscosity and cold paste viscosity increased from 467 to 778 BU and 678 to 1017 BU, respectively when the flours were subjected to moist heat. Moist heat treated flours lost its elastic property when mixed with water and appeared to be similar to non-gluten flours. SDS-page gel electrophoresis indicated that protein profile changed especially in the region of gliadin, which was further, validated immunochemically using ELISA with anti-gliadin antibody. Treated flours had 41% reduction in immunogenicity against gliadin. The specific volume of breads prepared from moist heat treated flour was significantly lower whereas, the crumb firmness value was higher than control breads. Bread samples showed more than 50% reduction in immunogenicity against gliadin.

Wheat grains were ground for the production of the whole grain flours. Different formulations were made with the whole wheat flours as base. The obtained flours were evaluated for the physico-chemical and nutritional characteristics. An increase in protein content was observed from 12.69 to about 13.84% and from 14.47 to 14.68% for the formulation with soft and hard wheat, respectively. Selection of grains for the production of multi-whole grains atta is done and the physico-chemical characterization was carried out.

Raw material was evaluated for the proximate analysis, color values and granulation. The result showed that the fenugreek, green gram and Bengal gram were found to be higher in protein content among the grains and contained 26.2, 24.0 and 17.1% protein, respectively. The minerals content was higher in amaranths (5.3%), green gram (3.5%), foxtail millet (3.3%), Bengal gram (3.0%) and fenugreek (3.0%). The fat content was higher in fenugreek (5.8%) followed by Bengal gram (5.3%), amaranths (3.5%). Different grains, fruits, vegetables and their components has been identified for the development of Nutrimix - health concentrate. The physico-chemical characterization of these components are in progress.

The proximate analysis of buckwheat (Fagopyrum esculentum) and sorghum (Sorghum vulgare) for

preparation of high fibre flat bread (pizza base) was carried out. The protein and total dietary fibre content of buckwheat and sorghum were 7.80, 9.70 and 6.50 and 9.20%, respectively.

Plant proteins- based staple foods (Prabhasankar P)

Two different commercial wheat varieties, Triticum durum and Triticum aestivum were replaced in varying proportions by black gram (Vigna mungo) flour at 30, 40, 50 and 60% proportions for pasta preparation. Proximate studies indicated an increase in ash and protein content, while moisture decreased from control with increasing level of incorporation of black gram flours in the blends. With incorporation of black gram, FWA (Farinograph Water Absorption) increased in both flour blends due to increased protein content. Pasta cooking quality characteristics showed an increase in cooking loss with addition of black gram flour in both species which could be due to dilution of gluten matrix. However, the values were below 8% which is normally accepted cooking loss for pasta samples. Sensory, colour, particle size distribution, cooking loss and texture studies favoured 40% replaced blends of both aestivum and durum and hence 40% replaced wheat flour blends were optimized for pasta preparation. Based on the optimized 40% level of blends, two variations of black gram - toasted and untoasted black gram flour were selected for finalization of pasta products. These pasta samples were subjected to biochemical and nutritional evaluations. SDS-PAGE showed an increase of protein bands supporting the increase in protein value (15%) compared to control (11%). SEM exhibits increase in protein matrix distribution entrapped starch granules. In vitro Protein Digestion (IVPD) increased from 70% (control) to 89% (40% BG). Mineral content levels of iron and calcium increased relative to control. Sensory analysis indicated that samples up to three months were highly acceptable with overall sensory score of >8 on 15 cm QDA scale. Amino acid profile indicated that there is increase in levels of sulphur containing amino acids in the optimized pasta samples than the control and commercially available pasta samples. The present study shows that pasta with higher protein content with increased essential amino acids especially sulphur containing amino acids and minerals can be prepared using black gram flour.

Sensory analysis grades the samples as those with high consumer acceptance. Storage studies and other nutritional parameters of optimized pasta samples are in progress.

Wheat based food products (Prabhasankar P)

Indigenous five major wheat milled products (whole wheat flour, refined wheat flour, semolina, sooji and dicoccum) from three different varieties (T. aestivum, T.durum, T. dicoccum) were selected for the development of hypo-immunogenic flours. The selected wheat milled products were successfully modified by enzymatic hydrolysis and chemical deamidation to reduce the allergenicity against gliadin antibodies. The reduction in allergenicity was confirmed by qualitative and quantitative methods. The rheological characterization, microstructure studies, Fourier transmission, infrared spectroscopic analysis (FTIR) and particle size analysis were carried out for treated flours. Based on the studies, atta and maida were found to be best hypo-immunogenic flours with enzymatic hydrolysis and chemical deamidation (alkaline condition), respectively. Preliminary product (chapati, pasta and biscuits) formulation trials were made with hypo-immunogenic flours and their validation confirms that the products are hypo-immunogenic in nature. The hypo-immunogenic muffin was developed by blending protease treated atta and pearl millet flour with addition of hydrocolloids and emulsifiers. In addition, cookies formulation was optimized with gluten free flours. Further studies such as product quality, storage and molecular changes during modification are in progress.

Finnish-Indian ingredients for improving food safety and health (Akmal Pasha & Ramaswamy K)

Essential oils of anise, basil, thyme, lavender and cardamom showed effect on both Rhizopertha dominica as well as on Tribolium castaneum stored-product insects. Peppermint, lemongrass, rosewood and rosemary oils were effective on R. dominica whereas, caraway, sage, nutmeg, tea-tree and lemon oil were effective against T. castaneum. These results are encouraging to formulate a natural insecticide against stored product insects for usage at domestic level.

The super-critical fluid carbon dioxide (SCF-CO_2)extracts supplied by Flavex were not found to have any insecticidal effect up to 5000 ppm till 48 h of observation with S. oryzae and T. castaneum. However, some extracts had repellent activity which is being studied further. When mixed age culture of insects was employed, 20-70% mortality was observed using these extracts. Synthetic thymol at 1000 ppm in 24 h was found more effective. Extract of Amorphophallus campanulatus did not have any insecticidal activity when treated from 250-5000 ppm till 48h on S. oryzae, R. dominicaand T. castaneum.

The effect of SCF-CO_2 Flavex extracts was studied against pathogenic bacteria. Ajowain extract showed maximum inhibition (18-63 mm) against all tested pathogenic bacteria. All the samples, except schisandra and margosa extracts showed maximum inhibition (22-63 mm) against Listeria over the other test pathogens. Majority of samples showed very little or no inhibition against E. coli and S. entirica. Oregano, thyme, cinnamon bark, hop have shown positive effect on S. aureus, B. subtilis and L. monocytogenes whereas, lemon myrtle and antimicrobial blend were active against B. subtilis and L. monocytogenes.

Lemon myrtle, ajowain, thyme, oregano, clove, cinnamon bark SCF-CO_2 extracts showed inhibition against five fungi. Fennel and basil showed slight inhibition (10-30 mm) for all the five fungi except Colletotrichum sp.Garlic showed wide range of inhibition of about 12-16 mm against A. niger, Fusarium sp. and maximum inhibition against Colletotrichum sp.

Cactus: Chemistry and food applications (Shashirekha MN)

The purified mucilage extracted from the cactus (Opuntia dillenii) stem (cladode) demonstrated bio-functional activities such as lipase, protease inhibition, anti-hypertensive and anti-ulcer activities.The anti-diabetic, anti-ulcer and antioxidant effect of cladode powder was observed in male Wistar rats.The anti-diabetic effect and antioxidant effect of cladode powder was significant over isolated mucilage possibly because of association of mucilage (as such in natural form in cladode) with bioactive substances such as phenols, tannins and flavonoids. The isolated mucilage was more effective in showing anti-ulcer activity than cladode powder. The dietary fiber (isolated mucilage) probably may affect the gastrointestinal mucosa regeneration or may form a protective covering on it. The pectin was extracted from cactus pear peel by three different acid media. Pectin was characterized to be methyl ester of galacturonic acid along with xylose at branch chains and demonstrated for its bio-functional activities such as lipase, protease and tyrosinase inhibition and anti-proliferative.

Hydrothermal processing of rice (Manisha Guha)

A wide variation in physical, physico-chemical and starch digestibility exists among the rice genotypes. Starch digestibility and total amylose content of polished rice varieties ranged 60.1-82.2% and 4.4-32.7%, respectively. Results indicated that polished, pigmented rice do not necessarily influence the starch digestibility and the amylose content. Further studies on whole (unpolished) rice is under progress.

Anthocyanins from different rice varieties: Acidified methonolic extracts of coloured and white varieties of rice (6 No) were analyzed for total phenolic and total anthocyanin contents. These extracts were also evaluated for their inhibition against ACE-I. Strong ACE-I inhibition was observed in the extracts of dark coloured rice varieties. However, the extracts of white varieties showed weak ACE-I inhibitory activity. The inhibitory activities of coloured varieties of rice, as determined by the IC_{50} values, were found to be correlated to their total anthocyanin content.

Whole red rice (Oryza sativa L.) in streptozotocin-induced diabetic rats: Health effect of whole red rice forms in experimental diabetes showed that whole red rice forms such as raw, parboiled and phosphorylated parboiled exerted favorable influences in diabetic rats by improving the body weight and reducing hyperglycemia. Diabetic complications such as severe glucosuria, proteinuria, blood urea and nephropathy were notably reduced. Besides, it reduced the level of cholesterol, LDL cholesterol and triglyceride concentrations in the plasma of diabetic rats.

Whole red rice on hepatic antioxidation system in diabetic rats: Supplementation of whole red rice forms to diabetic rats significantly decreased hepatic MDA levels and decreased the activities of the enzymes superoxide dismutases, catalase, glutathione peroxidase and glutathione reductase in the liver compared to diabetic group indicating the reduction in oxidative stress.

Nutra-coconut oil rich in ω6/ω3 fatty acids (Sukumar Debnath)

Sensory analysis was carried out for poori fried in nutra-coconut oil blends to develop the profiles and consumer acceptance studies for the products. Sensory odour profiles were developed for individual oils, blended oils and fried oils.

Nutra-coconut oil was prepared using coconut and flaxseed oil and its efficacy was analyzed as a frying medium. Flaxseed concentrate was made by extracting flaxseed in soxhlet apparatus using ethanol, methanol and 20% aqueous ethanol separately for 16 h. Different antioxidants were estimated using spectrophotometer. Phytoceuticals viz., secoisolariresinol, phenolic acids and TAG were estimated using HPLC. Coconut oil and flaxseed oil were blended in the ratio of 70:30 and 3000

ppm extract of flaxseed cake concentrate was added to prepare nutra-coconut oil (NCO). Fatty acid composition and triacylglycerol (TAG) of nutra-coconut oil and its counter parts were analysed using GC and HPLC, respectively. The various functional group of nutra-coconut oil were detected by FT-IR spectroscopy. Results indicated that, there was no significant difference observed in physico-chemical properties of these oils such as saponification value (SV), iodine value (IV), free fatty acid (FFA), peroxide value (PV) and apparent viscosity. However, based on the yield obtained, ethanol was found to be the best suited solvent for extraction of phytoceuticals concentrate containing different bio-active molecules viz., polyphenols (20.89-39.04%), tocopherols (0.62-4.37%), β-carotene (2500-2800 mg/100g) and anti-radical activity (93-94%). The ferulic acid (0.17 mg/g), p-coumaric acid (2.24 mg/g), chlorogenic acid (16.11 mg/g), gallic acid (8.58 mg/g), sinapic acid (0.64 mg/g) and secoisolariresinol (30.13 mg/g) were estimated. The nutra-coconut oil was found to have polyphenols (2.86%), tocopherols (442.96 ppm/100 ml), β-carotene (450 mg/100 ml) and antiradical activity of 85%. The PUFA content was found to increase in nutra-coconut oil from 2 to 22%. There was a significant increase of triunsaturated TAG content (0.83-6.86%) observed in nutra-coconut oil. FT-IR spectra of nutra-coconut oil showed a typical characteristic of absorption bands for common triglycerides, the spectra of nutra-coconut oil revealed that the peaks at 3009 and 1651 cm^{-1} were associated with the presence of unsaturated fatty acids. There was no significant ($p>0.05$) differences observed in sensory attributes of snacks food prepared using coconut oil and nutra-coconut oil indicating that nutra-coconut oil could be used as frying medium.

Flavour and taste interaction studies (Maya Prakash)

Atomic absorption spectroscopy was used to analyze the mineral content of the nutricereal samples, which is based on the absorption of UV-visible radiation by free atoms in the gaseous state. The nutricereal samples were analyzed for both macro minerals (calcium, sodium and potassium) and micro minerals (copper, iron, zinc and manganese) and the results were expressed as mg/100g of sample. Minerals in diet have many major roles to play such as metabolic reactions, transmission of nerve impulses, bone formation, regulation of water and electrolyte balance etc. The iron content of samples S3-S6 was 9.07-9.77 mg / 100 g, which could meet 90-97% of RDA (10mg/day) of iron for children of age 4-8 years. S4 showed higher percent of calcium content (2521 mg/100 g) followed by S6 (2134 mg/100 g). S2 exhibited least Ca content of 905 mg/100 g. The RDA for Ca is 1000 mg/day for children aged 4-8 years and 1300 mg/day for age group of 9-13 years (Food and Nutrition Board 2011). This clearly shows that all the samples adequately meet the nutritional needs of preschool children (2-5 years) and school children (9-13 yrs) (FNB 2011). Zn content among the samples varied from 1.6-2.0 mg/100 g which meets 35-40% RDA. Zn deficiency appears to be a major health concern affecting more than 2 billion people in less developed nations and children are at a higher risk, leading to delayed physical growth, impaired immunity and possibly delayed mental development. Na and K content was significantly low content in all the samples (S1-S6). Manganese content was slightly high in samples containing higher pearl millet (S1-S3) whereas, it decreased as the level of green gram flour increased (S4-S6). Copper content of the nutricereal ranged from 0.24-0.39 mg/100 g.

The total polyphenolic content of nutricereal samples was found to be in the range of 131 to 145 GAE mg/100 g. S3 exhibited maximum polyphenolic content (145 mg/100 g) among the six samples, which can be attributed to the higher ratio of pearl millet to green gram (70:10) followed by S4. There was no significant difference in total phenolic content among samples S1, S2 and S6. S5 exhibited least phenolic content (131 mg/100 g). The presence of certain non-nutrient derived secondary metabolites termed as phytochemicals in plant derived food has been associated with its capacity to reduce chronic health ailments and hence shown to exert a wide range of biological activities. These benefits have been shown to be associated with polyphenols in particular. Studies showed that roasting not only increased the total polyphenolic content but also increased the tannin content of pearl millet but there were also significant release of phenolic acids from the food matrix making it more bioaccessible. Therefore, roasted millet holds a good potential for antioxidant activities and as a source of nutraceuticals in food formulations.

Standardization of nutraceutical concentrate from the wheat bran oil and analysis of the fat soluble bioactives such as steryl ferulates, tocopherols and carotenoids were carried out. Content of these components were found high in wheat bran oil concentrate and their health beneficial effect needs to be evaluated in the next milestone. The project has mainly focused on RBO oil concentrate, where oryzanol content was higher (16 fold) and its efficacy in amelioration of diabetic nephropathy needs to be addressed. Data showed clearly that 0.1% reduced the blood glucose, lipid profile and parameters related to nephropathy. Further mechanism in the amelioration of diabetic nephropathy is under progress.

Characteristics of purslane (Sukumar Debnath)

Purslane (Portulaca oleracea L.) has several health benefits, such as it reduces risk of CVD, obesity and diabetes. The objective of the study was to investigate the effect of different drying on retention of bioactive molecules, such as omega-3 fatty acids, total phenolic content and antiradical activity of purslane. Five different drying methods including microwave (100 MW, 5 min), tray, vacuum, low temperature-low humidity and infrared were used at 55-60°C for 5-7 h for drying of purslane. Three solvents, viz. water, ethanol and methanol were used for extraction of bioactive molecules from purslane. Tdtal polyphenol content, antiradical activity, flavonoid content and rehydration ratio of the bioactive molecules were determined. It could be concluded that vacuum drying of purslane is an effective method for retention of bioactive molecules and good rehydration behaviour of dried purslane.

Portulaca oleracea L. in the treatment of hyperlipidemia (Sukumar Debnath)

The present work was to investigate the usefulness of the aqueous extract of Portulaca oleracea L. in the treatment of hyperlipidemia. The administration of extract concluded that 150 mg/kg bw extract is a potent cardio protective agent and it significantly lowered the lipid levels, SGOT, SGPT, alkaline phosphatases and increases the HDL levels. The above study reveals that use of aqueous extract of Portulaca oleracea L.as antihyperlipidemic agent have preventing and curative effect against hyperlipidemia. However, the study of plant for hypoglycemic, antioxidant and hypolipidemic activities may give new pharmaco approaches in the treatment of hyperlipidemia. The study reveals that the use of aqueouas extract of Portulaca oleracea L.as antihyperlipidemic agent having preventing and curative effect against hyperlipidemia.

MCT enriched mango kernel fat (Jeyarani T)

Medium-chain triacylglycerols have properties different from long chain triglycerides and offer numerous health benefits. Incorporating capric acid, a medium chain fatty acid into mango kernel fat was attempted. Accordingly, fat blends were prepared by weighing the fat and the fatty acid in 3:1(A), 1:1(B) and 1:3(C) ratios and subjected to enzymatic interesterification for different time intervals of 30 min. to 24 h. The FFA content of blend A was 25.1%, that of blend B was 50.2% and C was 74.1%. The increase in FFA was due to the higher amounts of added fatty acids in the blends. With increase in the time of reaction there were no significant differences in the FFA content. The fat was alkali refined and the interesterified fat was collected. It was interesting to observe that the fatty acid got incorporated even after 30 min of reaction and was incorporated upto 48% when the reaction was carried out for 24 h.

Major triglycerides in mango kernel fat were StOSt followed by StOO. On incorporation of C10:0 fatty acids, the major triglycerides decreased considerably and lower molecular weight triglycerides increased. The acidolysis product after incorporation of C10:0 showed new peaks corresponding to medium chain triglycerides. The fat obtained had varying consistency due to the incorporation of C10:0 fatty acid. The sample B after 5 h of the reaction remained liquid at ambient conditions indicating its suitability for use as liquid oil. Other characterisation studies are in progress. However, it could be concluded that MCT enriched mango kernel oil which does not crystallize at ambient conditions could be obtained by interesterification using capric acid.

In an attempt to standardize the protocols for extracting fat from mango seeds, waste products from a mango fruit processing industry were collected. Seeds were separated out, dried and kernels were removed. Batch I from good quality fruits contained 31% seeds while the batch II contained 57% seeds. The kernels were found to contain 12% fat. Extraction of fat was carried out in pilot scale by two different techniques. About 10 kg of the powdered kernels were subjected to cold extraction and about 5 kg of the grits sieved to remove fine particles, were subjected to Soxhlet extraction. The defatted material contained 1.2% fat. This study showed that the fat can be extracted upto 90% efficiency.

Measuring sensory stimuli and optimizing product characteristics (Roopa BS & Ravi R)

The electronic tongue (e-tongue) profiles were generated for intense sweeteners like aspartame, sucralose along with sucrose as a function of concentration using Principle Component Analysis (PCA). The results were shown in 2D representation of PCA plots with respect to their first two principal axes. The PCA axis 1 and PCA 2 indicate the variance explained by the 'x' axis (PCA 1) and 'y' axis (PCA 2) and also the validity of the model developed. Sucrose, sucralose and aspartame were analyzed at various concentrations i.e 50, 100, 200, 300 and 500 mg in 100 ml distilled water.The levels were selected based on their usage level in various food applications. The test protocols were standardized using the inbuilt software to suit and analyze different sweetener samples. The PCA profiles generated clearly showed distinct clusters formed as a function of concentration, indicating their sensor response as

unique. This also indicates the testing profile is adequate for modeling development. The e-tongue model developed for various sweeteners can be stored as a library and can be retrieved to compare with unknown samples. The results and models are useful in optimizing sweetness perception in various food applications.

Sprinklers and syrups based on polyol and intense-sweeteners were prepared using optimization design. Traditional sweets such as shankarpoli using sprinklers were prepared and evaluated for sensory quality attributes. Jamuns were prepared using syrup as per the optimisation design. Optimization study of jamun showed increased overall quality with the increased concentration of maltitol and stevia. Optimization study of shankarpoli showed increased perception of sweetness when both maltitol and stevia concentration increased. Overall quality was 8.5 when stevia and maltitol was 6 g and 0.08 g respectively. Syrups were subjected to rheometer analysis to determine the viscosity and rheological constants.

A method of growing wheat grass was standardized. The tender blades of wheat grass were used to extract the juice. The extract contains 95% of liquid and remaining is the nutrition part. The wheat grass was made into nutritious powder. The tender blades were dried by three different methods namely freeze drying (FD), oven drying (OD) and sun drying (SD). The sensory acceptability of these powders were evaluated by incorporating into garlic vegetable clear soup. Different concentrations of dried wheat grass powder at 1, 0.5, 0.05 and 0.01% were added to soup and tasted initially. The final concentration 0.05% of wheat grass powder was decided to be added in the soup based on the acceptable flavour of wheat grass in the soup. Among the three different drying methods, freeze drying method retains the chlorophyll content compared to oven drying and sun drying methods. Carotenoid is the major pigment present in nature in 27 substantial amount and as a pro-vitamin role. The concentration of β-carotene is highest (0.97 mg/g) in powders of FD. Thus chlorophyll and carotenoids are known to have antioxidant activity and being associated with reduced risk of disease induced by various free radicals such as cancers. Among the three dried powders, freeze dried wheat grass powder is highest in protein content (48.9%). Both oven and sun dried powders showed 31.1% of protein content.

Sodium substitute foods (Amudha Senthil)

The basic taste intensities of saltiness with varying levels of sodium and potassium chloride was studied using psychometric methods in order to know the impact of sodium reduction and KCl addition.Psychophysical characterization of saltiness has an important role to play in the substitution of salt. The psychophysical study mainly involves threshold determination and time intensity response of saltiness in aqueous media. Several studies indicate that water plays an important role in taste response, as most insoluble substances are tasteless. Psychometric studies were conducted to establish the threshold values and time intensity response for NaCl and KCl. The salt and salt substitute (NaCl and KCl) were used at different proportions viz., NaCl (100:00), NaCl:KCl (75:25), NaCl:KCl (50:50), NaCl:KCl (25:75) and KCl (00:100) and designated as S1, S2, S3, S4 and S5. The results showed that S1 (100% NaCl) had the least threshold value of 0.06% while sample S5 (100% KCl) had the highest threshold of 0.09% indicating that S1 had higher intensity of salt perception while S5 had the least intensity. Hence, the recognition threshold for the above mentioned saltiness could be taken as a tool for further data generation. Trials were also carried out to standardize murukku preparation with varying levels of sodium and potassium chloride. The profilogram showed that the murukku had high scores for crispness (8.9) and overall quality (11.2) for S1 which was closely followed by samples S2 and S3. Among the samples, S5 had higher perceived intensity of metallic/bitter taste which limits KCl's potential as 100% substitute for NaCl.

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

Studies on the properties and mechanism of action of fibrinolytic enzyme of food-grade bacilli, were undertaken. Bacillus spp. obtained from food sources were exploited for the production of fibrin degrading enzymes. A fibrin degrading serine metallo protease (MW >150 kDa) of Bacillus circulans with α-chain specificity was demonstrated. Analysis of degradation products of fibrin by CFR-11 protease is being carried out. In addition, a fibrinolytic enzyme (MW 32kDa) from Bacillus amyloliquefaciens CFR15 was purified and properties are being studied. The fibrinolytic enzyme from CFR15 was found to possess both fibrin and fibrinogenolytic activity. Besides, purification and characterization of Bacillus sp. BCF3 enzyme (MW 40 kDa) is being studied. The enzyme shows activity against both fibrin and fibrinogen. This culture is known to produce a single fibrin degrading enzyme (unlike other native isolates). In another study, a multiple protease producing Bacillus subtilis BR21 was studied for its ability to degrade fibrin and fibrinogen effectively. Zymogram indicated presence of six fibrinolytic proteases and these degraded all the four peptide chains

of fibrin rapidly. However, only α, β chains of fibrinogen were highly susceptible to the enzymes. Activity inhibition by PMSF and EDTA indicated the presence of serine and metallo proteases. In another study, oxidative stress response of Monascus purpureus under nutritive limitation was investigated. It is well known that, changes of nutrient sources effect metabolism and the rate of electron transport, that leads to production of reactive oxygen species. Hence, the adaptive response of M. purpureus in changing nutrient condition was studied by culturing in various carbon sources. The higher pigment yield was observed in the fungi grown in the fructose medium and lowest in the sucrose medium. The M. purpureus grown in fructose has shown higher (20%) ability to scavenging ROS compared to the sucrose (3%) grown medium, whereas, the catalase and superoxide dismutase activities were higher in the fungi grown in sucrose medium compared to the fructose medium. This indicated that the M. purpureus can adapt to the oxidative stress condition by scavenging the ROS by either antioxidative enzymes or by production of the secondary metabolites.

Hango, a new preparation for the reduction of acetaldehyde levels (Sattur AP)

A number of microbes were tried for activities specific to the reduction of acetaldehyde levels, a primary cause of alcoholic hangovers. Consequent to the selection of source organism, a medium optimization was carried out to enhance the specific activities. Further optimization of product development study using various drying techniques were successfully carried out. Animal studies are under progress.

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

Studies were carried out in the presence of probiotic marker genes and its rapid evaluation using multiplex PCR and comparison with standard strains. Anti-inflammatory potential of L. fermentum MCC0759, L. fermentum MCC2760 and L. delbrueckii MCC2775 were assessed in carrageenan rat paw edema model. Reduction in inflammation and activity was observed in rats treated with probiotic cultures (paw thickness, motility, stair climbing activity and histopathology). In vitro adhesion and expression studies are under progress in cell line model. In addition to above, the work on in vivo safety assessment of probiotic strains (L. salivarius FIX and L. fermentum CUR1) was carried out in a Wistar-rat model. Results indicated cholesterol reduction with L. fermentum CUR1. Also behavioral aspects (hair-fall and hypersensitivity, food intake, body weight) were found to be normal with both the cultures. No toxic effect was observed in vivo (histopathology test) and blood agar test. Presently host probiotic interactions using both the native isolates are being investigated.

Food grade Bacillus sp. as probiotics
(Shobha Rani P)

Work was initiated with isolation of heat-resistant microflora and selected for non-pathogenic cultures devoid of cytK, hblD and nhe1 virulence genes. The cultures were characterized through 16S rDNA sequencing and fatty-acid profiling and studied for their survival under simulated gastrointestinal condition. A remarkable shift was observed in the fatty acid profile and enhanced H^+-ATPase activity under acidic pH supported the acid tolerance of Bacillus spp. Further, the selected cultures were analyzed for their potential antimicrobial, antioxidant and cholesterol reducing activity. These probiotic Bacillus spp. were applied in soy-curd to enhance antioxidant activity along with its nutritional, textural and sensory properties including mineral and fatty acid composition. Probiotic soy-curd analysis revealed higher nutritional value along with enhanced mineral ions and PUFA/SFA ratio. Texture and sensory profile of probiotic product was found acceptable. The results suggest that the enhanced nutritional and antioxidant properties could be additional advantage in combating malnutrition problem. Further, the Bacillus sp. was incorporated into chocolates and nutrient bar as a tasty way of delivering probiotic bacteria and studied for their survival during storage. Additionally, the antimicrobial compound from the two Bacillus licheniformis strains (MCC2512 and MCC2514), was purified and its mode of action was identified to be on cell wall synthesis and RNA synthesis, respectively using Bacillus biosensors. Further, safety and efficacy of selected Bacillus cultures were evaluated by acute and sub-chronic studies under in vivo condition using albino wistar rats. No mortality or treatment related toxicity was observed during the experimental period. Administration of Bacillus spp. enhanced pathogenic excretion through feces with simultaneous increase in Bacillus and lactic acid bacterial count in caecum. Reduced serum cholesterol, enhanced excretion of cholic acid in feces, antioxidant activity of liver extract and the rise in PUFA content in liver fatty acids composition are the additional advantages of probiotic administration. Further, the work is in progress to evaluate the in vivo anti-hypercholesterolemic activity of selected probiotic Bacillus spp.

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

Plectranthus amboinicus (Indian borage) leaves (hot water extract) were characterized for their polyphenolic constituents using HPLC. The effect of individual polyphenol supplementation on the growth of probiotic Lactobacillus plantarum was studied. Individual polyphenols had varying influence on growth of L. plantarum. Chlorogenic acid and caffeic acid were able to stimulate growth of the bacterium to an extent of 55% in comparison to control at a concentration of 0.08 mg/ml. A slight decrease in growth was observed after this with a decrease of >80% at concentrations above 2.56 mg/ml. Coumaric and gallic acid could bring a 4 fold increase in growth of L. plantarum at a concentration of 0.16 mg/ml with decrease in growth above this concentration. Ferulic acid also stimulated the growth of the bacterium (74%) at 0.04 mg/ml with a gradual decrease above this concentration. Thymol showed inhibitory effect on L. plantarum at the concentrations used.

A total of 108 cultures were isolated from different food sources and screened for their probiotic potential. They were screened for their ability to survive under simulated gastrointestinal conditions as well as for antimicrobial activity against foodborne pathogens namely Staphylococcus aureus, Listeria monocytogenes, Salmonella typhimurium and Escherichia coli. 15 isolates showing good antibacterial activity against the tested pathogens and ability to survive in gastrointestinal conditions are being tested for their other probiotic attributes.

Lactic acid bacteria from fermented foods (Prapulla SG)

A novel Pediococcus lolii A4 strain producing exopolysaccharide (EPS) was isolated from indigenous fermented food (fermented milk). The EPS was found to be heteropolysaccharide and the crude yield of the same being 1g/L. The monomeric composition determined using HPLC comprised of rhamnose and galactose and the FTIR profile revealed O-H stretches, alkenes and esters as the functional groups. P. lolii A4 was further tested for probiotic potency and the results indicated a tolerance to 0.5-5% oxgall bile and 1.5-2 pH. P. lolii A4 also sustained and survived through the gastric juice assay with the capability of auto aggregation up to 38.5%, cell surface hydrophobicity of 58% and could deconjugate the bile salt, sodium taurocholate hydrate. EPS obtained from P. lolii A4 exhibited stable emulsification activity with different oils such as mustard, sunflower oil etc. The antibiotic susceptibility tests performed using 10 antibiotics showed that the strain was resistant to vancomycin and polymixin-B.

Prebiotic pectic oligosaccharides from coffee pulp (Prapulla SG)

The isolation and characterization of potent endo-pectinase producing organisms from coffee pulp, degraded coffee husk as well as citrus peel were carried out. Out of the 19 isolates, depending on the growth characteristics, five yeast and seven fungal cultures were further studied for their endo-pectinase activity. Fermentative production of pectinase using the two fungal cultures CCA100 (coffee pulp) and CCA101 (coffee husk) which showed high endo-pectinase activity in the screening trials was carried out. Fermentation using pectin at 0.5% and 1% was carried out for 8 days and the sampling was done at a regular interval of 24 h. An apparent viscosity reduction of 69% (6th day) and 75% (8th day) was observed in case of CCA100 and CCA101, respectively. Efforts were made to recover pectin from the coffee pulp by ethanolic precipitation. Pectin obtained was characterized in terms of total polyphenols and sugars; equivalent weight (6250) and methoxy content (21.95%). Production of pectic oligosaccharide using commercial pectin and coffee pulp pectin using both commercial enzymes as well as the pectinase from CCA100 and CCA101 were carried out. The products were further analyzed by TLC and HPLC.

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

Work was initiated in the present project by screening for the acid (pH 2) and bile (0.3% oxbile) tolerant different Lactobacillus sp. isolated from North East fermented vegetable samples such as sinki, khalpi, gundruk and bamboo shoots. Morphological, physiological and biochemical characterization of the acid and bile tolerant cultures were performed. Subsequently, molecular characterization of the selected cultures was determined by RAPD and (GTG_5) PCR. It was observed that the selected cultures were divergent and belonged to different species of Lactobacillus. Further, these isolates were also observed for their production of anti-listerial bacteriocin producing ability. Among 44 acid and bile tolerant isolates, 30 cultures were found to be Lactobacillus plantarum as detected by species specific PCR. These 30 cultures were found to be divergent based upon the carbohydrate utilization pattern as well as by molecular typing tools (RAPD and (GTG_5). Among these L. plantarum isolates, 12 isolates gave a positive

amplicon size of around 428 bp for the plantaricin specific gene. These 12 isolates were further subjected to detect the presence of probiotic marker genes such as bile salt hydrolase (bsh) and fibronectin binding protein (fbp) Most of the isolates were found to possess these two marker genesbased upon their specific PCR assays. Further, allelic diversity in the 1.6 Kb PCR fragment of fbp gene was observed on digestion with HaeIII restriction enzyme. Two types of alleles were observed for the fbp gene among the 12 L. plantarum isolates. Several in vitro probiotic properties were studied such as bile salt hydrolase activity, cellular hydrophobicity and auto-aggregation ability. It was observed that these isolates had good auto-aggregation and cell surface adhesion abilities. Further analysis will be performed by sequencing the 16S rDNA and fbp gene among the selected isolates.The selected isolates will be subjected to cell-line adhesion assays for further confirmation.

Fermented fish products of North East India
(Bhaskar N)

Popular fermented fish products (FFPs) of North East India, namely Shidal, Phasa shidal. Ngari, Namsing, Hentak and Lona ilish were brought to the laboratory under sterile conditions. Microbial analysis revealed the association of both lactics and non lactics throughout the fermentation. Among 28 salt tolerant isolates from all FFPs 75% were found to be homo-fermentative type of lactic acid bacteria (LAB) and remaining 25% were found to be non-LAB species (Micrococcus spp and Staphylococcus spp). The LAB strains were screened for their antimicrobial and antibiotic activity followed by their evaluation of their susceptibility under varied pH, temperature and salt concentrations. The dominant genus of LAB, involved in the fermentation were identified as Enterococcus spp and Streptococcus spp. Hemolytic test of all these strains had shown that they are non-pathogenic/ avirulent.

Chemical composition and antioxidant activities of all FFPs were carried out. Among the FFPs, water extracts of Hentak has showed greater DPPH, ABTS radical and superoxide scavenging activity of 88, 92.4 and 78.8%, respectively. Total antioxidant activity was found to be higher in Ngari, 440 (µg equivalents of ascorbic acid value/ml). Proximate composition (%) indicated moisture, ash and protein to be in the range of 25.48±1.37(Ngari) to 54.48 ± 1.67 (Namsing); 19.50 ± 0.85 (Phasa shidal) to 28.28 ± 0.72 (Hentak) and 28.09 ± 0.32 (Lona ilish) to 71.14 ± 0.82 (Hentak), respectively. The pH values were between 4.86 (Phasa shidal) and 6.23 (Shidal), and water activity is in the range of 0.73 (Shidal) and 0.93 (Namsing). Fatty acid profile of all products revealed the higher content (%wt of total fatty acids) of linoleic acid (Shidal - 19.64; Hentak - 39.77; Namsing - 37.46) and palmitic acid (Shidal - 19.85; Phasa shidal - 48.36; Lona ilish - 26.61). Amino acid profile of all FFPs revealed presence of significant amount of all essential amino acids. Amongst 6 FFPs studied for mineral analysis, calcium ranged from 90 to 470 mg/100 g dry weight, potassium also recorded relatively higher content followed by magnesium. Zinc and manganese were in the range of 0.313 to 1.037 and 0.073 to 0.868 mg/100 g, respectively.

Egg based ready-to-use convenience mixes
(Modi VK)

Egg based shelf stable seasoning mix and soup mix, spatiality products with enhanced functional and nutritional properties were developed and their storage stability studies were performed under ambient conditions. The product formulation and processing were optimized using egg powder as a base material for the development of studied products. Egg powder 25-30% was found to be optimum along with spices and condiments for both the products. Whereas, 25% starch in combination from different sources was used as a thickening agent in the development of egg soup mix. Lipid 15% for soup mix and 21% for seasoning mix was found to be optimum. The pH and water activity of the soup mix and seasoning mix was 5.1, 4.8 and 0.856, 0.505, respectively.

The basic composition of egg soup mix was protein 16.36 ± 0.01%, fat 26.91 ± 0.01% and moisture 10 ± 1.1 and the basic composition of seasoning mix was protein 17.64±0.64%, total lipids 32.6±1.14% and moisture 8.46±0.43%. The important minerals zinc, iron, calcium and sodium were also estimated. Hunter colour values indicated that there were no significant changes during storage of the products. No significant changes were observed in FFA and TBA values during storage of the products. After six months of storage under ambient temperature 37±2^{0}C the seasoning mix scored less in sensory evaluation using 9 point Hedonic scale. However, both the products sensorialy were highly acceptable after six month storage. Coliforms, Staphylococcus and Salmonella were not detected during storage of the mixes. The TPC and yeast and moulds were less than 2-3 logs during storage. A shelf-life of six months has been established for both mixes when packed in metalized flexible pouches.

Selected leafy vegetables for potential bioactive molecules (Giridhar P)

Nutritional and nutraceutical potential of green leafy vegetables (GLVs) Hibiscus cannabinus, H. sabdariffa, Rumex vesicarius, Basella alba and B. rubra were established. The functional attributes of B. rubra fruit extract rich in betalains against cervical cancer cells were also shown. Efficient tissue culture protocols to get elite plants were standardized. Food formulations were developed to perform value addition to these GLVs.

Caffeine biosynthesis in Coffea sp. (Giridhar P)

As a part of ongoing project on coffee, studies were continued with transformation of Arabidopsis thaliana with TS-promoter deletion constructs. Quantitative extraction of protein from plants was done followed by western analysis from one transgenic tobacco plant expressing small modified green fluorescent protein (smgfp) in order to design a method to detect changes in amount of GFP protein expected in the deletion analysis and check the specificity of the antibody. Expression analysis of N-methyltransferase (NMT) genes during fruit maturation plus elicitor stress was also initiated. NMT transcripts were repressed during the later stages of endosperm maturation, coincident with the onset of dry weight accumulation and seed desiccation. Salicylic acid (SA) and methyl jasmonate (MeJ) augmented the caffeine content up to 2.5 folds in young coffee leaves, concomitant with the overexpression of the three NMTs. Thus, transcriptional regulation of caffeine biosynthetic genes may play a vital role in caffeine accumulation. Overall, the two salient observations were: Salicylic acid (SA) and Methyljasmonate (MeJ) are capable of removing the developmental induced repression of NMTs thus indicating that SA/MeJ and developmental signal cross talk during determination of transcription regulation. Extant/basal NMT-3 and not transcript de-repression cause increase in caffeine. High SA may lead to post-transcriptional check in extent of caffeine accumulation. Silver thiosulphate induced better response of C. canephora var. S-274 cotyledonary leaves to primary somatic embryogenesis. Silver thiosulphate induction during primary embryogenesis improves the binding efficiency of Agrobacterium to the surface leading to stronger and uniform GUS signals in transfient assay.

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

The project aims to identify and characterise phytochemicals with nutraceutical value in fruits and leaves of Physalis minima and Carissa spinarum. Fruits of Physalis minima and Carissa spinarum were collected. The fruits which were dried was extracted using various solvents. These extracts were analysed for their antioxidant activity such as DPPH, total antioxidant and LDL oxidation assay. Further P. minima extract was also tested in the animal cell culture for their anti-inflammatory properties. Two stages of the P. minima fruits were used for this study and data indicated that unripe fruits have more activity than ripe. The extracts were analysed for phytochemicals in HPLC.

Nutraceutically important molecules from microalgae and higher plants (Nandini P Shetty)

For the enhancement of anthocyanin in carrot callus culture, various elicitor treatments were given both in solid and suspension culture and the content of anthocyanin in each treatment was quantified at various time intervals. To investigate the effects of sodium nitroprusside (SNP) as elicitor for induction of anthocyanin the callus were transferred to MS medium containing various concentration of (0.25, 0.5, 1.0 mM) SNP. The calli which were transferred to SNP (0.5 mM) developed colour faster than the control. For analysing the expression profile of genes associated with anthocyanin biosynthesis and transport were designed by NCBI primer designing interface. DFR gene was analysed in control and anthocyanin containing callus. DFR gene was expressed in coloured callus and was not expressed in control. Expression profile of other anthocyanin biosynthesis genes (CHS, CHI, F_3H, DFR, LDOX and UFGT) and transporters (ABC, MATE, GST) involving in transport of anthocyanin in vacuole is being standardized from callus and suspension culture after elicitor treatment.

Enhancement in the level of isoflavone concentration and total isoflavone content of soybean seeds were achieved by using elicitor mediated approach under field conditions. All the abiotic elicitors at different concentrations used in the present study influence the levels of isoflavone and total folate content in soybean seeds. Of the various elicitors used, significant increase in the isoflavone and folates content with optimized levels of salicylic acid was observed. Also the response surface methodology for soy suspension cultures based on isoflavones production was standardized.

Proteins and micronutrients of flax seed and pumpkin seed and peel (Sindhu Kanya TC & Prasanna Vasu)

Flax Seeds:

Macro nutrients and antinutrients in flax seed: Flax seed and its hulls were analyzed for fat, protein, crude fiber,

soluble and insoluble ash contents and were found to be 38.5 and 23.0%, 21.9 and16.0%, 3.8 and 7.3%, 0.001 and 0.086%, 3.4 and 2.9% respectively. The meal upgraded to 37.3% protein content was analysed for anti-nutritional/toxic components like tannins, phytates, trypsin inhibitors and cyanogenic compounds and found to be 0.94%, 0.93%, 10 TIU/mg meal and 100.7 mg/ 100 g meal respectively. Due to the presence of these toxic compounds, the seed meal has not been used as a major food ingredient specially, in children's food. A chemical treatment was approached using salt and mild acids in different concentrations 1-3% and determination of cyanogenic compounds in treated, untreated, dehulled and undehulled flax seed is underway. The other major obstacles in the development of the process for protein rich material from flax seeds is the presence of hulls and mucilage. The development of a process for separation of hulls from the kernels is an important pre requisite for the preparation of protein rich ingredients. In the present work, dehulled flaxseed with relatively low moisture level (0.5%) was defatted and ground to get flaxseed meal. The protein content was 40% in the defatted sample. The flaxseed meal was studied for protein solubility in the pH range 2-11 which showed the solubility minima of 11-14% in pH 4-6 range, the maximum solubility was 54.1% at pH 9.0. The relatively low solubility of the meal was due to the presence of hulls and mucilage in the meal which inhibits the extractability of proteins. Efficiency in extractability of the protein (globulin) from flax seeds were also approached after the separation of the hulls. The dehulled defatted meal was fractionated for different soluble proteins namely albumin (35%±2), globulin (45%±2), prolamin (9%±2) and glutelin (16%±2). The globulin isolate had a protein content of 91%. The in vitro digestibility studies show the protein to be completely digestible.

Effect on carbohydrate digestive profile: Modulation of food matrices or formulation of the composite flours may lower the release of glucose. Effect of flaxseeds on carbohydrate digestive profile such as 'rapidly available starch', 'slowly digestible starch,' 'resistant starch' and 'total starch' and 'rapidly digestible starch' on cereal flours such as corn and wheat was studied. Carbohydrate digestion was determined by in vitro enzymatic method. With incorporation of 5-10% flax seeds to wheat flour, 3-4% decrease in the RDS was observed. In case of corn flour incorporation of 5-10% flax seeds lead to 9-13% decrease in RDS. SDS content decreased with the addition of flax seeds endosperm in corn flour only. Flax seed was found to be more effective in lowering RDS.

Flax seed hulls for recovery of pigments: Flax seed hull forms approximately 20-35% of the total seed. Recovery of natural pigments present in hulls was studied using different solvents. The maximum colour (25 mg/g hull) could be extracted under alkaline conditions. The antioxidant and antimicrobial activity of the pigment powder was studied. Flaxseed hull pigment showed activity against food pathogen Listeria sp. Stability towards pH, light, temperature were studied and the pigment was quite stable. The extracted pigment was identified as melanin by FT-IR and chemical tests.

Flax seed meal as nitrogen source for bacterial cultures: Bacterial cultures of Bacillus sp. PKD-9 and Bacillus sp. CAM-21 were evaluated for their capability to utilize defatted flax seed meal as cost-effective nitrogen source [yeast extract and peptone; (50% w/v supplementation)] for producing two hydrolytic enzymes viz. xylanase and glucoamylase under submerged fermentation (SmF). After 25 h of incubation at 37°C, indicated that Bacillus sp. PKD-9 and CAM-21 produced appreciable levels of xylanase 1010.2±50.0 IU/ml and 30.7±3.0 IU/ml, respectively whereas, Bacillus sp. CAM-21 produced 16.1±0.14 IU/ml of glucoamylase. Incorporation of flax seed meal in basal media (Luria broth) (medium 1) and half strength basal media (medium 2) improved ManB-1601 production. However, utilization ofonly FSM containing broth (medium 3) resulted in a very low level of ManB-1601 production (119 ± 11 IU/ml).

Pumpkin Seeds:

Evaluation of nutrients in pumpkin seeds: Total protein and fat content of pumpkin seeds were found to be 27-30% and 40.4% respectively. The protein was extracted from defatted seed in distilled water at pH 9.0, 2 h and precipitated. A bulk extraction process with 40 g defatted seeds was performed to sequentially extract different protein concentrates (total yield of protein was 19.2%). The major fraction was found to be NaOH-soluble (13.9%). Ammonium sulfate precipitation was performed to precipitate all protein fractions. The seed oil is mainly composed of fatty acids such as oleic (39.4%), linoleic (37.9%), palmitic (11.2%) and stearic acids (8.0%). Physicochemical characteristics of the seed oil like BRR, RI, and Iodine Value showed 56.2, 1.4634, and 84.5, respectively indicating similarity to ground nut oil (GNO). Seed shell however is rich in fibre content (29.5%) and carbohydrate (47.1%) comparatively. Whole pumpkin seeds are rich in vitamin E (17.5 mg/100 g) and vitamin C (2.80 mg/100 g). Phytochemicals were extracted from peels and pulp with 90% acetone and were analyzed using HPLC. The carotenoids, mainly beta-carotene

varied from 0.28 to 0.59 mg/100 g peel, and 0.11 to 0.59 mg/100 g pulp.

Agri and marine waste for value addition (Purnima Kaul Tiku)

Most of the oil seeds have been reported to have globulins as the major seed storage proteins. Though oil palm is one of the highest oil yielding crop in the world, unlike other oil seeds very little work has been done in the field of identification of the oil palm seed storage protein. Globulin being the major protein fraction present in the oil palm kernel, the protein isolate (protein content of 85%) predominantly consists of globulins. The isolate was checked for its digestibility using human gastro-intestinal juice and the peptide profile (by MS/MS analysis) and free amino acid released was determined after the in-vitro digestion. The globulin is completely digestible and the digestibility is comparable to casein. Arginine was found to be the major free amino acid released (28%),followed by leucine (13%), phenylalanine (13%) and valine (12%) after gastro intestinal digestion. The results are evident that high digestibility makes it ideal for utilization of human consumption. The dietary approach through potential health promoting foods has an imperative role in prevention and treatment of diseases, due to their biological properties. At present the final digest is being checked for its biological activity such as anticancer activity, antioxidant and ACE-inhibitory activity. Arginine rich proteins are known to have hypocholesterolemic activity. The hypocholesterolemic activity of palm kernel globulin by nutrigenomic approach using rat models is being evaluated and the results may suggest the utility of palm kernel protein isolate as a nutritional supplement which may serve as a potential edible protein source for human consumption with nutraceutical properties. Cloning and expression of the globulin is underway.

High protein low calorie butter spread (Radha C)

Nutri-spread high in protein (20-25%) and low in fat (18-20%) with acceptable colour, mouth feel, taste and texturewas developed. Shelf-life studies are under progress to make the process ready for commercialisation.

Biomolecules from moringa seeds (Radha C)

A process was developed for the preparation moringa seed protein isolate (MPI) having a protein content of >90% and its protein composition and functional properties were studied. The protein isolate preparation process developed in the laboratory reduced the anti-nutritional factors in MPI while retaining the protein subunit profile intact. Functional properties of MPI obtained generally scored over the reference soy protein isolate (SPI) thus giving an edge in their choice in the formulation of protein based functional foods.

Total dietary fiber in defatted moringa seed flour was estimated to be 33.5% out of which 27% comprised of insoluble dietary fiber. Soluble fiber was evaluated for its prebiotic effect. In vitro assays, growth curve with moringa seed soluble dietary fiber as carbon source confirms the growth of certain beneficial species of lactobacillus and thus may be beneficial in reducing serum cholesterol levels. In conclusion, soluble fiber isolated from moringa seed flour showed very good prebiotic effect.

Phenolic constituents of FPE and BPE from Moringa oleifera seed cake with and without gastric digestion were identified and quantified by HPLC. Gallic acid,catechin, epicatechin, protocatechuic acid and quercetin were common in both the extracts. Free phenolics were more pronounced compared to bound phenolics before gastric digestion. Compared to other phenolics,quercetin was increased by 17% in bound form showing more bio-accessible compared to free form which decreased by 63%. This study showed that moringa seed bound phenolics are comparatively more bio-accessible than free phenolics.

Probiotics for antigen delivery (Rajagopal K)

A simple, interactive Cancer Cell Line Data Base (CCLDB) was made available at http://118.151.209.75/ccldb/index.html. Currently, CCLDB consists of approximately 61 cancer cell lines and, allows the user to search for a specific cancer cell line based on the alphabetical or tissue of origin (21 types) using a browser tool. Each cell line has been described in detail, about its source, media requirement, temperature, its commercial availability, phenotypic character and genotypic character. Possible gene manifestations, corresponding gene length, uniprot link and references can be retrieved. Biomarker information for each cancer cell line has been provided with protein sequence coding for biomarker and references. Nucleic acid and protein sequences were also included corresponding to each cell lines.

INNOVATIVE FOOD PROCESSING

Spices processing by unconventional methods (Borse BB, Hafeeza Khanum, Sowbhagya HB & Nagarajan S)

Isolation of the total colourants by newer extraction methods was attempted. Extractions by Soxhlet, microwave assisted, jacketed column and high pressure extractions were tested. The preliminary trials by Soxhlet and microwave extractions with water and ethanol gave extraction yield upto 87.5% which contained various components of the pigments. Further isolation and analysis is under progress.

For sterlization of black pepper using ozone, four different treatment conditions were used. Black pepper directly subjected ozone in gas phase (conc. of 10 g/m^3 at 3 lpm, for 30 min) was not effective in microbial load reduction of black pepper and that may be attributed to non-interaction of ozone with surface of black pepper. However, black pepper with water (2:1) was subjected to the ozone concentration (10 g/m^3 at 3 lpm for 30 min) provided 1 log cell reduction in total microbial count in black pepper. Black pepper and water (1:1) treated with higher conc. of ozone (25 g/m^3 at 3 lpm flow rate for 360 min) showed 2 log reductions in total microbial count in pepper.To check the effect of lower temperature of water (10°C), black pepper and water (1:4) was treated with ozone (conc. 25 g/m^3 at 3 lpm flow rate for 60 min) showed 2 log cells of total microbial cell reduction.

Terpenolipids synthesis and limonene biotransformation (Bettadaiah BK)

Experiments were carried out to synthesize mono and di-glycerides containing a terpene moiety. These are envisaged as new molecules whose flavour and other attributes like stability and solubility would be explored. Three main approaches were attempted. Reaction of glycerol with aldehydes was investigated with several catalysts including Lewis acids. Another approach tried was to start from a monoglyceride ester and react with a terpene aldehyde. The reaction of glycerol with citronellal afforded a mixture of two major acetals, which were characterized by NMR and MS spectral data. In another approach synthesis of allyl-methyl ether as an intermediate for the synthesis of terpenolipids was carried out. It was prepared using (1R,2S,5R) - menthol and allyl bromide in the presence of base. This step is solvent-free and reagents along with phase transfer catalyst like tetrabutyl ammonium iodide were stirred to afford the product. Bases like KOH, NaH, Cs_2CO_3 and Zn dust were tested. In the case of KOH mediated reaction conversion was about 60%. The crude product was isolated by column chromatography over silica gel. The pure product was characterized by ^{1}H and ^{13}C - NMR spectral studies.

Up-gradation of neera technologies (Ramalakshmi K)

Process parameters were standardised for the preservation of neera in PET bottles at room temperature condition. Several experiments were carried to optimise the level of additives and pasteurization conditions to keep the quality of the processed neera very close to the fresh neera with respect to colour and flavour. Fresh coconut sap was tapped under hygienic conditions during the night, to avoid exposure to sunlight and transported at low temperatures (<5°C) from Palakad, Kerala to CFTRI, Mysuru. Sap was immediately centrifuged, 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, sucrose, sensory acceptance, total plate count, E. coli count, yeast and mold count. Storage studies of the product for two months shelf-life with respect to physicochemical, microbiological and sensory quality is in progress.

Bio functional properties of irradiated by-products of aquatic and agro-processing (BAAP) (Madhava Naidu M)

Irradiation of black pepper and pepper powder was conducted at 10 kGY doses using Co^{60} batch irradiation unit to make it safe for human consumption. The samples (100 g) were packed in metalised polyster polythene laminated pouches prior to irradiation. The irradiated samples were analyzed for physical, chemical and microbial quality. The microbial count by using PCA media decreased from 4.75 cfu/g to < 2 at a dose rate of 10 kGY in pepper powder and from 4.56 cfu/g to < 2 in whole pepper. By using PDA media microbial load reduces from 2.32 (whole pepper) and 2.48 cfu/g (pepper powder) to < 1.

Biotechnological approaches (Pushpa S Murthy & Madhava Naidu M)

Starter consortium was developed with potential microbes Saccharomyces cerevisiae (yeast), Lactobacillus plantarum (LAB) and Acetobacter aceti (AAB) with optimal concentrations of yeast (2.58-5.62% (w/v)), LAB (13.65-19.18% (w/v)) and AAB (20% (w/v)). Pre washing of the cocoa with water after fermentations also revealed improved quality. Drying of the cocoa beans using hot air drier was good with quality profiles. The diffusion coefficients estimated for water as well as solute are expected to be useful in optimizing the dehydration process conditions and scaleup. The bioreactor for fermentation of cocoa was modified and fermentation was operated and validated.

Bioactive flavourants in food and beverages (Nagarajan S)

The bioactives from garlic cloves was extracted by preparing the volatile and non-volatile extracts and were subjected to chromatography. The sulphur containing bioactives were extracted with 95% ethanol followed by diethyl ether extraction. This was subjected to column chromatography using chloroform, methanol and ethanol in various proportions. The pure compounds were separated and subjected to HPLC and LC-MS analysis. The isolated compounds showed single peaks with ESI-MS indicated that they are pure constituents. Further characterisation by NMR and application studies are under progress.

Concentration of liquid foods (Rastogi NK & Subramanian R)

The study is focused towards the maximum recovery of albumins (water soluble) and globulins (salt soluble) employing physical extraction methods from four different types of rice bran representing high (Jyothi, IR64), intermediate (Basmati) and waxy (Agonibora) amylose rice varieties. Agonibora bran contained the maximum protein content (19.6%). However, IR64 bran exhibited greater extractability of water and salt soluble proteins. Hence, IR64 bran was selected for optimization and standardization of extraction methods. Maximum recovery of 29.1% of water soluble proteins and 38.0% of salt soluble proteins were achieved at 1:20 bran-solvent-ratio, 1 h duration and 2% salt (NaCl) concentration at 25°C. Among the selected varieties, IR64 bran exhibited the maximum recovery of water and salt soluble proteins followed by Basmati, Agonibora and Jyothi under the standardized conditions. Sequential extraction of IR64 bran with water followed by salt resulted in a higher overall protein recovery (42.5%) compared to direct salt extraction (38.0%). Besides, this approach also gave a scope to obtain relatively high purity globulins. The protein recovery did not vary significantly between shaking and stirring with IR64 bran, while homogenizing substantially improved the recovery by 48% and 10% under water (10,000 rpm;10 min) and salt environment (5,000 rpm; 10 min), respectively. Jyothi bran exhibited the maximum increase of 68% with homogenization, however IR64 bran showed the maximum protein recovery (37.1%). Since water soluble protein recovery obtained with homogenization was closer to salt extraction, it is required to analyze the increased extractability of proteins in terms of protein quality.

Dehydration, infusion and extraction of fresh fruits and vegetables (Rastogi NK)

High pressure assisted infusion of anthocyanin was attempted in apple slices. The application of pressure (100-350 MPa for 10 min) resulted in higher infusion (821 mg/100 g) as compared to the infusion that took place at ambient condition (375 mg/100 g). The infusion was found to increase with an increase in pressure. The maximum infusion of anthocyanin was found to be maximum at 250 MPa (821 mg/100 g) and beyond which it decreased. Application of high pressure also resulted in partial inactivation of enzymes such as PPO (80%) and POD (75%).

Viscoelastic foods (Bhattacharya S & Chakkaravarthi A)

Multiloop experiments: The present study proposes a single experiment to determine both time-dependent and time-independent properties simultaneously in addition to proposing an index termed as 'isoviscosity' to quantify these properties by using a model food system of a chickpea flour dispersion.

Frying of dough strands with hydrocolloid: Rice dough with different moisture (44, 46, 48 and 50%) and gum (0, 1, 3 and 5%) contents were extrusion-formed to obtain strands followed by frying. The fried snacks were subjected to estimation of fat content, detailed instrumental textural attributes, microstructural features and sensory assessment. The addition of gum significantly influences the oil absorption during frying, textural and sensory attributes.

Food gels: The effect of selected additives on rheological and sensory attributes has been studied to develop nutritious gels using gellan gum (1-2%, w/w), mango pulp (0-40%), sugar (0-20%) and ferrous sulphate (0-0.10%). In addition, flaxseed powder (0-10%) and whey protein concentrate (0-5%) are incorporated to selected gel samples to develop nutritious gels. It is possible to develop acceptable gels with nutrients as a convenience food.

Imaging and image analysis: Agar and gellan gels having nutrients like ferrous sulphate, sucrose, mango pulp, whey protein concentrate and flaxseed powder were subjected to freeze-drying followed by image analysis of the cellular structure. Freeze-drying offers closed type cellular structure having five non-equal sides.

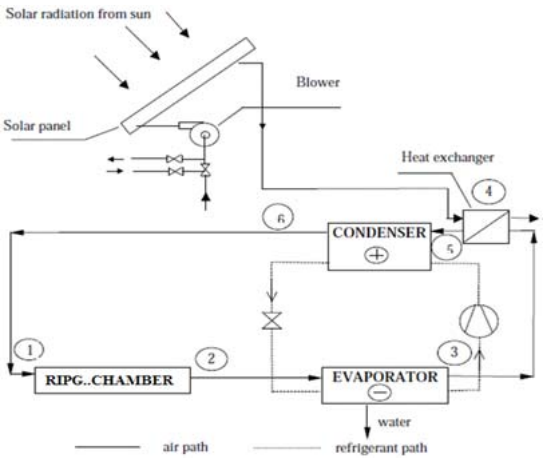
Extraction of pomegranate peel extract (Singh RP)

The extraction of pomegranate peel powder was achieved using ecofriendly solvent combination (ethanol:water, 1:1 v/v ratio) at room temperature (28-30°C). The extraction protocol utilizes minimum energy. The extraction was carried out with 1:10 (solid-solvent ratio). Initial results indicate no significant change in the yield, RSA profile and polyphenol content of the peel powder extract prepared at lab level (1, 10 and 50 g batches) and pilot level (1 kg batch).

Solar assisted mobile artificial fruit ripening control apparatus (Sridhar BS)

Development of a solar assisted mobile artificial fruit ripening control apparatus to promote as well as retard the ripening process of climacteric fruits such as bananas was taken up and the preliminary design of ripening control apparatus and solar power requirements were completed. Vendor development for the fabrication of the designed equipment is being processed.

Some salient design features: Volume: 125 litres; Inner dimension: 500 x 500 x 500 mm; temperature range: 5-60°C; Humidity range: ambient to 98% RH; Refrigeration system provided with hermetically sealed compressor with CFC-free, eco-friendly refrigerant condenser (as a heat exchanger at high temperature and pressure to remove heatfrom the working fluid); Evaporator (as a heat exchanger at low temperature and pressure to absorb the heat from air outside the working fluid tube); Heat exchanger and blower (to pre-heat, dehumidify and recirculate the air); Finned evaporator coil to be provided inside the chamber along with circulation fan for uniform temperature throughout the chamber; Humidity generated by means of steam generator bath with ceramic heater; Provision of ripening control encompassing ambient temperature and RH, pulp temperature, CO_2 and C_2H_4 monitoring and control sensors. Solar PV system size - 1.46 kW, 12 V DC array; Area required -10.9 m^2, No. of solar panels - 6-8. A schematic of the proposed designed equipment is shown.



Schematic diagram of the designed apparatus

Advanced Oxidation Processes treatment (AOPs) in vegetable and fruit processing wastewater (Parande AK)

Fruits and vegetables processing wastewater has its own characterestics and seasonal variation which causes major problem in treatment. The raw products were processed in season that may vary from month to month. The quality data (w/w) was collected and are under evaluation process.

Sources of wastewater generation include: Fruits processed, raw product condition, product conveying system, process methods, clean-up methods, time of frequency and discharge of water.

The wastewater was collected from nearby food industry (Suruchi food industry) Sindhuvalli village (Nanjangud Taluk), Hebbal industrial estate, Madikeri and Chikkaballapur. Processed and washed fruits and vegetables (papaya and ginger w/w) were collected and

preserved in the lab for further analysis as per the standard methods. The wastewater characteristics analysis was carried out as per standard methods for the examination of water and wastewater testing methods. COD and BOD analysis were carried out for different samples of papaya, tomato, mixed fruits and ginger (w/w). BOD test for zero day and 5th day at 20^{0}C were analysed. pHvalues of papaya washed water was 7.2, that for mixed fruits 4.5 and ginger 7.03.

Dissolved oxygen (DO) was fixed at the site and was analysed in the lab to check the DO level. The DO levels declining to dangerous concentrations (<2.0 mg/l) and the rate of DO additions to the system needs an effective measurement to increase the DO level concentrations. In this study, the aquarium aerators were used. The volume of the cone was calculated and found out to be 8314.74 cm^{3}. The size of the cone was defined as 12 cm at the top and 11 cm at the bottom. Increase in DO concentration of the processed wastewater of tomato and papaya was studied using aeration system. The observations were recorded for every 30 minutes after switching on the aerators. Gradual increase in DO concentration was observed.

Engineering model of human stomach for understanding food digestion (Anandharamakrishnan C)

Stomach digestion is important in the extraction of nutrients from the food matrix. The stomach acts as a reservoir, mixer, grinder and sieve that breakdown the food materials and convert them to a consistency easier for nutrient absorption. Various in-vivo and in-vitro methods have been employed to understand thebreakdown mechanism behind food digestion. However, experimentally it is very difficult to reproduce the complex stomach shape and motility which is critical during food digestion. Computational modeling techniques have the capability to overcome such difficulties and helps in understanding the interaction between food and the human body. Hence, finite element modeling was used as a tool to investigate the dynamics of gastric contents. Human stomach geometry was constructed using the in vivo published images obtained from MRI movie sequence. The effects of varying gastric juice viscosities (0.001, 0.03 and 25 Pa.s) on food particle distribution were studied. Increase in viscosity of gastric juice resulted in diminished characteristic flow pattern viz., retropulsive and eddy, inside the stomach. The maximum fluid flow velocity around the simulated particle ranged from 5 to 15 mm s^{-1}, whereas, the maximum shear rate was found to be 21.7s^{-1}.The drag force on the particle increases with viscosity and delays food particle breakdown.

Biosensors for assessing the microbiological quality of foods (Raghavarao KSMS)

A light proof enclosure was designed and fabricated to house the photo multiplier tubes (PMT) and to load sample. The PMT based Bio-Luminometer creates an electric charge in proportional to light energy it receives is housed in the light proof enclosure. PMT used is C5460-01/H7828, a Hamamatsu model which has peak sensitivity at 800 nm. Sensing of the bioluminescent signals by the module was further amplified and read out in form of photon counts.

Field assisted processing of vegetables and spices (Umesh Hebbar H)

Studies were carried out on application of microwave (MW) and radio frequency (RF) waves for direct as well as in-pack sterilization of black pepper (Piper nigrum L.). The exposure of black pepper to MW at 663 W (40 W/g) for 12.5 min was found to be sufficient to inactivate the microbial load to the permissible level internationally. MW processing resulted in moisture loss and the same was compensated by increasing the initial moisture content of black pepper (26±0.3%) before processing. The retention of volatile oil, piperine and resin was found to be 89.1±0.03, 84.0±0.02 and 88.9±0.05%, respectively in MW treated black pepper. The color of MW treated black pepper appeared darker in color when compared to untreated black pepper. RF heating was improved by increasing the initial moisture content of black pepper (30%). In case of RF sterilization, complete elimination of total coliforms, Salmonella and Shigella and desired level of sterilization of total aerobic mesophiles and total yeast and mold (5 log reduction) were attained when processed for 60 min. During MW based in-pack sterilization, permissible level of microbial load reduction was attained when processed for 10 min. Nearly 6% loss in piperine was observed when processed with MW. In case of RF based in-pack sterilization, desired level of microbial load reduction was attained by increasing initial moisture content to 23%. The content of volatile oil, piperine and resin was found to be marginally higher than that of raw, which could be attributed to higher degree of extraction after treatment. The study indicated that EMR based sterilization can be employed for simultaneous microbial inactivation and finish drying of black pepper.

Ultrasound assisted ozonator for processing of liquid foods (Navin K Rastogi)

The ultrasound treatment (120µ amplitude, 4.5 pH coupled with 50°C water bath, 10 minute, 5 s on 5 s off) gave the 5 log reduction of natural micro-flora of

sugarcane juice. At the same time, PPO and POD enzymes were reduced to 19% and 28% of initial activity, respectively. The fresh sugarcane juice treated with ozone resulted in 3.1 log reduction in 15 min. Sequential treatment of ultrasound (90 μ at 1 s on 1 s off, 10 min) and ozone (0.12 g/h for 30 min) resulted in 2.8 - 2.9 log reduction, whereas, simultaneous treatment showed synergistic effect with 3.5 log cell reductions in 20 min. The combined treatment with ozone and lactic acid showed 5 log cell reductions in natural micro-flora of sugarcane juice. Further studies on different combinations of lactic acid and ozone are under progress with storage studies and sensory quality analysis.

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

Til pitha is the traditional sweet of Assam and is made from waxy rice flour and has til (gingelly) and jaggery as filling. In appearance pitha are thin roll with white outer covering of rice and black coloured filling of gingelly in the inner part. For preparation of pitha, the whole waxy rice is soaked to full saturation, drained well to make the rice surface-dry, and the soaked rice is powdered in a dheki to get moist rice flour. This dheki is a traditional hand and foot operated milling and pounding unit. The moist rice gets powdered because of the pounding action of the dheki. The moist flour thus obtained is kept covered and a fistful of the powder is spread on a hot flat griddle (tava) and cooked for a minute or so. During cooking, the rice flour being waxy and moist binds together which can be rolled over as in a roll. Before rolling, gingelly powder and jaggery mix is spread at the center. The sweet is therefore dry and crisp. The dheki being a traditional device cannot be used in modern concrete houses. People therefore try to replace dheki with a grinder. The grinder however cannot powder moist rice as lumps are formed. If slightly dried rice is used, then the powder is coarse and gives an unappealing look and coarse texture while eating. The unit shown in photograph is a small sized equipment that has been designed to yield moist powder from waxy rice, and is put to use/demonstration for the urban society in Assam and for commercial production of the til pitha.

Multispouted bed roaster for roasting of makhana (Sridhar BS)

Makhana (Euryale ferox), a highly nutritious product containing protein (14.52%), total fat (0.01%), phosphorus (2397 mg), iron (2236 mg), zinc (66 mg) and no cholesterol. At present, the processing of makhana is very laborious, cumbersome and unhygienic. Experimental data assimilation, design of conceptualized Multi-Spouted Bed Roaster (MSBR) including design drawings needed for processing of makhana seeds was completed and the fabrication of the unit is in progress. Various technologies for producing different products from makhana such as makhana flakes, makhana milk powder, dehulled makhana and popped makhana were developed. These developed technologies can increase the economic prosperity of makhana growing farmers with various value added products.

Packaging material to prevent spoilage of foods (Matche RS)

Antimicrobial packaging is a novel development that incorporates antimicrobial agent into polymer film, packaging materials or edible films and coatings to suppress the activities of targeted microorganisms. Films prepared with curcumin nanoparticle as low as 0.2% showed inhibition while films with curcumin showed no inhibition, which proves that curcumin nanoparticle films shows more antimicrobial property than films prepared with curcumin.

RTE packaged foods for disaster relief operations (Sathish HS)

Extensive literature survey has been done on the above subject. Region specific foods catering to different parts of the country were identified and also samples were prepared.

The hurdle process was designed to extend the shelf-life of chapati, pulioggare, lemon rice, tomatocurry and carrot halwa. Hurdles used in this study includes low dosage of preservatives (0.05% of sorbic acid and 35 ppm of potassium metabisulfite) in case of chapati, pasteurization (P_{90} of 10 min), water activity control and

Food products developed and supplied to Anti Naxal Force, Udupi

vacuum packaging to get a desired shelf-life of 30 days under ambient conditions. The processed products were subjected to microbial and sensory evaluations. Sixty days of shelf-life in case of chapati with sorbic acid with other hurdles and 15 days in case of lemon rice and pulioggare were obtained, whereas, the shelf-life of tomato curry and carrot halwa were 90 days under ambient conditions.

a b c

Edible films from a) Isabgol b) Katiragond & c) Blend of isabgol and katiragond

Edible packaging films of isabgol and katiragond (Satish HS & Keshava Murthy PS)

Edible blend films of isabgol/katiragond in different ratios were prepared by simple wet casting method. The static mechanical properties was studied and tensile tests showed that the strength at break increased with the incorporation of 0.5 g katriagond in isabgol/katiragond blend film, further increase in katiragond concentration was found to decrease in tensile strength.

Structurally modified natural compounds (Akmal Pasha & Manivannan S)

Organophosphate pesticides are commonly used in agriculture and storage to control insect pests. However, many insects have developed resistance to this group of insecticides. Hence, the following phosphorothioate derivatives of the naturally occurring compounds 4-hydroxyacetophenone and acetovanillone were prepared as an alternative compounds: (1) O -(4-acetylphenyl) O ,O -diethyl phosphorothioate, (2) O -(4-acetyl-3-

methoxyphenyl) O,O-diethyl phosphorothioate, (3) O-(4-acetylphenyl) O,O-dimethyl phosphorothioate (4) O-(4-acetyl-3-methoxyphenyl) O,O-dimethyl phosphorothioate. The effect of compound 1 was evaluated for contact toxicity on the adults of R. dominica at five different concentrations viz., 0.05, 0.10, 0.15, 0.20 and 0.25 mg/cm^2 over 24, 48 and 72 h of exposure. No mortality was observed over 24 h. However, 7.7 and 10.2 mortalities were observed at 0.20 and 0.25 mg/cm^2 concentrations; no significant increase in mortality was observed. After 72 h of exposure, a linear increase in mortality response was observed over increasing concentrations. At 0.05 mg/cm^2 the obtained mortality was 21.3%, when the concentration was increased to five times the mortality of the tested adults increased to two folds i.e., to 46.3%. Compounds 2 and 3 were tested at 0.001, 0.003, 0.006 and 0.012 mg/cm^2 concentration against Tribolium casteneum and Oryzaephilus surinamensis stored-product insects. But no mortality was observed at this concentration.

2-methoxy-4-(prop-2-en-1-yl) phenyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate (Akmal Pasha)

The compound 2-methoxy-4-(prop-2-en-1-yl)phenyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate was prepared using eugenol and 3-(2,2-dichloroethenyl)-2, 2-dimethylcyclopropanecarbonyl chloride and identified by TLC and ^{1}H and ^{13}C NMR. Mortality of Tribolium castaneum was observed for 72 h. The LC_{50} and LC_{90} values were found to be 0.0139 mg/cm^2 0.0238 mg/cm^2, respectively.

C O_2 and N_2 against stored-products insect pests (Bhanu Prakash)

Effect of CO_2 and N_2 were tested at different concentrations (15, 30, 45 and 60%) against the major storage insect pests such as Rhizopertha dominica, Sitophilus oryzae, Oryzaephilus surinamensis, Tribolium castaneum.A concentration and time dependent activity has been observed in case of CO_2 while N_2 has no effect up to 60% following 72 h exposure. Mortality of 100% of all selected insect pests has been observed for CO_2 at 60% following 72 h exposure during in vitro assay.

In addition, insecticidal efficacy of some terpenes such as Citral, Citronellol, Limonene, Thymol and also non-terpenes like Methyl salicylate and Eugenol, was tested against S. oryzae. Among all tested terpenes, thymol and non-terpenes eugenol and methyl salicylate following 24 h exposure exhibited 100% toxicity against test insect pest at 150, 200 and 300 ppm, respectively. Citral toxicity ranged between 20-30% at 300 ppm on 72 h exposure. While, Limonene, and Citronellol had no effect till 72 h exposure at 300 ppm.

Terpenes/terpene mixtures on stored product insect pests (Manivannan S)

The contact toxicity of terpenes viz, α-pinene, myrcene and their mixtures were tested against the adults of R. dominica. The bioassay studies involved seven different test concentrations ranging from 0.001-0.018 mg/cm^2 and mortality was calculated using Abbott's formula. The treatment of adults to α-pinene at 0.015 mg/cm^2 concentration over 48 h exposure resulted in 17 % mortality, while no mortality was observed in the test that involved myrcene. The synergistic effect of α-pinene in combination with myrcene (1:1 ratio) were tested for their contact toxicity against the adults of R. dominica. Five different concentrations viz., 0.001, 0.008, 0.016, 0.024, 0.032 mg/cm^2 were tested for their contact toxicity using filter paper test method over 24, 48 and 72 hrs of exposure. The results revealed that, none of the tested concentrations induced mortality of the adults over 24 and 48 h exposure. However,after 72 h, mortality of the adults was observed only in 0.024 (11.21 %) and 0.032 (13.33 5) mg/cm^2.

Ready-to-eat breakfast from selected grains (Meera MS)

Studies were carried out to obtain a blend from malted grains which revealed that the maximum viscosity of the blend reduced drastically with the increase in the quantity of substitution of finger millet malt with that of barley and wheat malt. Hence, substitution of finger millet malt with 25-30% barley or wheat malt was appropriate to improve the textural and cooking properties. Sorghum was also enzymatically modified and milled to obtain low-fat flour with improved protein digestibility and flour functionality. Nutraceutical and antioxidant properties of maize and quinoa were also assessed which revealed that big flint yellow corn showed higher carotenoid content whereas, anthocyanin was higher in popcorn. Milling of quinoa revealed that ferulic and vanillic acids were the principal phenolic acids and rutin and quercetin were predominant flavonoids found in all the fractions of quinoa grains whilechlorogenic acid, diadzein, naringenin, myricetin, luteolin and apigenin were not uniformly distributed and varied in whole grain, bran and milled fractions.

A ready-to-prepare (RTP) convenient mix for Dhokla, an ethnic fermented spongy-textured product was prepared from bengal gram and oats after suitable pre-processing.

Fifty percent substitution of bengal gram flour with oats flour produced a good quality, organoleptically acceptable dhokla rich in protein (17.7%), dietary fibre (5.5%), fat (6.1%), carbohydrates (64.9%) and β-glucan (~2.04%). This novel nutritious oat based dhokla is expected to have a good market potential as a breakfast item.

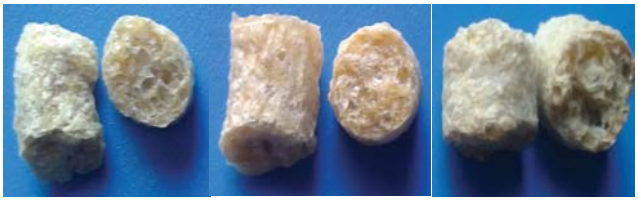
Ready-to-eat convenience health foods
(Sila Bhattacharya)

Two millets (proso and foxtail) were used for the study. Different treatments were given to proso and foxtail millet and their functional, rheological and technological characterization was studied to make them suitable for making products. A process for ready-to-eat extruded snack was standardized using proso millet and characterized the product. The extruded product showed a shelf-life of more than 12 months when packed in 250-300 gauge PP or HMHDPE pouch with respect to the loss of crispness.

Proso millet cookies

The effect of hydrocolloids on cookie dough was studied for textural characteristics in relation to their cookie product quality characteristics. Gluten free cookie from proso millet was developed which has good taste and texture and shelf-life can be extended up to 6 months when packaged in 200 gauge BOPP. The particle size distribution of flour samples was estimated by using a laser-based particle size analyser. An electronic nose with metal oxide semi-conducting sensors was used to assess the flavour characteristics of the prepared cookie. Addition of different hydrocolloids significantly changed the functional and technological characteristics of the cookie dough and the quality of the cookie also differed in terms of their texture and other sensory attributes.

Sensory assessment of the samples shows that all samples are well accepted in terms of texture and overall acceptability.



Proso millet snack extruded at a) 180° b) 190° c)200°

Migration of bioactive phytoceuticals: A kinetics study (Sukumar Debnath)

Oil gets absorbed into the food product during frying that become critical part of our diet. So, it is essential to explore the presence of health promoting phytoceuticals in fried foods. The kodubale is one of the South Indian traditional snack food available in India. It was prepared with chickpea flour, spices and salt by blending, dough making, shaping and frying at 120-160°C for 2-10 min using nutra-coconut oil (NCO). Qualities of kodubale obtained using NCO and control (coconut oil CO) were compared. First-order mass transfer kinetics was fitted for calculation of kinetic parameters. Results showed that, mass transfer coefficients of oil (ko), β-carotene (k_{β}), total polyphenol content (k_{TPC}) and antioxidant activity (k_{AO})of the product varied from (0.023-0.034 s^{-1}), (0.0027-0.0015 s^{-1}), (0.011-0.041 s^{-1}) and (0.009-0.014 s^{-1}), respectively. Activation energies for moisture loss and fat uptake was higher in case of CO fried product and lower for β-carotene, total polyphenol content, antioxidant activity in NCO fried product. Hardness of kodubale fried in CO and NCO increased with increase in frying temperature and time, but showed a slight close breaking strength values. Frying temperature showed negative effect on L*, b*, ΔE and positive effect on a* values. Zero-order and first order rate equation was used to model the kinetics of color change. Zero-order and first order models were desirable for describing the data of L*, b*, ΔE and a* values, respectively. HPLC analysis showed highest retention of secoisolariresinol than the phenolic acid in NCO. NCO fried kodubale retained polyunsaturated fatty acids which were lacking in CO fried product along with lauric acid and sensorily evaluated. Sensory analysis of the product showed that there was no significant difference observed in fried product obtained using CO and NCO ($P<0.05$). Variation in the physico-chemical properties of CO and NCO during frying was not significant ($P<0.05$).

Heat stable frying oil from fruit peel
(Sukumar Debnath)

Coconut oil is very special oil and sesame oil is a potent antioxidant. Development of stable functional oil from fruit peel involves blending of coconut oil with sesame

oil at a specific ratio. The pomegranate peel extract is fortified to the blend as phytoceutical. Different bio-active factors viz., polyphenols, tocopherols, anti-radical activity and β-carotene were estimated using spectrophotometer for extract, individual oils, blended oil and functional oil. Fatty acid, TG composition and functional groups and thermal properties of functional oil and its counterparts were analysed using GC, HPLC, FT-IR and DSC, respectively. The storage stability of the oil was checked by frying followed by physico-chemical tests. The sensory evaluation of the fried product was carried out using hedonic scale. Results indicated that the extract has different bio-active factors viz., polyphenols (45.8%), tocopherol (6.9%), anti-radical activity (90.06%), and β-carotene (7200 mg/100g). Individual oil, blended and functional oil were found to contain polyphenols (0.40-2.43%), tocopherol (100.3-344.5 ppm), anti-radical activity (61.08-84.4%) and β-carotene (70-190 mg/100 ml). FT-IR spectra of individual oil and functional oil showed typical absorption bands. The physico-chemical and thermal analysis of functional oil and its counterpart corroborated the higher stability of functional oil. There was no significant ($p>0.05$) difference observed in sensory attributes of snack food prepared using coconut oil, blended oil and functional oil. The quality parameters of the functional oil developed were observed similar to control with added advantage of having phytoceuticals. Therefore, functional oil can be used as alternate health oil. Shankarpoli fried in coconut oil blend (coconut and sesame oil) and functional oils (addition of 3000 ppm pomegranate peel concentration) was subjected to sensory profiling. Oils were subjected to sensory odour profiling to determine acceptance.

Vacuum frying system and healthy snack products (Sukumar Debnath)

A vacuum frying system (capacity: 10 kg/batch) has been designed and developed.The process variables were optimized to retain charantin and betalain moleculeand their effect on quality attributes of fried bitter gourdand red beet chips. Experimental design with frying temperature (86-154°C), vacuum pressure(1.3-9.7kPa) and frying time (3-9 min.) as independent variables was adopted using response surface methodology to study the effect of these variables on product responses (oil uptake, hardness, color, charantin and betalains). Multiple regression equations were acquired to describe effects of each variable on product responses.Results predicted that optimum frying conditions are temperature 101-106°C, vacuum 2.51-3.97 kPa and time 6.0 min required for preparing bitter gourd chips with oil content (Y_1) ≤ 29, breaking force (Y_2) ≤ 11.84, L* value (Y_3) ≥ 43.8, a* value (Y_4) ≤ 3.09, b* value (Y_5) ≥ 18.32, charantin content (Y_6) ≥ 0.048 and overall acceptability (Y_7) ≥ 7.5. Further results showed that conventionally fried bitter gourd chips contain 0.016% charantin and (51.4%) oil content. In case of traditional fried red beet chips 82% betalain content reduction and 62% higher oil uptake was observed when compared with vacuum fried red beet chips. Further, the results predicted the optimum frying conditions (temperature 110.59°C, vacuum 30 mbar and time 4 minutes) that were required for preparing red beet chips with breaking force 13.55, color L* 27.63, a* 17.63, b* 6.88 and over acceptability 7.6.

The eggplant is used in several parts of India as a traditional 'bhajji' like product in which batter made of besan flour is used for coating of eggplant slices before frying. The bhajji has higher oil content which is not advisable for consumption for health conscious consumers. The effect of vacuum on changes in quality attributes during production of eggplant chips was investigated. The eggplant was washed, sliced (2±0.5 mm) and fried using conventional (180±1°C, 4 min) and vacuum frying methods. During vacuum frying the processing variables were optimized and their effect on quality attributes (oil uptake, breaking force, color and polyphenol content) of fried eggplant chips was studied. The eggplant slices were fried in lab scale vacuum fryer using refined palmolein. Experimental design with temperature (87-153°C), vacuum pressure (14-97 mbar) and time (2.67-9.3 min) as independent variables which produced 20 different combinations, were studied using response surface methodology to observe the effect of these variables on product responses (oil uptake, breaking force, color and polyphenol content). Multiple regression equations were obtained to describe the effects of each variable on product responses. Results showed that in traditional fried red beet chips 82% betalain content reduction and 62% higher oil uptake was observed when compared with vacuum fried red beet chips. Results predicted that optimum frying conditions to be temperature 111°C, vacuum 30 mbar and time 4.4 min required for preparing eggplant chips with oil uptake of 28.3%, breaking force 10.3 N, color L* 44.6, a* 6.03, b* 18.6 and polyphenol content 3123 mg/100 g. Therefore, the vacuum frying may be used as an alternative method of frying that could be adopted by the food industries for production of healthy fried snack food products.

Jatropha curcas seed cake for meal feed (Somashekar D)

The detoxification of Jatropha seed cake was carried out by solid state fermentation using fungal cultures, followed by an ethyl alcohol treatment. Safety evaluation of detoxified Jatropha seed cake with fungal cultures was carried out in Wistar rats by acute and subchronic oral toxicity studies. In the acute toxicity study, Jatropha seed cake was solid state fermented with Saccharomyces cerevisiae MTCC-36 and Cunninghamella echinulata CJS-90 and were fed to rats at 20% level. Rats fed with Jatropha seed cake solid state fermented with S. cerevisiae was found to be safe compared to untreated Jatropha seed cake and Jatropha seed cake fermented with C. echinulata. In a subacute study, rats were fed diet containing 0, 10 and 20% of fermented Jatropha seed cake with S. cerevisiae for a period of four weeks. Rats fed with untreated Jatropha seed cake showed increased levels of serum liver enzymes, serum glutamic oxaloacetic transaminase, serum glutamic-pyruvic transaminase, alkaline phosphatase was observed as an indication of the onset of liver disease. Histopathological studies of the liver, kidney and spleen showed abnormal cellular architecture in rats fed with untreated Jatropha seed cake. The rats fed with untreated Jatropha seed cake (control) showed severe clinical and pathological symptoms. The rats fed with detoxified Jatropha seed cake up to 10% level survived with no adverse effects. The results suggested that detoxified Jatropha seed cake could be a potential source of protein in the animal feedstuffs.

Coffee pulp effluent (Anu Appaiah KA)

Yeast is able to utilize coffee pulp carbohydrates under aerobic and anaerobic condition. To manage these effluents, 4 isolates were selected from coffee effluent. The selection was based on their ability to grow in acidic pH, degrade polyphenols and utilize pectins as a source of carbon. Furthermore, coffee effluent when stored releases odor due to the production of oxides of sulphur and nitrogen causing air pollution. Hence, second screening was to check the selected isolates for the production of esters and aldehydes. Based on these characters, 4 isolates were selected. These organisms were identified as P1 Pichia kudriavzevii (GenBank accession number-KC841145), P2 Pichia kudriavzevii, (GenBank accession number - KC841146), P3 Pichia kudriavzevii, (GenBank accession number -KC841147) and P4 Candida tropicalis,(GenBank accession number - KC841148). These organisms when tested as a consortium under field condition increased the pH from 4.19 to 5.6. Further the COD of the effluent decreased by 65-77% in 40 days. There was no obnoxious odour generated and no scum formation (initiation of anaerobic conditions) during the same period. In the control (without the selected 4 organisms) COD increased by 140% with thick scum formation. Studies with individual strains with plug flow digester and immobilized systems have been carried out. The chemical constituents of the coffee effluent i.e. the presence of macro and micro nutrients (Mg, K, Ca, Fe, Mn, Zn, Cu), phosphorous, total organic carbon, total solids were estimated. Experiments for reduction in pH and COD using an aeration system in lab-scale were carried out. Inoculum preparation for commercialization using Lignite/ Bentonite preparation and 10% lactose were carried out.

Bench-scale prototype reactor (Sarada R)

Amongst the seventeen indigenous microalgal strains evaluated with 20% v/v CO_2, the Scenedesmus sp. and Desmodesmu ssp. exhibited higher CO_2 fixation rates of up to 0.210 g CO_2/g biomass/day with lipid accumulation of 20-25%. The cultivation of these cultures in experimental raceway ponds (50 L) with CO_2 sparging enhanced the biomass content up to 15%. The cultures have been further acclimatized and scaled up in outdoor open raceway ponds at 1000 L. The harvesting of the biomass using different flocculants indicated the chitosan to be the most effective flocculant. The extraction of lipid from algal biomass indicated up to 88% recovery under optimized conditions. The microalgal strains of Desmodesmus sp., Coelastrum asteroidum and Scenedesmus sp. were also tested with actual flue gas (diluted) and showed high tolerance to flue gas along with high CO_2 sequestration potential. The algal remnants post lipid extraction indicated favourable potential for biogas generation, animal feed and as adsorbent.

Algae based value-added products (Sandeep Mudliar, Chauhan VS & Sarada R)

The project objective is to assess the life cycle and techno-economics of algae-based CO_2 sequestration and conversion to value-added products (food, feed, fuel). Towards this endeavor, the Life Cycle Assessment (LCA) model was developed using GaBI Software Platform. Two case studies involving cultivation of microalgae in open raceway pond and flat panel closed photobioreactor were developed based on the secondary data available in literature. The case studies also involved integration of downstream processing for dewatering of algal slurry using multiple drying options. Energy requirement for various operations were predicted along

with environment impact parameters. The initial results indicated that open raceway pond is energy efficient than flat panel photo-bioreactor. Also, the dewatering option using hybrid combination of systems (flocculation followed by filtration) is more energy efficient than standalone systems like centrifugation. LCA model development under multiple scenarios and validation with primary data is in progress.

Computational Fluid Dynamic (CFD) modeling of algal photobioreactors (Sarada R, Sandeep Mudliar & Chauhan VS)

The project aims to predict the hydrodynamics and light transfer in algal photobioreactors, both open and closed configuration and experimental validation of the modeling predictions. The IISc team has developed a hydrodynamic model simulating the conditions of the 100-1000L capacity open raceway ponds existing at CSIR-CFTRI. The experiments on 100 L capacity open raceway pond for cultivation of a unicellular green algal isolate (*Scenedesmus* sp.) are in progress. Initial results on cultivation under varying light and temperature conditions indicated the light to be the significant factor affecting the overall productivity following the classical photosynthetic efficiency (P-E) curve. Further studies on integration of the hydrodynamic model with light transfer model along with experimental validation of the modeling prediction is under progress. The parameters for open raceway ponds will involve the culture depth, speed and positioning of paddle wheels and incident light intensities.

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 was screened for key metabolites resveratrol, anthocyanin and 1-deoxynojirimycin. The best variety which showed the metabolites was used for tissue culture. The callus was induced in vitro and the metabolite are being analysed.

Vegetable juices and non-acidic fruit juices preservation (Math RG)

A prototype was developed for microwave heating system with a capacity of 30 l/h for sterilization/pasteurization of non-acidic vegetable juices and fruit juices/blends. Five blends of juices were prepared, processed and validated through continuous-flow of microwave heating system (2kW) at 250 ml/min, using specially designed helical spherical applicator in cubical cavity. The effect of microwave heating and applicator on the rate of pasteurization/ sterilizationand the effect of microwave power on the quality of juices were studied during the storage period of 6 months. Specific energy consumption was 0.142 kW-h/l and energy cost for 1 L of juice processing was 0.99 INR compared to the conventional specific energy consumption 0.7 kW-h/l and cost approx. 4.9 INR (1 kWh = 7.00 INR). Energy saved during MW heating is approx. 337% and processing time was reduced by about 3 times compared to conventional, indicating increase in the production of processed juice.

LONG TERM STRATEGIC RESEARCH

Relationship between zinc status and complications of diabetes (Srinivasan K)

Studies were conducted in streptozotocin-induced diabetic rats to verify if zinc supplementation would ameliorate severity of hyperglycemia and associated abnormalities. Experimental diabetes was induced by a single IP administration of streptozotocin (50 mg/kg body weight). Hyperglycemic rats with >2.5 times the normal fasting blood glucose were considered for dietary interventions for 6 weeks with zinc supplementation (5x RDA and 10x RDA). There was a significant reduction in glucosuria in diabetic animals maintained on a zinc supplemented diet. Urinary excretion of proteins and urea was also significantly lowered as a result of zinc supplementation.

The compromised antioxidant status in diabetic animals was assessed for restoration, if any, by zinc supplementation. Activities of glutathione reductase and glutathione-S-transferase in plasma and liver of diabetic animals were significantly enhanced as a result of zinc supplementation. Liver lipid peroxides of diabetic animals were lowered in zinc supple-mentation which was accompanied by an increase in ascorbic acid concentration. Among the severity of secondary complications, nephropathy was also assessed. Increased kidney weights in diabetic animals were partially countered by intervention with zinc supplemented diets. The results suggested that zinc supplementation has beneficial effect in diabetes.

Diabetic nephropathy (Srinivasan K)

The main objective of the proposal is to evaluate the additive/ synergistic effect of a combination of dietary fenugreek seeds (as a source of dietary fibre) and onion on glucose homeostasis and diabetes related metabolic abnormalities in experimentally induced diabetic rats. Diabetes was induced in male Wistar rats (150-160 g) by a single IP administration of streptozotocin (45 mg/ kg body weight). One week after injection of streptozotocin, blood was drawn from retro-orbital plexus, and blood glucose level determined. Rats with more than 2.5 times the normal fasting blood glucose concentration were recruited as hyperglycemic rats. The groups of these hyperglycemic animals were fed with diets containing 10% fenugreek seeds, 3% onion powder, and their combinations for 6 wks. During the course of the experimentation, weekly interval urine was collected and metabolites such as urine glucose, protein, urea and creatinine were estimated. Blood was collected biweekly by retro orbital plexes. Fasting blood glucose and insulin level were checked biweekly.At the end of 6 wks, rats were sacrificed and blood, kidney, liver, heart and lens were collected for biochemical analysis.

The decrease in body weight in diabetic animals was partially reversed by the dietary interventions, the combination producing higher effect. Fasting blood glucose and insulin level in diabetic rats were countered by dietary interventions, combination of dietary spices showed a higher effect than the individuals. Activity of renal and lens polyol pathway enzymes and tryptophan related fluorescence levels significantly decreased during diabetic condition, which was countered by dietary interventions. AGEs related fluorescence in kidney and lens were increased upon diabetes, and was countered by dietary spices. Diminished activities of antioxidant enzymes in heart and lens in diabetic animals were countered by dietary fenugreek, onion or their combination. Compromise in plasma vitamin C and glutathione was also restored by all the three dietary interventions which were associated with a decrease in lipid peroxides. In general, the beneficial influence of dietary fenugreek and onion were higher than when given together compared to their individual treatment, sometimes amounting to an additive effect.

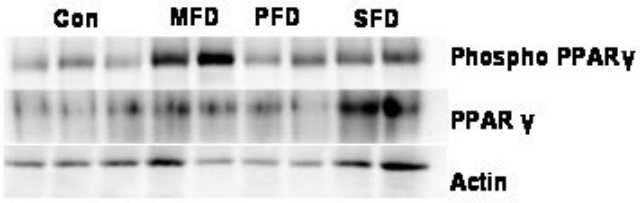
Influence of supplemental levels of iron and calcium (Kalpana Platel)

Experimental rats were rendered zinc deficient by maintaining them on a zinc-deficient diet for a period of five weeks. The zinc-deficient rats then received repletion diets containing normal levels of zinc (control), and with added supplemental levels of iron and calcium, for ten days. Zinc status of these animals was analyzed by estimating the zinc concentration in serum, organs,

bones and the activities of zinc-containing enzymes in circulation and liver.Zinc concentration in serum, organs and bone of zinc deficient rats maintained on diet containing normal levels of zinc was lower than that of the normal (zinc-sufficient) rats, the extent of reduction ranging from 21 to 38%; this reduction was significantly higher in rats fed diets containing supplemental levels of iron and calcium ranging from 28 to 73%. This significant reduction was also evident in the activities of zinc-containing enzymes in circulation and liver ranging from 26 to 64%. The activities of these enzymes in serum and liver of zinc-deficient control rats was only marginally lower than that of the normal rats (< 20%). This clearly indicates that supplemental levels of iron and calcium interfered with recovery of zinc status in zinc-deficient rats.

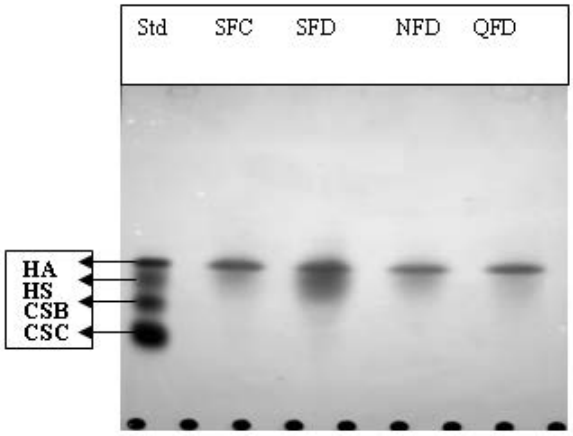
Maternal diabetes on foetal brain glycosaminoglycans (Salimath PV & Nandini CD)

Influence of maternal diabetes on brain glycosaminoglycans (GAGs) was studied. GAGs are important components present in all cells and extracellular matrix which play a plethora of functions. Maternal diabetes resulted in resorption of foetus which was significantly circumvented by feeding flavonoids, quercetin and naringenin in the diet. Characterization of foetal brain GAGs revealed that there is a significant overexpression of heparan sulfate (HS) class of molecules. HS proteoglycans in brain have been determined to be the modulators of feeding behaviour.It needs to be determined whether this molecule is expressed when the foetus matures into adulthood.



Effect of diabetes and mulberry feeding on PPA Rã in kidney Con-Control, MFD-mulberry fed diabetic, PFD- Pioglitazone-fed diabetic, SFD- Diabetic

Peroxisome Proliferator Activated Receptor γ (PPA Rγ) is one of the key transcription factors which is involved in kidney development. During diabetic nephropathy, the expression of PPA Rγ is increased which is attenuated by feeding mulberry leaves. Interestingly, phosphorylated PPA Rγ expression increases by feeding mulberry. Phosphorylation of PPA Rγ is known to decrease its transcription activity. Thus mulberry might



by

GAGs from brain of embryonic 19 day rats were isolated and species characterised by cellulose acetate membrane electrophoresis after digestion with chondroitinase ABC. SFC-Con, SFD-Diabetic, NFD-Naringenin-fed diabetic, QFD - Quercetin-fed diabetic

Green gram root peroxidase and flavonoids (Prasada Rao UJS)

Peroxidase from the germinating root was partially purified and characterized. As peroxidase has oxidised most of the phenolic compounds, it may be classified under class III peroxidase. Compared to horseradish peroxidase, it has wide range pH and higher temperature stability. Flavonoid content was higher in husk (31 mg/g husk) followed by plumule, aleurone and germ rich fraction, whereas, dhal had the least (0.6 mg/g). Most of the vitexin and isovitexin were concentrated in the husk followed by plumule fraction. Isovitexin content was more compared to vitexin in all the tissues. Exudates of seeds soaked in warm water (40^{0}C) had 2-fold higher amount of flavonoids compared to that of room temperature.

Xylo-oligosaccharides (XOS) (Muralikrishna G)

Xylo-oligosaccharides (XOS) were obtained from water un-extractable polysaccharides of finger millet by xylanase treatment. Sugar composition of XOS revealed the presence of arabinose and xylose in a relative ratio of 1:2.4. Cinnamic acid derivatives such as ferulic acid and coumaric acids were found to be major bound phenolic acids in XOS. Finger millet XOS were separated into neutral (~70%, eluted with water, fraction 1) as well as bound phenolic containing XOS (~20-25%, eluted with methanol, water(1.1), fraction 2) on Amberlite XAD-2 adsorption chromatography. Fraction 2 was further purified on Sephadex LH-20 into three peaks i.e., two minor and one major peak. Major peak was structurally characterized by ^{1}H NMR and signals were observed in the range of 3.0-5.0 ppm which are typical

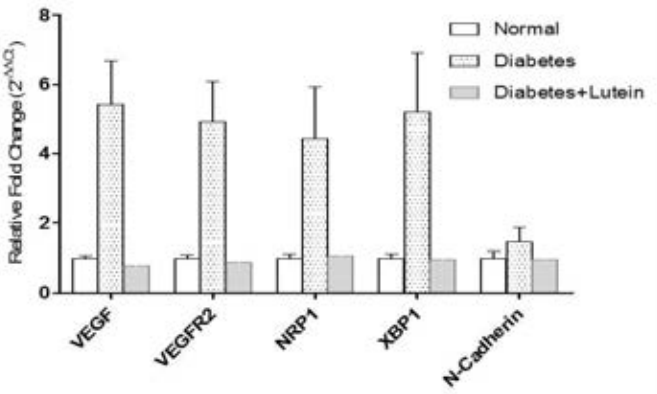
of XOS. Signals at 5.3 ppm (H-1) indicated the presence of α-arabinose furanosyl moiety. Signals falling in the range of (a) 6-8 ppm (H-1 to H-5 of ferulic acid), (b) 3.85 (O-methyl group present in the ferulic acid) and (c) 2.10 (O-acetyl groups substituted to xylose) were typical of feruolylated/acetylated XOS. FT-IR absorbance observed at 3600-3200 cm^{-1} (stretching of the hydroxyl groups both XOS as well as phenolic hydroxyl groups), 1731cm^{-1} (ester group of ferulic acid), 1596cm^{-1} (phenyl ring group) and 1253 cm^{-1} (conjugated double bonds of ferulic acid) substantiated ^{1}H NMR studies. However, the major peak were resolved into two peaks on LC-ESI-MS-TOF indicating the m/z values as 728 (feruloylated arabino xylotetraose) and 567 (O-acetylated feruloyl arabino xylobiose).

Age related macular degeneration (Baskaran V)

Influence of lutein on sodium selenite induced cataract: Neonatal Wistar rat pups (n=24) were divided into 4 groups of 6 each. Pups in group 1 served as control animals with no injections. Pups in group 2, 3 and 4 were received a single subcutaneous injection of 0.9% saline alone (saline control), sodium selenite (μM/kg body weight) of 25 and 30 on postnatal day 11. The lenses were examined for the induction of nuclear cataract on day 21. Pictures were taken with a hand held camera to ascertain the status of cataract. All pups in selenite treated groups exhibited nuclear cataract with 30 μM/kg body weight being the highest dose. Work is in progress with respect to the effect of lutein on lens proteins and other antioxidant defence molecules and enzymes. Cataract formation in mice upon sodium selenite is shown below.

Cataract formation in eyes of mice on sodium selenite injection

Retinal angio-protective effect of lutein in streptozotocin-induced diabetic rats: Lutein down regulated the expression of retinal angiogenic factors at genomic level and decreased blood and urine glucose levels in diabetic rodent model. Streptozotocin injection was given intraperitoneally (35 mg/kg body weight) to male Wistar rats and diabetes was confirmed by fasting blood glucose (FBG), greater than 250 mg/dL. FBG after induction was 323.6±15.9 mg/dL in diabetic group, whereas, in control (NC) it was 112.4±4.0 mg/dL. Urine glucose elevated in diabetic group (9.41±1.7 g/24 h) than the NC group (0.12±0.0 g/24 h). Diabetic animals were grouped into lutein supplemented (LSD) and diabetic control (DC) groups. Lutein (200 μ of 200 μ dispersed in liposomes) was gavaged to LSD group for 8 wks, whereas, NC and DC group received vehicle alone (200 μ of liposomes). After 8 wks of gavages, FBG was found to be 375.8±19.7 mg/dL in DC group, whereas, in NC group it was 91±3.3 mg/dL. In LSD group, FBG was found to be 260.3±40.0 mg/dL. In addition, there was significant decrease in urine glucose in LSD group (5.2±2.1 g/24 h) compared to DC group (12.3±1.2 g/24 h). VEGF is a master regulator of retinal angiogenesis. Real time PCR analysis for VEGF, VEGFR2, neurolipin 1, VEGF promotor binding protein like XBP1 and junctional proteins N-cadherin were done in retina. Relative fold in gene expression normalized with beta-actin and GAPDH were calculated using $2^{-\Delta\Delta Ct}$ method.



Effect of lutein on relative fold change of angiogenic factors and VEGF gene binding protein

Garden cress (Lepidium sativum L.) seed oil as dietary supplement (Akhilender Naidu K)

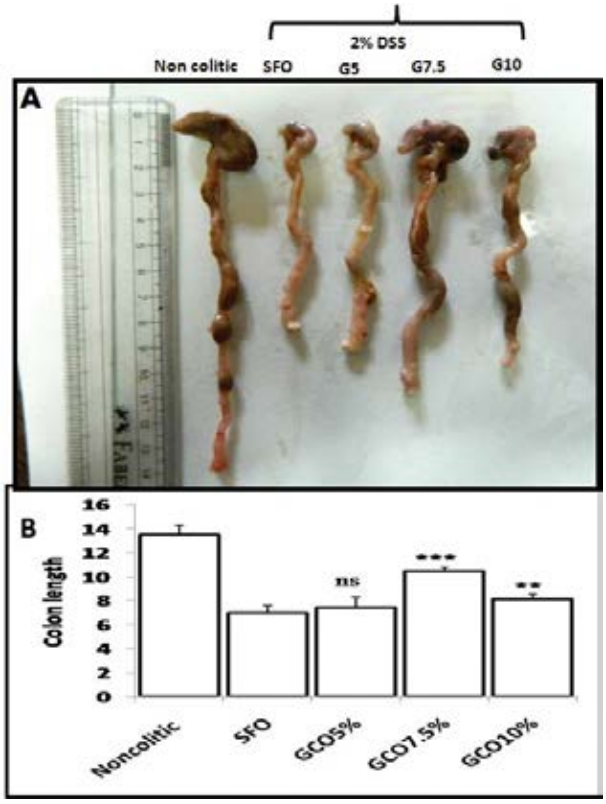
Influence of dietary supplementation of n-3 PUFA in maternal and neonatal diets on experimentally induced ulcerative colitis in the young adult rats was evaluated. Female Wistar rats were fed isocaloric diets supplemented with n-6 PUFA rich sunflower oil and varying doses of α-linolenic acid (ALA) rich Garden cress oil (GCO) for eight wks prior to mating, during gestation and lactation periods. The pups from postnatal day were fed diet similar to their mothers.Colitis was induced on postnatal day (35th day) in young rats by administering 2% dextran sulphate sodium (DSS) in drinking water for 10 days. Colitis was assessed based on the clinical and inflammatory markers in the colon.

In GCO (7.5%) diet fed young rats, a significant amelioration in the survival rate, loss of body weight,

shortening of the colon and clinical symptoms were observed in colitis induced rats. This was associated with a remarkable improvement in the colonic architecture, significant inhibition in colonic myeloperoxidase (MPO) activity.

The production of inflammatory markers such as nitric oxide (NO), prostaglandin E_2 (PGE_2), TNF-á and IL-6. COX-2 and iNOS were remarkably suppressed in GCO fed group.

These results suggest that n-3 PUFA supplementation in maternal and neonatal diet could attenuate inflammation in pediatric colitis.



(A) The length of the colons of rats of different diet groups. The colons from the DSS treated young rats of G7.5 and G10 groups were protected from the DSS induced damage. (B) Data represent mean ± SD (n=8 rats per group). **Different from SFO group, P < 0·01. ns: not significant from SFO group.

Marine carotenoids in modulating age related macular degeneration (Baskaran V)

The objective of the study was to find out the comparative antioxidant effect of astaxanthin and fucoxanthin against lutein in lutein deficient rat model. Groups of lutein deficient rats were gavaged orally (200 ìM/day) for 14 days with β-carotene, lutein, astaxanthin or fucoxanthin. Group received groundnut oil with no carotenoids served as control. Lipid peroxidation was suppressed ($p<0.05$) in plasma and liver on feeding β-carotene (15 and 39%), astaxanthin (24 and 50%), fucoxanthin (35 and 30%) and lutein (10 and 37%) compared to control. Similarly, SOD activity in plasma and liver were decreased in β-carotene (8 and 23%), astaxanthin (55 and 54%), fucoxanthin (31 and 50%) or lutein (12 and 29%) fed groups compared to control. Whereas, catalase activity in plasma and liver increased in β-carotene (5 and 30%), astaxanthin (63 and 68%), fucoxanthin (36 and 70%) or lutein (19 and 63%) fed groups compared to control. Glutathione reductase activity in plasma and liver was elevated on feeding β-carotene (23 and 63%), astaxanthin (32 and 130%), fucoxanthin (48 and 106%) or lutein (36 and 54%) compared to control. Fatty acid profile showed significant decrease in saturated fatty acids (15 to 21%) and an increase in unsaturated fatty acids (30 to 42%) when compared to control group. These results indicate astaxanthin and fucoxanthin as much as potent antioxidant than lutein.

Role of glycosaminoglycans in macrophages (Nandini CD)

The emphasis of this project was to delineate the changes in structure-function relationship of macrophage glycosamino-glycans. Groups of rats which were made either hypercholesterolemic (SFH) or diabetic with respective age-matched controls were used to isolate peritoneal macrophages. They were isolated from various groups after its adhesion at 37°C for 2 h at 5% CO_2 level. When comparison was made with respect to binding of macrophages to extracellular matrix components, it was observed that activated macrophages from diabetic animals showed increased cytoadhesion compared to that of macrophages from hyper-cholesterolemic rats, especially with respect to type IV collagen and laminin.

Structural and functional characterization studies (Ravi Kumar)

Characterization of proteins involved in bacterial chromosomal segregation was attempted. As the mechanism of bacterial cell division appears to be substantially different from that of eukaryotes, these proteins were investigated as potential drug targets. Structural and functional characterization of these proteins would provide the platform for in-vitro screening of food molecules that can inhibit the process of chromosomal segregation in pathogenic bacteria. Cloning of relevant genes as parA, parB, scpA and scpB genes from M. smegmatis in E. coli expression vectors was initiated.

Aroma compounds in basmati varieties (Radhika Reddy K)

About 50 basmati paddy samples (2014 crop), comprising of traditional as well as crosses (HBC-19, Pusa basmati and Pusa 1121), from various mandis belonging to different states and a few breeder samples from IARI were collected. Paddy was shelled and milled (8–9% DM) with standard laboratory equipment. Head rice was separated from brokens and stored in cold (5°C) for further experimentation. Rice volatiles were extracted and separated using Head Space Solid Phase Micro-Extraction (HS-SPME). Three varieties from 2013 crop were used for standardization of the method. The quantity of sample, rice water ratio, type of fibre, adsorption time was examined and conditions for testing were finalized. The chromatograms were obtained with a reasonable repeatability with respect to retention times of major components.

Propensity of monocrotophos (MCP) (Rajini PS)

The main objective of the study was to understand the impact of monocrotophos, an organophosphorous insecticide on glucose homeostasis and lipid profile in rats after single and multiple doses. Rats treated with single doses of MCP (0.9 and 1.8 mg/kg b.w) exhibited transient hyperglycemia which was nearly 100% over control. Increase in blood glucose in single dose was associated with hypercorticosteronemia with concomitant increase in both gluconeogenesis and glycogenolysis enzyme activities. However, rats treated chronically with MCP showed blunting hyperglycemic responses during earlier phase (15 d) and which peaked again in later phase (45 and 90 d) with concomitant increase in plasma insulin and corticosterone levels. Plasma insulin levels decreased after 15 d, whereas, it increased as exposure continued (30 d onwards). Plasma corticosterone level remained high throughout experimental regime while triglyceride levels decreased during earlier phase (15-30 d). Hypertriglycerdemia was evident after 45d. Interestingly, HDL-c levels decreased after 45 d, whereas, total cholesterol level remained same throughout exposure period. Plasma adiponectin level was significantly increased after 15 d, whereas, it started decreasing as the duration of exposure to MCP increased. Plasma leptin levels were decreased, whereas, no alteration in plasma TNF-alpha levels was observed. Plasma IGF1 levels decreased after 15 d and started increasing as exposure to MCP was continued.

Mechanisms involved in β-cell adaptation (Rajini PS)

Previous study demonstrated that rats when exposed to multiple doses of monocrotophos, (MCP) developed insulin resistance along with hypercorticosteronemia. However, these rats failed to develop classical type-2-diabetes when treatment was further prolonged. Whether pancreatic beta cells will adapt to insulin resistance induced by MCP was studied. Male rats were administered with sublethal doses of MCP for 180 days. After the treatment period, plasma was collected and used for biochemical measurements. Islets were isolated from pancreas and were used for studying insulin secretion in response to various concentrations of glucose and also assessing biochemical parameters involved in GSIS. The insulin and GLUT-2 positive cells in islets were quantified by immunostaining. MCP treated rats depicted hyperglycemia, dyslipidemia along with significantly elevated plasma insulin, IGF1, free fatty acid and corticosterone levels. Both pancreatic and islet insulin content was elevated. Interestingly, islets isolated from MCP treated rats showed significantly increased GSIS elevated pyruvate and malate content. Glucokinase, pyruvate carboxylase and shuttles activities were increased in the islets which was also associated with increase in ATP content. There was a marked increase in insulin positive cells in pancreata of MCP treated rats. Long-term exposure to MCP results in increase in IGF1, which plays a major role in beta cell survival and multiplication. Islet biochemical parameters were significantly amplified in MCP treated rats in order to promote GSIS. The data suggests that increase in IGF1 and pyruvate carboxylase activity might be the major factors involved in beta cell adaptation to insulin resistance induced by MCP.

Ensuring food Security (Akmal Pasha & Manivannan S)

Phosphine resistance bioassay: Adult insects of different strains and species collected (parent generation) were tested for resistance using Discriminating Dosage (DD) assays. Mortality was assessed 7 days from the end of the exposure period. This post-treatment holding period will allow time for end-point mortalities to be reached. The criterion of response was death. If death was recorded in the controls, the percentage responding to all test levels were corrected using Abbott's formula (adjusted % mortality = % alive in control - % alive in treatment x 100% alive in control). A lower dosage diagnoses resistant or susceptible insects, and a higher

dosage diagnoses level of resistance: either weak resistance or strong resistance. The bio-assay was completed in all the strains of T. castaneum, Sitophilus oryzae and Rhizopertha dominica collected from different food storage depots. All the insect populations tested for phosphine resistance confirmed the higher resistance to phosphine. The highest frequency of survivors in T. castaneum was found in the strain TC-29 with 96.59±1.13% followed by TC-32 with 90.01±3.68% resistance in high discriminatory concentration. In the case of R. dominica, RD-01(86.67±0.00)and RD-12 (51.98±3.77) strains recorded maximum % resistant at high discriminatory test. In S. oryzae, the strain SO-8 (85.39±5.28) and SO-16 (84.00±6.135) recorded the maximum % resistance.The characterization of resistance has been carried out in two strains in each of the insect species by subjecting them to a range of concentrations and arriving at an LC_{50} concentration. The dead and survivors (selected strains) of the discriminatory dose tests were preserved in 70% alcohol and molecular analysis is being carried.

Fumigation protocols for extinction of resistant test insect population: Three different protocols viz., current, improved and extended were evaluated for their efficacies against rice stacks with phosphine resistant insects populations as test samples. Prior to fumigation, grain moisture was recorded and temperature/humidity data loggers were placed in between the bag stacks. Natural infestation of the individual bag stacks were recorded by peripheral sampling. Stack probe traps were placed each in top, bottom and middle portions and two replicates of highly phosphine resistant strains of T. castaneum and R. dominica on each on front-top, sides-centre and back-top portions of the stack were placed near to the monitoring lines. Phosphine concentration was recorded at daily interval throughout the exposure period using Porta Sens II monitor.The phosphine gas concentration was always peak in the improved protocol compared to the other treatments. Periodic observations on the re/cross infestation data was recorded in the three bag stacks which underwent different treatment protocols for 8 wks. The extended protocol proved effective in controlling the cross infestation-re- infestation pest problems in the stacks which underwent fumigation.

Ecologically safe phytochemicals (Guruprasad BR & Akmal Pasha)

A novel phosphorothioate derivative of hydroxybenzaldehyde were synthesized and screened for their toxicity to the stored product insects Rhizopertha dominica and Tribolium castaneum in comparison with the standard methyl parathion. Results indicate that O,O-dimethyl phosphorothioates were more toxic than the diethyl derivatives and the toxicity was comparable with methyl parathion.To confirm whether the above pesticides are ecologically safe, soil degradation studies were conducted on ethyl derivatives. It was found that the derivatives degraded completely in 15 days as studied by GC using flame photometric detector.

Pulse beetle attention was given to find the possible use of components of essential oils such as eugenol/ citronellol as promising agents for the control of C. maculatus in domestic small storage conditions. A cotton napkin tablet fortified with eugenol/ citronellol was designed as a source of vapour to control the above insect. The efficacy of eugenol/ citronellol vapour was evaluated at different dosages in the range of 100 to 600 mL treatment. Reduction in oviposition, adult emergence and increase in mortality were observed up to two months period during storage condition. The effect of treatments on germination was studied at the above dosages. Flavour and consumer acceptability was studied through Quantitative Descriptive Analysis (QDA) in the sensory analysis. Both the vapours of eugenol and citronellol were found to be effective in controlling the above insect.

Bioprospection studies (Bhanu Prakash)

The essential oils (EOs) of Piper betle, Rosmarinus officinalis, Gaultheria procumbens, Boswellia carterii were tested for their insecticidal potential against Rhizopertha dominica, Sitophilous oryzae, Oryzophilus surinamensis and Callosobruchus spp. Test EOs were characterized by GC-MS to explore their chemical profile. Thereafter, R. officinales and G. procumbens with known chemical profile were tested for their detailed fumigant toxicity, anti feedant potential to recommend them as a biorational alternative of synthetic fumigants. Further, their effects on in vivo biochemical efficacy (AChE enzyme and antioxidant defense system) of test insect pest were studied. In addition, mycoflora analysis of food grain such as Eleusine coracana (ragi), Macrotyloma uniflorum (horse gram), Sorghum sp. (jowar/ cholam) was studied.

New azurin peptides as cell proliferation inhibitors (Manonmani HK)

The effect of azurin derived hexa peptides on in vitro proliferation of human cancer cell lines (human colon carcinoma, HCT 116) was tested. The anti-proliferative activities were evaluated using the MTT cell growth assay and apoptosis was confirmed by microscopic and FACS analysis. Entry of peptide across the plasma membrane was assessed by means of confocal microscopy using

alexa flour 488-labelled peptide. Hexa peptide exerted significant dose- and time-related apoptotic effects. There was no elevation of p53 levels in treated cells. The penetration of peptide 4 into HCT116 was blocked by nocodazole (20%), monensin (72%), tunicamycin (22%), sodium azide (71%) and by CPZ (95%). Nystatin and filipin inhibitors of caveolae-mediated endocytosis completely blocked the entry of peptide 4.Similar work is underway using EAC cell lines.

Analysis of contaminants in food and environmental samples (Manonmani HK)

Heptachlor hapten was prepared by reaction with tert-butyl hypochlorite. This was conjugated to four carrier proteins bovine serum albumin (BSA), ovalbumin (OVA), alkaline phosphatase (ALP) and horseradish peroxidase (HRP). Chicken IgY antibodies raised against endosulfan haptens were used for the detection of endosulfan. The competitive assay formatted was specific to endosulfan with a limit of detection of 1ng. The application and efficiency of the assay was tested for the detection of residues in different food samples. With an efficient extraction method, the recoveries ranged from 48-100% in spiked food matrices. The precision of the assay was satisfactory. Validation of the technique was done with spiked food samples using gas chromatography (GC).

Colorimetric (CO) and chemiluminescence (CL) enzyme-linked immunosorbent assay (ELISA) techniques for the detection of endosulfan isomers in a food matrix were compared. CL ELISA assay was found to be more sensitive than CO assay.The mean recovery was 81.2-95.6% for α- and β-endosulfan-spiked food samples with 2.8-4.6% relative standard deviation. The detection of the endosulfan isomers was linear in the range 100 μg/mL-5 fg/mL, with a limit of detection at 100 μg/mL and 5 fg/mL for the CL ELISA method and 100 μ/mL and 1 ng/mL for the CO ELISA method, respectively.

Cadmium sulphide (CdS) quantum dots were synthesized, purified and attached to anti-endosulphan IgY antibodies for the detection of endosulphan. The recovery of endosulphan in water samples ranged from 84.5% to 96.2% and that in vegetables ranged from 72.5% to 125.7% using QDs attached to anti-endosulphan IgY antibodies.

Generation of recombinant antibody (scFv) fragments: First-strand cDNA derived from the spleen and bone marrow of the immunized chickens was used to amplify the VH and VL genes for the construction of combinatorial scFv antibody fragments.Two scFv libraries were produced, one with a short linker sequence for diabody formation and one with a long linker to favor monomeric scFv.A primary PCR which amplifies VH and VL gene segments was done separately followed by a secondary overlap PCR which randomly combines VH and VL via a common linker sequence to form a full length scFv fragment.

Agaric acid in mushroom (Ashok Kumar Maurya)

Full in-house validation of a complete method intended for routine measurements was performed. The calibration curves were created at six levels and good correlation coefficients ($\geq$ 0.996) was obtained. The trueness of method was assessed by recovery studies using blank matrices spiked at three concentrations (20 µg/g, 40 µg/g and 100 µg/g, n=6). The concentrations, recovery and relative standard deviation (RSD) were 80-105% and $\leq$ 15. The within-day and between-day precision values were determined for each matrix at 40 µg/g and expressed as RSD over 3 days with individually prepared samples (n=6). Inter and intra assay values ranged from 80-110% and %RSD was $\leq$ 10, which are within acceptable range. Ten samples were collected from different locations of Mysore and analyzed. Though agaric acid residues were determined in mushroom, it did not exceed the maximum residue limit (100 ppm) under FSSAI standards. The performance parameters indicated that agaric acid in mushroom complies with current regulatory requirements.

Salmonella detection in food samples (Rajashekhar Ballari, Mohan Kumari, Prema Vishwanath & Asha Martin)

A qualitative PCR method was developed for the detection of Salmonella bacterium based target gene namely fimbrial sub unit type 1 (fimA) with a PCR product size of 120 bp. Specificity of the method was assessed using 10 different Salmonella reference stains and 30 different non Salmonella organisms. Results indicated that the developed method is highly specific to Salmonella and suitable for routine analysis of food samples.

Gluten free products (Rajashekhar Ballari & Asha Martin)

There is a need to develop cost effective, rapid and reliable method to authenticate gluten free foods. A 300 bp target sequence of glutenin gene (U86029) was cloned into pJET cloning vector and positive clone confirmed by PCR. SYBR green real time PCR method was developed using the above plasmid as a calibrant to detect the presence of wheat in foods. The specificity of

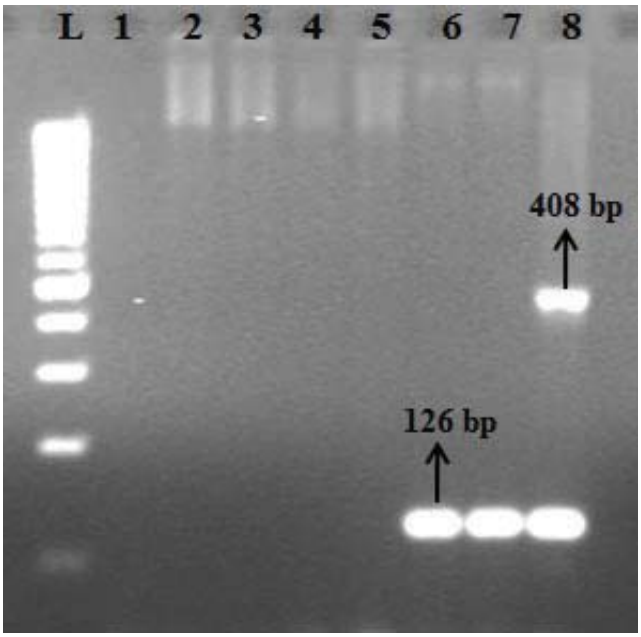
the primer pair was evaluated by RT-PCR using genomic DNA extracted from different plant species. Other than wheat, amplification was not observed with any of the species tested. All the three varieties of wheat viz. Triticum aestivum, Triticum durum and Triticum coccum tested positive for glutenin indicating that the RT-PCR assay was specific for wheat. Sensitivity of the method was assessed using plasmid DNA serial dilutions and the RT-PCR assay could detect 10 copies of target DNA. Applicability of the method was further assessed by analysing commercial food samples containing wheat ingredient. The assay was able to reliably detect trace amounts of wheat indicating its suitability for use in processed food samples, which contain very low copies of target DNA. This method will thus aid in labelling and regulation of 'gluten free' food products.

Validation of endogenous reference gene for Brassica oleraceae (Rajashekhar Ballari & Asha Martin)

Identification of the endogenous reference gene is a prerequisite for developing quantitative DNA based GMO detection methods. Amplification of a segment of a gene that encodes ACCO (aminocyclopropanecarboxylate oxidase) and HMG-I/Y (high-mobility group protein) gene was optimized for use as the endogenous reference gene for the detection of Bt cauliflower by quantitative real time PCR. Specificity of the primers designed were assessed using genomic DNA isolated from rice, onion, cabbage, tomato, maize, soya, capsicum, turnip, bengal gram, mustard and cauliflower samples. Results showed 126 bp HMG-I/Y gene and121 bp ACCO gene fragments could be amplified only in Brassica species i.e. cabbage, mustard, turnip and cauliflower. Both PCR methods will be valuable tools for the quantitative detection of the unapproved GMO Bt cauliflower in food samples.

Duplex PCR assay for the detection of insect resistant Btcauliflower event CFE-4 (Rajashekhar Ballari & Asha Martin)

Bt cauliflower event CFE-4 containing cry 1Ac gene has undergone confined field trial in India but as of date has not been approved for commercial cultivation in India. Hence, there is a need to monitor these unapproved GM crops from entering into food supply chain which necessitates the development of detection and quantification methods. A duplex qualitative PCR targeting 126 bp fragment of 35S-cry1Ac construct specific genein conjunction with the 408 bp fragment of the Brassica oleraceae specific HMG-I/Y endogenous reference gene was optimised for the unambiguous identification of event Bt cauliflower CFE-4. This assay reliably differentiates Bt cauliflower event CFE-4 from MON 863 maize, MON 810 maize, Bt 11 maize, Bt 176 maize, Bt cotton and Bt brinjal.



Duplex PCR for the detection of Bt –Cauliflower. Lane L,100bp DNA ladder; Lane 1, Premise Control; Lane 2-8, MON 863 Maize, MON 810 Maize, Bt-11 Maize,Bt-176 Maize, Bt -Cotton, Bt -Brinjal and Bt - Cauliflower, respectively.

Effect of treatment on moringa leaf on antinutrient content (Sila Bhattacharya)

Development and characterization of a moringa leaf based snack is the overall objective of the investigation. Problems related to the utilization of moringa flour are undesirable pungent flavour, dark green colour and bitter after taste which lasts long in the mouth. Pretreatment was provided to moringa leaf to remove the pungent flavour and bitter after taste. Fresh and pretreated moringa leaves were dried to prepare flour. After treatment the phenolic and flavonoid contents reduced drastically in the processed leaf flour as well as in the snack for which the bitter and pungent off-flavour and aftertaste was markedly reduced. After treatment the phenolic, flavonoid and glucosinolate contents were reduced. In untreated moringa the polyphenolic content was found to be high as compared to the treated. Flavonoids were present in the high concentrations in the untreated leaf flour but found reduced in the treated moringa and the product.

Natural therapeutic solid state fermented food (Sattur AP)

SSF of kodo millet using Penicillium roqueforti (Nilamadana), showed an inhibition of 17% against pancreatic lipase and 55% towards AGE formation and exhibited a 50% increase in fat content, with both soluble

and reducing sugars present in higher amounts as compared to the control. A drastic reduction in Na with increased levels in K and Ca was observed with an increase in overall flavonoid content. SSF of horse gram using P. camemberti (Kaulath) showed an inhibition of 30% to against pancreatic lipase and 10% towards alpha glucosidase. A 60% increase in total fat content and a reduction in Na with increased levels in K and Ca was also observed in Kaulath with an increase in free radical scavenging activity. Nilamadana and Kaulath, up to 1 g per kg body weight did not exhibit any mortality or any toxic reaction in experimental rats in a single dose 14 day study. While the haematological and clinical parameters were within safe limits between the groups supported by the histopathology of liver and kidney, there was a 13% reduction in cholesterol in Nilamadana as compared to the control. In a separate study, P. camemberti fermented on millets and legumes decreased anti-nutritional factors tannins, phytic acid, alkaloids and trypsin inhibitor.

Foodborne microbes and their toxins in food and feed (Venkateswaran G)

Preliminary screening for potent aflatoxin B_1 (AFB_1) detoxifying bacteria was done using coumarin as the single carbon and energy source. Fifty-six bacterial strains were isolated from 45 samples collected from different sources. All these strains showed AFB_1 detoxification ability while growing in nutrient broth amended with AFB_1 and residual AFB_1 was quantified using HPTLC and HPLC. Among the fifty-six isolates, seven showed reduction in AFB_1 in the liquid media by over 75%. 'Fd1' was the most potent strain and reduced AFB_1 by 96% after incubation in the liquid medium at 37°C for 72 h. Further, 'Fd1' was identified as Bacillus licheniformis by using conventional and molecular identification methods. In addition, culture supernatant of Bacillus licheniformis was more effective in AFB_1 detoxification than viable cells and cell extracts. Furthermore, SDS plus proteinase K- treatment of culture supernatant resulted in complete exclusion of the AFB_1 detoxification ability. Hence, these preliminary data trigger the need for further work in order to identify the specific compounds and to elucidate the mechanism of detoxification.

Study was initiated to investigate the chemo- preventive action of dietary compounds against AFB_1 genotoxicity. AFB_1 degradation was observed as decrease in fluoresces at 365 nm (UV) on TLC plates and HPLC. Among the 55 vegetables and spices screened for AFB_1 degradation in vitro, only the aqueous extract of mint showed significantly higher degradation over the control. Furthermore, to evaluate the protective capacity of dietary compounds against AFB_1 induced cytotoxicity by induction of phase II liver enzymes, in vitro assays were conducted. AFB_1 treatment decreased cell viability up to 40% of untreated control values, whereas, ginger extract suppressed this decrease in a dose dependent manner, when HepG2 cells were pre-treated with ginger extracts. Similarly, ginger extracts treated cells showed less ROS production compared to untreated controls. But, the specific bioactive molecules and the mechanism of degradation and inhibition wasstudied. Thus, more investigation is needed to elucidate the mechanism and to identify the specific molecules in force. Saccharomyces cerevisiae is known to bind to these aflatoxins and help in decontamination. Yeasts other than Saccharomyces are predominant in most of the fermented foods. However, their binding capacities to these toxins are not known. On screening, 3 promising isolates having high binding affinity to aflatoxin were obtained. The bound toxins were characterised through LC-MS which indicated the formation of sodium adducts. Among the isolated strains Candida tropicalis was found to be efficient in aflatoxin binding. The isolates were identified based on biochemical and molecular techniques. These organisms are common residents of most of the fermented foods, which pave a new way for the decontamination of aflatoxin.

Pesticides/bacteria in food and environmental samples (Punil Kumar HN)

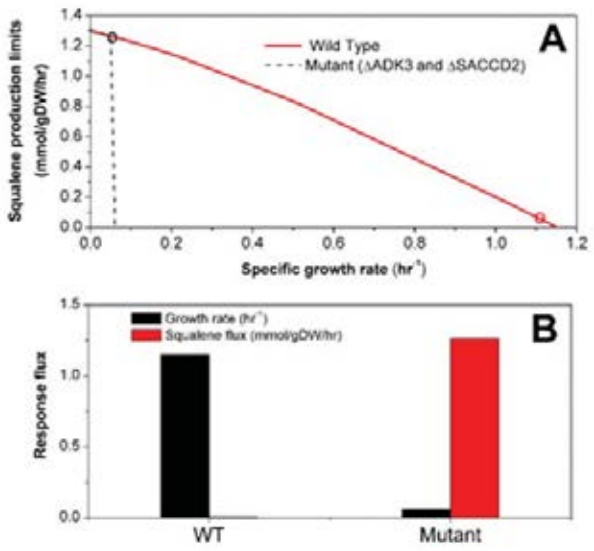
Quick detection of organophosphorus pesticides by chemiluminescence and colorimetric techniques for onsite application: Detection of organophosphorus pesticides by chemiluminescence and colorimetric technique using PMT and spectrophotometer, respectively was attempted. A sensitive, quick, simple chemiluminescence (CL) method was used for the determination of methylparathion (MP) and fenthion (F) based on the reaction of organophosphates with luminol-H_2O_2 in an alkaline medium. The CL method for the determination of organophosphorus pesticides MP and F is based on the phenomenon that MP and F can apparently enhance the CL intensity of the luminol-H_2O_2 system. The light emitted through the reaction for different pesticide concentrations was measured and checked for the cross reactivity of different reagents. The result showed the amount of light emitted to be proportional to the concentration of pesticides used.

Dot-ELISA for endosulphan detection: Suitably diluted antibody (IgY) was applied on to premarked and 0.1% triton X-100 pre-soaked PVDF membrane strips. After blocking with blocking solution (1% gelatin in PBS) the spots were treated with suitably diluted hapten-ALP conjugate and different concentrations of endosulphan. Colour was developed in the air-dried strips using BCIP-NBT (for visual observation). Reaction was stopped by adding distilled water. The membrane was then photographed using scanner and grabbed images were further processed and analyzed using image analysis software. After adequate assay concentration was determined by competitive assay format, IC_{50} values were determined. For α - and β -endosulfan, values were in the range of 5 and 6 µg, respectively. Antibody displayed a higher affinity to both isomers of endosulfan.

Food-grade terpenes (Sarma MVRK)

Analysis of thermodynamic feasibility of ergosterol pathway in Saccharomyces cerevisiae using Gibbs free energies for all possible reactions was calculated according to group contribution methodology. It was observed that only one reaction possessed a positive Gibbs free energy of 26.1 KJ/mol with K'_{eq} of 2.6×10^{-5} involving acetoacetyl coA thiolase. Gene targets for manipulation to increase the acetyl-coA pool inside the cell were identified using Opt Knock algorithm by spanning entire genome of Saccharomyces cerevisiae using iMM904 in-silico model.

Different Saccharomyces cerevisiae strains ranging from wild type (although there are no true wild type strains for S. cerevisiae) to single gene deletions in ergosterol pathway were obtained to screen for squalene synthesis (a triterpene which leads to ergosterol synthesis). Among all these strains the Erg11 deletion strain (ΔErg11) was found to yield higher squalene. Subsequently this strain was screened for optimal temperature and at 30°C the squalene synthesis was observed to be high in the studied range of 30-40°C. Also studies were conducted at different initial pH of the medium and it was found that at 6 pH the squalene production was in the range of 250-300 µg/mL, highest in the pH range of 5-7. PUG6 deletion cassette was procured from EUROSCARF and was successfully transformed into DH5α E. coli strain, and will be used to knockout the gene target obtained through computational analysis towards increasing the squalene synthesis flux.



(A) The production limits of squalene are obtained by separately maximizing and minimizing its synthesis for the range of specific growth rates available in the network. The points depict the solution identified by OptKnock. (B) Bar Graph comparing Pre (WT) and Post Knockout (mutant) fluxes for growth rate and squalene.

Antibiotic resistance genes (Prakash M Halami)

Presence of multidrug resistant lactic acid bacteria (LAB) in poultry and meat products was investigated. Phenotypic and genotypically confirmed macrolides, tetracyclines, glycopeptides resistant determinants along with efflux genes for macrolides (MsrC) and tetracycline (tetC) were studied. It was observed that the antibiotic genes were also associated with transposons-Tn916 and Tn91. These determinants were functional and transferable, which were confirmed by RT-PCR studies and in vivo conjugation studies. In another approach, occurrence of resistance against life-saving drugs such as aminoglycosides in LAB isolated from poultry and meat products was investigated. High level aminoglycoside resistance with MIC values greater than 2048 µg/ml for gentamycin, kanamycin, streptomycin, apramycin, neomycin, spectinomycin and amikacin was noticed. Resistant determinants which encode aminoglycoside resistance such as the widely spread aac-aph, aph(3)-IIIa, aad6 were also observed in enterococci, lactobacilli and pediococci. Presence of Tn916 indicated the possible transfer of gentamycin, kanamycin and streptomycin among previously unreported species. Aminoglycoside resistant genes were observed on high and low molecular weight plasmids and confirmed by southern hybridization. In addition, multi-drug resistance in LAB is being studied and for simultaneous detection of genes by Mutliplex PCR is being standardized. The detection of macrolides,

lincosamides and aminoglycoside resistant determinants in LAB of poultry origin was investigated.

Aptamer based biosensing and food toxins detection (Aptafood) (Praveena Bhatt M)

Aptamers were generated against an algal toxin (Spirolide X) by an in vitro procedure(SELEX) which involved immobilization of the toxin to an agarose matrix. Prior to the immobilization, the spirolide toxin was biotinylated via EDC mediated ester linkage. The DNA library was loaded to the agarose column and the first SELEX cycle was initiated. DNA molecules able to bind to the toxin were selected by affinity chromatography and the pool of highly selective nucleotides which evolved with each SELEX cycle were cloned and sequenced. Synthesis of gold nanoparticles (GNP's) was carried out using a protocol developed previously in the laboratory. The synthesized GNPs were characterized by UV-Vis spectroscopy, zeta particle analyzer or DLS and by SEM. The size of the GNPs was found to be between 10-12 nm. DLS particle size measurement showed a good correlation to the theoretical calculation made using the UV-Vis spectroscopic analysis. Results of SEM and DLS showed that the shape of the particle is spherical; diameter of the particle is 10 nm by mean of the volume and the zeta potential value was around 24.3 mV indicating that the GNPs are not very stable over a long period of time. Work to increase the stability of the synthesized particles is in progress.

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

The marine samples were collected at various regions of Chennai coastal area. The samples were preserved at 4ºC till further processing. The media for isolation were designed to isolate the maximum number of colonies. The colonies were randomly isolated based on the morphology. The colonies were preserved in glycerol sock at -20ºC. The selected colonies were grown in the zobel marine broth for 48-72 hrs. The culture broth was centrifuged and supernatant was used for liquid-liquid partition chromatography. The ethyl acetate layer was separated and solvent was evaporated. The known quantity of extract was dissolved in the DMSO. The disc prepared with extracts were used for antibacterial assay using ampicillin as positive and DMSO as negative control. One of the isolates has shown activity against food borne pathogens.

Molecular regulation of pigments and folates (Giridhar P & Nandini P Shetty)

The major constraint in production of anthocyanin pigment in suspension culture is due to lack of knowledge on basicparameter studies. Daucus carrota as a model system was used for studying enhanced production of anthocyanin. Daucus carrota (variety GR004) seeds were obtained and inoculated into MS (Murashige & Skoog, 1962) medium. The colored callus obtained was chopped and transferred to a MS liquid media containing IAA (2.0 mg/L) and Kin (0.2 mg/L) for suspension culture studies. In order to enhance the production of anthocyanin in the suspension various parameters were optimized. The effect of MS medium strength (0.25, 0.5, 0.75, 1.0, 1.5, 2.0), pH (4, 5, 6, 7, 8, 9), speed (110, 90, 70, 60, and 50 rpm) and inoculum density (inoculum size of 0.05, 0.125, 0.5 g/250 ml) and sucrose concentration (3%, 5%, 7%, 9%) were tested on the accumulation of anthocyanin in suspension culture. The incident light intensity on surface of the flask was 250-350 lux and temperature was 25°C. Effect of inoculum density on productivity was shown to be 0.05 g/L at 5.8 pH in 0.5 MS strength media. The anthocyanin accumulation occurred only at 90 rpm, whereas, at other rpm the development of colour were not seen. The established cultures were inoculated to the conical flasks (100 ml) containing 25 ml of anthocyanin induction medium. To investigate the effects of above parameter on the cell growth, fresh cell weight, dry cell weight, and medium pH value and conductivity was measured at various time intervals. The monomeric anthocyanin were measured and confirmed. The highest accumulation of anthocyanin was recorded in the medium containing a 0.5 strength MS media (1.82 mg/g FW) and 7% sucrose concentration showed higher production of anthocyanin (1.9 mg/g FW) compare to 3% sucrose in media. Medium pH 6 (23 mg/g FW) was suitable for anthocyanin accumulation. Precursor feeding of L-phenylalanine was attempted in order to enhance anthocyanin content in suspension culture.

Oil cake rich animal feed (Mukesh Kapoor)

A comprehensive screening programme was carried out to isolate alkaline/neutral phytase producing microorganisms from various ecological niches. A total of 186 wild type bacteria were isolated in pure form from various samples of soil, plant litter, compost, etc. The bacterial samples were characterised for their colony and morphological (gram staining) characteristics. A total

of 12 bacterial isolates were found to produce alkaline/ neutral phytase qualitatively and were subjected to submerged fermentation (SmF) for quantitative alkaline/ neutral phytase production. Isolate number 7 was found to produce higher level of alkaline/neutral phytase (0.046 IU/ml) and was selected for further studies. Under SmF, using one factor at a time approach various factors like incubation period, initial pH, inoculum age and inoculum size were studied for their role on alkaline/neutral phytase production from isolate number 7. Under SSF, using wheat bran as a prime solid substrate, role of moisture content and buffer strength were evaluated. Attempts were also made to partially purify alkaline/ neutral phytase from isolate number 7 using ammonium sulphate precipitation. Isolate number 7 was identified as Citrobacter koseri strain PM-7 on the basis of 16s rDNA sequencing.

NT8U and soya saponins in high fat fed mice (Uma V Manjappara)

Nt8U is an analog of the N-terminal 13 residue fragment of the satiety peptide obestatin with G(8) being replaced by α-aminoisobutyric acid. Nt8U, similar to that of obestatin, has been shown to reduce food intake, gain in body weight, levels of cholesterol and triglycerides in the blood, epididymal and perirenal fat in chow fed adult male mice. Many studies have established the effect of saponins from plants in reducing obesity. The aim was to study the combined effect of Nt8U and soya saponins (A & B) in reducing obesity in high fat fed C57BL/6J mice. Four to six week old C57BL/6J male mice were obtained from institutional animal house facility. The mice were fed with high fat diet for 16 weeks. Mice were divided into 6 groups. Combinations of Nt8U with soya saponin A, B was injected for an 8 day period. Food intake and reduction in the body weight was monitored every day during the treatment period. After dissection, different fat pads and organ weights were measured. Although there was no significant difference in food intake, Nt8U with soya saponin-A was found to be the best combination as it reduced body weight, perirenal, retroperitoneal and anterior subcutaneous fat compared to the saline control.

Acid resistance mechanism in E. coli (Mahejibin Khan)

To identify a new regulatory system for gadA gene expression for acid resistance in E. coli, a 1.5 bp GadA gene was amplified using E. coli DH5α genomic DNA as template and ligated to poprz::plpp vector. Vector construct with ligated gadA:LAcZ amplicon was transformed into E. coli host and screened on selective plates. Positive clones were selected, and gadA gene was confirmed by sequencing. The gadA-LacZ fusion constructs were then inserted into the chromosome of the wild-type (BW 25113) and gidA (mnmE) mutants (JW31719). These clones will be further analyzed for multicopy suppressor of gadA expression in a gidA (mnmE) mutant.

PROGRESS UNDER XII PLAN PROJECTS

Biological Science Cluster

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

Curing paddy and rice

Two paddy cultivars IR-64 (common variety) and Sona masuri (fine variety) obtained immediately after harvest from field were tested for their milling and cooking characteristics. It was observed that the moisture content was 14% (IR-64) and 18% in Sona masuri and breakage was very high (~60%) but as the rice was equilibrated at room temperature (15 days) breakage reduced to 40% in Sona masuri but not in IR-64 or Jyothi.

Studies to optimize the parameters to improve the head rice yield of freshly harvested paddy revealed that enhancing the moisture of paddy by soaking at an elevated temperature for 5 h and drying either at room temperature or in a dryer reduced the broken rice (20-25%). This method was found simple and energy efficient.

Studies were initiated to accelerate the ageing process of rice. Since ageing of rice depends on moisture, temperature and time, various experiments with two approaches were followed. In one set of experiments, the grain was treated by enhancing the moisture and drying. In another set of experiments, paddy, brown rice and milled rice were stored in modified atmospheres at preset RH and/or temperature. It was observed that storing paddy and brown rice at higher temperature improved the head rice yield (63-79%) after 15 days of storage and to some extent improvement in cooking characteristics like reduced solid loss and stickiness. Paddy stored at higher temperature and RH for 15 days showed an improvement in head rice yield (72%) and the cooked rice properties that resembled old rice (i.e., cooked rice was hard and fluffy, increased volume expansion and reduced solid loss and stickiness was also observed) whereas, brown rice and milled rice showed improvement after one month. Changes in protein and starch characteristics during natural and accelerated aging conditions were also monitored.

Quality characteristics of brown/ unpolished broken red rice flour

Effect of size reduction of brown broken in hammer and plate mill, and thermal processing of plate milled flour by toasting on flour quality characteristics were investigated. Compared to hammer milling, plate milling increased very fine particles, redness value, bulk density, sedimentation value, damaged starch content and peak viscosity; and absence of distinct starch structure in SEM. Toasting of the flour did not affect the particle size, colour and bulk density and reduced the moisture. Toasting increased sedimentation value and damaged starch, but did not affect the gelatinization temperature but reduced the peak viscosity, and microstructure showed puffiness in the starch structure. Cooked product (string hopper) from plate milled toasted flour showed acceptable sensory and textural qualities.

Storage quality of instant string hopper

Value addition to brown broken of red rice resulted in convenient traditional product such as instant string hopper (Idiyappam). Its nutritional and nutraceuticalquality evaluation showed that it is rich in protein, fiber, minerals and nutraceuticals like oryzanol, tocopherols and polyphenols. Whole grain products like these are healthier than the refined products which are responsible for present day life style disorders. Instant string hoppers were stored in polypropylene (PP) and polyethylene (PET) covers. Sensory results indicate that samples stored in PET and PP packs had acceptable sensory quality (to a considerable extent comparable to the initial sample) for 180 days.

Instant iron fortified breakfast cereal

To address the micronutrient deficiency and to add value to brown broken rice which is rich in micronutrients, instant breakfast cereal with and without additives was prepared. It was prepared by technological interventions such as appropriate milling, flour particle size reduction

and size separation, blending of iron and flavour enhancer, dough preparation, extrusion, cooking, drying and thermal treatment. Prepared product was subjected to consumer acceptance study by hedonic test on a 7 point scale for flavour, colour and overall acceptability by providing it with milk and sugar in a ratio of 1:10. Further quantitative analysis of iron, micro structural changes and hydration properties were studied. Results of consumer study indicated that likeness for colour was high for sample without additives and that for flavour was high for sample with additives. 75% of the respondents liked the products moderately and above. QDA analysis of the product was done by trained panelist for colour, strand separateness, crunchiness, chewiness, flavour and overall quality. Results showed that overall quality of both samples were acceptable. Hydration study at different intervals of the time showed that there was increase in water uptake by 113% within 30 sec. This indicates that intake of small volume will provide satiety. Iron estimation by AAS showed that fortified sample retained 90% of iron even after processing. SEM showed the micro structural changes at different stages of development of the sample.

Fabricated protein rich rice analogue

A few trials were attempted for the preparation of long grain fabricated rice using broken rice. Raw fabricated rice is brittle, but tough whereas, cooked fabricated rice is soft with slight stickiness. Rice analogues are rich in protein. Improvement in the quality of rice analogues is in progress. For the shaping machine two different dies were fabricated for obtaining the proper rice shaped product. Experimental design was made for optimisation of maximum head yield of rice during milling in three rice varieties of Sona musuri, IR 64 and Jyothi and furtherwork is in progress.

Ready mix/batter for uniformly textured idli

The growing awareness of potential health benefits of fermented foods is gaining popularity.Although, a number of ready mixes are available in the market, the textural properties vary considerably amongst brands. The textural quality of idli depends on a number of parameters like processing of black gram, quantity of mucilaginous principle, particle size of components amongst other factors. Thus, this study aims at identifying the quality determinant factors responsible for texture of idli and developing a ready mix / batter for uniformly textured idli.

Eight certified cultivars of black gram which are high yielding, disease resistant and short term crops were identified and procured from different Agricultural Universities and one commercial variety from a dhal mill. They were size graded as a pre-requisite to milling and their physical properties like hardness, size and colour were determined. Among the 9 cultivars, 3 cultivars namely CO-6, LBG-645 and LBG-752 had high percentage of bold (+4 fractions) grains (78.8, 84.9 and 83.1%, respectively) whereas, 4 fractions (MDU-1, Vbn-4, Vbn-6 and PU-31) had 43-51% bold grains. LBG-645, LBG-752, T-9 cultivars and Bellary commercial samples had highest hardness values ranging from 84.2 to 89.9 N. The CO-6 cultivar showed 3% increase in moisture uptake after 24 h of hydration. PU-31 and T-9 had highest bulk density of 858 and 866 kg/L whereas, the dhal mill sample had the least bulk density of 810 kg/L.

The nine cultivars were given dry pre-treatments consisting of pitting, oiling, tempering, drying and then dehulling in Mini Versatile Dhal Mill. The physical properties of the dehulled splits were determined. The black gram dhal cultivars were analyzed for their fermentation capacity. It was observed that the batter volume varied from 117.6 to 152 ml across varieties. After fermentation for 16 h, the percentage rise in batter was found to vary from 40 to 162%. Viscosity and pH of the batter was found to reduce after fermentation across varieties.

Idlis were prepared from these nine varieties and were analyzed for their textural characteristics as well as sensory profile. MDU-1 had balanced rice and fermented aroma compared to CO-6 and LBG-645 which had higher pulsey and fermented aroma. Perceived intensity of sourness was least in MDU-1 which was desirable.

Meanwhile, few market samples of idli ready mixes (powder) and batters (fermented) were procured and idlis prepared from them. The traditionally prepared idli was used as the standard reference against which all other idlis were compared. CFTRI ready mix 1 was found to be less spongy, less fluffy and less cellular structure compared to traditional idli although colour was comparable. CFTRI ready mix 2 had an unpleasant aroma and firm texture which affected its overall acceptability score. Idli from ready batter had high perceived intensity for the desirable sensory attributes of colour, fluffiness, cellularity and sponginess. Idli prepared from the powder had unpleasant fermented aroma and hence had low overall quality score, despite desirable textural characteristics.

Shelf-life extension of bread

Effect of combination of ingredients namely sugar, cinnamon, raisin and vinegar (SCRV) on the shelf-life of bread was studied. Addition of SCRV decreased the pH of the bread from 6.05 to 4.92; water activity (0.96 to 0.92); moisture content (36.0 to 34.2%) and volume (540 to 500 ml). The sensory evaluation with special reference to taste showed that the bread with SCRV had perceptible sweetness with cinnamon and raisin taste. Use of SCRV increased the shelf-life of bread with reference to appearance of visual mold growth from 2 to 14 days. Further microbiological studies of bread during storage are in progress.

Shelf-life studies of rolls

The flour selected for the studies had 11% moisture, 0.62% ash, 8.3% dry gluten, 535 sec falling number and protein content of 10%. Rheological characteristics of the flour were also studied. Yeast leavened bakery products have less shelf stability. In order to increase the shelf life of rolls, cinnamon was used as a natural preservative. The formulation of cinnamon rolls was standardized. Different levels of cinnamon were tried in the rolls and 2% level was acceptable. The rolls were packed in polypropylene pouches and were stored at room temperature (28°C). It was observed that the control and cinnamon rolls had a shelf life of 9 days and 14 days, respectively. Microbial studies and chromatographic studies are under progress.

Shelf-life extension products from wheat germ

Trials were carried out on several parameters of wheat milling process that affect product shelf life. The products were further subjected to thermal and electromagnetic wave treatments in various combinations of treatment cycles. Qualities of all products after and before treatment were evaluated by various standard methods, ascertaining microbiological safety.

Production of DAG oils

The DAG oils were prepared from deodorizer distillate (DOD) of rice bran oil, one with high phytonutrients and another with low phytonutrients. The oils were analysed for various physico-chemical parameters. Bad odour was also a problem and a method has been developed to purify the DOD by using silica gel treatment in solvent.

The DAG oils were prepared from refined rice bran oil and refined sunflower oil using a 20 L capacity vacuum flash evaporator anda 50 L capacity blending vessel. Both the equipmentcould be used to prepare DAG oils from purified deodorizer distillate of rice bran oil and commercial rice bran oil and sunflower oil at 2 L batches. It was found that, using these equipment, production of 10 L to 30 L of DAG is possible. The DAG oils prepared showed 40-45% DAG content and these were found to be more stable than their respective control.

Molecular distillation of the fatty acid distillate was carried out at 190-230°C and a pressure of 250-300 µm Hg. Distillate and non-distillate of the DAG oils were obtained having 5-10% enrichment of the starting DAG content. The fatty acid distillate from rice bran oil industry after molecular distillation yielded a distillate fraction of 6-20% and a non-distillate residue of 54-80% with almost similar FFA content. This indicated that there is uneven distribution of different fatty acids in distillate and non-distillate fractions. This technique may not be of much use for enrichment of the DAG fraction in the DAG oil or for removal of bad odour from DOD. Characteristics of the oils, specification for the DAG oils and storage studies are in progress.

Arabinoxylan from defatted wheat bran and rice bran

Wheat bran and rice bran (100 g each) were extracted separately with water to obtain water soluble polysaccharides (WSP). The water unextractable polysaccharide (WUP) was digested with termamyl for 1 h in boiling water bath followed by glucoamylase digestion for 48h at 55°C in order to remove the associated starch. The destarched water unextractable bran (1 g) was further extracted separately with varying volumes of saturated barium hydroxide ranging from 10 to 100 ml (w/v) containing 1% (w/v) sodium borohydride for 16 h at room temperature followed by centrifugation (5000 g, 15 min.) and the resultant supernatant was acidified with 50% glacial acetic acid to pH 4.8, concentrated, dialyzed extensively against water and then lyophilized. The polysaccharides thus obtained from the above extractions were evaluated for yield, total sugar, uronic acid, protein and sugar composition.The yield of polysaccharides extracted from wheat bran increased from 8 to 41% with respect to increase in dilutions of saturated barium hydroxide whereas, in rice bran the yield was very low up to 1:40 dilution and increased from 1:60 to 1:100. The sugar composition of all the extracts indicated arabinose to xylose in different ratios. Changes in relative viscosity of arabinoxylans obtained from wheat bran were studied with respect to varying concentrations (0.1 to 0.5%) of solution. Viscosity increased with increase in concentration but decreased with respect to increase in barium hydroxide volume/dilution. From the studies conducted so far, itis

inferred that (1) Yield of arabinoxylans was higher in wheat bran as compared to rice bran, (2) 1:100 dilution of saturated barium hydroxide gave maximum yield of arabinoxylans, (3) Viscosity of wheat arabinoxylan increased with increase in its concentration but decreased with respect to increase in barium hydroxide volume/dilution, (4) Wheat bran is the better source for obtaining arabinoxylans as compared with rice bran and (5) Saturated barium hydroxide (1:100) is the ideal extractant for isolating the arabinoxylan.

Utilization of mango peel

Mango peel waste (Totapuri cultivar) collected was washed and treated to inactivate the native enzymes and also to remove the adhering pulp solids. The treated peels contained a high moisture content of 85-88%. The peels were dehydrated using different dryers viz., infra-red dryer and cross flow hot air drier. Infra-red drying of treated mango peel resulted in reduction of drying time by 50% and further large scale trials are planned for determining the energy efficiency.

Microwave extraction studies of pectin from mango peel

Microwave extraction at energy levels of 250, 440, 660 and 1000 Watt (W), with time period ranging from 10 min to 25 min were studied. Microwave extraction affected the yield, methoxyl content, galacturonic acid and viscosity of pectin. Maximum pectin yield could be obtained within a short heating period as compared to the conventional method of extractions reported earlier. Higher methoxyl content and viscosity were observed in the mango peel pectin extracted at 660 and 1000 W for 20 min indicating the better gelling properties of the pectin. Yield of pectin was found to be maximum from the mango peel exposed at microwave energy of 1000 W for 20 min. Methoxyl content, viscosity, galacturonic acid decreased at 25 min of extraction at all microwave energy levels studied. Mango peel pectin extracted at the optimum conditions showed galacturonic acid, methoxyl content and viscosity of 57.2%, 8.2% and 98.2 mPa.s, respectively. Microwave extraction of mango peel under the conditions selected resulted in higher yield of pectin.

Optimization of conditions for the extraction of pectin from mango peels and characterization of carbohydrates from peels and mango peel pectin are in progress. Work on application of mango peel powder for development of products such as agarbathi, face pack, animal feed, manure and mosquito coil are also initiated. Utilization of treated mango peel powder as a gelling agent in the manufacture of mixed fruit jam and its advantages in the production were investigated.

Mango peel waste for the production of organic manure

Mango peel was tried for the production of compost. Two fungal cultures were used for composting. Trichoderma viride could not colonize and degrade the peel completely whereas, Mycotypha colonized and converted the peel into compost by 40 days. Mango peel, a cellulose and pectin rich waste contributes to about 10-12% of the fruit. As this contains copious amounts of polyphenols, it inhibits the microbial degradation. Efforts were made to degrade mango peel waste using thermophilic fungi Mycotypha. This fungus was isolated from coffee waste and had shown promising results to be used as a microbe for the degradation of polyphenols containing pectin rich agro waste. Fermentation was carried out for 22 days at 40°C. The pH of the mango peel inoculated with Mycotypha increased from 3.9 to 5.4 in 22 days and the total sugar reduced from 12.86 to 1.88 during the same period. The organic content of the final product was 10.5%. Initial results indicate that the organism can be used for the conversion of mango peel waste to organic manure at the site of production.

In-pack sterile chilli paste from fresh red chilli

Development of a process for preparation of in-pack sterile chilli paste was studied from fresh red chilli (Capsicum annuum L.). The process consists of grading/ separation of green capsicum fruits from ripe capsicum fruits followed by thorough washing with hot water at temperature ranging between 70-80°C to remove the soil, stones, dirt and other foreign materials. Washed fruits were subjected to air/shade drying for removal of surface moisture. Washed fresh red chilli fruits were subjected to size reduction in a fruit mill followed by grinding in a colloidal mill to get fine paste. Salt (2-5%) was added to fine red chilli paste and packed in thermo sterile pouches. Paste filled pouches treated with microwave for about 10-60 seconds having a power of 800~1500 W . No additives were used for retention of flavour and colour. Microbial analysis showed the absence of Aspergillus flavus, the main causative microorganism for aflatoxin B1 production. The fresh red capsicum paste has a shelf-life of 3 months at 37± 2°C in thermo stable pouches.

Extraction of 6-gingerol from ginger (Zingiber officinale Roscoe)

Ginger is valued for its characteristic flavor, a desirable combination of odour and pungency, which imparts individually or in combination with other compatible herbs and spices. The pungent taste of ginger is due to nonvolatile phenylpropanoid-derived compounds, particularly gingerols and shogaols, which converts from gingerols when ginger is dried or cooked. 6-gingerol is a major principal ingredient of ginger which also has potent biological activity. 6-gingerol is the most abundant constituent of fresh ginger but it decreases during postharvest storage and processing, especially thermal processing. It is desirable to develop a simple and economically viable method to prepare 6-gingerol from ginger. The study relates to the isolation of 6-gingerol using innovative techniques from ginger rhizomes.

A facile separation method for the preparation of 6-gingerol from fresh ginger (Zingiber officinale Roscoe) comprises of the following steps: i) cleaning of the raw ginger rhizomes ii) size reduction/crushing of the cleaned rhizomes iii) pressing/ filtration of the crushed mass iv) allowing the filtrate to settle the starch and decanting of the supernatant followed by drying to obtain starch as a by-product iv) drying of the rhizomes residue in cross flow hot drier/air drying v) grinding/size reduction of the dried rhizome residue vi) extraction of the powder with hydrocarbon solvent over magnetic stirrer/ SCFE-CO_2 extraction/ Microwave extraction vii) filtration followed by desolventization of the extract to obtain 6-gingerol rich extract viii)subjecting the 6-gingerol rich extract to column chromatography (silica gel size) and eluted using mixture of pet ether and ethyl acetate ix) eluted mixture were desolventized and 6- gingerol fraction crystallized with pet ether. "6-gingerol" is chemically known as 5-hydroxy-1-(4`-hydroxy-3`-methoxyphenyl)-3-decanone and its authenticity was established by TLC, HPLC followed by NMR spectra. The invention also provides two by-products viz. starch and aqua resin which have good nutritional as well as pharmaceutical properties, respectively.

Extraction of melatonin

The neuro-stimulator compounds – serotonin and melatonin (SER & MEL) are in great demand. Natural formulations rich in SER and MEL are in need for the regulation of human diurnal rhythm and as neuromodulator drugs. Banana fruit is one of the richest sources of natural SER & MEL. Banana fruit were analysed and found that SER-MEL were predominant in fruit peel on 15th day of ripening than in pulp. A higher content of SER (3500 µg/100 g FW) was recorded in yellow varieties (Silk, genotype AAB) than in vastly grown Cavendish (genotype AAA) whereas, the content of MEL in peel was 200 µg/100 g FW. Pulp was poor in MEL content. For obtaining high yields of MEL, extraction using ethanol and removal of solvent to obtain the residue appears feasible. Studies on SER and MEL stability in such preparations is in progress.

Production of pyrethrins in vitro

Natural pyrethrins, obtained from flowers of Chrysanthemum cinerariaefolium are efficient food-grade bio-pesticides, currently finding importance in grain storage. India imports pyrethrins from Kenya. Alternatively, production of pyrethrins through tissue culture method was addressed. Callus was induced from seedling node and multiple shoot cultures were obtained from shoot apex. Best callus growth occurred in MS medium containing 2,4-D (3 mg/L) and kinetin (1 mg/L). For best (20-fold) multiplication of shoots, MS medium with BAP (2 mg/L) and kinetin (1 mg/L).

Pyrethrins were analyzed by HPLC in callus, cell suspension and shoots grown in vitro, and compared with standard pyrethrum extract and Pestenal (standard pyrethrins from Sigma). The concentrations (DW) of cinerin II, pyrethrin II and jasmolin II were quite high in callus grown on solid medium (7.04 µg/g, 3.9 µg/g, 5.7 µg/g, respectively, totally about 16.5 µg/g). In cell suspensions harvested from liquid medium, the content was much lesser (0.14 µg/g, 0.17 µg/g, 0.3 µg/g) and further less in shoot culture (0.12 µg/g, 0.02 µg/g, 0.53 µg/g). In cultured shoots, cinerin I, pyrethrin I and jasmoline I were quite low and jasmolin was completely absent.

Callus grown on agar-gelled medium was found to contain total pyrethrins content of 17.5 µg/g DW, which is more than that in natural flowers of certain cultivars having 0.8% and about 80% of that in high yielding cultivars (2% DW).

Controlled ripening of banana

Using molecular analyses data of the genes involved in ripening of banana fruit, several treatment formulations were prepared with natural plant growth regulators and other natural fruit-ripening signal regulators. A few formulations showed significant extension of climacteric phase and extended shelf-life without greatly hampering the ripening process. Further fine-tuning and applicability to different banana varieties are being evaluated, mainly considering textural and sensorial parameters.

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

In-vitro studies in screening of aroma molecules

In in-vitro studies, 10 essential oils and 11 aroma molecules between 62.5 and 500 ppm were screened for their antifungal activity against two spp. of Collectotrichum (C. gloeosporioides L and C. acutatum L) by using broth dilution method (CLSI-M38-A2,2008). Results indicated that among essential oils only lemongrass oil at 200 ppm and among aroma molecules, only cinnamaldehyde, citral, phenyl acetaldehyde and n-nonanal at 150 ppm were found to be most effective incomplete inhibition of spore germination and mycelial growth of both the species of the pathogen that causes anthracnose disease in mango.

In vivo studies on screened bioactive molecules

Studies on the response of mango fruits to different concentration of screened bioactive molecules by dip treatment method were carried out in order to find out effective concentration that controls anthracnose disease in mango (var. Neelum) in in-vivo condition. Periodical observations on RT stored Neelum mangoes (0, 6 and 12 days) in terms of visual changes were recorded. Results indicated that there was no significant disease spread area (mm^2) growth on fruit peel of all treated fruits observed during 6 days of RT storage. However, on 12th day, among the four bioactive molecules tested, n-nonanal was found to be most effective followed by cinnamaldehyde, citral and phenyl acetaldehyde with optimum disease spread area (disease growth rate) was 14.2±2 mm^2 for C. gloeosporioides L. While phenyl acetaldehyde was found to be most effective followed by cinnamaldehyde, n-nonanal and citral with optimum disease spread area (disease growth rate) was 10.88±2 mm2 for C. acutatum L as compared to their respective positive control fruits after 12 days of RT storage.

Anthracnose disease resistance in mango

Studies on the unsprayed and tagged at peak flowering stage of selected mango orchards of 3 varieties (Raspuri, Alphonso and Totapuri) were carried out to assess the levels of production of bioactive compounds (such as alkyl resorcinol) in fruits during fruit development and maturation are under progress.

Bio-formulations

Major constituents of emulsion for postharvest dip treatment (as surface coating) which comprises of known concentration of individual bioactive molecules (cinnamaldehyde, citral, phenyl acetaldehyde and n-nonanal), selected wall materials as emulsifier (gum arabic, carboxy methyl cellulose and hydroxy propyl methyl cellulose), plasticizer (glycerol), surfactant (Tween-80) and solvent (water). Results on stability of these emulsions indicated that optimized concentration of these wall materials in combination with 3% of above bioactive molecules were 10% gum arabic powder, 0.3% carboxy methyl cellulose and 1% hydroxy propyl methyl cellulose powder on w/v basis. Further optimization studies of these wall materials with phenyl acetaldehyde and n-nonanal in emulsion form as well as in combination for synergetic effects of these four bioactive molecules have been planned.

Edible plant mucilages as surface coating agents

The papaya fruits at mature unripe stage were divided into four groups (untreated-control; mucilage treated; positive control-MCP treated; negative control-ethrel treated). The fruits surface coated with cactus mucilage showed an extended storage life of ~16 days compared to control at room temperature (~9 days).The mucilage treated fruits, ripened normally at the end of 16 days. The ethrel treated fruits attained overripe stage at 8 days and MCP treated fruits showed 100% ripening at 16thday of experiment.

The fruits were sensorially evaluated for their texture, flavor/ aroma, taste and color. Quantitative Descriptive Analysis (QDA) was used to assess the quality of fruits. The control and ethrel treated fruits at the end of 9 and 8 days, respectively showed overripe condition with loss of cellular integrity and flavor.The mucilage treated fruits showed 100% ripe stage with optimum texture, fruity aroma with sweet taste on 16th day of storage. Though the ripening phenomenon of MCP treated fruits appeared similar to mucilage treated fruits on 16th day of experiment, when compared to mucilage treated fruits, sensory parameter showed that the MCP treated group was having less aroma, lesser sweetness and rubbery texture indicating its unacceptability.

The pectinolytic enzyme like polygalactouronase (PG) was estimated in the experimental fruits at different stages of ripening. The PG activity increased with the rise in ethylene liberation and drastic fall was observed once the control fruits reached 100% ripening whereas, treated fruits showed a similar trend with the extension of time (on 16th day of experiment). To further evaluate the biochemical data, gene expression profiling of PG in experimental fruits was carried out using qRT –PCR. The data also confirmed the rapid increase in expression level of PG in control fruits (7 fold) on 5th day of experiment and reached basal level on 9th day of

experiment. On contrary, the mucilage treated group showed a gradual increase in PG expression and maintained till the fruit attained 100% ripeness. Further, similar experiments with cell wall metabolizing enzymes are under study.

Natural pyrethroids as food protectants

Three insect species were reared at the laboratory for the bioassay experiments namely, Tribolium casteneum, Sitophilus oryzae and Rhizopertha dominica. For S. oryzae and R. dominica, whole wheat (12-14% moisture) was used as the medium of culture. While, whole wheat flour supplemented with 5% yeast was used as culture medium for rearing T. casteneum. All the insect species were reared individually in a glass jar covered with muslin cloth held by rubber rings and were held at 30±1°C and 60±5% relative humidity. Prior to bioassay experiments, the adults were separated out from the stock culture by sieving the culture contents through appropriate sieves. 7-10 days old adults were then used for the experiments.

Bioassay was carried out with pyrethrum (300, 450 and 600 ppm concentration) in combination with deltamethrin/cypermethrin and PBO in the ratio of 1:4. Pyrethrum was administered in five different doses in each of the combination with two replicates each. Each concentration was diluted with acetone appropriately to ensure that the spread of the tested concentration was uniform onto a 90 mm dia Whatman no.1 filter paper. After evaporation of the solvent, 20 adults of the tested insect species were released onto the filter paper. Five controls individually with PBO, deltamethrin, cypermethrin, acetone and untreated control were maintained for all the three insects. The above combinations were compared with the 2% pyrethrum extract at 600 and 1000 ppm. The mortality was recorded at 12, 24 and 48 h of treatment. The corrected mortality % was calculated and subjected to probit analysis for the determination of LC50 values.

The mortality response of the tested insect showed dose-time dependent response. The adult of Rhizopertha dominica responded well to all the three tested concentration of pyrethrum extract in combination with deltamethrin and cypermethrin. However, the results were promising in the treatment which involved the treatment of deltamethrin. At 300 ppm concentration of pyrethrum the obtained LC50 concentration at 12 h exposure was 3.29 mg/cm^2. The LD50 concentration showed 59.2% reduction from 3.29 to 1.34 mg/cm^2 when the exposure period was extended to 48 h. The obtained LC50 concentration were homogenous as evident by the narrower LC50 to LC90 concentration obtained. However slight decrease in LC50 concentration was observed with increased exposure times. No significant variation in response was observed with Sitophilus oryzae in all the three concentrations of pyrethrum over 12 to 48 h of exposure unlike R. dominica. At 48 h of exposure the LC50 concentration were 1.35, 2.3 and 1.03 mg/cm^2 for 300, 450 and 600 ppm concentration of pyrethrum, respectively. No mortality was observed at initial 12 h exposure of all the three pyrethrum concentration tested. With Tribolium casteneum at the maximum concentration of 600 ppm, the LC50 concentration at 12 h was 1.307 mg/cm^2 which came down to 0.7039 mg/cm^2 over 48 h. At 48 h of exposure the LD50 concentration showed 52% variation from 1.4688 mg/cm^2 at 300ppm to 0.7039 mg/cm^2 at 600 ppm. Among the tested insect species, R. dominicawas succeptable to deltamethrin combination as evident from the obtained LC50 and LC90 concentration.

No mortality was observed in any of the tested insect species at 12 h exposure in all the tested concentration of pyrethrum in combination with cypermethrin. Similar to deltamethrin combination R. dominica proved comparatively succeptable to cypermethrin extract in comparison to S. oryzae and T. casteneum. The cypermethrin extract did not prove effective from 12 to 24 h in both 300 to 450 ppm concentration in T. casteneum. Not much variation in LC50 value was observed between 450 to 600 ppm concentrations of pyrethrum extract in T. casteneum.

Biopesticides for the control of stored product insect pests

Fumigant action of trans-anethole against the stored grain insect pest-Sitophilus oryzae: The influence of exposure of Sitophilus oryzae to trans-anethole at varying concentrations (100 to 500 ppm) and durations (1 to 5 days) were studied. It was observed that continuous exposure to longer duration exhibited better results i.e., higher mortality rate was observed. Further different adsorbants viz., filter paper, cellulose mats, cardboard and silica gel were evaluated for their efficacy to contain and release the biofumigant in test environment. It was observed that filter paper was more efficient than others followed by silica gel.

Decontamination strategies for aflatoxin

With an objective of looking at the biochemical characterization of the interaction between aflatoxin and the cognate molecules, binding of Saccharomyces cerevisiae 101 (live and dead cells) with aflatoxin is being carried out to standardize the appropriate

concentration of aflatoxin that can be decontaminated by known amount of cells. Saccharomyces cerevisiae 101 cells were harvested in their exponential phase (16-18 h) and were used for the binding experiments. Cells were set to different OD in different set of experiments for standardization. The concentration of aflatoxin was also varied to obtain optimum concentration in the binding experiments. Similar experiments were carried out using the autocalved S. cerevisiae 101 cells (autoclaved at 121°C for 15 min). As there was no definite pattern of binding observed, the standardization work is still being continued. The binding experiment is expected to throw light on the number of cells that are required to be packed in the column that will aid in the purification of the sample contaminated with aflatoxin.

Value added products from fish and fishery by-products

Studies were conducted to extract gelatin from both dry and wet fish skins using different acid treatments. It was observed that treatment with organic acids yielded lesser gelatine compared to mineral acids and gelatine yield improved when dry skins were subjected to acid treatment than wet skins. In order to optimize the conditions for extraction of gelatine from dried tilapia skin, experiments were conducted using response surface methodology. In a fractionally factorial design experiment, the effect of normality of sulphuric acid, acid pre-treatment time, extraction temperature and extraction time on yield and gel strength of gelatine was evaluated. The optimum condition for the maximum yield of 85.5% was found to be pre-treating the dried skin with 0.0525 N sulphuric acid for 30 h and later extracting the gelatine at 40°C for 12 h. However, to obtain higher gel strength, use of 0.1 N acid for pre-treatment and extraction of gelatine for 4 h was found to be optimum, with a marginal decrease in yield to 77.5%. Studies were also initiated to optimize the conditions for extraction of gelatin from fresh water fish scales. For decalcification of scales before gelatin extraction, different acids at different strength and different time were attempted. Treatment of scales with 0.5M HCl for 72 h was found to yield maximum decalcification. The decalcified scales were treated with 0.3 M NaOH for 30 min for removal of non-collagenous protein, hydrolysed with 0.1 NH_2SO_4 for 24 h and the gelatine was extracted in water by heating at 70°C for 5 h. The yield of gelatin from tilapia scale was 10-15%, while that from carp scales was 20-23%.

Biodegradable nanocomposite film from basil

Basil (Ocimum) germplasm lines belonging to three species i.e. O. tenuiflorum (OT), O. basilicum (OB) and O. gratissimum (OG) were investigated for development of biodegradable nanocomposite film for food packaging applications. It was found that OB (sweet basil) is the potential species for better mucilage production. Further evaluation was carried out within the species to screen sweet basil accessions (15 numbers) in "Preliminary Yield Trial" and identified 9 promising accessions with moderate to high seed and mucilage yield. Among the 9 accessions, RR 25 has produced high seed and mucilage yield. Identified accessions will be subjected to initial evaluation trial to select the promising entry (high seed and mucilage yield).

Seed

Musilage formation

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

Quinoa (Chenopodium quinoa) the protein rich super food pseudo-cereal have been subjected to selection for protein-rich and high seed yielding plants. Quinoa population grown from seeds collected from Anantapur (Andhra Pradesh) farmers were found to be highly variable for both morphology and quality. The heterogeneity will conceal the actual genetic potential resulting in low yield, less protein and non-uniform grains necessitating homogenous, protein-rich and high seed yielding population. The variable population were grouped into 9

different morphotype clusters based on plant height, inflorescence shape, colour and other variations. Within each cluster phenotypically superior plants were selected. A total of 54 superior plants were identified with moderate to high seed yield. Plants with higher seed yield (>85 g/plant) were studied for the protein content that ranged from 11.4 to 16.3%. Selections with high protein content and high seed yield were identified and the superior selects will be subjected to further evaluation for their homogeneity and protein yield. Morphologically uniform protein-rich selects will be pooled to derive the homogenous population with desirable qualities.

In order to facilitate wide spread cultivation of this crop, seed packets were distributed free of cost to 109 farmers during "All India Farmers Empowering Workshop" held on 17th October, 2014 at CSIR-CFTRI Campus, Mysore. The brochure on "Quinoa Agro technology" in bilingual (English and Kannada) were also distributed to guide farmers for cultivating this crop.

Quinoa grains

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

Wellness through Foods and Nutraceuticals (WELFO) will culminate in development of micronutrient fortified foods, specialty foods such as low GI foods and functional foods. Progress of work carried out is given below.

Food systems / products with functional ingredients targeted for lifestyle disorders

Bio-processing of paddy varieties by germination showed differences in development of rootlets and shootlets, differences in milling yield, changes in physical properties and bioactive components. Analysis revealed that in germinated pigmented rice, soluble polyphenols decreased and bound polyphenols increased. Oryzanol content was not affected by germination. GABA content increased significantly at different durations of germination.

AMP - activated protein kinase (AMPK) is an evolutionarily conserved serine threonine kinase, which acts as an energy sensor and plays an important role in whole body energy homeostasis. There is evidence to show the involvement of AMPK in altered glucosaminoglycans (GAGs) metabolism during diabetic nephropathy. AMPK activators of dietary origin, thymoquinone, coumestrol and syringic acid were initially tested at 0-100 mM concentration on cell proliferation (MTT assay). The compounds tested did not significantly affect cell proliferation at 25 mM but showed dose dependent decrease in cell proliferation at 50-100 mM concentration. Treatment of MDCK cells with 30 mM glucose for 24 h resulted in decreased phosphorylation of AMPK and also decreased amount of sulphated GAGs.

The effect of obestatin and nutraceuticals on diet-induced obese C57BL/6J mice was studied by feeding ad libitum with high fat diet for a period of 18 weeks. Six groups of mice were administered saline, obestatin, capsaicin, genistein, obestatin + capsaicin and obestatin + genistein for a period of 8 days. Administration of capsaicin showed significant reduction epididymal and subcutaneous fats by 40% and 38%, respectively. Similarly obestatin + capsaicin group showed lowered epididymal fat by 32%. Obestatin also lowered epididymal and subcutaneous fat compared to the control group by 27% and 25%. Overall, 28% reduction in fat deposition was observed in the capsaicin administered group. This trend was followed by the obestatin and obestatin + capsaicin administered groups by 15% and 11%, respectively.

Work on probiotics for gastroenteritis management was initiated with selection of bifidobacteria from breast milk fed infant faecal samples. Forty five putative isolates were tested using gene specific PCR of which, 8 were confirmed by gene and enzyme assay. Standard cultures were also procured including B.adolescentis NCDC236, B. animalis subsp lactis Bb12, B. longum DJO10A for comparison. In addition, antimicrobial activity against food-borne pathogens was tested and three of these bifidobacterial cultures i.e Bifidobacterium $sp81_{5j}$, Bifidobacterium $sp81_{5k}$, and Bifidobacterium sp. 24 showing antimicrobial activity against the range of pathogens tested were then subjected for bile and pH tolerance assay. Curdling of sterile skimmed milk by the isolates was also studied and it was observed that

bifidobacterial cultures had good milk coagulation property. These cultures were identified to be B. longum as per 16S rRNA gene sequencing. The safety traits of the above cultures were evaluated by in vitro assays; accordingly the cultures were tested for production of biogenic amines from amino acids and haemolysis on blood agar. In addition, the antibiotic sensitivity of the cultures to commonly used antibiotics was also studied and they were found to be sensitive to the antibiotics tested. Further sugar utilisation pattern of the cultures were also determined.

Nutraceuticals and bioactive compounds into functional food ingredients

A database on the carbohydrate digestive profile of commonly consumed Indian foods is under development to understand the release of rapidly available glucose, slow available glucose, total glucose, total starch, rapidly digestible starch, slowly digestible starch and resistant starch pattern in these foods. The various digestive fractions of around forty foods were analysed. Rice being the major staple of South Indian menu, the carbohydrate digestive profile of rice with sambar containing different class of vegetables, kinds of rice, type of cooking and adjuncts (eg. legumes) were analysed. This is apart from rice items along with different sprouted legumes, lemon rice, rice with rasam, rice with dhal, parboiled rice and other variants. The average and standard deviation were computed from 6 replicate values analysed from three batches of foods individually prepared at different time intervals. The data being compiled will be put to the database.

L-Arginine (Arg) is the substrate for the synthesis of nitric oxide (NO), the endothelium-derived relaxing factor essential for regulating vascular tone. The oral administration of L-arginine to animals and humans has been demonstrated to slow the progression of atherosclerosis or its component processes. A RP-HPLC precolumn derivatisation method was developed to estimate L-arginine, homoarginine, ADMA, SDMA and homocysteine simultaneously in plasma and serum. HPLC method was validated against commercial ELISA assays available for the detection of ADMA and SDMA. Hypercholesterolemia was induced in Wistar male rats (6 wk old) for about 8 wks and later with increased cholesterol diet for 4 wks. After treatment with different arginine: lysine ratios, the total cholesterol and triglyceride levels were not affected significantly within the normal groups but showed decrease in both total cholesterol (20% decrease) and triglycerides levels (30% decrease) in the hypercholesterolemic group.

Finger millet (both brown and white variety of ragi), sorghum, amaranth and buck wheat grains were tempered suitably and subjected to milling to prepare endosperm, seed coat and middling fractions. The total and soluble pentosan contents of the fractions were determined. Subsequently, the grains were processed by popping, germination and steaming and changes in the total pentosan contents of the different fractions due to processing were determined. The seed coat fractions showed highest pentosan contents than the control, endosperm and middling fractions. Popping and steaming showed a deleterious effect on the total pentosan contents of whole and seed coat fractions, while, germination increased the total pentosan contents in all the fractions. The endosperm fraction of the steamed sample showed slightly higher pentosan contents than that of the control sample.

Food-based strategies to improve the bioavailability of micronutrients such as iron and zinc from plant foods would be a feasible approach to combating their deficiency. In this context, EDTA (ethylene diamine tetra acetic acid), a well-known metal chelator, was explored for a possible beneficial effect on the bioaccessibility of iron and zinc from food grains. Commonly consumed food grains and pulses - rice, wheat, finger millet, sorghum, red gram dhal and black gram dhal were used for the study. Based on the inherent iron and zinc content of the food grains, EDTA was added to the grains at increasing molar ratios (1:0.25 to 1:2) to the inherent iron and zinc content. EDTA enhanced the bioaccessibility of both iron and zinc to a significant extent in all the cereals and pulses examined, the effect being mostly dose-dependent. This enhancing effect of EDTA on mineral bioaccessibility was retained even when the food grains were subjected to heat treatment by pressure cooking.

Groups of experimental rats were maintained on diets supplemented with iron (molar ratio - Zn:Fe 1:30) and calcium (molar ratio – Zn:Ca 1:667) both individually and in combination for four and six wks. Zinc status of these animals was evaluated by measuring body weight, bone weight, zinc concentration in serum, kidney, spleen and liver and the activities of zinc containing enzymes – alcohol dehydrogenase, carbonic anhydrase, super oxide dismutase (SOD), and alkaline phosphatase, in serum and liver. The zinc status of experimental rats receiving supplemental levels of iron and calcium was significantly compromised. Zinc concentration in serum, kidney, spleen and liver was reduced significantly by six weeks supplementation of iron and calcium, both individually and in combination. Supplementation with

iron and calcium for six weeks, however, had a significant lowering effect on the activities of all the zinc-containing enzymes in the liver.

Extraction of identified nutraceuticals and bioactive compounds

Attempts were made to fortify paddy with iron using two Indian varieties viz IR-64 and Jyothi. The paddy samples were fortified with iron salt (sodium iron (III) ethylenediamine tetraacetic acid) by soaking in water and parboiled under open atmosphere. After soaking, the paddy was further heated which was done by steaming under open atmosphere. The parboiled paddy was then shade dried. Fortification was carried out at two concentrations 250 and 450 mg/kg of rice.

Phytonutrient rich jelly was prepared using the technique of frozen reverse spherificaton. Inside the jelly a small ball rich in phytonutrients was trapped. The prepared jelly was placed in fresh jamun juice, covered and the entire contents were sterilized in boiling water for 15 minutes. The jellies stored at room temperature were microbiologically safe and had acceptable sensory qualities at the end of the storage period of 20 days.

The production of β-galactosidase by Lactobacillus plantarum MTCC 2156 (LAB) using whey and compatibility on the growth of the strain in presence of grape seed extract as well as galactooligosaccharides have been carried out. A symbiotic formulation consisting of LAB, GOS, GSE with ragi-barley hydrolysate has been prepared.

Bioavailability and stability of nutrients/ nutraceuticals

Eicosapentaenoic acid (EPA), an omega-3 fatty acid, is a highly oxidative neutraceutical compound. Electrospraying, an electrohydrodynamic technique, was adopted to fabricate the nanoencapsulated EPA particles. EPA nanoparticles were prepared by encapsulating EPA in synthetic and natural polymers with the electrospraying technique. Nanoparticles were analyzed in terms of size, morphology, encapsulation efficiency, oxidation, interaction between core and wall material. Particle size of about 200-300 nm was achieved with the encapsulation efficiency of 67-85% in zein. FTIR analysis confirmed the presence of EPA without much interaction between the fatty acids and polymers.

The development of a model system to carry various types of nutrients was attempted. The different nutrients that can be incorporated may be solid (soluble/insoluble in water, powder of different particle sizes and soluble in oil) and liquid (dispersible in water/oil, colloidal, volatile, and heat and light sensitive). In the initial stage, simulation studies using steel balls were employed to understand the process of coating and flavouring. Latter, two types of products such as sweet coated and flavoured products containing the nutrients were developed. Initially, the products were prepared at a one kg batch and later at a batch of 15 kg. The model solid employed for coating/flavouring is the whole puffed gram. The average mass per individual piece is 0.32 and 0.21 gram for sweet coated and spice flavoured products, respectively.

Decreased feed cost would help in bringing down the cost of animal products like eggs and chicken meat. Feed grade rice protein (FGRP) is a cheap source of poultry feed ingredient, costing 30 to 40% less than that of soy bean meal and fish meal, the common sources of protein in animal feeds. In order to evaluate the substitution of these expensive protein ingredients with feed grade rice protein, two types of feed grade rice protein (FGRP), one prepared by fermentation process and the other by hydrolytic process were procured and analysed for their proximate composition. Feed compositions were formulated by partial replacement of ground nut oil cake, fish meal and soya bean meal with FGRP. The effect of these feeds on egg laying performance of layers is underway.

Formulation of functional food products

Tea catechins are valued for their health promoting properties. The large scale extraction of catechins by microwave acetylation was done under optimized conditions. The acetylated catechins were separated by column chromatography.The column was eluted with increasing polarity of hexane:ethyl acetate. Catechin standards were acetylated and compared with individual separated catechin acetates and characterised by TLC and NMR. The separated individual esterified catechins were deacetylated and crystallised from anhydrous ethyl acetate. Large scale extraction of catechins by liquid-liquid extraction from green tea leaves was also attempted. Extraction by ethyl acetate of the aqueous layer and flash evaporation resulted in a catechin mixture.

The chemical synthesis of [6]-gingerol was accomplished on a gram scale. It is known that the molecule is lipophilic in nature and less stable under acidic conditions. The stability studies of synthetic glucosylated [6]-gingerol under acidic pH and heat is under progress. It will also be analysed for its aqueous

solubility. The bioactivity potential of glucosylated [6]-gingerol against food borne bacteria is being studied.

Noodle processing was carried out using low Glycemic Index (GI) ingredient (Chickpea flour- CF). Blends were prepared using CF at 10-60% (CF6). Physico-chemical and sensory characteristics were analyzed for the prepared samples and results indicated that noodles with 50% incorporation of CF was acceptable. Cooking quality of the noodles resulted in cooking loss within acceptable levels (<8%). Texture was firmer with addition of CF to the noodles. Microstructural characteristics showed disruption of protein matrix as the addition of CF increased. Low GI chapati, North Indian parotta, high fiber buns and muffins are also being developed.

Processing, nutraceutical quality assessment and development of ready-to-use/ ready-to-eat food products from Garden cress (Gc) seeds (*Lepidium sativum* L.) is being carried out. Analysis of phenolic extracts of Gc seed milled fractions by HPLC revealed that vanillic acid was predominat phenolic acid in milled fractions (622.92 µg/g in whole Gc seed and 666.68 µg/g in dehulled Gc seed). Flavonoid analysis by HPLC showed that rutin was the major flavonoid in all the three milled fractions. Gc seed coat phenolics showed inhibitory activity against alpha amylase and alpha glucosidase and trypsin. Gc seeds were processed to prepare ready-to-use (R-T-U) Gc seed flour. R-T-U Gc seed flour was prepared by soaking the seeds in water followed by cooking and further drying of the cooked slurry.

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

- Lipidomics Centre (LIPIC)
  (Ram Rajasekharan & Malathi Srinivasan)

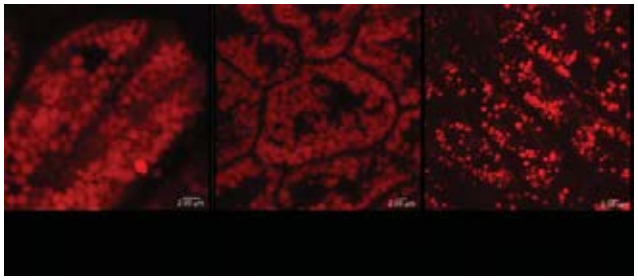
Facility Creation

Towards the primary objective of creating a state-of-the-art lipid research facility, procurement of all major equipments that were committed to CSIR was fulfilled. A GC/MS and LC/MS/MS were procured during this year.

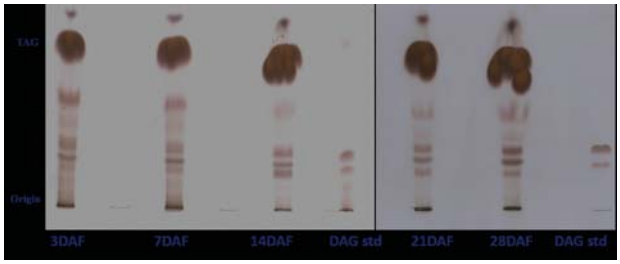
Substantial progress was made in the research projects. Our findings in the plant projects are provided in detail, while a short account under the yeast programs is given.

Plant lipidome: Four plants were studied extensively.

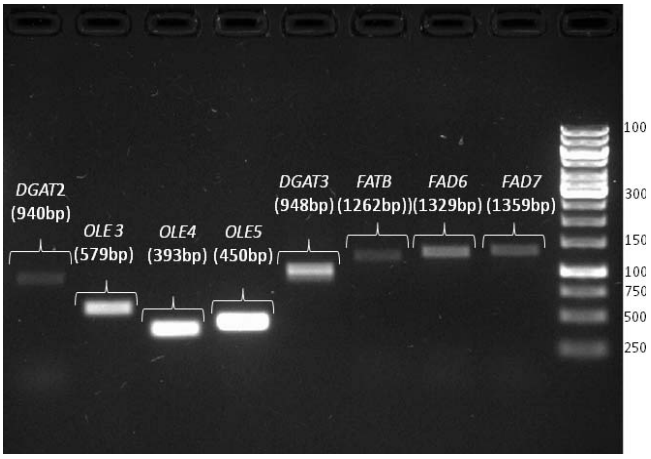
Chia: After completing the transcriptome of the 5 different development stages of chia (now available on NCBI), the bio-informatic analyses and biochemical studies were continued. The following genes: ShOLE1, ShMGAT, ShDGAT1 and ShDGAT2 were successfully identified, cloned and expressed in a heterologous yeast system. Efforts are on to clone and express the chia desaturases which are responsible for making it an ALA rich plant. Lipid profiling, imaging and quantification of the oil bodies in chia seed and chia embryo during the stages of development have been completed. While TAG gets accumulated with maturity in the seeds (Fig A. Days after flowering –DAF), TAG levels decrease with seed germination, due to hydrolase activity (Fig B).



Portulaca: The present study identifies Portulaca leaves as a rich source of ALA and proposes to develop chlorophyll enriched omega-3 fatty acids from green leafy vegetables. The transcriptome of Portulaca leaves have also been completed. From the transcriptome data, it was found that one of the putative desaturases is highly expressed in ALA-rich leaves. This has been cloned and expressed in yeast; the function of the desaturase has also been determined.



Lettuce: In continuation with the earlier report about identifying a new edible oil seed lettuce plant that is a short duration, ratoon crop and almost drought tolerant, the transcriptome of the seed was sequenced, by pooling the mRNA from seeds of five different developing stages. Transcriptome analyses revealed transcripts that were similar to the already known lipid gene sequences from oil plants like Arabidopsis and peanut. The genes were further validated by PCR and their sizes and sequences were matched with known sequence information. Biochemical characterization and functional annotations of these lettuce lipid genes are underway. Besides these analyses, the transcriptome was mined for SSR sequences also. The varietal difference between 5 different known lettuce varieties was studied using these SSR sequence information.



Quinoa: Quinoa population grown from seeds collected from Anantapur (Andhra Pradesh) farmers were found to be highly variable for both morphology and quality. The heterogeneity will conceal the actual genetic potential resulting in low yield, less protein and non-uniform grains necessitating homogenous, protein-rich and high seed yielding population. The variable population were grouped into 9 different morphotype clusters based on plant height, inflorescence shape, colour and other variations. Within each cluster phenotypically superior plants were selected.

A total of 54 superior plants were identified with moderate to high seed yield. Plants with higher seed yield (> 85g/ plant) were studied for the protein content that ranged from 11.4 to 16.3%. Selections with high protein content and high seed yield were identified and the superior selects will be subjected to further evaluation for their homogeneity and protein yield. Morphologically uniform protein-rich selects will be pooled to derive the homogenous population with desirable qualities.

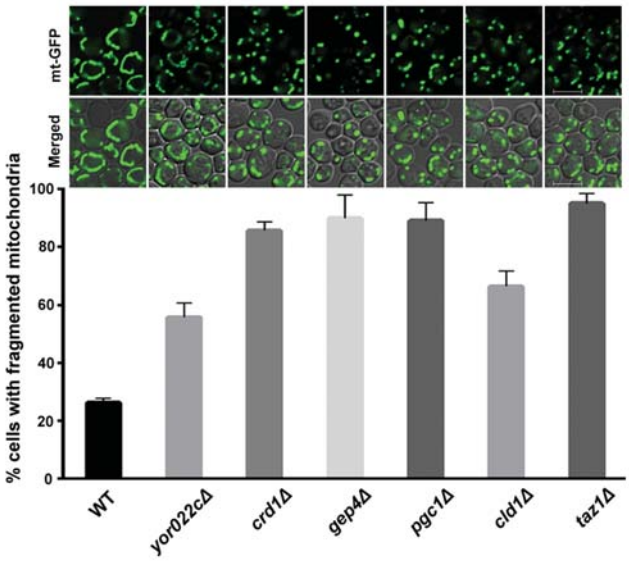
Earlier products relevant to the Indian context using these seeds were developed. This includes a method to make quinoa upma and quinoa idlis.

Yeast Lipidome: A few yeast transcription factors that could possibly play key regulatory roles in lipid metabolism were identified. The transcription factor FKH1 positively regulates the lipid phosphatase gene LPP1, which leads to TAG accumulation in the deletion mutants of a family of genes called RAD genes that are involved in RAdiation Damage response and hence in DNA repair. Quite interestingly, RAD mutants due to deficiency in damage repair, show short chronological life span and premature aging symptoms. These signature events of aging with high levels of lipids, which is providing a cue that lipid accumulation could perhaps serve as biomarkers in aging were correlated.

In another study involving the transcription factor PHO4 and its regulation on PHM8, a lysophosphatidic acid (LPA) phosphatase that is involved in the conversion of LPA to Monoacylglycerol (MAG), subsequent increase in triglyceride levels were observed. While TAG is formed from the precursor DAG molecule that comes from the dephosphorylation of Phosphatidic acid as per the Kennedy pathway, for the first time it was proposed that there could be a MAG mediated TAG biosynthetic machinery in yeast, wherein the MAG flux from the overexpression of PHM8 is converted to DAG and then

subsequently to TAG by the DGA1 gene which thus far has only been known to be a DAG acyltransferase.

In a third study involving the yeast transcription factor IME4, a positive regulation of this factor on a yet to be characterized gene, YOR022C was observed. In the study, it was possible to characterize this as a mitochondrial phospholipase with special preference for cardiolipin as substrate. It was also proposed that mitochondrial dysfunction was due to the deficiency of cardiolipin in the cells and also due to the upregulation of YOR022C gene.The strains deficient of cardiolipin showed fragmented mitochondria was demonstrated.



- Creation of advanced research facility in molecular nutrition (Nutri-Arm) (Balaji Prakash)

Dipeptidyl peptidase - IV inhibitors of natural origin

Dipeptidyl peptidase -1V (DPP-1V) is an attractive target for diabetes therapy due to its incretin hormone regulatory effects. It is widely distributed in almost all human tissues and fluids. Incretin hormones (GLP-1 and GIP) are endogenous physiological substrates for DPP-1V enzyme. Inhibition of DPP-IV prevents degradation of these biologically active incretin hormones and enhances glucose-dependent insulin secretion from pancreatic β-cells. Although synthetic inhibitors of DPP-IV are in clinical use for the control of hyperglycemia, several adverse side effects associated with these drugs necessitate the need for natural and safe inhibitors. In the present study fenugreek seeds were used as a natural source for DPP-1V inhibitors. Phenolic and alkaloids extract were prepared and quantified from fenugreek seeds. Compositional analysis and quantification of phenolics and flavonoids revealed the presence of myricetin, rutin, Gallic and ferulic acids at highest concentrations than other phenolics. Trigonelline was separated and quantified by reverse phase HPLC and the content in fenugreek seedswas found to be 8.6 mg/g (Figure A&B). Both the extracts showed multiple antioxidant activities. Free radical scavenging, reductive abilities and metal chelating activities of extracts were found to be 360.08 µmoltrolox equi/g, 1778.9 µmol Fe^{2+}equi/g and 4027.9 µmol EDTA (trigonelline extract) and 279.2 µmoltrolox equi/g, 426.8 µmol Fe^{2+}equi/g and 145.7µmol EDTA equi/g (phenolic extract) of defatted flour, respectively. However, trigonelline reference standard showed weak antioxidant activities determined under same conditions. Extracts and trigonelline reference standard also inhibited protein fragmentation by scavenging hydroxyl radicals and showed the protective effects against structural damage to protein induced by free radicals (Figure C).In addition, preliminary studies indicated that phenolic and trigonelline extracts from fenugreek, and trigonelline reference standard inhibited DPP-1V activity. Detailed studies on the inhibition of DPP-1V activity, kinetics and mode of binding in the active site of the enzyme are in progress.

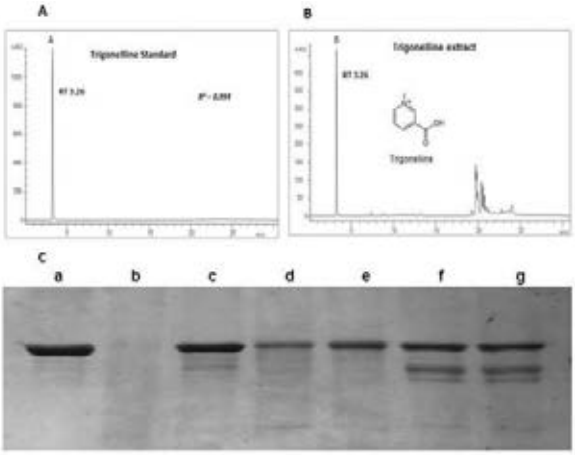


Fig 1: HPLC separation, quantification and antioxidant activities of fenugreek phytochemical extracts and reference standard. [A] Trigonelline reference standard, [B] Trigonelline extract from fenugreek seeds, [C] Inhibition of hydroxyl radical-mediated protein fragmentation. (a) BSA, (b) $BSA+CuSO_4 + H_2O_2$, (c) $BSA+CuSO_4 + H_2O_2$+ EDTA, (d) $BSA+CuSO_4 + H_2O_2$ + phenolic extract (27.3 µg/ml), (e) $BSA+CuSO_4 + H_2O_2$ + phenolic extract (54.5 µg/ml), (f) $BSA+CuSO_4 + H_2O_2$ + trigonelline standard (15 mg/ml), (g) $BSA+CuSO_4 + H_2O_2$ + trigonelline standard (21 mg/ml)

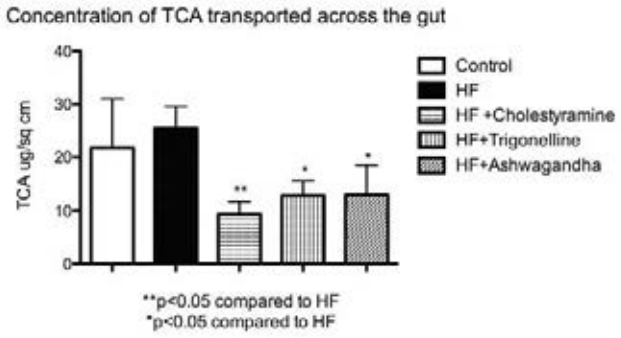
Food molecules to modulate Bile Acid Transporters (ASBT)

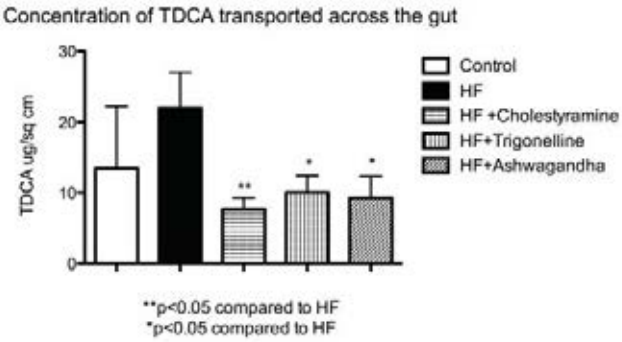
Diminishing intestinal reabsorption of bile acids triggers the synthesis of bile acids by utilizing the endogenous pool of cholesterol and thus can reduce the blood cholesterol and other lipids level. The recirculation of bile acids can be disrupted at the ileal level by modulating the ileal apical sodium-dependent bile acid

transporter (ASBT). Bile acids successfully complete the enterohepatic recirculation through the complex transporter system involved at each junction in the enterocyte and hepatocyte. ASBT actively pumps bile acids across the enterocyte membrane, from where other transporters shuttle bile acids to the hepatocyte. Molecular docking was carried out to screen phytomolecules, which act as potential ASBT modulators.Swiss Dock was used only as a primary tool, for preliminary results. Outcome of docking studies i.e. binding energy, poses, scores were interpreted to make a comparative assessment. Trigonelline (Trigonella foecum) and Withanolide (Withania somnifera) were selected as test molecules. Withanolide A yielded optimal binding interaction with ASBT of -9.17 kcal/mol. On the basis of the results obtained from the in silico studies, the bile acid transporter modulation ability of the test molecules was studied in vivo in dyslipidemic model of Swiss albino mice, by the everted gut sac experiment. Dyslipidemia was induced by feeding high fat diet (HF) of 35% vanaspati and control at 7% fat level. To understand the effect of dietary intake of the test molecules on regulation of bile acid metabolism, the expression of rate limiting enzymes of bile acid biosynthetic pathway and transporters is being studied by Western blotting. Cholesterol 7 alpha hydroxylase (CYP7A1) rate-limiting enzyme involved in multistep conversion of cholesterol to primary bile acid was probed. It will be reprobed with B-tubulin to quantify the expression.

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

The anti-carcinogenic effect of squalene was studied on two glioblastoma cell lines (LN229 and U87MG) and three leukemia cell lines (K562, U937 and HL60). Different concentrations of squalene ranging from 0.05 to 1mM were tested. The percentage of apoptotis induced death in treated cell lines was detected by employing the annexin fluorescene iso-thiocyante (FITC) assay. Squalene was found to inhibit the proliferation in a dose dependent manner. However, a sudden death was observed at a concentration of 0.5 mM for both the glioblastoma cell lines whereas, the effective concentration (mM) for K562, U937 and HL60 cell lines was found to be 0.1, 0.1 and 0.05, respectively. However, cell cycle analysis proved that squalene did not arrest any phases in the cell cycle.





Chicken bone protein hydrolysates (CBPHs) were prepared by fermentation using Enterococcous feacium MTCC5691 (CBF) and enzymatic hydrolysis (CBE) using commercial enzyme alcalase under optimized conditions. Both CBF and CBE were readily soluble in water and showed good emulsifying activities (51 and 42% for CBE and CBF, respectively) at pH 6 apart from good emulsifying stability (42% at pH 10 for CBE, 42.1% at pH 6 for CBF). Likewise, both CBE and CBF showed more than 80% protein solubility in the pH range of 2-12. Foaming activity was highest at pH 2 for CBE while CBF exhibited no change in foaming activity across the pH range. However, foam stability was poor (<4 minutes). The CBF exhibited considerable gelling ability at 6-12% concentration; while, CBE did not show gelling ability. Both the hydrolysates showed good antioxidant properties as well. CBE and CBF had a total antioxidant activity (mg ascorbic acid equivalent/mg protein) of 23.3 and 58, respectively. The DPPH and ABTS scavenging activity were found to be 46.1% and 93.1% for CBE, 87.4% and 88% for CBF, respectively. The reducing power increased with increasing concentration of both the CBPHs (50-250 mg/ml). The results indicate the potentiality of biotechnological approaches for utilizing chicken bone, a poultry by-product.

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

Major Phenyl Propanoid Pathway (PPP) intermediates upstream to vanillin were identified. Their levels along

with vanillyl alcohol and 2-hydroxy-4-methoxy benzaldehyde were augmented when callus cultures were either subjected to abiotic elicitor stress (SA, MJ) and also when fed with ferulic acid. Significant levels of flavour metabolites were leached into spent medium too. The data obtained in this regard prompted to proceed for scale up studies which are in progress. Similarly for the antioxidant and anticancer properties of root extracts of swallow root, LN Cap P23 (prostate cancer cell line), Mia-Paca-2 P16 (pancreas cancer cell line) were maintained by DMEM + 10% FBS with antibiotics and the work is in progress. Preliminary studies to find out the possible food formulations by using root extracts of D. hamiltonii were aimed and completed with required sensory analysis.

- Nano-materials: Applications and impact on Safety, Health and Environment (NanoSHE) (Mukesh Kapoor)

Partial purified α-galactosidase from Vigna mungo seeds was found to be not stable at high temperatures and broad range of pH. A combination of citric acid precipitation, ammonium sulphate precipitation, ion-exchange (DEAE-Cellulose and CM-Sepharose) for purification of α-galactosidase from Vigna mungo resulted in two peaks (P1 and P2) showing enzyme activity. P2 was further purified using affinity (Concanvalin A) chromatography and gave a single band of M_w~ 40 KDa on a silver stained SDS-PAGE gel. Magnetically active nanoparticles (iron oxide $FeCl_3.6H_2O$ and $FeCl_2 4H_2O$ in 2:1 molar ratio) were prepared by using chemical co-precipitation method using low molecular weight chitosan and TPP.The particles were loaded with CM-Sepharose fraction of α-galactosidase. FTIR spectra showed characteristic peaks like Fe-O vibration 520 and 597 cm^{-1} relevant to, N-H, O-H stretch at 3461 and 3467 cm^{-1}, amide at 1624 and 1627 cm^{-1}, C-O-C at 1069 and 1027 cm^{-1} in bare and enzyme loaded nanoparticles. Cross-linked enzyme aggregates of á-galactosidase using glutaraldehyde were also made and immobilized on magnetic nanoparticles with good retention of activity.

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

Nutritious products like rice-milk mix, high protein rusk, energy food- new formulation, nutri-chikki with spirulina, dhal based nutritional supplement for foods (DBNS), sesame based nutritious supplement, and fortified mango bar were developed to integrate with ICDS feeding schedule to meet the required RDA for macro and micro nutrients of targeted preschool children suffering from malnutrition. Important nutritional parameters of all the developed products were tested to compute the required RDA and also to ascertain their safety.

Two day training program on production and handling of nutritious food products was conducted for 20 representatives of the Department of Women & Child Development of Mysore Dist. at CSIR-CFTRI.Officials of the Department of Women & Child Development, Child Development Project Officials (CDPOS), Mahila Supplementary Food Production and Training Centre (MSFPTC) and Anganawadi workers were integrated into the project plan. Subsequently ethical clearance was obtained.

CSIR-CFTRI team visited Anganawadis of Nanjangud Taluk along with officials of Women and Child Development Department, Mysore District, and selected a few Anganawadi for distribution of CSIR-CFTRI products along with existing menu of ICDS. Selected Anganawadies were Rampura, Hegadahalli and Chamalapuradahundi followed by Kothannahalli Colony as control in Nanjangud Taluk. Target population was 3-6 year old children. Baseline anthropometric survey of 250 children for 12 centers of Anganwadis (Rampura, Heggadahali and Chamalapuradahundi) were carried out as per questionnaire for analyzing their social status, health status and family background. Compilation of these data is under progress. The products distribution along with Anganawadi foods will be continued and biochemical parameter as suggested is being analyzed.

Chemical Sciences Cluster

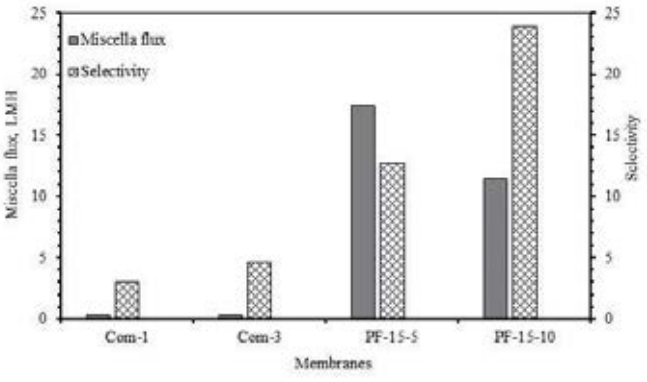
- Animal and bird feed and probiotic metabolites from fleshings (Bhaskar N)

In continuation to the previous work done on antibacterial activity of lactic acid bacteria (LAB) against different food borne pathogens, the LAB cultures were also tested for antibacterial among each other and other LAB. The results showed no antagonistic activity among them or other LAB cultures. These cultures were also tested for their growth at different range of temperature, pH and salt concentration. The resistance towards 25 different antibiotic available for Gram positive and Gram negative organisms were also tested. Amongst these, the cultures showed resistance to almost 14 of them. The cultures were analyzed for collagenase and gelatinase activity as well. Of the 12 LAB cultures, 4 cultures exhibited good collagenase and gelatinase activity. Besides this, bacteriocin isolated from 12 LAB cultures were also tested for the preservations of raw goat skin.

This study revealed that there was significant reduction in population of E. coli, S. aureus and Pseudomonas spp.in the bacteriocin treated raw skin compared to control (without treatment). This preservation study was conducted for 9 days at ambient temperature. Further work with relation to feed formulation based on tannery fleshing products is in progress. In addition, the institute poultry complex is also being renovated as a part of this project.

- Membrane and adsorbent technology platform for effective separation of gases and liquids (Subramanian R)

CFTRI's component mainly focuses on application of solvent resistant nanofiltration and ultrafiltration membranes for select processes with emphasis on extraction and purification involving organic solvents. Lab-cast membranes developed indigenously by CSMCRI and imported commercial membranes were evaluated for their possible application in desolventizing and degumming steps in vegetable oil processing and desolventizing ethanol extracts of spent green tea with respect to solvent stability, selectivity and productivity. The performance of lab-cast SRUF membranes nearly matched the performance of commercial membranes in degumming vegetable oils. Desolventizing hexane-oil miscella employing membranes is a challenging task and some promising results were obtained with lab-cast SRNF membranes. Desolventizing ethanol extract of spent green tea using commercial SRNF membrane is under progress.



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

Poly Unsaturated Fatty Acids (PUFAs) are considered to be an important aspect both nutraceutically and pharmaceutically. Humans are unable to synthesize PUFAs, therefore intake of these speciality lipids are necessary through food. A balanced ω-6:ω-3 PUFA ratio has been linked to health benefits and it prevents chronic diseases such as heart disease, hypertension, inflammation and other auto immune disorders. A field survey was conducted to collect soil samples in Western Ghats region covering Kerala, Karnataka and Tamil Nadu. From 100 soil samples, 150-160 fungal cultures were isolated for their oleaginesity.The screening was carried out using standard microbiological methods and qualitative selection of oleaginous fungi using Sudan Black B and Nile red stain. Around 55-60 strains were qualitatively identified as oleaginous fungi. These cultures were subjected to screen for PUFAs contents and found that about 15 cultures produced PUFAs with specific reference to GLA by Gas Chromatography (GC) analysis. All these strains are being confirmed by 18s rRNA sequencing method for their species identification, the sequences are deposited and published in NCBI. The native isolate Cunninghamella elegans CFR-C07 (GenBank ANo. KF916583, NCBI) 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) was observed as 21.72% v/w of the total lipid obtained at 28ºC, 180 rpm and pH 5.5 for 132 h. This strain was further subjected to grow at 20ºC to obtain the maximum yield of GLA. Observation indicated that the native isolate C. elegans CFR-C07 produced 11.84 g/L (DW) biomass, 19.68% 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 conformed with GC and GC-MS chromatograms. The growth of this fungus at low temperature (20ºC), which altered the biosynthetic pathway and for the production of ω-6 and ω-3 fatty acids which includes GLA and ALA.

- Encapsulation and drying of the cell mass of representative microbes to maximize viability (Raghavarao KSMS)

The main emphasis of this research project was the production of dry microorganisms, with high viability by drying. Availability of encapsulated microorganisms will help in bioremediation and waste water treatment. In the earlier experiments yeast was used as representative of the microorganisms being developed in the project for environmental protection. Drying trials were conducted with suitable microorganisms from participating laboratories which will be of further use for environmental purpose. The present work aims at preparation of encapsulated microorganisms with high viability by using spray drying.

The carrier materials employed earlier for yeast cell and which was giving good results was chosen to encapsulate

microorganisms. Phase contrast microscopy was carried out in order to confirm the presence of microorganisms and the possible contaminants in the spray dried samples. Based on the initial spray drying trials of yeast using 7 different carrier materials Maltodextrin (MDX) exhibited the highest cell count/g and corn starch gave the highest powder yield. These two carrier materials were used in combination to perform few experiments to dry the microbial cells by granulating them in a granulator followed by drying at temperature of 40°C in Low Humidity Low Temperature (LTLH) dryer.

Information Sciences Cluster

- CSIR Knowledge Gateway and Open Source Private Cloud Infrastructure (KNOWGATE) (Ragavan I)

A total of 63,438 records comprising of books, bound volumes, student project reports, theses and dissertation were validated and migrated from current library software (OpenBiblio) to KOHA installed on the KNOWGATE server. Around 560 library member's data available is keyed in KOHA software. Bibliographic data of patents filed by CSIR-CFTRI for the period 2000-2010 (337 records) has been provided to Nodal Lab (NISCAIR) for CSIR-Trend Module. Domain name and Public IP address has been assigned to access the data and available at URL: http://library.cftri.com.

Physical Sciences Cluster

- Measurement Innovation in Science and Technology (MIST) (Sreenivasa MA)

The objective of this programme is preparation of vegetable oil and milk powder CRMs for pesticides and conducting proficiency testing. Refined vegetable oil (15L) was procured and screened for pesticide residues. Antioxidants were added and half the portion of oil was spiked with methyl parathion and α-endosulfan pesticides at 1.0 and 0.5ppm levels, respectively, while remaining half portion was used as control. Using the prepared CRMs, a proficiency testing was conducted where 29 laboratories participated. Obtained results were subjected to statistical evaluation and the z-scores of the participated laboratories were intimated. A bench scale preparation of milk powder with pesticide was prepared to study the degradation, recovery and achievable homogeneity of pesticides. Milk was spiked with methyl chloropyriphos and lindane pesticides at 1.0 and 0.5ppm levels to represent organochlorine and organophosphorus pesticides. Spiked milk was homogenized and spray dried. Spray dried control milk powder is being analyzed for its homogeneity.

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