cftri

CSIR-CFTRI

PERFORMANCE REPORT

2011-12

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

CONTENTS

CSIR-CFTRI
PERFORMANCE REPORT

2011-12

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

CSIR-CFTRI
PERFORMANCE REPORT
2011-12

Published by :

Director
CSIR-Central Food Technological
Research Institute, Mysore, India

Content Editing & Production

Manilal P
Kusuma K

From Director's Desk . . . . .

It gives me immense happiness to present the Annual Performance Report of CSIR-Central Food Technological Research Institute (CFTRI), Mysore for the year 2011-12.

During this period significant strides were made by our R&D in the areas of Food technology and allied areas under the broad categories namely health foods & nutrition, value addition to agri-resources, innovative food processes & products along with Long term strategic research.

Two of the CSIR network projects in which CSIR-CFTRI as the nodal laboratory and seven other network projects as the participating laboratory were concluded during 2011-12. In addition, 18 in-house projects, 45 grant-in-aid projects and 45 industrial projects which were active as part of the ongoing programmes. It is also noteworthy that the efforts put out by Institute Scientists & Technologists during last year have culminated towards garnering two CSIR Network projects for XII plan period.

This year was one of the milestones in the history of CSIR, as CSIR ventured into creating the Academy of Scientific and Innovative Research (AcSIR) for higher education and CSIR-CFTRI too streamlined its human resource development activities in this direction. Human resource development activities were also supplemented by its prestigious post-graduate programme in Food Technology as well as Certificate course in Milling.

The Institute participated in the CSIR's flagship project, CSIR-800 programme enabling societal outreach of our vast knowledgebase. A good number of technologies were transferred to food industries, especially SMEs and budding entrepreneurs catalyzing the growth in the food processing sector. Also in the research front, a good number of publications have appeared in peer-reviewed journals along with book chapters as well as papers in symposia/conferences.

I gratefully acknowledge the guidance and support provided by Prof. Samir K. Brahmachari, Director General, CSIR (New Delhi) and Prof. M.S. Swaminathan, Chairman, CSIR-CFTRI

Research Council and other members of the council helping to sustain the momentum in the thrust areas.

I also wish to put on record, the support provided by various stakeholders in our endevours including scientific bodies, collaborators, funding agencies and industries.

I take this opportunity to thank the S&T and administrative staff for putting qualitative and sustainable efforts to achieve excellence in our domain of activities.

Looking forward for a more fruitful outcome in the coming year as well.

Date: **November 1, 2012**
Place: Mysore

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

निदेशक की कलम से . . . . .

सीएसआईआर-केंद्रीय खाद्य प्रौद्योगिक अनुसंधान संस्थान मैसूर (सीएफटीआरआई) के वर्ष 2011-12 वार्षिक निष्पादन प्रतिवेदन प्रस्तुत करने में मुझे बेहद खुशी हो रही है।

इस अवधि के दौरान हमारे अनुसंधान एवं विकास के खाद्य प्रौद्योगिकी एवं संबंधित क्षेत्रों एवं दीर्घकालीन सुनियोजित अनुसंधान के साथ ततसंबंधित क्षेत्रों के विस्तृत श्रेणियों जिनके नाम हैं स्वास्थ्यवर्धक खाद्य एवं पोषण, कृषि संसाधनों का मूल्य संवर्धन, नवोन्वेषी खाद्य प्रविधियों एवं उत्पादों में अनुसंधान एवं विकास में महत्वपूर्ण प्रयाश किए गए।

वर्ष 2011-12 के दौरान सीएसआईआर की नेटवर्क परियोजनाओं में सें दो को सीएसआईआर-सीएफटीआरआई ने एक नोडल प्रयोगशाला के तौर पर और सात अन्य नेटवर्क परियोजनाओं को एक सहभागी प्रयोगशाला के तौर पर पूरा किया। इनके अलावा 18 घरेलू परियोजनाओं, 45 सहायता अनुदान परियोजनाओं और 45 औद्योगिक परियोजनाओं जो चालू कार्यक्रमों के एक हिस्से के तौर पर सक्रिय रही हैं। यह भी उल्लेखनीय है कि XII वीं योजनावधि हेतु संस्थान के वैज्ञानिक एवं प्रौद्योगिकविदों द्वारा सीएसआईआर की दो नेटवर्क परियोजनाएं जुटाने के प्रयाश सफल रहे हैं।

सीएसआईआर के इतिहास में यह वर्ष एक मील का पत्थर रहा है क्योंकि इस वर्ष सीएसआईआर ने उच्च शिक्षा हेतु वैज्ञानिक एवं नवीन अनुसंधान अकादमी के निर्माण के लिए कदम उठाया है। सीएसआईआर-सीएफटीआरआई ने भी इस दिशा में अपने मानव संसाधन विकास के क्रिया-कलापों को सुव्यवस्थित किया है। मिल्लिंग में प्रमाणपत्र पाठ्यक्रम सहित खाद्य प्रौद्योगिकी में अपने गौरवपूर्ण स्नातकोत्तर कार्यक्रम द्वारा मानव संसाधन विकास की गतिविधियों को भी संपूरित किया है।

संस्थान ने हमारे विस्तृत नोलेजबेस को समाज तक पहुंचाने में सहायक होने हेतु समर्थ सीएसआईआर फ्लैगशिप परियोजना, सीएसआईआर 800 कार्यक्रम में भाग लिया। अधिक संख्या में प्रौद्योगिकियों का हस्तांतरण खाद्य उद्योगा को, विशेष रूप से एसएमई एवं खाद्य प्रसंस्करण सेक्टर में विकास को उत्प्रेरित करने वाले नवोदित उद्यमियों को किया गया। संगोष्ठियों /सम्मेलनों के पत्रों के अलावा पुस्तक अध्यायों के साथ नेमी विद्वानों द्वारा समीक्षित पत्रिकाओं में बडी संख्या में लेख प्रकाशित हुए हैं।

मैं प्रो. समीर के ब्रम्हचारी, महानिदेशक, सीएसआईआर (नई दिल्ली) और प्रो. एम एस स्वामीनाथन, अध्यक्ष, अनुसंधान परिषद, सीएसआईआर-सीएफटीआरआई के मार्गदर्शन एवं सहायता तथा महत्वपूर्ण क्षेत्रों में विकास गति बनाए रखने में सहायता करने वाले परिषद के अन्य सदस्यों का आभार प्रकट करता हूं।

मैं विभिन्न वैज्ञानिक निकायों, सहयोगियों, आर्थिक सहायता एजेंसियों एवं उद्योगों सहित विभिन्न स्टेक होल्डरों द्वारा किए गए सहयोगों को भी कभी नही भूल सकता।

हमारे कार्यक्षेत्र में उत्कृष्टता हासिल करने के उद्देश्य से विज्ञान एवं प्रौद्योगिकी एवं प्रशासन के स्टाफ को गुणात्मक एवं स्थायी प्रयास करने के लिए इस अवसर पर मै धन्यवाद देना चाहूंगा।
आगामी वर्ष में और भी अधिक उपयोगी परिणाम प्राप्त करने की उम्मीद के साथ

राम

दिनांक: 1 नवंबर 2012
स्थान: मैसूर

प्रो. रामराजशेखरन
निदेशक
सीएसआईआर-केंद्रीय खाद्य प्रौद्योगिक
अनुसंधान संस्थान, मैसूर

Summary

The report comprises of a brief on achievements, outcomes from R&D projects including the societal, supra-institutional and network projects. Some of the measurable outcome from the R&D activities during 2011-12 are listed below:

Achievements at a glance 2011-12	
Patents filed	4
Research Papers Published	264
Number of Reviews	16
Number of Book Chapters	15
Number of Grant-in-aid Projects	45
Industrial Achievements	
Number of Consultancy Projects	52
Number of Sponsored Research Projects	10
New Processes Developed	18
Technologies Transferred to Industries	70
Product Samples Analyzed	2679
Number of Technical Counselling	664
Number of Technical Enquiries	4787
Human Resource Development	
M.Sc. Students Passed Out	23
ISMT Students Passed Out	20
Number of Short Term Courses Conducted	38
Number of Ph.Ds Awarded	32

Summary of R&D Projects

Achievements in R&D areas have been grouped under Health foods & nutrition, Value addition to agri-resources, Innovative food processes & products and long term strategic research. It also reflects the work carried out under societal and CSIR Network projects.

Health Foods and Nutrition

Structured lipids containing behenic and medium chain fatty acids were prepared from palm stearin. The modified products of palm stearin were similar in melting characteristics as that of commercial bakery shortenings. Palm oil was fractionated to get stearin rich fraction which was blended with sunflower and flax seed oils in fixed proportions and subjected to chemical and lipase catalysed interesterification reactions. The solid fat content of the modified fat was reduced and the resulting fats had similar melting characteristics as that of ghee. A high fat margarine containing essential fatty acids were developed which can be used to replace hydrogenated fats. A cocoa based ready-to-eat spread having soybean oil was prepared, which provided n-3 fatty acids. A novel delivery system in the form of nano particles was developed for increasing the bioavailability of n-3 fatty acid containing oils. A commercially available product called Lipoid was found to be most effective for nano particle preparation and delivery of n-3 PUFA rich oils. Studies were carried out on underutilized oil seeds such as Moringa and Niger. Moringa seed oil had high levels of oleic acid while Niger seed oil had high levels of linoleic acid. The by-products from palm oil were utilized for preparing fractions containing high levels of nutraceuticals. The enzymatic de-acidification of palm oil fractions was used for the preparation of low melting palm stearin fraction having high levels of nutraceuticals. Garden cress seed oil (GCO) encapsulated powder dispersed well in water and it can be supplemented in bakery products. GCO blended oils fed to rats also showed a significant decrease in serum total cholesterol and serum triglyceride levels as compared to their respective control groups.

Bran from non-pigmented and pigmented variety of paddy were taken for studies. Bioactive component and antioxidant properties were high in pigmented rice bran compared to non-pigmented one. Black gram husk extract exhibited various antioxidant properties and it could be used as a functional food or nutraceutical product for health benefits.

The effect of fish oil on apoptotic death of HT22 mouse hippocamped neuronal cell induced by ER stress inducers were investigated. Results suggested that fish oil could protect HT22 neuronal cells against ER stress-induced apoptosis by reducing C/EBP homologous protein induction and mitochondrial damage as well as ROS accumulation.

Low GI-ingredients were replaced with wheat flour in biscuit preparation. Sensory parameters revealed that biscuits prepared with 10% level of banana flour and chickpea flour was comparable to that of control.

Optimization of hypoallergenic pasta with the addition of xanthan gum and locust bean gum were carried out. The sensory characteristics of hypoallergenic pasta were found comparable to that of control. Effect of partially defatted coconut flour rich in protein, fat and dietary fibre on the quality of rusk was studied. The North Indian *parotta* making characteristics of different milled fractions of green gram and black gram showed that size of the parottas increased with straight run flour, protein rich fraction, protein and fibre rich fraction. *Parathas* were prepared by mixing whole wheat flour, normal or dehydrated leaves, salt, oil and water. Based on the pliability, tearing strength, color and eating quality, addition of 25% normal and 7.5% dehydrated leaves were found to be optimum. The formulation of millet based gluten free cookies containing gluten replacer at the level 10% was optimized using additives. Wheat flour was fortified with folic acid along with iron. The added folic acid retained in breads after baking was found to be 80%.

Composite flours were developed from brown rice, Bengal gram, *singhada* and wheat. The biscuits prepared from these flours were sensoraly good and had no perceived off-odours or off tastes in the biscuits. Paddy varieties like *IR 64*, *Jyothi* and *Njavara* were used to prepare *Idiappam* (String hopper).The conditions for processing were optimized. Traditional fermented dry mix of sorghum for *Idli* was prepared. Pre-gelatinized Bengal gram and soy bean flour was incorporated to wheat flour to make protein rich *Chapati*. Dhal analogues from underutilized pulses/ pulse flours (Cowpea, Horse gram, Pea) were prepared. Gadgets useful for processing and product development from grains were developed.

Shelf-stable paste using hurdle technology for traditional meat products was prepared. Influence of freeze-dried shrimp meat at different levels in pasta processing was studied. Preparation of high quality chitin and chitosan from shrimp shell and their application as a bio-preservative for fresh meat was explored. Purified extracts of chicken viscera improved the texture of layer meat indicating that chicken viscera can be employed as a tool for texture improvement.

The fingerprints of sweetness by studying the amino acid composition and structure properties of sweetener proteins were explored. The genomic relation between human and rat genome with reference to Type 1 diabetes mellitus was evaluated.

The efficacy in enhancing the mineral bioaccessibility by casein phosphopeptides was studied. Whey protein hydrolysate was investigated for its effect on hypercholesterolemic rats by measuring hepatic enzyme activity and mRNA expression of enzymes involved in lipid metabolism and subsequently by their effect on hypertension.

Protein isolates were prepared from soybean, mustard and groundnut using isoelectric precipitation and membrane filtrations. Membrane processing resulted qualitatively and quantitatively better results. The BBI gene

cloned and functionally expressed as rHG-III was a potent competitive inhibitor of bovine trypsin and the Ki for trypsin inhibition and chymotrypsin were similar to that of horsegram seed inhibitor.

Total carotenoids, beta carotene and folate contents were analysed in different commercial varieties of coriander, *Moringa oliefera* and *Hibuscus cannabinus* during their growth cycle. The elicitors such as methyl jasmonate and salicylic acid significantly enhanced beta-carotene, lutein, alpha-tocopherol and folates.

Ginger flavoured sugar syrup, a byproduct from the process for ginger candy, was formulated into a ginger beverage concentrate, which on dilution and carbonation affords a refreshing beverage. Zerumbone derivatives - Zerumbol, Zerumbamide, and Zerumboneoxime- were synthesized and their anti-mutaegnicity attributes were investigated. The antimicrobial susceptibility investigations were conducted for essential oil, raw ginger, ginger aqua oleoresin, ginger spent (gingerol rich conserves) and Dehydrozingerone and its derivatives against food borne pathogenic bacteria and fungi. The organisms were susceptible for ginger extracts and growth inhibition was observed in the case of gingerol rich conserves. Aqueous stem extract added in sweet lime (*Citrus limetta*) juice revealed a dose dependent increase in radical scavenging activity as against that of unsupplemented juice. The biological activity associated with leaves of Indian borage (*Plectranthus amboinicus*) was evaluated. The extract also exhibited antibacterial activity against selected food borne pathogenic bacterial species.

Microencapsulation of *Garcinia* fruit extract by spray drying with maltodextrin (MD) as the wall material had a higher efficiency than whey protein isolate used individually and in combination with MD. Studies were carried out to find the influence of roasting and brewing methods on antinutritional diterpenes in coffee brew. The ACE inhibitory activity, antioxidant and antimicrobial activity of the hydrolysed seaweed were assessed. The water soluble pigments from *Monascus purpureus* were microencapsulated with whey protein as coat material. The antioxidant activity and total polyphenols showed significant increase in activity after encapsulation. The antioxidant potential, peroxyl radical scavenging, anti-inflammatory and anti-atherogenic efficacies of *Scoparia dulcis* leaves were studied.

A potent probiotic lactic acid bacteria with an active principle specifically against watery diarrhea causing *E. coli* O-8 was characterized. Lactic acid bacteria were screened for the ability to produce exopolysaccharide (EPS) and the strain T5-1, isolated from *Takrarista*, exhibited potent probiotic properties. Heat resistant *Bacillus* sp were isolated from different fermented samples of cereals and legumes and fibre degrading enzyme from *Bacillus circulans* was detected. A diversity study of lactic acid bacteria in the North East region of India was initiated.

Value-addition to Agri-resources

Thermal processing of muskmelon pulp resulted in the decrease of total carotenoids, beta carotene and ascorbic acid content. Process for muskmelon beverages and blended beverage formulations in glass bottles and PET bottles was developed. Pre-treatments and storage conditions for post-harvest quality of papaya was studied. Physicochemical characterization of ripe and unripe pepino (*Solanum muricatum*) and the quality changes during storage was studied. The wild edible fruits, banana passion fruit and hill raspberry of Nilgiris (South India) were analyzed for vitamin C content and phenolics extract. The process conditions for the preparation of intermediated moisture (20% moisture) jackfruit and papaya fruit bar using fruit juice concentrates were optimized. Storage studies were undertaken for the selected formulation of pickle and candy from watermelon rind. Stevia extract and steviol glycoside were found to be suitable as low calorie sweetener in RTS fruit beverages such as pineapple, pomegranate, jamun, purple grapes, mango and vegetable juices such as cucumber and carrot. Various lime and kokum based products such as kokum paste, lemon paste, kokum based RTS beverages and squash, lime based RTS beverages were developed in the laboratory.

Storage studies of products such as pickles, herbal jam, dehydrated cut pieces/dices and dried powder prepared from *Ramkela;* mulberry fruit Juice, RTS-beverages, nectar and squash, *Karaunda* bars and toffees; and *Parwal* dehydrated slices were carried out.

Different annatto dye formulations were prepared as water soluble powder, oil soluble liquid, sugar powder formulation containing water soluble annatto dye and a propylene glycol (PG) formulation. These formulations were used in various traditional and processed foods for preparing tailor-made formulations. Studies were carried out on the isolation of carotenoprotein from shrimp wastes. Antioxidant activity of crude carotenoid extract from shrimp waste and its fractions was evaluated.

Ragi seed coat based drink mixes were prepared. The instant drink mix produced was found to be rich in dietary fibre, minerals, protein and antioxidants. *Idli* was prepared by small millet and *Kodo* millet *Idli* had overall high sensory acceptability. Suitable methodologies were adopted for the removal of antinutritional factors such as tannins, phytates, trypsin inhibitors, saponins, alkaloids, phorbol esters and curcin from karanja, simarouba and jatropha seed meals.

The water extract of the mushroom variety, *L. edodes* showed most potent radical scavenging activity. The tender bamboo shoot candy is a good source of calcium, crude protein and crude fibre. It has good calorific value as compared to pickle. Sensory analysis indicated that the tender bamboo shoot products such as candy and pickle were acceptable even after 6 months of storage.

Also the process conditions for the removal of HCN were optimized.

The actinomycetes cultures were identified as *Streptomyces globisporus* CA1 and *Streptomyces globisporus* CA2. The potential of CA1 and CA2 for enhanced production of chitosanase and their uses in the preparation of bioactive chitosan oligosaccharides were evidenced. Fresh water and marine fish processing wastes (FPW) as a source of quality lipid was assessed. Studies showed LAB fermentation was effective for recovering lipids and protein simultaneously from FPW. Animal experiments confirmed the safety of oil recovered from fish processing waste for its use as an animal feed.

Innovative Food Processes and Products

Lipoxygenase from soybean was encapsulated using different carriers using spray drying and freeze drying techniques. The combination of sodium alginate, maltodextrin and polyethylene glycol (PEG) 6000 as a carrier resulted in highest yield during spray drying and freeze drying. An aqueous two phase extraction was explored for the isolation and purification of invertase from crude Baker's yeast. Impregnation of curcuminoids in coconut slices using osmotic dehydration was studied. Extraction and purification of anthocyanins from red cabbage was explored. Removal of phenol using a flat sheet supported liquid membrane impregnated with triglycerides was carried out.

Sterilization of black pepper *(Piper nigrum)* was carried out using infrared, microwave (MW) and RF radiations and processing by MW was found comparitively better. Elevated temperature wet grinding of soybean in the presence of curcumin in its emulsion form was demonstrated as an effective method of inactivating lipoxygenase without affecting the protein solubility during soymilk conversion.

Processing tofu-whey using a combination of ultrafiltration and reverse osmosis membranes revealed that the soy-whey concentrate obtained was completely devoid of proteins and suitable for further processing into high purity isoflavone products. Membrane clarification of tea extracts reduced tea cream formation and haze in RTD tea beverages and improved its stability during refrigerated storage while retaining most of the natural quality characteristics of tea.

A method for the aeration of gels were developed. Aeration of agar and gellan gels at different concentrations were conducted and rheological characteristics of the product were determined to ascertain the changes due to aeration. A process for obtaining vanilla extract of 2-8% concentrations using super critical carbon dioxide with vanilloids was standardized.

A method for obtaining mangosteen water-in-oil emulsions with different concentrations was evaluated for their stability. Dry blanching of red bell pepper using microwave and infrared

was studied and their performance was compared with water and steam blanched samples. Different approaches for the extraction of antioxidants, polyphenols, theaflavins (TF) and thearubigins (TR) by both microwave assisted extraction (MAE) and conventional extraction method were compared. In the case of TF's and TR's, the MAE method showed better extraction than conventional extraction method which indicated the quality of tea extract. Also the MAE procedure required shorter time, lower energy consumption and provided higher extraction.

Basil and coriander leaves were subjected to different drying methods i.e., low temperature low humidity (LTLH)- , IR-, sun- and oven drying. Results showed that the LTLH dried sample was best in colour value, total chlorophyll, carotenoids, ascorbic acid compared to other drying methods. Microwave assisted extraction (MAE) process for ginger was compared with the conventional methods. Results showed that MAE allowed higher recoveries compared to conventional extraction process. The effect of microwave on the extraction of natural materials such as coriander, mango ginger and fenugreek were carried out. Superheated system (SHS) blanching of green capsicum was compared with normal steam blanching. Retention of nutrients was found good in SHS blanched samples. Studies on electromagnetic radiation based drying of onion slices were carried out. Results indicated that hybrid drying was better compared to IR drying with or without vacuum.

Effect of processing conditions such as microwave (MW) power, air velocity and temperature during MW - convective drying were carried out. In terms of volatile oil retention, rehydration characteristics and color, MW-convective drying with moderate air velocity resulted in a better yield. The influence of drying methods on the volatile components of *Zingiber officinale* rhizomes was studied. The MW fried extract showed highest quantity in total polyphenol content and antioxidant activity compared to convective drying. Effects of convectional drying and microwave drying on the physico-chemical constituents and antioxidant activity of *Mentha spicata* leaves were studied. Results showed that the drying method significantly affected polyphenols and flavonoid contents as well as their antioxidant activity.

The outdoor cultivation conditions of lipid producing algal strains were optimized and a method to control rotifer (predator) infestation was developed. The potential of an indigenous, naturally derived coagulant seed material from the *Moringa oleifera, Tamarindus indica* and *Abelmoschus esculentus* produced under ambient and cryogenic conditions as a viable alternative for chemical salts in improving the water treatment process was explored. *Bombay Halwa* was prepared using alternate sweeteners such as sorbitol, maltitol and fructooligosaccharides. Traditional popular snack, *Sev* was enriched with leafy vegetable such as *pudina*, betel, curry leaves and coriander. Groundnut husk concentrates was

chosen for incorporating into biscuits. Biscuits were found to be comparable along with control and BHA impregnated samples.

The formulation of *Halubai* was optimized. Wheat based *Halubai* had the highest overall quality followed by ragi-wheat and ragi-wheat-rice combinations. The preparation of *Kajjaya* was standardized. Also in order to reduce fat intake during frying, formulation of *Namkeen* was modified.

L-asparaginase from *Cladosporium* sp. grown on SSF was purified and the optimum temperature and pH for enzyme activity was found. L-asparaginase activity studied in the presence of thiols showed decrease in V_{max} values and an increase in K_m values indicating non-essential mode of inactivation.

Dosa and *Paddu* samples packed in PET/PP pouches were subjected to heat processing in a retort and stored in a refrigerator. The study showed that stored *Dosa* and *Paddu* were acceptable at the end of 10 weeks. Storage studies were carried out for flour from ragi varieties, GPU 66 and Indaf 5. GPU 66 had 150 days of shelf-life in LDPE and 180 days in PET laminate while Indaf had acceptable quality after 180 days of storage. Methodology was standardized for the estimation of acetaldehyde from polyethylene terephthalic upto detectable limit of 0.1mg/ Litre by using standard calibration curve. Methodology was also standardized for the estimation of phthalic acid and iso-phthalic acid in polyethylene terephthalate bottles.

The design of the existing spouted bed roaster (SBR) was modified. Prototypes for Annatto seed separator and Continuous microwave pasteurization/ sterilization system were developed. Development of a cost-effective fish meat-bone separator on a continuous mode was undertaken. A prototype instrument named as “Edible Oil Quality Monitor” was developed in the Institute. A novel hybrid heating (infrared + electrical) baking oven was designed and fabricated. Hybrid heating oven conditions were optimized in terms of baking temperature, time, serial and hybrid heating modes.

Dipstick based immunochemiluminescence (immuno-CL) biosensor for the detection of vitamin B_{12} in energy drinks was developed. The developed method is suitable for an accurate, sensitive, and high-throughput screening of vitamin B_{12} in energy drinks samples. A gold nanoparticle (GNPs) based immunodipstick biosensor for vitamin B_{12} was attempted. Another simple and stable RNA aptamer based colorimetric sensor for the detection of vitamin B_{12} using GNPs was also attempted. This colorimetric aptasensor would be advantageous for onsite detection with naked eye. Isolation of caffeine biotransformation microorganism was carried out from coffee waste including husk, hull and spoiled coffee seed. For the detection of theophylline, aptamer was designed and bioconjugation of theophylline to gold nanoparticles was done.

Long Term Strategic Research

The effect of banana flower and stem on diabetic nephropathy was studied. In order to decipher the extracellular remodeling by dietary factors during diabetes, elucidation of structure-function relationship of the Chondroitin sulfate/dermatan sulfate was attempted. Work was undertaken to elucidate primarily the changes in glycosaminoglycan metabolism in liver during hypercholesterolemia and its modulation by dietary factors such as oat bran and curcumin. Studies provided the ability of modulation of several regulatory factors by black cumin pectic polysaccharide - BCPP to heal the gastric ulcer caused by acetic acid. The role of phenolic and pectic polysaccharide fractions of Carrot (*Daucus carrota*) was examined against UV-DMBA-7,12-Di-Methyl Benzanthracene induced skin cancer. Antioxidant potential of fucoxanthin with beta-carotene in relieving lipid peroxidation caused by retinol deficiency in rats were compared. Results demonstrated that fucoxanthin has greater potential than beta carotene in modulating lipid peroxidation, catalase and glutathione transferase in plasma and liver of retinol deficient rats

Effect of micellar lipids, dietary fiber and beta carotene on lutein bioavailability in aged rats with lutein deficiency were studied. To improve the absorption of lutein, foods with sufficient fat, low dietary fiber and beta-carotene is suggested. Soluble fibre-rich cluster beans, along with capsaicin were evaluated for weight management in high-fat fed rats. The study indicated that 15% cluster bean powder produced the maximum desired effect with respect to body weight management. The gastrointestinal protective effect of soluble dietary fibre-rich tender cluster beans, with respect to activities of antioxidant enzymes and concentration of antioxidant molecules was examined in Wistar rats.

Neuromodulatory potential of *Selaginella delicatula* which grows on wet rocks in western ghats was explored. The propensity of tomato seed aqueous extract to render protection against neurotoxicants employing *Drosophila* model was examined. Results suggest the aqueous extract of tomato seeds, which are a rich source of bioactive compounds possesses significant neuroprotective action. The propensity of fish oil (FO) supplements to modulate endogenous markers of oxidative stress and attenuate neurotoxicant-induced oxidative stress and mitochondrial dysfunction in rat brain were examined. FO prophylaxis significantly enhanced GSH levels in brain regions and it could attenuate ROT induced oxidative stress as well. Neuroprotective effect of fish oil (FO) in combination with quercetin (Q) against 3-nitropropinoic acid (NPA) induced stress in rat brain was examined. Acrylamide - induced oxidative stress and the ameliorative effects of spice actives in *Drosophila melanogaster* was explored. The results demonstrated that acrylamide -induced neurotoxicity could be mediated and the potential of spice actives in abrogating oxidative stress.

Guduchi immunomodulatory protein (ImP) is highly immunogenic in mice (mucosal administration without an adjuvant) as measured by its humoral IgG and IgA responses. Guduchi ImP possesses significant adjuvanticity in enhancing the humoral IgG and IgA responses of co-administered weak antigen (ovalbumin) by mucosal route in BALB/c mice. Sapodilla genomic DNA was isolated using fresh leaves of sapodilla plant (cv. cricket ball); a PCR product of ~0.6 kb (603 bases) was cloned, which upon sequence analysis corresponded to acidic thaumatin-like protein by homology analysis. The sequence of sapodilla acidic sapodilla thaumatin-like protein (TLP) shows high homology towards known food allergenic TLPs. Antibodies specific to ribitol and ribitol-5-P have been generated and characterized, which may find applications in the development of competitive ELISA for the quantification of riboflavin and its coenzymes in food samples.

Effect of phosphine fumigant on the immature stages of *Tribolium castaneum* with different concentrations of phosphine over different exposure period was carried out. Phosphorothioates of eugenol tested against stored insects and fungi was found to be promising. Trans-anethole with different concentrations was evaluated against *S. oryzae* on wheat and *C. chinensis* on green gram. *A. calamus* extract and trans-anethole had no inhibitory effect on grain germination. Effect of phosphine on the development of *C. elegans* was studied. Hyperglycemic and stressogenic effects of monocrotophos were explored. The parkinson-like effects elicited by sublethal concentrations of monocrotophos in rat was determined. Dopamine levels in rodent brain homogenates was quantified to assess the extent of loss of dopaminergic neurons in experiments using MPTP (1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) and MCP (organophosphorus insecticide).

Societal and CSIR Network Projects

Under CSIR-National Innovation Council programme, promotion of a mango cluster at Krishnagiri (Tamil Nadu) to benefit farmers, processors and exporters of the region was undertaken.

In the XI plan period, CSIR-CFTRI had been the nodal laboratory for two of the CSIR Network Projects. In the supra-institutional project, developments of nutritious products targeted to various categories of the population were addressed. Similarly, number of equipments and machineries were developed to augment automation in the food industry sector under the other network project. Besides these projects, the Institute also participated in seven other CSIR network projects.

ABOUT CSIR

Council and Scientific and Industrial Research (CSIR), New Delhi, with its network of 38 laboratories, Complexes, Field & Experimental stations and Regional Centres, have been working to fulfill the ever demanding scientific and technological needs of the nation over the last six decades.

"Anusandhan Bhavan" -
CSIR Headquarters, New Delhi

The constituent laboratories of CSIR, grouped into five broad areas, such as physical sciences, chemical sciences, biological sciences, engineering sciences and information sciences, are given below:

PHYSICAL SCIENCES

- CSIR-Central Electronics Engineering Research Institute, Pilani
- CSIR-Central Scientific Instruments Organisation, Chandigarh
- CSIR-National Geophysical Research Institute, Hyderabad
- CSIR-National Institute of Oceanography, Goa
- CSIR-National Physical Laboratory, New Delhi

CHEMICAL SCIENCES

- CSIR-Central Electrochemical Research Institute, Karaikudi
- CSIR-Central Leather Research Institute, Chennai
- CSIR-Central Salt and Marine Chemicals Research Institute, Bhavanagar
- CSIR-Indian Institute of Chemical Technology, Hyderabad
- CSIR-Indian Institute of Petroleum, Dehradun
- CSIR-North-East Institute of Science and Technology, Jorhat
- CSIR-National Chemical Laboratory, Pune

BIOLOGICAL SCIENCES

- CSIR-Central Drug Research Institute, Lucknow
- CSIR-Central Food Technological Research Institute, Mysore
- CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow
- CSIR-Institute of Genomics & Integrative Biology, New Delhi
- CSIR-Centre for Cellular and Molecular Biology, Hyderabad
- CSIR-National Botanical Research Institute, Lucknow
- CSIR-Indian Institute of Chemical Biology, Kolkata
- CSIR-Indian Institute of Toxicology Research, Lucknow
- CSIR-Institute of Microbial Technology, Chandigarh
- CSIR-Indian Institute of Integrative Medicine, Jammu
- CSIR-Institute of Himalayan Bioresource Technology, Palampur

ENGINEERING SCIENCES

- CSIR-Central Building Research Institute, Roorkee
- CSIR-Central Glass and Ceramic Research Institute, Kolkata
- CSIR-Central Institute of Mining and Fuel Research, Dhanbad
- CSIR-Central Road Research Institute, New Delhi
- CSIR-National Aerospace Laboratories, Bangalore
- CSIR-CSIR Centre for Mathematical Modelling and Computer Simulation, Bangalore
- CSIR-National Metallurgical Laboratory, Jamshedpur
- CSIR-National Environmental Engineering Research Institute, Nagpur
- CSIR-National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram
- CSIR-Advanced Materials and Processes Research Institute, Bhopal
- CSIR-Institute of Minerals and Materials Technology, Bhubaneswar
- CSIR-Structural Engineering Research Centre, Chennai
- CSIR-Central Mechanical Engineering Research Institute, Durgapur

INFORMATION SCIENCES

- CSIR-National Institute of Science, Technology and Development Studies, New Delhi
- CSIR-National Institute of Science Communication & Information Resources, New Delhi

ABOUT CSIR-CFTRI

CSIR-CFTRI Main Mansion, Mysore

CSIR-Central Food Technological Research Institute (CFTRI), Mysore (a constituent laboratory of Council of Scientific and Industrial Research, New Delhi) came into existence during 1950 with the great vision of its founders, and a network of inspiring as well as dedicated scientists who had a fascination to pursue in-depth research and development in the areas of food science and technology. The focus of the Institute has been towards low-cost effective technologies, utilisation of indigenous raw materials, bio-friendly processes with emphasis on integrated technology and high level pursuit for total technology with underpinning of food safety, health and nutrition to all sections of the population.

The Institute has geared up its R&D and impact of the globalisation has given very good dividends with a large number of externally funded projects from national and international agencies. The present scenario in the country is very vibrant with rising capital investment in food industry, which is expanding at a rapid pace in urban markets for processed foods, especially for the traditional foods through eco-friendly technologies.

The role of CSIR-CFTRI has always been on a high pedestal in the areas of human resource development and R&D partnerships cherished through the international linkages with institutions such as the Institute of Food Technologists (USA), UN University (Tokyo), European Economic Commission (Belgium), National Science Foundation (USA) and many more. CSIR-CFTRI is an ISO 9001:2008 and ISO 14001:2004 organisation and NABL accredited for chemical and biological testing of samples.

These unique features of CSIR-CFTRI are of importance in building an everlasting partnership with industries and agencies for excellence in science and technology, sponsoring consultative research and business tie-ups for long term strategic research as well as unparalleled technology development in the area of food science and technology.

This vibrant scenario has consolidated CSIR-CFTRI to evolve its capabilities and to position itself as a global R&D hub with a firm commitment in reaching its R&D to people through adaptable, affordable and appropriate technologies.

Environmental Policy

▲ We, at the CSIR-Central Food Technological Research Institute, Mysore are committed to the protection of environment by prevention of pollution, achieving continual improvement in environmental performance minimising energy and Carbon Food Print (CFoP) in both R&D and other activities in the campus, complying with legal requirements related to environmental aspects, with reviewing objectives and targets & ensuring the necessary and appropriate operational practices in our day to day Research and Developmental endeavours with a clear and concerted ***'TEAM CSIR-CFTRI'*** approach.

Departments at CSIR-CFTRI

R&D Departments

- Biochemistry & Nutrition
- Fermentation Technology & Bioengineering
- Flour Milling, Baking & Confectionery Technology
- Food Engineering
- Food Microbiology
- Food Packaging Technology
- Food Protectants & Infestation Control
- Food Safety & Analytical Quality Control Laboratory
- Fruit & Vegetable Technology
- Grain Science & Technology
- Human Resource Development
- Lipid Science & Traditional Foods
- Meat, Fish & Poultry Technology
- Plant Cell Biotechnology
- Plantation Products, Spices & Flavour Technology
- Protein Chemistry & Technology
- Sensory Science

Support Departments

- Agri-Horticulture
- Central Instruments Facility & Services
- Computer Centre
- Construction & Civil Maintenance
- Engineering & Mechanical Maintenance
- Health Centre
- Information & Publicity
- Library
- Planning, Monitoring & Coordination
- Technology Transfer & Business Development
- CFTRI Resource Centres
  - Bangalore
  - Hyderabad
  - Lucknow
  - Mumbai

Administration

- General Administration & Establishment
- Finance & Accounts
- Stores & Purchase

MAJOR INFRASTRUCTURE / FACILITIES AT CSIR-CFTRI

- Fully equipped Analytical Quality Control and Nodal Codex Food Laboratory for developing Food Standards and Testing samples of Food Products
- Pilot Plant and Food Engineering Centre with an array of Equipments and Machinery for Process evaluation and Scientific Study of Unit Operations
- A Functional Package Testing Laboratory for assessing Packaging Materials
- Computational Fluid Dynamics (CFD) Modelling & Image Processing
- Electronic Nose and Sensory Data Management Software
- Automatic system for the estimation fo glutens and its characterization
- A Library with more than 25,000 books on Food Science and Technology, 40,000 bound volumes of Journals, and current subscription of around 300 Journals in printed form and more than 450 online - journals
- State-of-the art Instruments for Advanced Research in Biological Sciences, Food Biotechnology, Food Technology and Engineering
- Advanced centre for wheat Milling Technology, equipped with Computerized Modern Roller Flour Mill (20 tonnes per day), for work in Partnership with Industry and Training

A view of the Food Engeneering Pilot Plant

Training session in the International School of Milling Technology in progress

- Scale-up Facility for Food and Biotechnological Processes for Commercial Application including trial runs by industry
- Advanced Plant and Animal Cell Culture Facility
- Central Instruments Facility & Services
- 500 MHz NMR facility
- State-of-art Laboratories, Class rooms, Student's Hostel, Accommodation for Short-term Course participants, 2-years Master Degree Course in Food Technology and Certificate course on Flour Milling and Ph.D. programmes

500 MHz NMR Spectrometer

Quality Policy

- We, at CSIR-Central Food Technological Research Institute (CSIR-CFTRI), Mysore, dedicate and commit ourselves to excel in Research & Innovation, Knowledge dissemination, Technology Transfer and Human Resource Development in the areas of Food Science and Technology through quality attributes, to be practiced and implemented at all levels.
- We shall endeavour to develop quality technologies which are globally competitive and ecofriendly and energy conserving with a clear mandate of economic edge to ensure safety and quality of the products and processes from CSIR-CFTRI.
- We nurture the capacity building through training, state-of-art analytical expertise and consultancies in the area of Food Science and Technology, emphasizing quality in all activities.
- We shall achieve these goals and continually improve through ***'Team CFTRI'*** and dissipate knowledge to society.

Vision

- To be a model organisation for Scientific and Industrial Research and a path-setter in the shifting paradigm of self-financing Research and Development.
- To be a global Research and Development platform for providing competitive Research and Development and excellent quality science based technical services in the area of Food Science and Technology.
- To be a vital source of Food Science & Technology to National Societal Mission for combining technology with human face.

Mission

- To generate and apply scientific knowledge in the area of Food Science and Technology for maximal conservation and optimal utilisation of Nation's Food and Energy Resources.
- To add value and utility to agro-resources through Research and Development and contribute to sustainable development, Food Security, Nutrition Security and Food Safety.
- To assist and promote the growth of food industry through innovative development of technologies for value addition and state-of-art technical services and Societal reach-out.

Achievements in Brief

1. ISO 9001:2008 QUALITY MANAGEMENT SYSTEM

CSIR-CFTRI was recertified as ISO 9001:2008 organisation. The quality management system in the Institute is applicable to the activities associated with Research & Development, Consultancy and Training for agro and food sector.

2. NABL ACCREDITATION

Testing and analytical services of the Institute is accredited to ISO 17025 by National Accreditation Board for Testing and Calibration Laboratories (NABL), DST, Govt. of India for Chemical and Biological Testing of samples. Also awareness lectures and training on internal auditing as per ISO 17025 requirements were conducted for staff during this period.

3. ENVIRONMENT MANAGEMENT SYSTEM ISO 14001

The Institute is certified under ISO 14001:2004 and periodic internal and external audits were conducted during this period.

4. PATENTS

During 2011-12, the institute filed four patents in India and abroad. The details are given below:

- An improved process for preparation of nutraceutical jelly from mangosteen rind
- An improved medium composition and a process for enhanced lutein production from microalgae
- A formulation for a carbonated beverage having antioxidants of ginger and turmeric and a process for the preparation thereof
- A formulation for ready-to-prepare compacted instant soup tablets and a process for the preparation thereof

5. TECHNOLOGY TRANSFER

a) Processes Released for Commercial Exploitation

Seventy processes were released for commercial exploitation to 118 parties and sixty one processes were demonstrated to 91 licensees. Details are given below:

- *Amla* candy
- Animal feed formulation: Cattle & poultry
- Bottling of sugarcane juice
- Cereal flakes: Rice
- Clear lime - Lemon flavour blend for soft drink manufacture
- Compounded asafoetida
- Decortication of *ragi*
- Dehydrated whole lime
- Desiccated coconut
- Eggless cake premix
- Energy food: New formulation
- Fermented and dehydrated ready mix for *dosa* batter
- Fermented and dehydrated ready mixes for *idli / dosa* batter
- Fish wafers
- Fruit bar mango
- Fruit jams & jellies: Preparation
- Fruit syrups and squashes
- Fruit toffees
- Fruits & vegetables: Canning
- Fruits & vegetables: Dehydration (grapes, banana, onion, potato, peas, green chillies)
- Garlic paste
- Garlic powder
- Ginger dehydration
- Ginger paste
- Groundnut (peanut) butter
- High protein rusk

Shelf stable egg albumen cube (Ready-to-use)

- High protein soya cereal ready mix for preparation of *kesari bhath, upma,* porridge & others
- Instant gravy mixes - Dehydrated
- Instant mushroom soup mix
- Instant traditional food: *Sambar*
- Liquid fruits (clarified fruit juices) - Apple, banana, grapes, gauava
- Low GI beverage for diabetics
- Mango pulp: Bulk preservation for RTS beverage
- Mangosteen fruit products
- Meat pickles: Fish; prawn; chicken and mutton
- Milk chocolate
- Online fortification of *atta* (whole wheat flour) / *maida* (refined wheat flour)
- Osmo air dried *amla* segments (sweet and salted)
- Osmo air dried fruits: Pineapple
- Oyster mushroom dehydration
- Pickles & chutneys preparation
- Production of atta (whole wheat flour)
- Pulse based papads
- Ready mix: *Dosa*
- Ready mix: *Idli*
- Ready mix: *Jamun*
- Ready mix: *Jelebi*
- Ready mix: *Maddur vada*
- Ready mix: *Pakoda*
- Ready mix: *Upma*
- Ready mix: *Vada*
- Ready spice mixes: *Sambar* & *rasam*
- Ready spice mixes: *Sambar*, *rasam* & *pulao*
- Ready to use *dosa* batter in retail packs
- Ready to use *idli* batter in retail packs
- RTS fruit juice and beverages
- Rural based biotechnological production of *Spirulina*
- Shelf stable and ready to eat foods: Thermo processed in retort pouches
- Shelf stable *Chapati*
- Shelf stable chicken biriyani
- Shelf stable chicken tit - bits

- Soya protein hydrolysate
- Sugar free rusk
- Tamarind candy
- Tamarind juice concentrate
- Tamarind powder
- Tomato products: Preparation
- Tutti fruity (papaya / carrot)
- Vanilla extract from cured vanilla beans
- Virgin coconut oil

b) Release of Design and Drawings

Seven design drawing were released to nine entrepreneurs for commercial exploitation. These include:

- Continuous dough sheet extruder
- Continuous wet cum dry grinding machine for foods
- Integrated rubber roll sheller huller rice mill
- Mini versatile dhal mill
- Moulding machine for besan, *soji / rava* & similar *laddus*
- Sugarcane de-skinning machine
- Tiny rice mill

Laboratory lyophilizer developed at CFTRI

CONSULTANCY ASSIGNMENTS

Fifty two projects were undertaken during this period and details are listed below:

Completed Assignments

- Evaluation of quality of wheat & milled products
- Studies on curcumin derivatives
- Shelf life evaluation of tea in tea bags
- Quality evaluation of wheat flour
- Quality evaluation of biscuit samples
- Studies on shelf stable sugarcane juice concentrate in glass bottles
- Influence of processing on dehulling properties, cooking and sensory properties and chemical composition of pulses
- Advisory assistance to setup a unit to manufacture *Kakambi*
- Preparation of a detailed project report (DPR) on Food processing training institute at Imphal
- Shelf life evaluation of flavoured green tea in tea bags
- Consultancy assistance on food compatibility of PVC compound sheets by overall migration as per IS 9845-1998
- Shelf life evaluation of flavoured black tea (bulk)
- Consultancy assistance for water soluble formulations of swallow root (*Decalepis hamiltonii wight & arn)* flavour
- Consultancy assistance on evaluation of rice bran
- Consultancy assistance for canning of *gulab jamun* and *rasagulla* and technical guidance on good manufacturing practices
- Conducting PER and overall growth studies on rats using food mix supplied by the party
- Advisory consultancy assistance on milling aspects of rice mills in Odisha State

Assignments in Progress

- Evaluation of whole wheat flour quality
- Quality evaluation of wheat and wheat flour for ash curve analysis
- Consultancy assistance on evaluation of rice bran
- Consultancy assistance for evaluation of polypropylene (PP) and polyethylene (PE) grades for overall migration studies for food contact applications
- Quality evaluation of biscuit samples

- Quality testing of pulses/dhal samples
- Influence of processing on dehulling properties, cooking and sensory properties and chemical composition of pulse (Green gram)
- Consultancy assistance for canning of *gulab jamun* and *rasagulla* and technical guidance on good manufacturing practices
- Conducting PER and overall growth studies on rats using food mix supplied by the party
- Testing of rice varieties for quality profile
- Bioefficacy of pyriproxifen 0.5% g (sumilarv 0.5% g) on housefly species, bioefficacy study of metofluthrin 0.32% LV for 60 nights and metofluthrin 0.005% mosquito red coil (35 g) for 12 hours against mosquito species of Culex quinquefasciatus, Aedes aegypti and Anopheles stephensi
- Consultancy project on implementation assistance for manufacturing rice flakes
- Consultancy project on implementation assistance for preparation of *Kakambi* and products there from
- Consultancy assistance on enumeration of bacterial and virus loads in water purified using filters provided by Tata Chemicals
- Quality evaluation of wheat flour
- Mechanization of *laddu* preparation
- Consultancy assistance for evaluation of polypropylene (PP) and polyethylene (PE) grades for overall migration studies for food contact applications-II Phase
- Standardization process conditions for the formulation of a sweetener with respect to selected unit operations
- Advisory consultancy for setting up a wheat flour mill
- Standardization of process conditions for the manufacture of clean palm jaggery powder from palm jaggery
- Consultancy assistance for evaluation of polypropylene (PP) and polyethylene (PE) grades for overall migration studies for food contact applications-III Phase
- Consultancy project on shelf life of sweet *Boondi* and *Peda* for a minimum shelf life of 6 months
- Consultancy assistance for studies on colour reduction of refined rice bran oil
- Evaluation of PET bottles for 5 grades for food contact applications as per USFDA and IS specifications.
- Thermal process optimization of *ready-to-drink* tea concentrate
- Studies on development of barley based health drink/beverage using fruit juices / flavours (orange and lemon)
- Consultancy assistance on sensory evaluation of coating material used as coating in vessels

- Evaluation of chewing gum and other samples using electronic tongue
- Consultancy assistance for evaluation of polypropylene (PP) and polyethylene (PE) grades for overall migration studies for food contact applications-IV Phase
- Cooking properties of differently germinated and dried chickpea split samples
- Consultancy assistance on evaluation of quality of wheat and milled products
- Development of REPFED technology for the manufacture of *Idli, Dosa* and *Paddu*
- Consultancy assistance on sensory evaluation of *desi* chickpea varieties
- Consolidation of process parameters for dry roasting of cashew kernels and flavouring
- Consultancy assistance for quality evaluation of food products

SPONSORED RESEARCH PROJECTS

Ten sponsored research projects were in progress during the period and details are listed below:

Completed Assignments

- Development of high content fructooligosaccharides (FOS), a prebiotic neutraceutical
- Continuous production of fermented dry *dosa* and *idli* mix
- Studies to prepare cocoa butter equivalents from indigenous fats
- Development of process for the preparation of liquid asafoetida
- Preparation of a detailed project report (DPR) for setting up of a canning & retort pouch processing unit

Assignments in Progress

- De-bittering of moringa seed cake
- Moisture sorption studies and prediction of shelf-life for their product using computer simulation software
- Preservation of sugarcane juice in PET bottles
- Studies on karanja oil from karanja seed
- Standardizing processing conditions of sesame oil used in continental preparations

8. GRANT-IN-AID PROJECTS

In the year 2011-12, **15** new grant-in-aid projects were initiated and **45** projects were underway during this period.

9. TECHNICAL ASSISTANCE TO INDUSTRIES

a) Counselling Services

A total of 664 technical interactions were held with entrepreneurs and other interested parties from various states on different aspects of food technology. The details are given below:

Subject	No. Pertaining to Specific States/Union Territories	Total
Cereals & Pulses	AP-3; ASM-3; CG-1;KAR-10; KER-8; MAH-2; MAN-3; ND-2; PUN-2; TN-5	39
Confectionery & Convenience foods	AP-5; ASM-4; BIH-1;CG-3; JHR-2; KAR-16; KER-8, MAH-2; ND-2; ORI-2; POND-1; PUN-2; RAJ-3;TN-9; UP-3	63
Food Machinery	AP-12; BIH-2; CG-2; GUJ-2; HAR-2; JHR-2; KAR-22, KER-12; MAH-2; MEG-1; ND-3; ORI-2; POND-2;PUN-6; RAJ-3;TN-12; UP-3; WB-2	92
Fruits & Vegetables Technology	AP-19; ARP-6; ASAM-5; BIH-3; CG-2, GUJ-4 HAR-3; INTL-4; JHR-4; KAR-26; KER-18; MAH-4; MANI-3; MEG-2; ND-1 ; NAG-2;ORI-3;POND-2;PUN-4;TN-15;UP-4; WB-2	136
Plantation and Spice Products	AP-13; ARP-4; ASM-5; BIH-2;CG-4; GUJ-4; INTL-4; JHR-3; KAR-26; KER-27; MAH-4; MAN-4; MIZ-2; MEG-2; NAG-2; ND-2; ORI-2; POND-1; PUN-4; RAJ-3; TN-11; UP-6; WB-2	137
Protein Foods	AP-11; ARP-2; ASM-4; CG-3; GUJ-3; KAR-20; KER-10; MAH-3; MAN-1; MEG-1; NAG-1; ND-1; POND-1; PUN-3; TN-9; UP-5	78
Miscellaneous (more than one subject)	AP-11; ARP-2; ASM-3; BIH-1; CG-2; GOA-2; GUJ-2; HAR-1; HP-3; INTL-3; JHR-1; KAR-26; KER-18; MAH-5; MAN-3; MIZ-2; MEG-1; NAG-1; ND-2; ORI-1; PUN-4; POND-3; RAJ-2; TN-14; TRI-1; UP-4; WB-1	119
	TOTAL	**664**

A&N: Andaman & Nicobar; AP: Andhra Pradesh; ASM: Assam; ARP: Arunachal Pradesh; BIH: Bihar; CG: Chattisgarh; GUJ: Gujarat; HAR: Haryana; HP: Himachal Pradesh; NAG: Nagaland; INTL: International; JHR: Jharkhand; KAR: Karnataka; KER: Kerala; MAH: Maharashtra; MEG: Meghalaya; MIZ: Mizoram; MP: Madhya Pradesh; MAN: Manipur; NAG: Nagaland; ND: New Delhi; ORI: Orissa; POND: Pondicherry; PUN: Punjab; RAJ: Rajasthan; TRI: Tripura; TN: Tamil Nadu; UP: Uttar Pradesh; WB: West Bengal

b) Technical Enquiries

A total of 4787 technical enquiries received from entrepreneurs, Government and private organizations were attended. The details are given below:

Area	Numbers of Enquiries
Cereals and Pulses	515
Convenience Foods	525
Food Machinery	701
Fruits and Vegetables	734
Human Resources Development	48
Microbiology & Fermentation	111
Spices and Plantation Products	928
Protein and Specialty Foods	444
Miscellaneous	781
Total	**4787**

10. TECHNICAL COLLABORATION WITH OTHER ORGANISATIONS

Organisation	Subject
• Oil and Natural Gas Corporation (ONGC)	Development of the process for mass cultivation of selected microalgae for hydrocarbon production
• National Mission on Bamboo Applications (NMBA) -TIFAC	Value addition to bamboo shoots through processing
• Aeronautical Development Agency (ADA)	Development of biosensors for assessing the microbiological quality of foods and monitoring of formaldehyde concentration in selected marine foods
• Research Council of Norway (RCN)	Design and development of functional foods from agri-and marine waste for value addition
• CEERI, Chennai	NIRS based online device for quality control of edible oils

11. NEW PROCESSES READY FOR COMMERCIAL EXPLOITATION

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

- Tiny rice mill
- Low cost servo based PLC operated grain/grain products automatic weigher for flour mill industry
- Preparation of convenience flour from *ragi* suitable for stiff porridge
- Preparation of marigold oleoresin
- Continuous wet cum dry grinding machine for foods
- Production of atta (whole wheat flour)
- Preparation of deep fat fried egg cubes
- Stabilized rice bran
- Preparation of finger millet based multigrain semolina for preparation of *upma, kesri bhat* and alike products
- Shelf stable egg albumin and egg yolk cubes
- Low fat meat kofta
- Multigrain bread
- Protein enriched *ragi* vermicelli
- Shelf stable *roti* from non wheat cereal and millet (*ragi* and rice)
- Value added products from custard apple : Shelf stable pulp, microfiltered beverage and jelly
- Products from pear fruit : Dehydrated fruit, juice and powder
- Shelf stable *biriyani* paste
- Production of refined wheat flour (*maida*), semolina (*soji / rava*) and resultant atta by roller milling

Servo-based automatic grain weigher for flour mill

12. HUMAN RESOURCE DEVELOPMENT

a) Post-graduate Programmes

M.Sc. [Food Tech.] degree was awarded to **23** students (2009-2011 batch) and **25** freshers were admitted to the 2010-2012 batch.

b) International School of Milling Technology

Twenty students were passed out from the 2010-11 batch after fulfilling the course requirements. In the 2011-12 batch, Twenty freshers were admitted.

c) Short-term training programmes

Thirty seven short term training programmes were conducted benefitting 719 personnel (including training of trainers) from food processing and allied industries.

1 Approaches towards business development in food processing industry

2 Fruit processing for the entrepreneurs from M/s Kudumbashree Mission, Ernakulum, Kerala

3 Scientific protocols in laboratory animal model studies

4 Advances in baking science and technology

5 Chromatographic techniques in food quality and safety

6 Science and technology of spices and their products for the personnel from Nestle R&D Centre, Singapore

7 Basics of nutrition and its application in laboratory animals

8 Fumigation, prophylaxis and pest management for stored products *(Batch I)*

9 Spectroscopy and food analysis

10 Basics in flour milling and quality evaluation of flour

11 Science and technology of chocolate and sugar confectionery

12 Texture profile of processed foods by sensory and instrumental methods

13 Essentials of packaging technology for distribution and marketing of food products *(Batch I)*

14 Holistic approach in processing of fruits and vegetables into value added products *(Batch-I)*

15 Modern methods of pesticide residue analysis

16 Science and technology of natural and synthetic food colours

17 Processing and handling of fruits and vegetables, spices, rice and fish for the personnel of SEWA Gram Mahila Haat, Ahmadabad, Gujarat *(Batch I & II)*

18 Developments in food science and technology for the personnel of Nestle India Pvt. Ltd.

19 Pesticide residue analysis in food commodities for the personnel of Indian Institute of Horticulture Research, Bengaluru

20 Molecular biology techniques in microbiology

21 Science and technology of biscuit making for the personnel of Assocom-India

22 Fumigation, prophylaxis and pest management techniques for stored products *(Batch-II)*

23 HPLC and GC: Operational, preventive and corrective measures

24 Indian snacks and breakfast foods: Consumer preference towards quality & safety attributes

25 Analysis of hydroxycitric acid from fruit samples for the personnel of IBSD, Imphal

26 Processing of rice and rice products

27 Physico-chemical and nutritional characteristics of protein foods

28 Spices: Processing, quality and safety aspects

29 Food processing and preservation with focus on quality & safety for the personnel of UN World Food Programme

30 Essentials of packaging technology for distribution and marketing food products *(Batch-II)*

31 Sensory analysis of aroma and flavour of food ingredients and processed foods

Training session in progress for
Kudumbashree mission entrepreneurs

32 Approaches to safety and quality in food processing

33 Alcoholic beverages: Quality and safety aspects

34 Approaches towards business development in food processing industry

35 Sensory science and consumer perspective

36 Holistic approach in processing of fruits and vegetables into value added products *(Batch-II)*

37 Post-harvest handling and storage of fresh fruits and vegetables for commercial trade

d) Summer Training Courses / Students Project

A total of 543 students from professional colleges / institutions completed short-term projects work as part of their academic programmes.

13. ANALYSIS AND TESTING

In the Customer Service Cell, 726 samples as per the Central Food Laboratory mandate were analyzed. The samples included packaging materials, flours (*maida*, wheat, soya etc), oils and fats, confectionery, energy food, spices and condiments, fish, cereals and pulses, fruits and vegetable products and so on. Also 1953 samples received from courts, ports / custom departments were analyzed.

UN World food programme participants with CSIR-CFTRI faculty

14. RESEARCH PAPERS PUBLISHED

SCI Papers

1 Ani V., Akhilender Naidu K., Antioxidant potential of bitter cumin *(Centratherum anthelminticum (L.)* Kuntze*)* seeds in *in vitro* models, *BMC Complementary and Alternative Medicine,* 2011, **11(1),** 40-48

2 Anila N., Arun Chandrashekar, Ravishankar G.A., Sarada R., Establishment of *Agrobacterium* tumefaciens-mediated genetic transformation in *Dunaliella bardawil, Eur. J. Phycology*, 2011, **46(1),** 36-44

3 Anu Appaiah K.A., Parvathy A., Mathew M., Karanth N.G.K., Replacement of hexachlorocyclohexane to environmentally friendly biosurfactant as precursor for the production of biosurfactant from *pseudomonas*, *J. Microbiol. Biotechnol.,* 2011, **21(8),** 858-860

4 Anup Srivastava, Jaganmohan Rao L., Shivanandappa T., 2,4,8-trihydroxybicyclo [3.2.1] octan-3-one scavenges free radicals and protects against xenobiotic-induced cytotoxicity, *Free Radical Res.,* 2012, **46**, 320-328

5 Anup Srivastava, Shivanandappa T., Antioxidant and cytoprotective properties of 2-(hydroxymethol)-3-methoxybenzaldehyde, *Food Chem.,* 2011, **128(2),** 458-464

6 Anup Srivastava, Shivanandappa T., Differential cholinesterase inhibition in the rat brain regions by dichlorvos and protective effect of *Decalepis hamiltonii* roots, *Neurotoxicology,* 2011, **32(6),** 931-934

7 Apurva Kumar R. Joshi, Rajini P.S., Hyperglycemic and stressogenic effects of monocrotophos in rats: Evidence for the involvement of acetylcholinesterase inhibition, *Experimental Toxicologic Pathology*, 2012, **64,** 115-120

8 Apurva Kumar R. Joshi, Raju N., Rajini P.S., Insights into the mechanisms mediating hyperglycemic and stressogenic outcomes in rats treated with monocrotophos, an organophosphorus insecticide, *Toxicology*, 2012, **294,** 9-16

9 Apurva Kumar R. Joshi, Raju N., Rajini P.S., Microplate-based kinetic method for assay of mitochondrial NADH- and succinate-cytochrome c reductase activities, *Analytical Biochem.,* 2011, **415(2),** 209-211

10 Arul Selvi A., Sreenivasa M.A., Manonmani H.K., Enzyme-linked immunoassay for the detection of glyphosate in food samples using avian antibodies, *Food Agri. Immunology,* 2011, **22(3),** 217-228

11 Arun Tapal, Purnima Kaul Tiku, Complexation of curcumin with soy protein isolate and its implications on solubility and stability of curcumin, *Food Chem.,* 2012, **130,** 960-965

12 Ayyappan A.A., Gobinath D., Prapulla S.G., Short chain xylooligosaccharides: A potential prebiotic used to improve batter fermentation and its effect on the quality attributes of *idli,* a cereal-legume-based Indian traditional food, *IJFST*, 2011, **46(7),** 1346-1355

13 Baby Latha R., Nagaprabha P., Bhat K.K., Suvendu Bhattacharya, Frying characteristics of cashew splits, *J. Food Process Eng.*, 2012, **35,** 250-263

14 Badarinath V., Prakash M. Halami, Purification of new beta-galactosidase from *Enterococcus faecium* MTCC 5153 with transgalactosylation activity, *Food Biotechnol.,* 2011, **25(3),** 225-239

15 Badarinath V., Prakash M. Halami, Molecular characterization of class IIa, heat-stable enterocin produced by *Enterococcus faecium* MTCC 5153, *Indian J. Biotechnol.,* 2011, **10(3),** 307-315

16 Balaswamy K., Prabhakara Rao P.G., Prabhavathy M.B., Satyanarayana A., Application of annatto (*Bixa orellena* L.) dye formulations in Indian traditional sweetmeats: *Jilebi* and *jangri, Indian J. Traditional Knowledge*, 2012, **11(1),** 103-108

17 Basheer S., Samyn D., Hedstrom M., Thakur M.S., Persson B.L., Mattiasson B., A membrane protein based biosensor: Use of a phosphate - H(+) symporter membrane protein (Pho84) in the sensing of phosphate ions, *Biosensors Bioelectronics,* 2011, **27(1),** 58-63

18 Bharathi S.G., Parvathy K.S., Srinivas P., Indi S.S., Rao K.S., Curcumin-glucoside, a novel synthetic derivative of curcumin, inhibits alpha-synuclein oligomer formation: Relevance to parkinson's disease, *Current Pharmaceutical Design*, 2012, **18(1),** 76-84

19 Bhumika Tripathi, Kalpana Platel, Iron fortification of finger millet *(Eleucine coracana)* flour with EDTA and folic acid as co-fortificants, *Food Chem.,* 2011, **126(2),** 537-542

20 Bhumika Tripathi, Kalpana Platel, Srinivasan K., Double fortification of sorghum *(Sorghum bicolor L. Moench)* and finger millet *(Eleusine coracana L. Gaertn)* flours with iron and zinc, *J. Cereal Sci.,* 2012, **55,** 195-201

21 Bhumika Tripathi, Ravi R., Maya Prakash, Kalpana Platel, Sensory acceptability of iron-fortified millet products, *Int. J. Food Sci. Nutri.,* 2011, **62(6),** 651-659

22 Bijinu B., Binod Prasad, Amit Kumar Raj, Suresh P.V., Mahendrakar N.S., Bhaskar N., *In vitro* antioxidant and antibacterial properties of hydrolysed proteins of delimed tannery fleshings: Comparison of acid hydrolysis and fermentation methods, *Biodegradation,* 2011, **22(2),** 287-295

23 Chandran G., Hosamani R., Muralidhara, Utilisation of third instar larvae of *Drosophila* to understand the neuromodulatory effect of ferulic acid against rotenone-induced oxidative stress and neurotoxicity, *Atla - Alternatives to Laboratory Animals*, 2011, **39(1),** 84

24 Chandrashekar P.M., Venkatesh Y.P., Fructans from aged garlic extract produce a delayed immunoadjuvant response to ovalbumin antigen in BALB/c mice, *Immunopharmacol. Immunotoxicol.,* 2012, **34(1-2),** 174-180

25 Chetana R., Yella Reddy S., Preparation and quality evaluation of peanut *chikki* incorporated with flaxseeds, *J. Food Sci. Technol.,* 2011, **48(6),** 745-749

26 Chhanwal N., Indrani D., Raghavarao K.S.M.S., Anandharamakrishnan C., Computational fluid dynamics modeling of bread baking process, *Food Res. Int.,* 2011, **44(4),** 978-983

27 Chopra R., Rastogi N.K., Sambaiah K., Enrichment of rice bran oil with alpha-linolenic acid by enzymatic acidolysis: Optimization of parameters by response surface methodology, *Food Bioprocess Technol.,* 2011, **4(7),** 1153-1163

28 Deepa C., Jeyanthi G.P., Venkateswaran G., Optimization of cultural conditions for maximum phytase production from enterobacter sp isolated from poultry litter, *J. Pure Appl. Microbiol.,* 2011, **5(1),** 131-136

29 Deepa G. Muricken, Lalitha R. Gowda, Molecular engineering of a small trypsin inhibitor based on the binding loop of horsegram seed bowman-birk inhibitor, *J. Enzyme Inhib. Med. Chem.*, 2011, **26(4),** 1-8

30 Deepa N., Jena B.S., Antioxidant fraction from bark of *Dillenia indica, Int. J. Food Properties,* 2011, **14(5),**1152-1159

31 Denny Joseph K.M., Muralidhara, Fish oil prophylaxis attenuates rotenone-induced oxidative impairments and mitochondrial dysfunctions in rat brain, *Food Chem. Toxicol.,* 2012, **50,** 1529-1537

32 Dhanalakshmi K.G., Jaganmohan Rao L., Comparison of chemical composition and antioxidant potential of volatile oil from fresh, dried and cured turmeric (*Curcuma longa*) rhizomes, *Industrial Crops Products*, 2012, **38,** 124-131

33 Dhanalakshmi K.G., Jaganmohan Rao L., Suvendu Bhattacharya, Turmeric powder and starch: Selected physical, physicochemical and microstructural properties, *J. Food Sci.,* 2011, **76(9),** 1284-1291

34 Divya K.H., Varadaraj M.C., Prevalence of very low numbers of potential pathogenic isolates of *Yersinia enterocolitica* and *Yersinia intermedia* in traditional fast foods of India, *Indian J. Microbiol.,* 2011, **51(4),** 461-468

35 Divya K.H., Varadaraj M.C., Response surface plots for the behavioural pattern of *Yersinia enterocolitica* in chocolate milk as affected by trans-cinnamaldehyde, a spice essential oil constituent, *Food Bioprocess Technol.,* 2012, **5,** 498-507

36 Divya P., Bijesh P., Bhagyalakshmi N., Carotenoid content, its stability during drying and the antioxidant activity of commercial coriander (*Coriandrum sativum* L.) varieties, *Food Res. Int.,* 2012, **45,** 342-350

37 Diwakar B.T., Lokesh B.R., Akhilender Naidu K., Modulatory effect of alpha-linolenic acid-rich garden cress *(Lepidium sativum L.)* seed oil on inflammatory mediators in adult albino rats, *British J. Nutri.,* 2011, **106(4),** 530-539

38 Dolly P., Anishaparvin A., Joseph G.S., Anandharamakrishnan C., Microencapsulation of *Lactobacillus plantarum* (MTCC 5422) by spray-freeze-drying method and evaluation of survival in simulated gastrointestinal conditions, *J. Microecapsulation*, 2011, **28(6),** 568-574

39 Gajendra S. Naika, Purnima Kaul Tikku, Influence of ethylenediaminetetraacetic acid (EDTA) on the structural stability of endoglucanase from *Aspergillus aculeatus, J. Agric. Food Chem.,* 2011, **59(13),** 7341-7345

40 Gautam S., Kalpana Platel, Srinivasan K., Influence of combinations of promoter and inhibitor on the bioaccessibility of iron and zinc from food grains, *Int. J. Food Sci. Nutri.,* 2011, **62(8),** 826-834

41 Gautam S., Kalpana Platel, Srinivasan K., Promoting influence of combinations of *amchur,* beta-carotene-rich vegetables and A*llium* spices on the bioaccessibility of zinc and iron from food grains, *Int. J. Food Sci. Nutri.,* 2011, **62(5),** 518-524

42 George K. Shinomol, Rejeswara B.M., Srinivas Bharath M.M., Muralidhara, *Bacopa monnieri* extract offsets rotenone-induced cytotoxicity in dopaminergic cells and oxidative impairments in mice brain, *Cell. Mol. Neurobiol.,* 2012, **32,** 455-465

43 George K. Shinomol, Srinivas Bharath M.M., Muralidhara, Pretreatment with *Bacopa monnieri* extract offsets 3-nitropropionic acid induced mitochondrial oxidative stress and dysfunctions in the striatum of prepubertal mouse brain, *Can. J. Physiol. Pharmacol.,* 2012, **90(5),** 595-606

44 Ghimire B., Ramaswamy K., Akmal Pasha, Insecticidal and fungicidal activity of phosphorothioates of eugenol, *J. Pure Appl., Microbiol.,* 2011, **5(1),** 307-311

45 Girish T.K., Pratape V.M., Prasada Rao U.J.S., Nutrient distribution, phenolic acid composition, antioxidant and alpha-glucosidase inhibitory potentials of black gram *(Vigna mungo L.)* and its milled by-products, *Food Res. Int.,* 2012, **46,** 370-377

46 Gupta K.J., Abir U.I., Manjunatha G., Shruthi S., Jose F. Moran, Bagyalakshmi N., Hermann Bauwe, Werner M. Kaiser, The emerging roles of nitric oxide (NO) in plant mitochondria, *Plant Sci.,* 2011, **181(5),** 520-526

47 Gurushree M.N., Nandini C.R., Pratheeksha K., Prabhasankar P., Hosamane G.G., Design, development and performance evaluation of *chapati* press cum vermicelli extruder, *J. Food Sci. Technol.,* 2011, **48(2),** 218-224

48 Hemalatha M.S., Bhagwat S.G., Salimath P.V., Prasada Rao U.J.S., Enhancement of soluble dietary fibre, polyphenols and antioxidant properties of chapatis prepared from whole wheat flour dough treated with amylases and xylanase, *J. Sci. Food Agric.,* 2012, **92,** 764-771

49 Hemavathi A.B., Raghavarao K.S.M.S., Membrane processing for purification and concentration of beta-glycosidases from barley *(Hordeum vulgare), Biotechnol. Bioprocess Eng.*, 2011, **16(2),** 282-290

50 Ivan Aranha, Fatima Clement, Venkatesh Y.P., Immunostimulatory properties of the major protein from the stem of the ayurvedic medicinal herb, guduchi *(Tinospora cordifolia), J. Ethnopharmacology,* 2012, **139,** 366-372

51 Jagadish R.S., Divyashree K.N., Prema Viswanath, Srinivas P., Baldev Raj, Preparation of N-vanillyl chitosan and 4-hydroxybenzyl chitosan and their physico-mechanical, optical, barrier, and antimicrobial properties, *Carbohydrate Polym.,* 2012, **87(1),** 110-116

52 Jagadish R.S., Raj B., Properties and sorption studies of polyethylene oxide-starch blended films, *Food Hydrocolloids*, 2011, **25(6),**1572-1580

53 Jamuna J. Bhaskar, Shobha M.S., Sambaiah K., Salimath P.V., Beneficial effects of banana (*Musa* sp var. elakki bale) flower and pseudostem on hyperglycemia and advanced glycation end-products (AGEs) in streptozotocin-induced diabetic rats, *J. Physiol. Biochem,* 2011, **67(3),** 415-425

54 Jayachandra T., Venugopal C., Appaiah K.A.A., Utilization of phytotoxic agro waste- coffee cherry husk through pretreatment by the ascomycetes fungi Mycotypha for biomethanation, *Energy for Sustainable Development*, 2011, **15(1),** 104-108

55 Jayadeep A., Malleshi N.G., Nutrients, composition of tocotrienols, tocopherols, and γ-oryzanol, and antioxidant activity in brown rice before and after biotransformation, *Cyta J. Food,* 2011, **9(1),** 82-87

56 Joladarashi D., Salimath P.V., Chilkunda N.D., Diabetes results in structural alteration of chondroitin sulfate/dermatan sulfate in the rat kidney: Effects on the binding to extracellular matrix components, *Glycobiology,* 2011, **21(7),** 960-972

57 Jyothi Lakshmi A., Purnima Kaul Tikku, Nutritional potential, bioaccessibility of minerals and functionality of watermelon *(Citrullus vulgaris)* seeds, *LWT-Food Sci. Technol.*, 2011, **44(8),** 1821-1826

58 Jyothi Maria Veigas, Divya P., Bhagyalakshmi N., Identification of previously unreported pigments among carotenoids and anthocyanins in floral petals of *Delonix regia* (Hook.) Raf., *Food Res. Int.,* 2012, **47,** 116-123

59 Jyothsna Rajiv S., Indrani D., Sai Manohar R., Venkateswara Rao G., Effect of fenugreek *(Trigonella foenum graecum L.)* on the textural characteristics and microstructure of vermicelli from triticum durum wheat semolina, *J. Food Processing Preservation,* 2011, **35(3),** 320-226

60 Jyothsna Rajiv S., Soumya C., Indrani D., Venkateswara Rao G., Effect of replacement of wheat flour with finger millet flour *(Eleusine corcana)* on the batter microscopy, rheology and quality characteristics of muffins, *J. Texture Studies,* 2011, **42(6),** 478-489

61 Khamrunissa Begum, Rajini P.S., Augmentation of hepatic and renal oxidative stress and disrupted glucose homeostasis by monocrotophos in streptozotocin-induced diabetic rats, *Chemico-Biological Interactions*, 2011, **193(3),** 240-245

62 Khan M.I., Denny Joseph K.M., Muralidhara, Ramesh H.P., Giridhar P., Ravishankar G.A., Acute, subacute and subchronic safety assessment of betalains rich *Rivina humilis* L. berry juice in rats, *Food Chem. Toxicol.,* 2011, **49,** 3154-3157

63 Khan M.I., Harsha P.S.C.S., Giridhar P., Ravishankar G.A., Berberine and lycopene profiling during the ontogeny of *Tinospora cordifolia* (willd.) Miers ex Hook. F. & Thoms fruit, *Current Sci.,* 2011, **100(8),**1225-1231

64 Khan M.I., Harsha P.S.C.S., Giridhar P., Ravishankar G.A., Pigment identification, antioxidant activity, and nutrient composition of *Tinospora cordifolia* (willd.) Miers ex Hook. f & Thoms fruit, *Int. J. Food Sci. Nutri.,* 2011, **62(3),** 239-249

65 Kiran G., Nandini C.D., Ramesh H.P., Salimath P.V., Progression of early phase diabetic nephropathy in streptozotocin-induced diabetic rats: Evaluation of various kidney-related parameters, *Indian J. Exptl. Biology*, 2012, **50,** 133-140

66 Krishnan R., Usha Dharmaraj, Sai Manohar R., Malleshi N.G., Quality characteristics of biscuits prepared from finger millet seed coat based composite flour, *Food Chem.,* 2011, **129(2),** 499-506

67 Krishnarjuna B., Anjali D. Ganjiwale, Uma V. Manjappara, Raghothama S., NMR structure implications of enhanced efficacy of obestatin fragment analogs, *Int. J. Pept. Res. Ther.,* 2011, **17,** 259-270

68 Kudachikar V.B., Kulkarni S.G., Keshava Prakash M.N., Effect of modified atmosphere packaging on quality and shelf life of 'Robusta' banana *(Musa sp.)* stored at low temperature, *J. Food Sci. Technol.*, 2011, **48(3),** 319-324

69 Kulkarni S.G., Kudachikar V.B., Keshava Prakash M.N., Studies on physico-chemical changes during artificial ripening of banana *(Musa sp)* variety 'Robusta', *J. Food Sci. Technol.,* 2011, **48(6),** 730-734

70 Kumar L.S.S., Thakur M.S., Competitive immunoassay for analysis of vitamin B_{12}, *Analytical Biochem.,* 2011, **418(2),** 238-246

71 Latha R., Ramasarma P.R., Thakur M.S., Manonmani H.K., Purification and characterization of DDT-dehydrohalogenase from *Pseudomonas putida* T5, *Preparative Biochem. Biotechnol.,* 2012, **42,** 60-76

72 Lincy S.V., Chandrashekar A., Narayan M.S., Sharma R., Thakur R.P., Natural occurrence of trichothecene-producing fusaria isolated from India with particular reference to sorghum, *World J. Microbiol. Biotechnol.,* 2011, **27(4),** 981-989

73 Madhava Naidu M., Sujith Kumar P.V., Shyamala B.N., Sulochanamma G., Maya Prakash, Thakur M.S., Enzyme-assisted process for production of superior quality vanilla extracts from green vanilla pods using tea leaf enzymes, *Food Bioprocess Technol.,* 2012, **5,** 527-532

74 Madhava Naidu M., Sheema F., Ravi R., Manisha Guha, Srinivas P., Physico-chemical and functional properties of starch isolated from ginger spent, *Starch-Starke*, 2011, **63(9),** 570-578

75 Madhu A.N., Awasthi S.P., Reddy K.B.P.K., Prapulla S.G., Impact of freeze and spray drying on the retention of probiotic properties of *Lactobacillus fermentum:* An *in vitro* evaluation model, *Int. J. Microbiol. Res.,* 2011, **2(3),** 243-251

76 Madhu A.N., Prapulla S.G., In vitro fermentation of prebiotics by *Lactobacillus plantarum* CFR 2194: Selectivity, viability and effect of metabolites on beta-glucuronidase activity, *World J. Microbiol. Biotechnol.*, 2012, **28,** 901-908

77 Madhumitha S., Prabhasankar P., Influence of additives on functional and nutritional quality characteristics of black gram flour incorporated pasta, *J. Texture Studies,* 2011, **42(6),** 441-450

78 Madhusudhan M.C., Chethana S., Raghavarao K.S.M.S., Electrokinetic demixing of polymer / salt systems containing biomolecules, *Separation Sci. Technol.,* 2011, **46(5),** 727-733

79 Madhusudhan M.C., Raghavarao K.S.M.S., Aqueous two phase extraction of invertase from baker's yeast: Effect of process parameters on partitioning, *Process Biochem.,* 2011, **46(10),** 2014-2020

80 Mahendranath G., Venugopalan A., Parimalan R., Giridhar P., Ravishankar G.A., Annatto pigment production in root cultures of achiote *(Bixa orellana L.), Plant Cell Tiss. Organ Cult.,* 2011, **106(3),** 517-522

81 Mamatha B.S., Arun Kumar R., Baskaran V., Effect of processing on major carotenoid levels in corn (*zea mays)* and selected vegetables: Bioavailability of lutein and zeaxanthin from processed corn in mice, *Food Bioprocess Technol.,* 2012, **5,** 1355-1363

82 Mamatha B.S., Baskaran V., Effect of micellar lipids, dietary fiber and beta-carotene on lutein bioavailability in aged rats with lutein deficiency, *Nutri.,* 2011, **27(9),** 960-966

83 Mamatha B.S., Sangeetha R.K., Baskaran V., Provitamin-A and xanthophyll carotenoids in vegetables and food grains of nutritional and medicinal importance, *Int. J. Food Sci. Technol.,* 2011, **46(2),** 315-323

84 Manisha Guha, Ali S.Z., Changes in rheological properties of rice flour during extrusion cooking, *J. Texture Studies*, 2011, **42(6),** 451-458

85 Manisha Guha, Umesh S.S., Yella Reddy S., Malleshi N.G., Functional properties of slow carbohydrate digestible rice produced adapting hydrothermal treatment, *Int. J. Food Properties,* 2011, **14(6),** 1305-1317

86 Manjula S., Jose A., Divakar S., Subramanian R., Degumming rice bran oil using phospholipase-A_1, *Eur. J. Lipid Sci. Technol.,* 2011, **113(5),** 658-664

87 Manjula S., Kobayashi I., Subramanian R., Characterization of phospholipid reverse micelles in nonaqueous systems in relation to their rejection during membrane processing, *Food Res. Int.,* 2011, **44(4),** 925-930

88 Manjulata Devi S., Prakash M. Halami, Detection and characterization of pediocin PA-1/ AcH like bacteriocin producing lactic acid bacteria, *Curr. Microbiol.,* 2011, **63(2),** 181-185

89 Manohar B., Udaya Sankar K., Prediction of solubility of *Psoralea corylifolia* L. seed extract in supercritical carbon dioxide by equation of state models, *Theoretical Foundations Chem. Eng.,* 2011, **45(4),** 409-419

90 Manu B.T., Prasada Rao U.J.S., Role of peroxidase and H_2O_2 in cross-linking of gluten proteins, *J. Food Biochem.,* 2011, **35,** 1695-1702

91 Matche R.S., Sreekumar R.K., Baldev Raj, Modification of linear low-density polyethylene film using oxygen scavengers for its application in storage of bun and bread, *J. Appl. Polym. Sci.,* 2011, **122(1),** 55-63

92 Mathur C., Jimsheena V.K., Banerjee S., Makinen K., Lalitha R. Gowda, Savithri H.S., Functional regulation of PVBV nuclear inclusion protein-a protease activity upon interaction with viral protein genome-linked and phosphorylation, *Virology,* 2012, **422,** 254-264

93 Meenata K., Soumya R., Rathina Raj K., Sachindra N.M., Antioxidant activity of protein isolate obtained by the pH shift technique from hydrolyzed and unhydrolyzed shrimp processing discards, *J. Aquatic Food Product Technol.,* 2011, **20(2),** 209-221

94 Meera M.S., Bhashyam M.K., Ali S.Z., Effect of heat treatment of sorghum grains on storage stability of flour, *LWT-Food Sci. Technol.,* 2011, **44(10),** 2199-2204

95 Meesha Sharma, Lokesh B.R., Effect of enzymatic trans- and interesterification on the thermal properties of groundnut and linseed oils and their blends, *J. Am. Oil Chem. Soc.*, 2012, **89,** 805-813

96 Mohammad Imitiyaz Khan, Asha M.R., Bhat K.K., Sakina Khatoon, Studies on quality of coconut oil blends after frying potato chips, *J. Am. Oil chem. soc.,* 2011, **85,** 1165-1172

97 Mohan Kumari H.P., Mohan A. Dhale, Akhilender Naidu K., Vijayalakshmi G., Antioxidant effect of red mould rice in hypercholesterolemic wistar male rats, *Cell Biochem. Function,* 2011, **29(7),** 597-602

98 Mohan Kumari H.P., Mohan A. Dhale, Vaishali G., Shradha K., Statins: 3-hydroxy-3-methylglutaryl-coa (HMG-CoA) reductase inhibitors demonstrate anti-atherosclerotic character due to their antioxidant capacity, *Appl. Biochem. Biotechnol.,* 2011, **163(2),** 215-222

99 Mounika C., Yella Reddy S., Preparation of palm olein enriched with medium chain fatty acids by lipase acidolysis, *Food Chem.,* 2012, **132,** 216-221

100 Muralikrishna G., Schwarz S., Dobleit G., Fuhrmann H., Krueger M., Fermentation of feruloyl and non-feruloyl xylooligosaccharides by mixed fecal cultures of human and cow: A comparative study *in vitro*, *Eur. Food Res. Technol.,* 2011, **232(4),** 601-611

101 Muruganantham N., Basavaraj K.H., Dhanabal S.P., Praveen T.K., Shamasundar N.M., Rao K.S., Screening of *Caesalpinia* bonduc leaves for antipsoriatic activity, *J. Ethnopharmacology,* 2011, **133(2),** 897-901

102 Namitha K.K., Archana S.N., Negi P.S., Expression of carotenoid biosynthetic pathway genes and changes in carotenoids during ripening in tomato *(Lycopersicon esculentum), Food Funct.*, 2011, **2,** 168-173

103 Nandeesh K., Jyotsna Rajiv S., Venkateswara Rao G., Effect of differently treated wheat bran on rheology, microstructure and quality characteristics of soft dough biscuits, *J. Food Processing Preservation,* 2011, **35(2),** 179-200

104 Narayan A.V., Madhusudhan M.C., Raghavarao K.S.M.S., Demixing kinetics of phase systems employed for liquid-liquid extraction and correlation with system properties, *Food Bioproducts Processing,* 2011, **89(1),** 251-256

105 Narsing Rao G, Prabhakara Rao P.G., Rao D.G., Preparation of wood apple *(Feronia limonia L.)* seed protein concentrate and evaluation of its nutritional and functional characteristics, *Int. Food Res. J.,* 2011, **18(3),** 914-920

106 Narsing Rao G., Balaswamy K., Prabhakara Rao P.G., Rao D.G., Satyanarayana A., Nutritional quality, fatty acid, amino acid and functional characteristics of bael (*Aegle marmelos* L.) seed protein concentrate, *J. Food Drug Analysis,* 2011, **19 (4),** 528-535

107 Narsing Rao G., Balaswamy K., Satyanarayana A., Prabhakara Rao P.G., Physico-chemical, amino acid composition, functional and antioxidant properties of roe protein concentrates obtained from *Channa striatus* and *Lates calcarifer, Food Chem.,* 2012, **132,** 1171-1176

108 Narsing Rao G., Prabhakara Rao P.G., Satyanarayana A., Chemical, amino acid and fatty acid composition of *Sterculia urens L.* seed, *Food Hydrocolloids,* 2012, **28,** 320-324

109 Nidhi B., Baskaran V., Influence of vegetable oils on micellization of lutein in a simulated digestion model, *J. Am. Oil Chem. Soc.,* 2011, **88(3),** 367-372

110 Nirmala Metwal, Jyotsna Rajiv S., Jeyarani T., Venkateswara Rao G., Influence of debittered, defatted fenugreek seed powder and flaxseed powder on the rheological characteristics of dough and quality of cookies, *Int. J. Food Sci. Nutri.,* 2011, **62(4),** 336-344

111 Nisha A., Udaya Sankar K., Venkateswaran G., Supercritical CO_2 extraction of *Mortierella alpina* single cell oil: Comparison with organic solvent extraction, *Food Chem.,* 2012, **133(1),** 220-226

112 Nisha A., Venkateswaran G., Effect of culture variables on mycelial arachidonic acid production by *Mortierella alpina, Food Bioprocess Technol.,* 2011, **4(2),** 232-240

113 Obulesu M., Sila Bhattacharya, Color changes of tamarind *(Tamarindus indica L.)* pulp during fruit development, ripening and storage, *Int. J. Food Properties,* 2011, **14(3),** 538-549

114 Parimalan R., Akshatha V., Giridhar P., Ravishankar G.A., Somatic embryogenesis and *Agrobacterium*-mediated transformation in *Bixa orellana L., Plant Cell Tiss. Organ Cult.,* 2011, **105(3),** 317-328

115 Parimalan R., Giridhar P., Ravishankar G.A., Enhanced shoot organogenesis in *Bixa orellana* L. in the presence of putrescine and silver nitrate, *Plant Cell Tiss. Organ Cult.,* 2011, **105(3),** 285-290

116 Policegoudra R.S., Chandrashekhar R.H., Aradhya S.M., Singh L., Cytotoxicity, platelet aggregation inhibitory and antioxidant activity of *Curcuma amada* Roxb. extracts, *Food Technol. Biotechnol.,* 2011, **49(2),** 162-168

117 Prabhakara Rao P.G., Narsing Rao G., Nagender A., Jyothirmayi T., Satyanarayana A., Standardization, chemical characterization and storage studies of an instant *pulihora* mix based on raw mango, *Indian J. Traditional Knowledge,* 2012, **11(1),** 90-95

118 Prachi Thatte, Indrani D., Jyothi Lakshmi A., Retention and bioaccessibility of beta-carotene from natural and synthetic sources on baking, *J. Food Quality*, 2011, **34,** 403-412

119 Prachi Thatte, Jyothi Lakshmi A., Nutritional potential, bioaccessibility of minerals and antioxidant properties of niger (*Guizotia abyssinicacass*) seed protein, *Int. J. Food Sci. Technol.*, 2012, **47,** 656-6634

120 Prakash M. Halami, Badarinath V., Manjulata Devi S., Vijayendra S.V.N., Partial characterization of heat-stable, antilisterial and cell lytic bacteriocin of *Pediococcus pentosaceus* CFR SIII isolated from a vegetable source, *Annals Microbiol.,* 2011, **61(2),** 323-330

121 Prasad B., Rashmi M.D., Yashoda K.P., Modi V.K., Effect of casein and oat flour on physicochemical and oxidative processes of cooked chicken *Kofta, J. Food Processes Preservation,* 2011, **35(3),** 359-368

122 Prasad N.S., Muralidhara, Modulatory potency of eugenol and its derivatives against acrylamide-induced oxidative stress and neurotoxicity in *Drosophila larvae*, *Atla-Alternatives to Laboratory Animals*, 2011, **39(1),** 85-86

123 Prathesha P., Ramaswamy K., Effect of naturally occurring antimicrobials and chemical preservatives on the growth of *Aspergillus parasiticus*, *J. Food Sci. Technol.,* 2012, **49(2),** 228-233

124 Prema Viswanath, Divyashree K.N., Hemalatha G., Akshatha M.D., Vinutha S., Aflatoxin determination in black tea (*Camellia sinensis*) - status and development of a protocol, *J. Food Safety,* 2011, **32,** 13-21

125 Purnima C., Ramasarma P.R., Prabhasankar P., Studies on effect of additives on protein profile, microstructure and quality characteristics of pasta, *J. Food Sci. Technol.,* 2012, **49(1),** 50-57

126 Pushpa S. Murthy, Madhava Naidu M., *Production and application of xylanase from Penicillium sp. utilizing coffee by-products, Food Bioprocess Technol.,* 2012, **5,** 657-664

127 Pushpa S. Murthy, Madhava Naidu M., Recovery of phenolic antioxidants and functional compounds from coffee industry by-products, *Food Bioprocess Technol.,* 2012, **5,** 897-903

128 Rahath Kubra I., Jaganmohan Rao L., Effect of microwave drying on the phytochemical composition of volatiles of ginger, *Int. J. Food Sci. Technol.,* 2012, **47,** 53-60

129 Rahath Kubra I., Ramalakshmi K., Jaganmohan Rao L., Antioxidant enriched fractions from Zingiber officinale roscoe, *E-J. Chem.*, 2011, **8(2),** 721-726

130 Rajeev Ranjan, Rastogi N.K., Thakur M.S., Development of immobilized biophotonic beads consisting of *Photobacterium leiognathi* for the detection of heavy metals and pesticide, *J. Hazardous Materials*, 2012, 114-123

131 Raju M., Lakshminarayana R., Baskaran V., Single oral dose of micellar beta-carotene containing phospholipids improves beta-carotene metabolism and plasma lipids in vitamin A-deficient rats, *Eur. J. Nutri.,* 2011, **50(7),** 531-541

132 Ramakrishna A., Dayananda C., Giridhar P., Rajasekaran T., Ravishankar G.A., Photoperiod influences endogenous indoleamines in cultured green alga *Dunaliella bardawil, Indian J. Exptl. Biology,* 2011, **49(3),** 234-240

133 Ramakrishna A., Giridhar P., Jobin M., Paulose C.S., Ravishankar G.A., Indoleamines and calcium enhance somatic embryogenesis in *Coffea canephora* P ex Fr., *Plant Cell Tiss. Organ Cult.,* 2012, **108,** 267-278

134 Ramakrishna A., Giridhar P., Ravishankar G.A., Calcium and calcium ionophore A23187 induce high-frequency somatic embryogenesis in cultured tissues of Coffea *canephora* P ex Fr, *In Vitro Cell. Dev. Biology-Plant,* 2011, **47,** 667-673

135 Ramakrishna A., Giridhar P., Udaya Sankar K., Ravishankar G.A., Endogenous proûles of indoleamines: Serotonin and melatonin in different tissues of *Coffea canephora* P ex Fr. as analyzed by HPLC and LC-MS-ESI, *Acta Physiol. Plant,* 2012, **34,** 393-396

136 Raman V., Ravi S., Effect of salicylic acid and methyl jasmonate on antioxidant systems of *Haematococcus pluvialis, Acta Physiol. Plant.,* 2011, **33(3),** 1043-1049

137 Rani M.U., Anu Appaiah K.A., *Gluconacetobacter hansenii* UAC09-mediated transformation of polyphenols and pectin of coffee cherry husk extract, *Food Chem.,* 2012, **130,** 243-247

138 Rani M.U., Anu Appaiah K.A., Optimization of culture conditions for bacterial cellulose production from *Gluconacetobacter hansenii* UAC09, *Annals Microbiol.,* 2011, **61(4),** 781-787

139 Rani M.U., Rastogi N.K., Anu Appaiah K.A., Statistical optimization of medium composition for bacterial cellulose production by *Gluconacetobacter hansenii* UAC09 using coffee cherry husk extract - an agro-industry waste, *J. Microbiol. Biotechnol.,* 2011, **21(7),** 739-745

140 Ranjini M.S., Hosamani R., Muralidhara, Ramachandra N.B., Differential susceptibility of a few members of nasuta-albomicans complex of *Drosophila* to paraquat-induced lethality and oxidative stress, *Genome,* 2011, **54(10),** 829-835

141 Rashmi Kumari, Jeyarani T., Soumya C., Indrani D., Use of vegetable oils, emulsifiers and hyudrocolloids on rheological, fatty acid profile and quality characteristics of pound cake, *J. Texture Studies*, 2011, **42(5),** 377-386

142 Reddy R.R.L., Srinivasan K., Dietary fenugreek and onion attenuate cholesterol gallstone formation in lithogenic diet-fed mice, *Int. J. Experimental Pathology,* 2011, **92(5),** 308-319

143 Reddy R.R.L., Srinivasan K., Hepatoprotective and antioxidant effect of fenugreek *(Trigonella foenum - graecum)* seeds in mice under lithogenic condition, *J. Food Biochem.,* 2011, **35,** 1619-1626

144 Reena M.B., Lokesh B.R., Effect of blending and lipase catalyzed interesterification reaction on the cholesterol lowering properties of palm oil with rice bran oil in rats, *Int. J. Food Sci. Technol.,* 2012, **47,** 203-209

145 Rekha C.R., Vijayalakshmi G., Accelerated fermentation of *'idli'* batter using soy residue okara, *J. Food Sci. Technol.,* 2011, **48(3),** 329-334

146 Revanappa S.B., Salimath P.V., Phenolic acid profiles and antioxidant activities of different wheat *(Triticum aestivum L.)* varieties, *J. Food Biochem.,* 2011, **35(3),** 759-775

147 Rohinishree Y.S., Negi P.S., Multiplex reverse transcription polymerase chain reaction to study the expression of virulence and stress response genes in *Staphylococcus aureus, J. Food Sci.,* 2012, **77(2),** 95-101

148 Rohit Upadhyay, Ramalakshmi K., Jaganmohan Rao L., Microwave-assisted extraction of chlorogenic acids from green coffee beans, *Food Chem.,* 2012, **130,** 184-188

149 Sairam S., Gopala Krishna A.G., Urooj A., Physico-chemical characteristics of defatted rice bran and its utilization in a bakery product, *J. Food Sci. Technol.,* 2011, **48(4),** 478-483

150 Sampurna S., Yella Reddy S., Preparation and application of trans-free vanaspati substitute in selected Indian traditional foods, *Food Sci. Technol. Res.,* 2011, **17(3),** 219-226

151 Sangeetha A.V., Mahadevamma S., Khyrunnisa Begum, Sudha M.L., Influence of processed sugarcane bagasse on the microbial, nutritional, rheological and quality characteristics of biscuits, *Int. J. Food Sci. Nutri.,* 2011, **62(5),** 457-464

152 Santoshkumar M.S., Arun Chandrashekar, Venkatesh Y.P., Eggplant polyphenol oxidase multigene family: Cloning, phylogeny, expression analyses and immunolocalization in response to wounding, *Phytochem.,* 2011, **72,** 2275-2287

153 Santoshkumar M.S., Arun Chandrashekar, Venkatesh Y.P., Promoter analyses and transcriptional profiling of eggplant polyphenol oxidase 1 gene (*SmePP01*) reveal differential response to exogenous methyl jasmonate and salicylic acid, *J. Plant Physiology*, 2012, **169,** 718-730

154 Sarath Babu V.R., Thakur M.S., Sanjukta Patra, Effect of physicochemical parameters on enzymatic biodecaffeination during tea fermentation, *Appl. Biochem. Biotechnol.,* 2012, **166,** 112-126

155 Saravanan K., Aradhya S.M., Polyphenols of pseudostem of different banana cultivars and their antioxidant activities, *J. Agric. Food Chem.,* 2011, **59(8),** 3613-3623

156 Saravanan K., Aradhya S.M., Potential nutraceutical food beverage with antioxidant properties from banana plant bio-waste (*Pseudostem* and *rhizome*), *Food & Function,* 2011, **2(10),** 603-610

157 Sasikala V.B., Ravi R., Narasimha H.V., Textural changes of green gram (*Phaseolus aureus*) and horse gram (*Dolichos biflorus*) as affected by soaking and cooking, *J. Texture Studies,* 2011, **42(1),** 10-19

158 Savitha Y.S., Vasudeva Singh, Status of dietary fiber contents in pigmented and non-pigmented rice varieties before and after parboiling, *LWT-Food Sci. Technol.,* 2011, **44(10),** 2180-2184

159 Selvakumar L.S., Thakur M.S., Dipstick based immunochemiluminescence biosensor for the analysis of vitamin B_{12} in energy drinks : A novel approach, *Analytica Chimica Acta*, 2012, **722,** 107-113

160 Shakuntala S., Pura Naik J., Jeyarani T., Madhava Naidu M., Srinivas P., Characterisation of germinated fenugreek *(Trigonella foenum-graecum L.)* seed fractions, *Int. J. Food Sci. Technol.,* 2011, **46(11),** 2337-2343

161 Shashikumar S., Rajini P.S., Alpha-tocopherol ameliorates cypermethrin-induced toxicity and oxidative stress in the nematode *Caenorhabdtis elegans, Indian J. Biochem. Biophys.,* 2011, **48(3),** 191-196

162 Shipra Tiwari, Suvendu Bhattacharya, Aeration of model gels: Rheological characteristics of gellan and agar gels, *J. Food Eng.,* 2011, **107(1),** 134-139

163 Shivakumar K.M., Chetana R., Yella Reddy S., Preparation and properties of encapsulated fat powders containing speciality fat and w/PUFA rich oils, *Int. J. Food Properties,* 2012, **15,** 412-425

164 Shivananjappa M.M., Muralidhara, Abrogation of maternal and fetal oxidative stress in the streptozotocin-induced diabetic rat by dietary supplements of *Tinospora cordifolia*, *Nutri.,* 2011, **28(5),** 1-7

165 Shivani Bansal, Sudha M.L., Nutritional, microstructural, rheological and quality characteristics of biscuits using processed wheat germ, *Int. J. Food Sci. Nutri.,* 2011, **62(5),** 474-479

166 Shobharani P., Renu Agrawal R., Enhancement of cell stability and viability of probiotic *Leuconostoc mesenteroides* MTCC 5209 on freeze drying, *Int. J. Dairy Technol.,* 2011, **64(2),** 276-287

167 Shobharani P., Renu Agrawal, A potent probiotic strain from cheddar cheese, *Indian J. Microbiol.,* 2011, **51(3),** 251-258

168 Shubha M.C., Reddy R.R.L., Srinivasan K., Antilithogenic influence of dietary capsaicin and curcumin during experimental induction of cholesterol gallstone in mice, *Appl. Physiol. Nutri. Metab.,* 2011, **36(2),** 201-209

169 Shubhra Pande, Kalpana Platel, Srinivasan K., Antihypercholesterolaemic influence of dietary tender cluster beans (*Cyamopsis tetragonoloba*) in cholesterol fed rats, *Indian J. Medical Res.*, 2012, **135,** 401-406

170 Shubhra Pande, Srinivasan K., Potentiation of the hypolipidemic influence of dietary tender cluster bean *(Cyamopsis tetragonoloba)* by garlic in cholesterol fed rats, *Food Chem.,* 2012, **133,** 798-805

171 Siddaraju M.N., Harish Nayaka M.A., Shylaja M. Dharmesh, Gastroprotective effect of ginger rhizome *(Zingiber officinale)* extract: Role of garlic acid and cinnamic acid in H(+), K(+)-ATPase/*H. pylori* inhibition and anti-oxidative mechanism, *Evidence-Based Complementary Alternative Medicine*, 2011, 1-13

172 Siddiq M., Iezzoni A., Khan A., Breen P., Sebolt A.M., Dolan K.D., Ravi R., Characterization of new tart cherry *(Prunus cerasus L.):* Selections based on fruit quality, total anthocyanins, and antioxidant capacity, *Int. J. Food Properties,* 2011, **14(2),** 471-480

173 Sivaprasad M., Policegoudra R.S., Kumar H.M.S., Aradhya S.M., Changes in the biochemical and bioactive constituents of Indian hog plum *(Spondias mangifera* willd.) fruit during ambient storage, *J. Horticultural Sci. Biotechnol.,* 2011, **86(3),** 267-276

174 Smita G., Kalpana Platel, Srinivasan K., Assessment of zinc deficiency and effect of dietary carrot, *Amchur* and onion on zinc status during repletion in zinc-deficient rats, *J. Sci. Food Agric.,* 2012, **92,** 165-170

175 Sneharani A.H., Sridevi Annapurna Singh, Srinivas P., Appu Rao A.G., Inhibition of lipoxygenase-1 by *tetrahydrocurcumin, Eur. Food Res. Technol.,* 2011, **233(4),** 561-568

176 Sowbhagya H.B., Mahadevamma S., Indrani D., Srinivas P., Physicochemical and microstructural characteristics of celery seed spent residue and influence of its addition on quality of biscuits, *J. Texture Studies*, 2011, **42(5),** 369-376

177 Sowmya N., Thakur M.S., Manonmani H.K., Detection of enterotoxigenic staphylococci by loop-mediated isothermal amplification method, *J. Food Safety,* 2012, **32,** 59-65

178 Sowmya R., Rathinaraj K., Sachindra N.M., An autolytic process for recovery of antioxidant activity rich carotenoprotein from shrimp heads, *Marine Biotechnol.,* 2011, **13(5),** 918-927

179 Sreerama Y.N., Sashikala V.B., Pratape V.M., Vasudeva Singh, Nutrients and antinutrients in cowpea and horse gram flours in comparison to chickpea flour: Evaluation of their flour functionality, *Food Chem.,* 2012, **131,** 462-468

180 Srikanta B.M., Harish Nayaka M.A., Shylaja M. Dharmesh, Inhibition of *Helicobacter pylori* growth and its cytotoxicity by 2-hydroxy 4-methoxy benzaldehyde of *Decalepis hamiltonii* (Wight & Arn); a new functional attribute, *Biochime,* 2011, **93(4),** 678-688

181 Srinivas S., Prakash V., Interaction of ZN (II) with bovine milk alpha-casein: Structure-function study, *J. Food Biochem.,* 2011, **35(4),**1311-1326

182 Sudhanva M.S., Nanishankar V.H., Improved synthesis of lysine- and arginine- derived Amadori and Heyns products and in vitro measurement of their *Angiotensin* I-converting enzyme inhibitory activity, *J. Agric. Food Chem.,* 2012, **60,** 1522-1527

183 Sujith Kumar P.V., Basheer S., Ravi R., Thakur M.S., Comparative assessment of tea quality by various analytical and sensory methods with emphasis on tea polyphenols, *J. Food Sci. Technol.,* 2011, **48(4),** 440-446

184 Sukumar Debnath, Maya Prakash, Lokesh B.R., Lipase-mediated interesterification of oils for improving rheological, heat transfer properties and stability during deep-fat frying, *Food Bioprocess Technol.,* 2012, **5(5),**1630-1641

185 Sukumar Debnath, N.K. Rastogi, Gopala Krishna A.G., Lokesh B.R., Effect of frying cycles on physical, chemical and heat transfer quality of rice bran oil during deep-fat frying of poori: An Indian traditional fried food, *Food Byproducts Processing,* 2012, **90,** 249-256

186 Sukumar Debnath, Raghavarao K.S.M.S., Lokesh B.R., Hydrodynamic, thermo-analytical and molecular structural investigations of enzyme interesterified oil and its thermo-oxidative stability by thermogravimetric analysis, *J. Food Eng.,* 2011, **105(4),** 671-679

187 Sukumar Debnath, Ravi R., Lokesh B.R., Optimisation of lipase-catalysed interesterification reaction for modulating rheological and heat transfer properties of frying oil, *Food Chem.,* 2011, **129(4),** 1444-1452

188 Suresh P.V., Anil Kumar P.K., Sachindra N.M., Thermoactive beta -N-acetylhexosaminidase production by a soil isolate of *Penicillium monoverticillium* CFR 2 under solid state fermentation: Parameter optimization and application for N-acetyl chitooligosaccharides preparation from chitin, *World J. Microbiol. Biotechnol.,* 2011, **27(6),** 1435-1447

189 Suresh P.V., Sachindra N.M., Bhaskar N., Solid state fermentation production of chitin deacetylase by *Colletotrichum lindemuthianum* ATCC 56676 using different substrates, *J. Food Sci. Technol.,* 2011, **48(3),** 349-356

190 Suresha B.S., Sattur A.P., Srinivasan K., Beneficial influence of fungal metabolite nigerloxin on eye lens abnormalities in experimental diabetes, *Can. J. Physiol. Pharmacol.,* 2012, **90,** 387-394

191 Susanna S., Prabhasankar P., A comparative study of different bio-processing methods for reduction in wheat flour allergens, *Eur. Food Res. Technol.,* 2011, **233(6),** 999-1006

192 Swapna C.H., Bijinu B., Amit Kumar Rai, Bhaskar N., Simultaneous recovery of lipids and proteins by enzymatic hydrolysis of fish industry waste using different commercial poteases, *Appl. Biochem. Biotechnol,* 2011, **164,** 115-124

193 Swapna Joseph C., Harish Prashanth K.V., Rastogi N.K., Indiramma A.R., Yella Reddy S., Raghavarao K.S.M.S., Optimum blend of *Chitosan* and poly - *(Epsilon-caprolactone)* for fabrication of films for food packaging applications, *Food Bioprocess Technol.,* 2011, **4(7),** 1179-1185

194 Usha Dharmaraj, Malleshi N.G., Changes in carbohydrates, proteins and lipids of finger millet after hydrothermal processing, *LWT-Food Sci. Technol.,* 2011, **44(7),** 636-1642

195 Usha Dharmaraj, Ravi R., Malleshi N.G., Physicochemical and textural characteristics of expanded finger millet, *Int. J. Food Properties*, 2012, **15(2),** 336-349

196 Usha N.S.P., Srinivasan K., Fat digestion and absorption in spice-pretreated rats, *J. Sci. Food Agric.*, 2012, **92,** 503-510

197 Usha Rani M., Udayasankar K., Anu Appaiah K.A., Properties of bacterial cellulose produced in grape medium by native isolate Gluconacetobacter Sp., *J. Appl. Polym. Sci.,* 2011, **120(5),** 2835-2841

198 Vadivelan G., Divakar S., Synthesis of L-dopa glycosides using glucosidases, *Indian J. Chem.,* 2011, **50,** 1779-1785

199 Vasantha K .Y., Murugesh C.S., Sattur A.P., Rapid screening of enzyme inhibitors using profiling of enzyme-metabolite assay by HPLC (PREMA-HPLC), *J. Enzyme Inhib. Med. Chem.,* 2011, **27(1),** 132-137

200 Veena R., Sila Bhattacharya, Rheological characterization of raw and roasted green gram pastes, *LWT-Food Sci. Technol.,* 2012, **46,** 260-266

201 Vikrant Badgujar, Rastogi N.K., Extraction of phenol from aqueous effluent using triglycerides in supported liquid membrane, *Desalination and Treatment*, 2011, **36,** 187-196

202 Vinayaka A.C., Thakur M.S., Photoabsorption and resonance energy transfer phenomenon in CdTe-protein bioconjugates: An insight into QD-biomolecular interactions, *Bioconjugate Chem.,* 2011, **22(5),** 968-975

203 Vishwanathan K.H., Vasudeva Singh, Subramanian R., Wet grinding characteristics of soybean for soymilk extraction, *J. Food Eng.,* 2011, **106(1),** 28-34

204 Yadav J.K., Prakash V., Stabilization of alpha-amylase, the key enzyme in carbohydrates properties alterations, at low pH, *Int. J. Food Properties*, 2011, **14(6),** 1182-1196

205 Zarena A.S., Sachindra N.M., Udaya Sankar K., Optimisation of ethanol modified supercritical carbon dioxide on the extract yield and antioxidant activity from *Garcinia mangostana L., Food Chem.,* 2012, **130(1),** 203-208

206 Zarena A.S., Udaya Sankar K., Isolation and identification of pelargonidin 3-glucoside in mangosteen pericarp, *Food Chem.*, 2012, **130(3),** 665-670

207 Zarena A.S., Udaya Sankar K., Xanthones enriched extracts from mangosteen pericarp obtained by supercritical carbon dioxide process, *Separation Purification Technol.,* 2011, **80(1),**172-178

Non SCI Papers

1 Anand Paul D., Chhanwal N., Anandharamakrishnan C., An investigation on thermization of milk in can using computational fluid dynamics, *J. Food Sci. Eng.,* 2011, **1,** 35-45

2 Arul Selvi A., Sreenivasa M.A., Manonmani H.K., Development of an enzyme linked immunosorbent assay for the detection of glyphosate in water samples using avian antibodies, *Asian J. Microbiol. Biotech. Environ. Sci.,* 2011, **13(2),** 243-250

3 Balaswamy K., Prabhakara Rao P., Nagender A., Satyanarayana A., Preparation of sour grape *(Vitis vinifera)* beverages and evaluation of their storage stability, *J. Food Processing Technol.,* 2011, **2(3),** 1-4

4 Balaswamy K., Prabhakara Rao P.G., Narsing Rao G., Jyothirmayi T., Functional properties of roe protein hydrolysates from catla catla, *Electronic J. Environ. Agri. Food Chem.,* 2011, **10(4),** 2139-2147

5 Bhatt P., Negi P.S., Antioxidant and antibacterial activities in the leaf extracts of Indian borage (*Plectranthus amboinicus*), *Food Nutri. Sci.,* 2012, **3,** 146-152

6 Dayananda C. Lakshmanan V., Bhagyalakshmi N., Ravishankar G.A., Assessment of genetic polymorphism among green microalgae *Botryococcus* of distinct origin by RAPD, *Genes, Genomes and Genomics,* 2010, **4,** 65-69

7 Deepa C., Vasudeva Singh, Nutrient changes and functional properties of rice flakes prepared in a small scale industry, *Oryza,* 2011, **48(1),** 56-63

8 Deepa G., Shanavas S., Vasudeva Singh, Akhilender Naidu K., Thermal and cooking properties of Indian medicinal rice *Njavara* in aqueous and milk media, *Oryza,* 2011, **48(2),** 160-170

9 Deepa G., Vasudeva Singh, Akhilender Naidu K., Characterization of antioxidant compounds and antioxidant activity of Indian rice varieties, *J. Herbs. Spices Medi. Plants,* 2012, **18,** 18-33

10 Ezhilarasi P.N., Karthik P., Anadharamakrishnan C., Preparation of curcumin nanoemulsion, *Sci. Soc.,* 2011, **9(2),** 87-90

11 Gangadharappa G.H., Mudalamani B., Determination of flour mill roll groove depth, machining time and power consumption by using computer aided spreadsheet, *Tecnica Molitoria,* 2011, **62,** 557-567

12 Gnanavel M., Muthukumar S.P., Identification of novel sweet proteins for nutritional applications, *Bioinformation,* 2011,**7(3),** 112-114

13 Gnanavel M., Shilpy S., Muthukumar S.P., Structure prediction and functional annotation of MHCII like hypothetical protein from laboratory rat (*Rattus norvegicus*), *Biotechnol. Bioinf. Bioeng.*, 2011, **1(3),** 331-335

14 Gopala Krishna A.G., Bhatnagar A.S., Prabhakar D.S., Anil Kumar H.G., Prasanth Kumar P.K.., Use of low temperature for the production of superior quality rice bran oil, *J. Lipid Sci. Technol.,* 2011, **43(3),** 102-110

15 Govardhan Singh R.S., Ogunsina, B.S., Radha C., Protein extractability from defatted *Moringa oleifera* Lam, seeds flour, *Ife J. Sci.,* 2011, **13(1),** 121-127

16 Hafeeza Khanum, Ramalakshmi K., Srinivas P., Borse B.B., Synergistic antioxidant action of oregano, ajowan and borage extracts, *Food Nutri Sci.,* 2011, **2,** 387-392

17 Harish Prashanth K.V., Advancement of chitosan based nanoparticles for present and future interests, *Asia Pacific Biotech. News*, 2011, **15,** 27-31

18 Jamuna J. Bhaskar, Puneeth Kumar A., Salimath P.V., Effect of Banana (*Musa* sp.var. elakki bale) flower and pseudostem on antioxidant and lysosomal enzyme activities in streptozotocin-induced diabetic rats, *J. Pharmacy Res.,* 2011, **4(4)**, 1087-1091

19 Jini R., Swapna H.C., Amit kumar R., Vrinda R., Prakash M. Halami, Sachindra N.M., Bhaskar N., Isolation and characterization of potential lactic acid bacteria (LAB) from freshwater fish processing wastes for application in fermentative utilization of fish processing waste, *Brazilan J. Microbiol.,* 2011, **42,** 1516-1525

20 Kalaimaran A., Formula derived mathematically for computation of perimeter of ellipse, *Int. Physics and Mathematical Sci.,* 2012, **2(1),** 46-49

21 Karthik P., Ezhilarasi P.N., Anadharamakrishnan C., Preparation of docosahexaenoic acid (DHA) nanoemulsion and investigation of its stability, *Sci. Soc.,* 2011, **9(2),** 83-86

22 Latha R., Mandappa I.M., Thakur M.S., Manonmani H.K., Effect of denaturants on the structure and activity of DDT-dehydrochlorinase, *Asian J. Microbiol. Biotec. Environ. Sci.,* 2011, **13(1),** 51-57

23 Latha R., Mandappa I.M., Thakur M.S., Manonmani H.K., Influence of metal ions on dehydrohalogenase activity, *African J. Basic Appl. Sci.,* 2011, **3(2),** 45-51

24 Mabel Merlen Jacob, Prapulla S.G., Microbial transglutaminase production by *Streptomyces griseocarneus* MTCC 328 and optimization of nutritional parameters by response surface methodological approach, *Int. J. Universal Pharmacy Life Sc.,* 2012, **2(1),** 64-78

25 Madhukumar M.S., Chandrashekar P.M., Venkatesh Y.P., Muralikrishna G., Immunomodulatory activity of xylo-oligosaccharides from Bengal gram (*Cicer arietinum L.*) husk, *Trends in Carbohydrate Res.,* 2011, **3(3),** 44-50

26 Mahendranath G., Akshatha V., Giridhar P., Ravishanakar G.A., Improvement of annatto pigment yield in achiote through laminarin spray: An ecofriendly approach, *Int. J. Agric. Environ. Biotechnol.,* 2011, **4(3),** 163-166

27 Mamatha B.S., Maya Prakash, Studies on pepper *(Piper nigrum L.)* cultivars by sensory and instrumental techniques, *J. Medi. Spice Plants,* 2011, **16(4),** 176-180

28 Mandappa I.M., Ranjini A., Devendra J. Haware, Manjunath M.N., Manonmani H.K., Immunoassay for the detection of lead ions in environmental water samples, *Int. J. Environ. Anal. Chem.,* 2012, **92(3),** 334-343

29 Manikanta V., Kumara S.S., Harsha P., Manilal P., Regional food diversity of traditional Indian cuisines - A perspective based on the database of Indian cuisines, *Information Studies*, 2012, **18(3),** 177-188

30 Mohan Kumar N.S., Manonmani H.K., A survey on acrylamide content in some of the food samples in and around Mysore city, India, *Asian J. Microbiol. Biotech. Environ. Sci.,* 2012, **14(1),** 149-155

31 Mohan Kumari H.P., Mohan A. Dhale, Vijayalakshmi G., Non-toxic effect of *Monascus purpureus* extract on lactic acid bacteria suggested their application in fermented foods, *Food Nutri. Sci.,* 2011, **2,** 837-843

32 Mukesh Kapoor, Nanotechnology in food sector: Current developments and future prospects, *Indian Food Industry,* 2011, **30(4),** 44-55

33 Panduranga Narasimha Rao B., Vijayendra S.V.N., Salooja M.K., Approaches for developing self learning instructional materials for industry-oriented courses, *Asean J. Open Distance Learning,* 2011, **3(1),** 63-78

34 Parimalan R., Mahendranath G., Giridhar P., Ravishankar G.A., Abiotic elicitor mediated augmentation of annatto pigment production in standing crop of *Bixa Orellana* L., *Indian J. Fundamental Appl. Life Sci.,* 2011, **1(4),** 229-236

35 Pradeep S.R., Malleshi N.G., Manisha Guha, Germinated millets and legumes as a source of gamma-aminobutyric acid*, World Appl. Sci. J.,* 2011, **14(1),** 108-133

36 Pushpa S. Murthy, Madhava Naidu M., Improvement of *Robusta* coffee fermentation with microbial enzymes, *Euro. J. Applied Sci.,* 2011, **3(4),** 130-139

37 Pushpa S. Murthy, Manjunatha M.R., Sulochannama G., Madhava Naidu M., Extraction, characterization and bioactivity of coffee anthocyanins*, Euro. J. Biological Sci.,* 2012, **4(1),** 13-19

38 Raghavarao K.S.M.S., Rastogi N.K., Hrishikesh A., Value added products from coconut, *Indian Coconut J.,* 2011, **7,** 11-14

39 Raghavendra R.H., Akhilender Naidu K., Eugenol and n-3 rich garden cress seed oil as modulators of platelet aggregation and eicosanoids in wistar albino rats, *The Open Nutraceuticals J.,* 2011**, 4,** 144-150

40 Ravi R., Vivek Kumar Singh, Maya Prakash, Projective mapping and product positioning of deep fat fried snack, *Food Nutri. Sci.,* 2011, **2,** 674 - 683

41 Rekha B., Sukumar Debnath, Lokesh B.R., Gopala Krishna A.G., Oil uptake and thermal stability of some vegetable oils and fats during frying and heating, *J. Lipid Sci. Technol.,* 2011, **43(2),** 56-63

42 Rohinishree Y.S., Negi P.S., Detection, identification and characterization of *Staphylococci* in street vend foods, *Food Nutri. Sci.,*, 2011, *2,* 304-313

43 Saini R.K., Giridhar P., Effect of temperature, chemical treatment, hydration and plant growth regulators on germination of seeds and immature zygotic embryo of swallow root *(Decalepis hamiltonii), Res. J. Agri. Sci.,* 2012, **3(1),** 40-44

44 Sanjay S., Pradeep S., Manikanta V., Kumara S.S., Harsha P., Manilal P., Genetic algorithm based approach for the selection of projects in public R&D institutions, *Indian J. Computer Sci. Eng.,* 2011, **2(4),** 523-529

45 Sarada R., Anila N., Algal transformations for enhanced metabolite production and pathway manipulation, *Asia Pacific Biotech News,* 2011, **15(9),** 32-34

46 Saranya Devi E., Vijayendra S.V.N., Shamala T.R., Exploration of rice bran, an agro-industry residue, for the production of intra- and extra-cellular polymers by *Sinorhizobium meliloti* MTCC 100, *Biocatalysis Agri. Biotechnol.,* 2012, **1(1),** 80-84

47 Sivaprasad M., Policegoudra R.S., Swaroop Kumar H.M., Aradhya S.M., Platelet aggregation inhibitory activity and radical scavenging activity of *Spondias mangifera* willd, *South Asian J. Exp. Biol.,* 2011, **1(1),** 25-30

48 Smitha J., Shylaja M. Dharmesh, Antiproliferative effect of antioxidative free and bound phenolics from *Andrographis serpyllifolia*, *Free Rad. Antiox.,* 2011, **1(3),** 17-26

49 Smitha J., Shylaja M. Dharmesh, Assessment of antioxidant potentials of free and bound phenolics of *Hemidesmus indicus (L)* R.Br against oxidative damage, *Pharmacognosy Res.,* 2011, **3(4),** 225-231

50 Sridevi V., Giridhar P., Ravishankar G.A., Evaluation of roasting and brewing effect on antinutritional diterpenes-cafestol and kahweol in coffee, *Global J. Medical Res.*, 2011, **11(5),** 17-22

51 Suresh D. Sakhare, Inamdar A.A., Application of eight-roller mill in wheat flour milling process, *Indian Food Industry,* 2011, **30(1),** 42-47

52 Utkarsh Kumar, Vasudeva Singh, Preparation and functional properties of noodles prepared from raw and hydro-thermally processed rice, *Oryza*, 2011, **48(3),** 258-266

53 Vadivelan G., Divakar S., Enzymatic catalyzed synthesis of serotonyl and epinephryl glycosides using amyloglucosidase from *Rhizopus* mold, *Indian J. Fundamental and Applied Sci.,* 2011, **1(2),** 15-21

54 Vasudeva Singh, Ali A.Z., Ravindranathan Kartha K.P., Physico-chemical properties of bamboo (*Bamboo arudinacea*) seed and its starch, *Trends in Carbohydrate Res.,* 2011, **3(2),** 54-59

55 Venkatachalam L., Lokesh V., Bhagyalakshmi N., A rare event of *Agrobacterium rhizogenes*-assisted genetic transformation of 'Silk' Banana (genotype-AAB), *J. Microb. Biochem. Technol.,* 2011, **3(1),** 13-17

56 Vijayalakshmi N.S., Baldev Raj, Suitability of plastic containers for drinking / potable water and regulations, *Beverage and Food World*, 2010, 38**(5),** 36-39

57 Vijayendra S.V.N., Panduranga Narasimha Rao B., Preparing microbiology professionals for food industry, *Indian Food Industry,* 2011, **30(5&6),** 33-44

15. BOOK CHAPTERS, REVIEWS AND PAPERS IN PROCEEDINGS

a) Book Chapters

1 Apurva Kumar R. Joshi, Rajini P.S., Organophosphorus insecticides and glucose homeostasis, In: Insecticides Pest Engineering, *Ed: Farzana Perveen,* Published by: In Tech, 2012, 63-84

2 Baldevaraj, Matche R.S., Jagadish R.S., Incorporation of chemical antimicrobial agents into polymeric films for food packaging, In: Multifunctional and nanoreinforced polymers for food packaging, *Ed: Jose-Maria Lagaron,* Published by: Woodhead Publishing (UK), 2011, 368-380

3 Baldevaraj, Matche R.S., Safety and regulatory aspects of plastics as food packaging materials, In: Multifunctional and nanoreinforced polymers for food packaging, *Ed: Jose-Maria Lagaron,* Published by: Woodhead Publishing (UK), 2011, 669-691

4 Baldevaraj, Matche R.S., Safety and regulatory aspects of plastics as food packaging materials, In: Emerging food packaging technologies principles and practice, *Ed: Kit L. Yam, Dong Sun Lee,* Published by: Woodhead Publishing (UK), 2011, 335-357

5 Bhagyalakshmi N., Jyothi Maria Veigas, Cellular antioxidant defenses and amelioration by biopigments with particular focus on mRNA oxidations, In: Emerging trends in dietary components for preventing and combating disease, *Ed: Patil B.S., Jayaprakasha G.K., Murthy K.N.C., Seeram N.P.,* Published by: American Chemical Society, **2012, 1093,** 487-519

6 Champagne C.P, Aachary A.A., Prapulla S.G., Technology and stability of probiotics and prebiotics in fruit and vegetable foods, In: Probiotic and prebiotic Foods, *Ed: Shah N.P., A.G. da Cruz et al.,* Published by Nova Science, 2011, 365-404

7 Gokul K., Manjunath M.J., Muralidhara, Exploring the neuroprotective efficacy of *withania somnifera*: A medicinal plant with diverse biological effects, In: Recent Progress in Medicinal Plants, *Ed: Govil J.N.,* Published by: Studium Press, (USA), 2012, 377-402

8 Kazuo Miyashita, Bhaskar N., Takayuku Tsukui, Hiroyuki Kamogawa, Masayuku Abe, Masashi Hosokawa, Brown seaweed lipids as potential source of Omega-3 PUFA in biological systems, In: Biotechnology and Applied Phycology, *Ed: Se-Kwon Kim,* Published by: Handbook of Marine Macroalgae: Wiley Blackwell, (UK), 2011, 329-339

9 Manonmani H.K., Bioremediation of hexachlorocyclohexane contaminated soil : Field trials, In: Pesticides in modern world, *Ed: Margarita Stoytcheva,* Published by: INTECH pen Acess, 2012, 475-504

10 Paul Singh R., Sukumar Debnath, Heat and mass transfer in foods during deep-fat frying, In: Batters and Breadings in Food Processing, Ed: Kulp K., Loewe R., Lorenz K., Gelroth J., Published by: AACC International, (USA), 2011, 185-206

11 Pratape V.M., Vasudeva Singh, Sashikala V.B., Waste utilization-cereal and grain processing industries, In: Food processing waste management, *Ed: Sharma S.K., Joshi V.K., Parmar Y.S.,* Published by: Scientific Book Suppliers (New Delhi), 2011, 53-72

12 Pura Naik J., Sowbhagya H.B., Madhava Naidu M., Borse B.B., *S*pices and condiments industrial waste management, In: Food processing Waste Management, *Ed: Joshi V.K., Sharma S.K.,* Published by: New India Publishing Agency, 2011, 195-228

13 Rajini P.S., Cashew nut (*Anacardium occidentale L.)* skin extract as a free radical scavenger, In: Nuts & Seeds in Health and Disease Prevention, *ED: Preedy V.R., Watson R.R., Patel V.B.,* Published by: Academic Press, Elsevier Inc., (London), 2011, 301-308

14 Sharma A.S.K.V.S., Vijananna patrikegala aashayagalu, In: Kannadadalli Vignana Samvahane, *Ed: Ramakrishna Rao H.R., Annantharamu T.R.,* Published by: Udayabhanu Centre for Advanced Studies, (Bangalore), 2011, 121-127

15 Srinivasan K., Spices for taste and flavor: Nutraceuticals for human health, In: Spices: The elixir of life, *Ed: Amit Krishna De*, Published by: Low Price Publications, (New Delhi), 2011, 43-62

b) Reviews

1 Akshatha V., Giridhar P., Ravishankar G.A., Food, ethanobotanical and diversified applications of *Bixa orellana* L.: A scope for its improvement through biotechnological mediation, *Indian J. Fundamental Applied Life Sci.,* 2011, **1(4),** 9-31

2 Chanakya H.N., Mahapatra D.M., Sarada R., Chauhan V.S., Abitha R., Sustainability of large-scale algal biofuel production in India, *J. Indian Institute Sci.,* 2012, **92(1),** 63-98

3 Dhanalakshmi K., Ghosal S., Suvendu Bhattacharya, Agglomeration of food powder and applications, *Critical Reviews Food Sci. Nutri.,* 2011, **51(5),** 432-441

4 Giridhar P., Sridevi V., Changes in agricultural biodiversity and its influence on food and nutrition, *Int. J. Agri. Environ. Biotechnol.,* 2011, **4(4),** 299-303

5 Gopala Krishna A.G., Raja Rajan R.G., Bhatnagar A.S., Rice bran oil and by-products: Chemistry, production and applications - a review, *Beverage & Food World* , 2012, **39,** 27-33

6 Gupta P.K., Health benefits of *Lactobacillus acidophilus* incorporated milk products, *J. Recent Trends in Bio. Sci.,* 2011, **1(2),** 3-12

7 Jayaprakasha G.K., Jaganmohan Rao L., Chemistry, biogenesis, and biological activities of *Cinnamomum zeylanicum, Critical Reviews Food Sci. Nutri.,* 2011, **51(6),** 547-562

8 Kedare S.B., Singh R.P., Genesis and development of DPPH method of antioxidant assay, *J. Food Sci. Technol.*, 2011, **48(4),** 412-422

9 Misra N.N., Tiwari B.K., Raghavarao K.S.M.S., Cullen P.J., Nonthermal plasma inactivation of food-borne pathogens, *Food Eng. Reviews,* 2011, **3(3-4),** 159-170

10 Murali Krishnan, Prabhasankar P., Health based pasta : Redefining the concept of the next generation convenience food, *Critical Reviews Food Sci. Nutri.,* 2012, **52,** 9-12

11 Policegoudra R.S., Aradhya S.M., Singh L., Mango ginger *(Curcuma amada roxb.)* - a promising spice for phytochemicals and biological activities, *J. Biosci.,* 2011, **36(4),** 739-748

12 Rahath Kubra I., Jaganmohan Rao L., An overview on inventions related to ginger processing and products for food and pharmaceutical applications, *Recent patents on Food Nutri. Agri.,* 2012, **4,** 31-49

13 Ramakrishna A., Giridhar P., Ravishankar G.A., Phytoserotonin - A review, *Plant Signaling & Behavior,* 2011, **6(6),** 800-809

14 Rastogi N.K., Opportunities and challenges in application of ultrasound in food processing, *Critical Reviews Food Sci. Nutri.,* 2011, **51(8),** 705-722

15 Sowbhagya H.B., Madhava Naidu M., Technological advances in food colours, *Chemical Industry Digest,* 2012 (March), 79-88

16 Zarena A.S., Udaya Sankar K., Design of submicron and nanoparticle delivery systems using supercritical carbon dioxide-mediated processes: An overview, *Therapeutic Delivery (Future Science Group),* 2011, **2(2),** 259-277

c) Short Communication, Short Notes and Editorial Notes

1 Akhilesh V. Singh, Lila K. Nath, Manisha Guha, Synthesis and characterization of highly acetylated sago starch, *Starch-Starke,* 2011, **63(9),** 523-527

2 Kumar S., Hemavathi A.B., Hebbar H.U., Affinity based reverse micellar extraction and purification of bromelain from pineapple *(Ananas comosus L. Merryl)* waste, *Process Biochem.,* 2011, **46(5),** 1216-1220

3 Policegoudra R.S., Goswami S., Aradhya S.M., Chatterjee S., Datta S., Sivaswamy R., Chattopadhyay P., Singh L., Bioactive constituents of *Homalomena* aromatic essential oil and its antifungal activity against dermatophytes and yeasts, *J. Medical mycology,* 2012, **22,** 83-87

4 Sarala M., Velu V., Anandharamakrishnan C., Singh R.P., Spray drying of *Tinospora Cordifolia* leaf and stem extract and evaluation of antioxidant activity, *J. Food Sci. Technol.,* 2011, **49(1),** 119-122

d) Proceedings

1. Anil Kumar Pulipaka, Krishna Rao S.N., Shilpa B.V., Divyadristi - A real-time hazard detection system using image analysis, *In: Proceeding of International Journal of Computer Applications* (IJCA), 2012, 12-15

2. Vijayendra S.V.N., Food safety systems for dairy industries, In: ISCON Proceedings of all India seminar on emerging technologies, in dairy industry, Bangalore, 2011, 19-25

e) Popular Science Articles

1. Sharma A.S.K.V.S., When silk and gold come together, Deccan Herald Daily, March 5, 2012

f) Books published

1. Recent trends in soft beverages, Editors: Jagan Mohan Rao L., Ramalakshmi K., Published by: Woodhead Publishing India Pvt. Ltd, New Delhi, 2011, (255 pages), (*Details of contributing authors with title and page nos. are listed below)*
    - Debabrata Patra, Ramalakshmi K., Jagan Mohan Rao L., Recent trends in coffee, 1-62
    - Maruti Prasad Panda, Bhanu Prakash G., Jagan Mohan Rao L., Recent trends in tea, 63-173
    - Deepika Sharma, Ramalakshmi K., Jagan Mohan Rao L., Recent trends in soft drinks, 179-255

2. Technology of muscle foods, Editors: Mahendrakar N.S., Sachindra N.M., Published by: Studium Press (India) Pvt. Ltd., USA, 2011, (355 pages), (*Details of contributing authors with title and page nos. are listed below)*

- Meat decontamination, Sachindra M.N., 29-52
- Recovery and application of biomaterials from animal byproducts, Bhaskar N., Mahendrakar N.S., 323-346

g) Handbook

1. Mabel Merlin Jacob, Prapulla S.G., Handbook of Fractions including India, In: Analysis of active compounds in functional foods, *Ed: Leo M.L. Nollet, Fidel Toldra,* Published by: CRC Press Taylor and Francis, 2012, 561-582

16. PAPERS PRESENTED AT SYMPOSIA AND CONFERENCES

The Institute scientists and students participated and presented posters as well as papers in various national and international symposia and conferences. The details are listed below:

Brief of the activities National and International

Event	National	International
• No. of papers presented	186	55
• No. of seminars in which papers presented	49	27
• No. of scientists associated	101	61

a) National

1 National seminar on recent advances in the development of fermented foods, BHU, Varanasi, April 8-9, 2011

2 National seminar on trends and developments in sensors instrumentation, Bangalore, April 8-9, 2011

3 Technology Summit 2011: Commercial technologies & innovations, Pune, April 28, 2011

4 National level seminar on emerging technologies in dairy industry, Bangalore, April 29-30, 2011.

5 Workshop on developing value added products from jackfruit seed and by product recovery from jackfruit waste, Trivandrum, Kerala, June 4-6, 2011

6 National conference on career and research trends in food processing, Thanjavur, June 24-25, 2011

7 National seminar on current technological challenges in food processing specially emphasizing food irradiation, Kolkata, June 25-26, 2011

8 Seminar on export opportunity for food processing, Chennai, July 22, 2011

9 National symposium on nanoscience and technology, Muvattupuzha, Kerala, September 1-2, 2011

10 National symposium on emerging trends in biotechnology, Cochin University of Science and Technology, Kochi, September 1-2, 2011

11 National conference on dissecting the complexities of plant biotechnology in the post-genomic era, Tumkur university, Tumkur, September 21, 2011

12 National conference on emerging trends in biotechnology & annual meeting of society for biotechnologists (India), Acharya Nagarjuna University, Guntur, A.P., September 24-26, 2011

13 National seminar on application of biotechnology in medical field-current scenario and future prospects, V.M.K.V. Engineering College, Vinayaka Mission University, Salem, September 28-29, 2011

14 Workshop on agriculture and allied R&D institutions and industry linkages, Bangalore, September 30, 2011

15 National symposium on functional application of colorants, Mumbai, October 14-15, 2011

16 ANSYS Users conference, Bangalore, October 19-20, 2011

17 Workshop on emerging technologies for food industry, Pune, October 20, 2011

18 Seminar on the food safety and standards act 2006 with special reference to milk & milk products, Kozhikode, October 22, 2011

19 National conference on agro food processing technologies, Pondicherry, November 3-4, 2011

20 COMSOL 2011, Bangalore, November 4-5, 2011

21 National conference on changing scenario of food science, technology and agricultural products, Bundelkhand University, Jhansi, UP, November 11-12, 2011

22 Fifty second annual conference of Association of Microbiologists of India (AMI), Chandigarh, November 3-6, 2011

23 National seminar on food security: Organic farming the need of hour, Hindu College, Guntur, Andhra Pradesh, November 5-6, 2011

24 Forty third national conference of nutrition society of India, Hyderabad, November 11-12, 2011

25 Eightieth SBC(I) Annual meeting, Lucknow, November 12-15, 2011

26 National seminar on role of bioactive compounds in foods on human health - (BIOFOODS2011)', Tezpur University, Assam, November 14-16 2011

27 Third National workshop on research and development in food processing sector - "FOODWORLD INDIA 2011", Mumbai, November 17, 2011

28 Twenty sixth carbohydrate conference, Kolkata, November 23, 2011

29 Food safety summit, Mumbai, November 29-30, 2011

30 Fourth Bangalore nano conference, Bangalore, December 8-9, 2011

31 Rice Tech Expo, Hyderabad, December 12, 2011

32 National conference on recent trends in food science and nutrition research, Bangalore, December 15, 2011

33 National seminar on millets, Dharwad, December 16, 2011

34 National conference on space transportation systems: Opportunities and challenges, Vikram Sarabhai Space Centre, Trivandrum, December 16-18, 2011

35 National conference on sustainable food safety and security (SFSS-2011)", GITAM University, Visakhapatnam, December 20-21, 2011

36 Sixty fourth annual session of the Indian Institute of Chemical Engineers, Bangalore, December 27-29, 2011

37 XXI ICFOST on innovations in food science and technology to fuel the growth of the Indian food industry, Pune, January 20-21, 2012

38 Workshop on north east connect 2011:from margin to centre stage - A promising business destination, Mumbai, January 27, 2012

39 National workshop on prospectus of food processing industries, Bihar Agri. University, Sabour, January 27-28, 2012

40 National seminar on microbial diversity-potential applications, Mahabubnagar, AP, January 28-29, 2012

41 Second National conference on antimicrobial resistance: A cause for global concern, Allahabad, UP, February 6-8, 2012

42 National seminar on secondary metabolites from horticultural crops – A boon for better life via biotechnological practices, Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh, February 15-16, 2012

43 Conference on biotech crops for food security in India, Bangalore, February 27-28, 2012

44 Seventh National conference on advancement of technologies - Information systems & computer networks, GLA University, Mathura, March 3-4, 2012

45 A national conference on appropriate technologies for Indian food processing industries, University of Agricultural Sciences, GKVK Campus, Bangalore, March 5-6, 2012

46 Sixth national seminar on biotech institute-industry interaction, Bannari Amman Institute of Technology, Tamilnadu, March 9-10, 2012

47 Colloquium on current trends in protein structural biology, CSIR-CFTRI, Mysore, March 22, 2012

48 National seminar on challenges, opportunities and emerging trends in microbial technology, Kakatuya university, Warangal, AP, March 26-27, 2012

49 National seminar on advanced immunology and immunomoducaltion, Sri Krishnadevaraya University, Anantapur, March 26-28, 2012

b) International

1. Sixth international CIGR technical symposium, Nantes, France, April 18-20, 2011
2. Second international symposium frontiers in polymer science, Centre de Congrès, Lyon, France, May 29-31, 2011
3. IFT-2011, Annual meeting & Food expo, New Orleans, LA, USA, June 11-14, 2011
4. International conference on microorganisms in environmental management and biotechnology, Barkatullah University, Bhopal, July 1-3, 2011
5. Eighteenth International Botanical Congress: 1BC-2011, Melbourne, Australia, July 23-30, 2011
6. Sixth Asian international conference on lactic acid bacteria, International Union of Microbiological Societies (IUMS) 2011, Sapporo, Japan, September 6-16, 2011
7. Fourteenth international symposium on trace elements in man and animals, China, September 19- 24, 2011
8. International conference on microbial biotechnology for sustainable development, Punjab University, Chandigarh, November 3-6, 2011
9. Asian women eco-science forum, South Korea, November 7-9, 2011
10. International conference on traditional dairy foods (ICTDF-2011), NDRI, Karnal, November 16-19, 2011
11. Sixty sixth annual convention of oil technologists association of India & international conference IOFATS-2011, IICT, Hyderabad, November 18-19, 2011
12. International symposium on recent trends in processing & safety of speciality and operational foods, DFRL, Mysore, November 23-25, 2011
13. BIT's First annual symposium of antimicrobial research - 2011, Beijing International Centre, China, December 1-2, 2011

14. Annual symposium of antimicrobial research (SAR-2011), Beijing, China, December 1-3, 2011
15. International workshop on recent trends in food processing – The global scenario", Chennai, December 8, 2011
16. Second international conference on advanced materials and nano technology-ICANN, IITG, Guwahati, December 8, 2011
17. Fifth international conference on fermented foods, health status and social well-being: Challenges and opportunities organized by Swedish South Asian Network on Fermented Foods (SASNET), CFTRI, Mysore, December 15-16, 2011
18. International conference of on challenges in biotechnology and food technology, Annamalai University, Chidambaram, January 9-10, 2012
19. First ICC grain conference, New Delhi, January 16-18, 2012
20. International conference on food web - A global connect, Chennai, February 17-18, 2012
21. XII International Congress of Ethnopharmacology on traditional medicines and globalization – The future of ancient systems of medicine, Kolkata, February 17-19, 2012
22. Second world congress on pharmaceutics & novel drug delivery systems, San Francisco, USA, February 20-22, 2012
23. TUM alumini expert seminar, Sao Paulo, Brazil, February 25-29, 2012
24. International workshop on strategies in value addition and safety aspects pertaining to dairy and food industry, Madras Veterinary college, Chennai, March 15-16, 2012
25. International conference on advances in biological sciences, Kannur University, Kannur, March 15-17, 2012
26. Third world congress on bioavailability and bioequivalence, Hyderabad, March 26-28, 2012
27. First Indo-US international conference on polymers for packaging applications (ICPPA 2012), Kottayam, Kerala, March 31–April 2, 2012

17. SYMPOSIA, CONFERENCES AND EVENTS ORGANISED / SPONSORED BY CFTRI

- ***Technology Day (May 11, 2011)***

In connection with National Technology Day 2011, a short term training cum demonstration programme on "Fruit Processing" was organized for the women entrepreneurs of Kudumbashree Mission, Ernakulam, Kerala from May 11-13, 2011

- ***Presentation Ceremony of Awards, Medals, Scholarships and Certificates to Students of M.Sc. (Food Technology) & Flour Milling Technology Certificate Courses (July 8, 2011)***

Dr. M. Murali Krishna, former Head, Applied Technology, The Solae Company, Gurgaon and former Member, CSIR-CFTRI Research Council, Mysore graced the occasion as the Chief Guest and presented awards, medals, scholarships and certificates to the students and addressed the gathering. Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI, presided.

- ***CSIR Foundation Day (September 26, 2011)***

The CSIR Foundation Day was celebrated in the Institute. Chief Guest Dr. K. Dinesh, Co-Founder, Infosys Technologies Ltd., Bangalore graced the occasion as the Chief Guest and delivered the CSIR Foundation Day lecture entitled ***"Infosys Exellence Journey – A Learning"***. Prizes were

Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI giving away a memento to one of the entrepreneurs during National Technology Day celebrations. Smt. Darly Thomas, Head, Technology Transfer and Business Development Department is also seen

Award Day Function of M.Sc (Food Technology) and ISMT certificate course: Student awardees with (from L to R) Shri C.V. Raghavan, Chief Scientist, FMBCT Dept.; Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI; Dr. M. Murali Krishna, former Head, Applied Technology, the Solae Company (Gurgon) and Dr. M.C. Varadaraj, Head, HRD Dept.

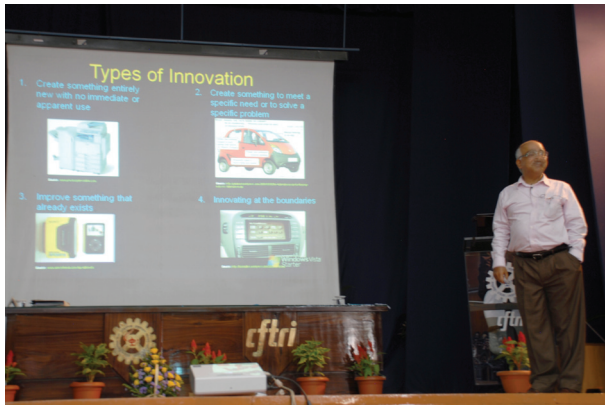
distributed to the children of CSIR-CFTRI staff who had won competitions organized as part of foundation day celebrations. On the occasion, mementoes and shawls to the CSIR-CFTRI staff who had retired during the year and mementoes to the staff who had completed 25 years of service were also distributed.

- ***Hindi Fortnight Celebration (September 26, 2011)***

As part of the Hindi Fortnight celebrations at CSIR-CFTRI, variety of competitions were conducted for CSIR-CFTRI employees, children of the staff, research scholars, project assistants and students of the Institute. Prizes to the winners of the competitions were presented by Chief Guest on the occasion of CSIR Foundation Day 2011. A report on the various activities carried out in the Institute under the official language implementation programme was presented by Dr. D. Rama Reddy, Senior Hindi Officer, CFTRI.

- ***CSIR-CFTRI Foundation Day (October 21, 2011)***

Dr. D. Rajagopala Rao, former Acting Director, CSIR-CFTRI graced occasion as the Chief Guest and delivered the CSIR-CFTRI Foundation Day lecture entitled ***"Social Responsibilities of Scientists"***. On the occasion **Know Your Food**, a booklet on nutrition brought out by Institute



Chief guest of the CSIR foundation day 2011, Dr. K. Dinesh, co-founder, Infosys Technologies Ltd. (Bangalore) delivering the Foundation Day lecture

Winner of competitions held as part of the Hindi fortnight celebrations receiving the prize from the chief guest, Dr. K. Dinesh, co-founder, Infosys Technologies Ltd. (Bangalore). Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI and Dr. A.G. Appu Rao, Head, PCT Dept. are seen

was released. The Chief Guest also distributed CSIR-CFTRI annual awards to staff and students of CSIR-CFTRI for their excellence in various activities. Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI presided.

- ***Vigilance Awareness Week (November 4, 2009)***

Vigilance Awareness Week was observed in the Institute and a function on vigilance awareness was organized. Shri Amar Kumar Pandey, IPS, IGP and Director, Karnataka Police Academy graced the occasion as the Chief Guest. Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI, presided.

- ***Open Access Day (December 2, 2011)***

CSIR-CFTRI observed the Open Access Day on December 2, 2011. Dr. Gangan Prathap, Director, CSIR-NISCAIR and Incharge Director, RAB, CSIR Hq, New Delhi graced the occasion and spoke on open access movement. Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI presided.

Release of the booklet 'Know Your Food' during CFTRI Foundation Day celebrations. (from L To R) Dr. A.G. Appu Rao, Dr. D. Rajagopala Rao, former acting Director, CSIR-CFTRI; Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI; and Dr. P.V. Salimath, Head, B&N Dept.

Vigilance awareness week celebrations, Shri Amar Kumar Pandey, IPS giving his remarks

- ***CSIR Programme for Youth on Leadership in Science (CPYLS) (December 22-23, 2011)***

CSIR-CFTRI conducted the first phase visit programme for CPYLS programme for the top ranking students in Karnataka and who passed class X examinations April 2010 and April 2011. One hundred students were invited, of which 58 along with one of their parents attended the programme. Visits to various departments in the Institute, demonstrations, film shows and talks were organized to familiarize the students and their parents on the contribution of CSIR, in general, and CSIR-CFTRI, in particular, to the S&T in India.

- ***National Science Day (February 28, 2012)***

The Institute celebrated National Science Day on 28 February, 2012. Talks by high school students on the theme 'Clean Energy Options and Nuclear Safety' were organized. Prizes to winners of the essay competition organized as part of National Science Day celebrations were distributed. The function was presided over by Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI.

Dr. Gangan Pratap, Director, CSIR-NISCAR giving his remarks during open access day celebrations

Scientist giving a presentation to CPYLS participants at CSIR-CFTRI

- ***Colloquium on Current Trends in Protein Structural Biology (March 22, 2012)***

A half-day colloquium on 'Current Trends in Protein Structural Biology' was organized in association with the Society of Biological Chemists (India), Mysore Chapter. The colloquium was inaugurated by Dr. A.G. Appu Rao, CSIR-Scientist Emeritus, University of Mysore and former Chief Scientist, CSIR-CFTRI. Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI, presided. In the technical sessions followed six technical seminars on various aspects of protein biology were presented by eminent scientists from Indian Institute of Science, Bangalore; The Solae Company, DuPont India and from the Institute.

18. CFTRI PUBLICATIONS

- CFTRI Performance Report 2010-11
- Directory of research projects in food science & technology in India (2006-2010), 7th Ed. 2012, (CD-ROM)
- Library e-Bulletin (Quarterly)

National Science Day celebration - winner of the competitions receiving prize from Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI. Dr. B.R. Lokesh, Head, LSTF Dept. is also seen

19. HONOURS, AWARDS (including Ph.D. Degrees)

a) Ph.D. Degree awarded

Name of the Awardee	Title of the Thesis
• Apurva Kumar RJ	Investigations on pesticide-induced endocrine disruption with special reference to biochemical alterations in adrenal cortex and their consequences
• Arul Selvi A	Studies on bioremediation of isoprothiolane, fungicide/ insecticides and glyphosate, a herbicide and monitoring of biodegradation using biosensors
• Bhumika Tripathi	Studies on the enrichment of millet flours with iron and zinc and strategies to improve the bioavailability of the added minerals
• Chandrasheka PM	An investigation of the immunomodulatory activities of garlic (*Allium sativum* L.)
• Chetan A Nayak	Integrated downstream processing involving biocompatible methods for extraction, purification and concentration of anthocyanin, a natural colourant
• Dayananda C	Studies on microalgal lipids with special reference to *Botryococcus* species
• Deepa Gopinath	Biochemical and genomic studies on medicinal rice njavara (*Oryza sativa* L.)
• Fatima Clement	Physico-chemical and functional characterization of the immunomodulatory proteins from garlic (*Allium sativum* L.)
• Girish Kumar B	Production and evaluation of probiotic lactic acid bacteria (LAB) for therapeutic application
• Hemavathi AB	Biotechnological approaches for the downstream processing of selected enzymes
• Jagadish RS	Modification of polyolefins and selected natural polymers for improved properties in food packaging applications
• Manohar B	Characterization of bioactive components from chiba seed *(Psoralea corylifolia L.)*

Name of the Awardee	Title of the Thesis
• Nandini KE	Studies on the use of various athermal biocompatible methods for downstream processing of selected enzymes
• Pushpa S Murthy	Biotechnological approaches to production of bioactives from coffee by-products
• Raghunatha Reddy RL	Biochemical studies on the anti-lithogenic effects of dietary fenugreek seeds (*Trigonella foenum-graecum*)
• Raghu Raj Singh Chouhan	Studies on the biosensor for the detection of methyl parathion
• Ramalakshmi K	Chemical and biochemical investigations on coffee by-products for value addition
• Ranga Rao Ambati	Production of astaxanthin from cultured green alga *Haematococcus pluvialis* and its biological activities
• Ravikumar Hosamani	Assessment of neuroprotective efficacy of phytochemcials against oxidative stress mediated neurodegeneration in *Drosophila melanogaster*
• Rekha CR	Soy based functional foods with reference to probiotics and isoflavones
• Renuka B	Biotechnological approaches for the preparation of FOS based prebiotic and probiotic foods
• Sangeetha Ravi Kumar	Influence of selected dietary carotenoids on retinol deficiency induced biochemical changes in tissue membranes of rats
• Sathisha UV	Modulation of biological functions of galectin-3 by dietary galectin inhibitors in *in vitro* and *in vivo* models
• Smita Gautam	Studies on the modifiers of zinc and iron bioavailability from food grains
• Sneha Rani AH	Structural and molecular basis of interaction of curcumin with proteins
• Srikanta BM	Mechanism of action of multi-potent ulcer blockers in *in vitro* and *in vivo* models
• Sujith Kumar PV	Role of specific enzymes in biosensor for tea analysis

Name of the Awardee	Title of the Thesis
• Sukumar Debnath	Studies on physical, thermal and hydrodynamic properties of interesterified oils
• Suresh Kumar TV	Studies on the extracts of black cumin (*Nigella sativa* L.) obtained by supercritical fluid carbon dioxide
• Usha NS	Biochemical studies on the influence of dietary spices on gastro-intestinal system
• Usha Dharmaraj	Technological and physic-chemical characteristics of hydrothermally treated finger millet
• Vasudeva Raju P	Studies on chromatin organization and the role of curcumin in chromatin stability in relevance to neurodegeneration
• Zareena AS	Characterization of bioactive compounds from *Garcinia mangostena* L. by supercritical fluid carbon dioxide process

Shri G.C.P. Rangarao, Chief Scientist & Head, Food Packaging Technology Department, receiving the Prof V Subrahmanyan Industrial Achievement Award-2010 from Dr. Sanjay Dave, Director, APEDA, at the 21st Indian Convention of Food Scientists & Technologists, Pune

b) Awards

Award Name	Instituted by	Awardee
• Prof. V Subrahmanyan Industrial Achievement Award 2010	Association of Food Scientists and Technologists (India)	Rangarao GCP
• Laljee Godhoo Smarak Nidhi Award 2010	Association of Food Scientists and Technologists (India)	Bhaskar N
• Low Cost Technology Development Award	Association of Food Scientists and Technologists (India)	Sila Bhattacharya
• Prof. Jiwan Singh Sidhu Award 2010 for excellence in teaching in the area of Food Science & Technology	Association of Food Scientists and Technologists (India)	Anandharamakrishnan C
• Dr. P P Kurien Award for excellence in R&D in pulse processing and utilization	Association of Food Scientists and Technologists (India)	Sasikala VB
• Best Science Communicator Award	Vision Group on Science & Technology, Dept of Information Technology, Biotechnology and S&T, Govt. of Karnataka, Bangalore	Sharma ASKVS

Sri A. S. K. V. S. Sharma, Head, Information and Publicity, CSIR-CFTRI, receiving the VGST State Award for Science Communicators from Prof. Roddam Narasimha, Secretary, SAC to the Hon'ble Prime Minister and former Director, CSIR-NAL, while Sri Anand Asnotikar, Hon'ble Minister for Science & Technology, IT and Biotechnology (second left) and Prof. C.N.R. Rao, Chairman, Vision Group on Science & Technology (VGST) Govt. of Karnataka (extreme right) look on

c) Recognitions by Academies

Recognition	Instituted by	Awardee
• Fellow	Society of Applied Biotechnologists 2011	Bhaskar N
• Life Time Achievement Award - 2011	Association of Carbohydrates Chemists and Technologists (I)	Vasudeva Singh
• Fellow	The Royal Society of Chemistry 2011	Jagan Mohan Rao L

d) Editors / Associate editor of Reputed Journals

- Editor - Journal of Food Science and Technology (Rastogi NK)
- Editor - Journal of Food Science and Technology (Vijayendra SVN)
- Associate Editor - ACES (Advances in Chemical Engineering Science) (Raghava Rao KSMS)

e) Editorial Board Memberships

- American Journal of Agricultural Science and Technology (Modi VK)
- CyTA- Journal of Food (Raghava Rao KSMS)
- Indian Food Industry (Bhaskar N)
- Indian Food Industry (Umesh Hebbar H)
- International Journal of Food Science and Technology, UK (Jagan Mohan Rao L)
- International Research Journal of Science & Technology (Bhaskar N)
- International Research Journal of Science & Technology (Modi VK)
- Journal of Food Engineering (Rastogi NK)
- Journal of Food Science and Engineering (Anandharamakrishnan C)
- Journal of Food Science and Technology (Jagan Mohan Rao L)
- Research & Reviews: Journal of Food Science and Technology (Rastogi NK)

Dr. Vasudeva Singh, Head, GST Dept. receiving the Life Time Achievement Award during the Annual Meet of Association of Carbohydrates Chemists and Technologists (I) at Kolkata

f) Nominations

- Chairman, Expert committee on M.Tech. programme in food technology, Jain University, Bangalore (Subramanian R)
- Member, Technical committee for revision of NABL guidelines & specific criteria 103 for chemical testing laboratories, New Delhi (Alok Kumar Srivastava)
- Member, Technical committee for revision of NABL guidelines & specific criteria 114 for food testing laboratories, New Delhi (Alok Kumar Srivastava)
- Technical Expert, Recruitment board of DRDO, Min. of Defence, GOI, CEPTAM, DRDO, Bangalore (Alok Kumar Srivastava)
- External Member, Assessment board (Life Science), DFRL, Mysore and CEPTAM (DRDO) (Alok Kumar Srivastava)
- Expert Member, JRF selection board, DFRL, Mysore (Alok Kumar Srivastava)
- Member, Constitution of expert group for alcoholic drink to review the draft regulation on alcoholic beverages, FSSAI, New Delhi (Sathyabodha JA)
- Member, Scrutiny committee for the deputation abroad for presentation of research paper of DFRL scientist at DFRL, Mysore (Modi VK)
- Member, Assessment board, DFRL, Mysore (Modi VK)
- Member, Stores procurement committee, DFRL, Mysore (Modi VK)
- Member, Scrutiny committee for the appointment of senior scientists, ASRB(ICAR), New Delhi (Bhaskar N)
- Member, International scientific committee of international conference on bio & food electrotechnologies (BFE 2012), Salerno, Italy (Rastogi NK)
- Member, International scientific committee of the upcoming International congress on food engineering and technology 2012, Bangkok, Thailand (Rastogi NK)
- Member, Board of studies (Biotechnology), Siddaganga Institute of Technology (SIT), Tumkur (Rastogi NK)
- Member, Selection committee for the selection of candidates for CSIR-Nehru Science post doctoral research fellowship, CSIR, New Delhi (Rastogi NK)
- Member, Research advisory committee (RAC) of Richcore Biotech, Bangalore (Raghava Rao KSMS)

- Member, Program advisory committee, DST & DRDO (Raghava Rao KSMS)
- Member, Quinquennial review team (QRT) CIFT, Cochin (Raghava Rao KSMS)
- Expert member, Committee of CDB, DST & AICTE (Raghava Rao KSMS)
- Member, Board of studies in chem. engineering, RV Engg. College, Bangalore (Raghava Rao KSMS)
- Member, Board of studies in Biotechnology, University of Mysore (Raghava Rao KSMS)
- Member, Advisory committee of DBT-HRD programme, Dept. of Biotechnology, University of Mysore (Raghava Rao KSMS)
- Member, State level co-ordination committee on promotion of various schemes of National horticulture board (Badgujar PM)
- Member, State level monitoring-cum-guidance committee on promotion of food processing units through EDPs in Maharashtra (Badgujar PM)
- Member, Syllabus committee of vocational courses of KVIC (Badgujar PM)
- Member, Advisory committee of Bhavan's Research Centre (Food, Hygiene & Environmental Microbiology) (Badgujar PM)
- Expert Member, Draft proposal approval committee for Benchmarks of food processing technologies, MFPI, Govt. of India, New Delhi (Anandharamakrishnan C)
- External examiner, M.Tech. programme (Chemical Engineering), Anna University, Chennai (Anandharamakrishnan C)
- Member, Governing council, Maniammai - Periar University, Tanjore (Rajarathnam S)
- Member, Research council, IIHR, Bangalore (Rajarathnam S)
- Expert Member, Committee for the selection of faculty for food science technology department, Tezpur University, Assam (Rajarathnam S)
- Member, National committee on artificial ripening agents for fruit ripening, under ICAR, New Delhi (Rajarathnam S)

g) Best Research Paper Award

- ***N.N. Mohan Memorial Award for Best Research Paper***, Vijayalakshmi N.S., Baldev Raj, Suitability of plastics containers for drinking/potable water and regulations, *Indian Food Packer*, January-February 2010
- ***Best Paper in Journal of Food Science and Technology (JFST)***, Manohar B, Divakar S, Enzymatic synthesis of cholecalciferol glycosides using beta-glucosidase from sweet almond, *J. Food Sci. Technol.,* **47(5)**, 469-475

i) Poster Awards

1. Anandharamakrishnan C., Computational fluid dynamic (CFD) model for Spray - Freezing operations, Indian Institute of Crop Processing Technology, Thanjavur, June 24-25, 2011 *(Best poster award)*
2. Anandharamakrishnan C., Computational fluid dynamics (CFD) applications in food processing operations, ANSYS 2011, Bangalore, October 19-20, 2011 *(Best poster award)*

15. Anbarasu K., Akshatha H.S., Anandha Ramakrishnan C., Umesh Kumar S., Vijayalakshmi G., Microencapsulation of xanthophyll of *Aspergillus carbonarius* by spray drying, Annual Conference of Association of Microbiologists of India (AMI-2011), Chandigarh, November 3-6, 2011 *(Best poster Award)*

4. Anandharamakrishnan C., Finite element modeling of volume expansion of bun during baking process, COMSOL 2011, Bangalore, November 4-5, 2011 *(Best poster award)*
5. Prabhakara Rao P.G., Prabhavathy M.B., Nagender A., Balaswamy K., Satyanarayana A., Application of annatto, a natural pigment in gold fingers as a replacement for synthetic azo dyes, NSI National seminar at NIN, Hyderabad, November 11-12, 2011 *(Best poster award)*
6. Umesha S.S., Akhilender Naidu K., Garden cress (*Lepidium sativum* L.) seeds as new, novel source of omega-3 fatty acid (α-Linolenic acid), 80th Annual meeting of Society of Biological Chemists, Lucknow, November 12-15, 2011 *(Best poster award)*
7. Inamdhar AA., Suresh D Sakhare., Madhukiran M.H., Indrani D., Fraction of black gram to get different streams using the roller flour mill and study of their chemical composition, International symposium on recent trends in processing & safety of speciality and operational foods, DFRL, Mysore, November 23-25, 2011 *(Best poster award)*

8. Girish T.K., Leela Bai S., Keshava Murthy P.S., Vijayalakshmi N.S., Baldev Raj, Estimation of bisphenol - A migration from polycarbonate baby feeding bottle by HPLC, National conference on recent trends in food science and nutrition research, conducted by Dr. P Sadananda centre for food science and research in association with Tumkur University and Jain University, Bangalore, December 15, 2011 *(Best poster award)*

16. Shubha J.R., Vanajakshi V., Ahamad Ifthikar M., Marican, Aparna M.B., Vijayalakshmi G., Effective use of mother culture for enhanced production of natural food colourant from *Monascus purpureus* fermented rice, Fifth International Conference on Fermented Foods, Health Status and Social Well-being: Challenges and Opportunities organized by Swedish South Asian Network on Fermented Foods (SASNET), Mysore, December 15-16, 2011 *(Best poster - 3rd prize)*

9. Suresh D Sakhare., Inamdhar A.A., Shwetha B.G., Indrani D., Fraction of green gram (Vigna radiata) by roller milling and study of incorporation protein rich, fiber rich and protein-fiber rich roller milled fractions on dough rheology and bread, XXI ICFOST, Pune, January 20-21, 2012 *(Best poster award)*

10. Chhanwal N., Indrani D., Anandharamakrishnan C., A study on effect of bread rotation on temperature of bread using computational fluid dynamics (CFD) simulations, XXI ICFOST, Pune, January 20-21, 2012 *(Best poster award)*

11. Aruna G., Baskaran V., Wheat germ oil improves lutein bioefficacy in mice, XXI ICFOST, Pune, January 20-21, 2012 *(Best Poster award)*

12. Vrinda R., Louella C.G., Prakash Halami, Bhaskar N., Synergistic effect of enterocin and lipase from *Enterococin faecium* in NCIM 5363 against food borne pathogens: mode of action, XXI ICFOST, Pune, January 20-21, 2012 *(Best poster award)*

13. Anil Kumar Pulipaka, Krishna Rao S.N., Shilpa B.V., Divyadristi - A real-time hazard detection system using image analysis, 7th National conference on advancement of technologies - Information systems & computer networks, GLA University, Mathura, March 3-4, 2012 *(Best paper award)*

14. Navya P.N., Pushpa S Murthy, Bioconversion of coffee husk cellulose and statistical optimization of fermentation conditions for production of exoglucanases, National conference on appropriate technologies for Indian food processing industries, University of Agricultural Sciences, GKVK Campus, Bangalore, March 5-6, 2012 *(Best poster award)*

j) Special Appreciation Award

Team CSIR-CFTRI Library received a Special Appreciation Award for institutional repository and cooperation in pursuit of CSIR's Open Access Movement in October 2011

k) CFTRI Awards 2011

On the occasion of CSIR-CFTRI Foundation Day - 2011 on September 26, 2011, CFTRI Annual awards for the year 2010-11 were presented by Dr. D. Rajagopala Rao, former Acting Director, CSIR-CFTRI along with Dr. Venkateswararao G, Acting Director, CSIR-CFTRI and other dignitaries. Awards were given under pre-notified categories for the staff and students for the year 2010-11. Details of the recipients are given below:

- **Best Research Paper Published by Staff**

  Basic Research:

  - Dr. B.R. Lokesh, *Lipid Science & Traditional Food Department*

  Applied Research:

  - Dr. (Mrs.) D. Indrani, *Flour Milling Baking and Confectionery Technology Department*
  - Dr. P.G. Prabhakar Rao, *RC-Hyderabad*

- **Best Technology Transferred to Industry**

  - Dr. (Mrs.) M.N. Shashirekha and Team, *Fruit & Vegetable Technology Department*

- **Individual Awards for Scientific and Technical Contributions**

  Group IV:

  - Dr. M. Madhava Naidu, *Plantation Products, Spices & Flavour Technology Department*

  Group III:

  - Dr. (Mrs.) V.B. Sasikala, *Grain Science & Technology Department*

- **Individual Awards for Best Support Staff**

  Group II:

  - Mr. G. Bammigatti, *Food Engineering Department*

  Group I:

  - Mr. Ramaiah, *Finance & Accounts*

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

  - Mr. Chandra Mohan Tudu, *Establishment - I*
  - Mr. K. Satyanarayana, *Finance & Accounts*
  - Mr. Laxminath Thakur, *Stores & Purchase*
  - Mrs. H.C. Komala, *COA's Office*

- **Best Research Publication Award for Project Assistants & Post Doctoral Fellows**

  - Mr. D. Gobinath., *Fermentation Technology and Bioengineering Department*

- **Best Student Award**

  - Ms. Meera Bhagat, *M.Sc. (Food Technology) Course*
  - Mr. Walwate Govind Ramaji*, International School of Milling Technology Certificate Course*
  - Mrs. Jamuna J Bhaskar, *Research Fellow, Biochemistry & Nutrition Department*

- **Special Award for Outstanding Contribution/Achievement not falling in any of the above category**

  Library

20. FELLOWSHIPS AND DEPUTATIONS

a) Deputations abroad

Subject / Name	Sponsoring Agency	Details
• Stakeholder panel on infant formula and nutritionals *(Lalitha R Gowda)*	AOAC International	Maryland, USA (April 4 - 6, 2011)
• Pre-symposium workshop on Food safety and 2011 CIGR International symposium on towards sustainable food chain *(Vasudeva Singh)*	Centre for International Cooperation in Science (CICS), Chennai CSIR, New Delhi DST, New Delhi	Dijon, France and Nantes (April 14 - 20, 2011)
• Eleventh International congress on engineering and food *(Suvendu Bhattacharya)*	CSIR, New Delhi CICS, Chennai DST, New Delhi	Athens, Greece (May 22 - 26, 2011)
• Second International symposium on frontiers in polymer science *(Baldev Raj)*	CSIR, New Delhi CICS, Chennai DST, New Delhi	Centre de Congress, Lyon, France (May 29 - 31, 2011)
• IFT 2011 conference *(Umesh Hebbar H)*	UNU-Kirin Fellowship	New Orleans, Louisiana, USA (June 11 - 14, 2011)
• 14th International symposium on trace elements in man and animals *(Ravishankar GA)*	Symposium organizers	China (September 19 - 24, 2011)
• Keynote address on perspectives of processing papaya fruit: National and International strategies *(Rajarathnam S)*	Symposium organizers	Porto Seguro, Brazil (October 31 - November 4, 2011)

Subject / Name	Sponsoring Agency	Details
• First Shunadzy Global Technology Forum *(Venkateswaran G)*	Symposium organizers	Marina Bay Sands, Singapore (November 9 - 11, 2011)
• First Annual SAR-2011 *(Renu Agarwal)*	CSIR, New Delhi CICS, Chennai DST, New Delhi	Beijing International Convention Center (BICC), Beijing, China (December 1 - 3, 2011)
• First Annual SAR-2011 *(Matche RS)*	CSIR & DBT	Beijing International Convention Center (BICC), Beijing, China (December 1 - 3, 2011)
• PHARMACEUTICA - 2012, Second World congress on pharmaceutics & novel drug delivery systems *(Srinivas P)*	SERB, New Delhi CICS, Chennai	San Francisco, USA (February 20 - 22, 2012)
• Technical University of Munich (TUM) expert seminar *(Sridhar BS)*	Alumni Service, Munchen University	Sao Paulo, Brazil (February 25 - 29, 2012)
• Collaborative programme *(Baskaran V)*	Project fund	Laboratory of Technology of Marine Bioproducts, Kyoto University, Japan (March 4 - 30, 2012)
• Indo-Japan cooperative science programme *(Prabhasankar P)*	DST-JSPS Joint Research Project	Laboratory of Technology of Marine Bioproducts, Kyoto University, Japan (March 4 - 30, 2012)

b) Deputations in India

Subject / Name	Sponsoring Agency	Details
• Training course on proficiency testing ISO/IEC 17043 (Alok Kumar Srivastava)	CSIR-CFTRI	NABL, DST, GOI, New Delhi (April 4-8, 2011)
• National workshop transition from PFA to FSSA (Jinesh P & Umamaheshwari P)	CSIR-CFTRI	Ghaziabad (April 18-19, 2011)
• Training programme on Crafting and managing R&D projects (Prasad Rao UJS & Mukesh Kapoor)	CSIR-CFTRI	Ghaziabad (September 19-23, 2011)
• Training programme on science for rural societies (Sharma ASKVS)	Department of Science & Technology, GoI, New Delhi	Centre for Disaster Management, LBSNAA, Mussorie, Uttarakhand (October 31-November 11, 2011)
• 3rd National R&D confernece (Darly Thomas)	CSIR-CFTRI	Mumbai (November 17, 2011)
• Processing of fruits and vegetables: Opportunities and challenges (Rajarathnam S)	Geetam University Vishakhapatnam	National Seminar on sustainable food security and safety-emerging trends in post harvest technologies and processing (SFSS 2011) (December 20-21,2011)
• CSIR 800 technology workshop (Darly Thomas)	CSIR-CFTRI	CSIR-CMMACS, Bangalore (January 28-31, 2012)
• CSIR 800 technology workshop (Chauhan VS)	CSIR-CFTRI	CSIR-CMMACS, Bangalore (January 28-31, 2012)
• Stakeholders panel meeting on infant formula and adult nutritionals of AOAC International (USA) (Lalitha R Gowda)	CSIR-CFTRI	Co-chair for Vitamin C working Group, New Delhi (February13-15, 2012)
• Short course on Vistas in nutrient profiling and nutritional labeling of sea foods (Suresh Raj & Rathina Raj K)	CSIR-CFTRI	Central Institute of Fisheries Technology, Kochi (February 14-23, 2012)

Subject / Name	Sponsoring Agency	Details
• Brainstorm meeting on neutraceuticals and functional foods to combat malnutrition in women and children (Darly Thomas)	CSIR-CFTRI	CSIR, New Delhi (February 16, 2012)
• An overview of processing of fruits and vegetables (Rajarathnam S)	UGC	MES Mampad College, Mampad, Malappuram District (Kerala) (March 6, 2012)
• Induction training programme for scientists (Prasanna Vasu)	CSIR	HRDC, Ghaziabad (March 18-27, 2012)

c) Participation of research students in symposia abroad

Subject / Name	Sponsoring Agency	Details
• Savitha YS	CSIR	IFT11 Annual meeting, New Orleans, USA June 11-14, 2011
• Vishwanathan KH	CSIR	IFT11 Annual meeting, New Orleans, USA June 11-14, 2011
• Sridevi V	DST	23rd International botanical congress, Australia July 23-30, 2011
• Manjulatha Devi S	DST	6th Asian conference on lactic acid bacteria, Japan September 8-10, 2011
• Nitya V	Asean Women forum, Korea	Asian women eco-science forum, South Korea November 7-9, 2011
• Denny Joseph KM	DST	XIX World congress on parkinsons disease and related disorders, Shanghai December 11-14, 2011

21. LECTURES AND DEMONSTRATIONS

Subject	Location	Institution/group
• Spice processing *(Sowbhagya HB)*	Coimbatore	Karunya University
• Natural colors and spice processing *(Sowbhagya HB)*	Kakinada, Andra Pradesh	JNT University
• Food science and sensory science *(Maya Prakash)*	Kakinada, Andra Pradesh	JNT University
• Sensory science : Product development, optimization *(Ravi R)*	Pondicherry	Pondicherry University
• Metabolic engineering of secondary pathways for food applications and evaluation of functional attributes *(Ravishankar GA)*	New Delhi	India - Taiwan workshop
• Biotechnology of algal foods and nutraceuticals *(Ravishankar GA)*	Pune	ICFOST XXI, Pune, January 20-21, 2012
• Recent developments in plant tissue culture and its perspectives *(Giridhar P)*	Madurai	Plant tissue culture training program of Winter school, Madurai Kamraj University
• Contemporary methods to validate toxicity and allergenicity of GM food *(Lalitha R Gowda)*	Jaipur	Global biosafety management program: Approach to product development and regulation conducted by Cornell University in partnership with Sathguru Mangement Consultants
• Food safety management systems *(Lalitha R Gowda)*	Chennai	CII
• Advanced food safety analytical techniques to accurately detect and prevent any potential food borne risks and hazards *(Lalitha R Gowda)*	Mumbai	Food safety summit

Subject	Location	Institution/group
• Food for space mission *(Lalitha R Gowda)*	Thiruvanantha-puram	National conference on space transportation systems: Opportunities and challenges, Vikram Sarabhai Space Centre
• HPLC in food analysis *(Lalitha R Gowda)*	Sathyamangalam	Applications of chromatography and mass spectrometry in biotechnology (ACMSB-2011), Bannari Amman Institute of Technology
• Latest developments in analytical procedures *(Lalitha R Gowda)*	Bangalore	BCIC Seminar of new food safety standards act, organised by Agro & Food processing committee of Bangalore Chamber of Industry and Commerce
• Advances in analytical techniques to meet current challenges of food industry *(Lalitha R Gowda)*	Pune	ICFOST XXI, Pune, January 20-21, 2012
• Bioactive peptides: Isolation and their role as biological clamps for hypertension *(Lalitha R Gowda)*	Mysore	Faculty development programme under the Vision group of Science & Technology, Govt. of Karnataka organized by Karnataka State Open University
• Angiotensin converting enzyme inhibitors of peanut (*Arachis hypogeae*) *(Lalitha R Gowda)*	Mysore	Dr. T.S. Vasundhara Memorial Lecture 2012 at Defence Food Research Laboratory
• Biosafety and environmental safety of biotech crops *(Lalitha R Gowda)*	Bangalore	Biotech crops for food security in India, organized by Foundation for Biotechnology Awareness and Education

Subject	Location	Institution/group
• The unusual Gal/GalNAc specific lectin of field bean (*Dolichos lablab*) and its sugar binding properties *(Lalitha R Gowda)*	Mysore	Colloquium on current trends in protein structural biology organized by SBC(I) Mysore chapter and CSIR-CFTRI
• Integrated food laws *(Alok K Srivastava)*	Mysore	Training program organized for senior army officers, Ministry of Defence at DFRL
• Food safety act 2006, rules & regulations 2011 with special reference to milk & milk products *(Aruna Kumar)*	Kozhikode	One day seminar on the food safety and standards act 2006 with special reference to milk & milk products
• Adulterants & contaminants in milk & milk products with special reference to FSSA 2006 & rules 2011 *(Nusrath Nasir)*	Kozhikode	One day seminar on the food safety and standards act 2006 with special reference to milk & milk products
• Microbiological safety of milk & milk products in relation to FSSA 2006 *(Prema Viswanath)*	Kozhikode	One day seminar on the food safety and standards act 2006 with special reference to milk & milk products
• Food borne infections *(Prema Viswanath)*	National Centre for Disease Control (NCDC), New Delhi	Global disease detection & investigation centre (GDDIC) and WHO- Global food borne infections network (WHO-GFN)
• Cloning and expression of cell wall-active enzymes in *Pichia pastoris* *(Prasanna Vasu)*	Tumkur	Tumkur University
• Role of ICT in popularisation of science : Global and regional aspects *(Sharma KVSAS)*	Bangalore	Vision Group on Science and Technology, Govt. of Karnataka and Karnataka State Council for Science and Technology
• Value addition to coconut *(Sharma KVSAS)*	Chamarajanagar	Karnataka State Coconut Growers Association, Chamarajanagar unit

Subject	Location	Institution/group
• Vijnana Patrikegala Ashayagalu (*in Kannada*) in a workshop on science communication in Kannada *(Sharma KVSAS)*	National College, Bangalore	Udayabhanu Institute of Higher Studies
• Knowledge text translation: Science and technology texts in Kannada *(Sharma KVSAS)*	Shimoga	National Translation Mission, Central Institute of Indian Languages, Mysore
• Popular science magazines in Kannada *(Sharma KVSAS)*	Mysore	Prasaaranga, University of Mysore
• Agro food processing technologies *(Bhaskar N)*	Puducherry	School of Food Science, Pondicherry University
• Application of biotechnology for utilizing (ABOUT) fish processing waste: Physiological impact of recovered fish oil *(Bhaskar N)*	Chennai	FOODS 2012 - Food web : A global connect
• Prospects of meat processing to fill gap in food security of North East *(Modi VK)*	Bangalore	North East Connect-2011 organized by National skills foundations of India
• Food preservation and safety *(Sachindra NM)*	Mangalore	St. Alyosius College
• Bioprospecting marine microorganisms *(Sachindra NM)*	Mangalore	St. Alyosius College
• Harvesting nutraceuticals through fermentation *(Prakash M Halami)*	Bangalore	The Institution of Engineers
• Genetic diversity in relation to functional properties of lactic acid bacteria from fermented foods *(Prakash M Halami)*	Mahabubnagar, Andra Pradesh	Palamuru University
• Next generation probiotics *(Prakash M Halami)*	Chennai	Madras Veterinary college

Subject	Location	Institution/group
• Next generation antibiotics- role of microbiologists: Challenges and opportunities *(Prakash M Halami)*	Warangal, Andra Pradesh	Kakatuya University
• Protein crystals and overview crystallography *(Uma V Manjappara)*	Mysore	Yuvaraja's College
• Utilization of soybean for nutritional and health benefit *(Sridevi A Singh)*	Bangalore	University of Agricultural Research
• Spectroscopy IR and Raman *(Sridevi A Singh)*	Mysore	JSS Arts and Science College
• Biosensors: Modern analytical tool *(Thakur MS)*	Bangalore	National seminar on trends and developments in sensors instrumentation
• Biosensors for dairy industries *(Thakur MS)*	Bangalore	Emerging trends in dairy Industry
• Biosensors: Emerging trends and potential *(Thakur MS)*	Cochin	National symposium on emerging trends in biotechnology
• Natural pigments and their role in bimolecular energy transfer *(Thakur MS)*	Mumbai	National symposium on functional application of colorants
• Extraction of bioactive compounds for incorporation in food for health benefits *(Raghavarao KSMS)*	Tezpur, Assam	National seminar on role of bioactive compounds in foods on human health, Tezpur University
• Food engineering - Prospects in India *(Raghavarao KSMS)*	Bangalore	UDCT Alumni Association
• Ways and means for the infusion of bioactive constituents in solid foods *(Rastogi NK)*	Tezpur, Assam	National seminar on role of bioactive compounds in foods on human health, 2011 (BIOFOODS2011), Tezpur University

Subject	Location	Institution/group
• Food process engineering: Applications in small scale industries *(Suvendu Bhattacharya)*	Kolkata	National seminar on current technological challenges in food processing specially emphasizing food irradiation
• Low-cost-technologies for nutritional intervention programmes: The pragmatic approach *(Suvendu Bhattacharya)*	West Bengal	Recent trends in research of nutrition science
• Metabolism of megacities: Development of a domestic waste water reclamation and reuse system *(Sridhar BS)*	Brazil	TUM Alumini expert seminar, Sao Paulo
• Opportunities for food processing industry and CFTRI's role *(Darly Thomas)*	Bangalore	Workshop on agriculture and allied R&D institutions and industry linkages
• Agro food processing *(Darly Thomas)*	Waynad, Kerala	Technology clinic, District Industries Centre
• Introduction, services & technologies available from CFTRI; Value addition to cereal products & convenience foods; processing of fruits & vegetables and beverage products; and value addition to spices, coconut and animal foods *(Balasaraswathi M)*	Ernakulam	Technology clinic on agro-Food processing industries, District Industries Centre
• Opportunities in food processing *(Balasaraswathi M)*	Salem	Emerging opportunities for new business & industry, CII, Salem District
• Opportunities in food processing industry *(Gupta PK)*	Manipal	Seminar on food processing, Karnataka Small Scale Industries Association in Association with District Industries Centre
• Scope for processing of commercial horticultural products with special reference to Ramanagara *(Usha Devi A)*	Ramanagara	Horiculture investor's meet, Dept. of Horticulture

Subject	Location	Institution/group
• Technologies and processes developed by CFTRI for rural entrepreneurs *(Manjunath N)*	Ramanagara	Horiculture investor's meet, Dept. of Horticulture
• Microbial polymers for packaging applications *(Vijayendra SVN)*	Kottayam, Kerala	First Indo-US international conference on polymers for packaging applications, M.G. University
• Emerging trends and opportunities for food packaging in India *(Indiramma AR)*	Mysore	Food Packaging India Business Meet organized by Air Seal India Ltd.
• Current trends in biscuit packaging *(Indiramma AR)*	Mysore	AIB International School of Baking
• Recent trends in modelling and computational simulations of food processing operations *(Anandharamakrishnan C)*	Thanjavur	Indian Institute of Crop Processing Technology
• Introduction to DNA *(Negi PS)*	Mysore	Defence Food Research Laboratory
• Application of modelling and simulation in food processing unit operations *(Anandharamakrishnan C)*	Hassan	College of Agriculture, University of Agricultural Sciences
• Benefits of ISO 14001 certification to research and educational institutions *(Anandharamakrishnan C)*	Mysore	National Institute of Engineering
• Recent trends in micro and nano-encapsulation of nutraceuticals *(Anandharamakrishnan C)*	Davangere	GM Institute of Technology
• Trends in nano-encapsulation of nutraceuticals *(Anandharamakrishnan C)*	Salem	Periyar University
• Application of modelling and simulation techniques in food and bioprocess engineering *(Anandharamakrishnan C)*	Erode	Kongu Engineering College

Subject	Location	Institution/group
• Recent trends in micro and nano-encapsulation of nutraceuticals *(Anandharamakrishnan C)*	Pune	Association of Food Scientists and Technologists (India)
• Applications of nanotechnology in packaging of foods *(Anandharamakrishnan C)*	Kottayam	Mahatma Gandhi University
• Opportunities in food processing & CFTRI contribution in the field *(Badgujar PM)*	Pune	Technology summit 2011: Commercial technologies & innovations, organized by APEX Cluster Development Services Pvt.
• Process control systems & technologies - Growth drivers of food industry *(Badgujar PM)*	Pune	Workshop on Emerging technologies for food industry organized by APEX Cluster Development Services Pvt. Ltd & SIDBI in association with Mahratta Chamber of Commerce, Industries & Agriculture
• Opportunities in food processing *(Badgujar PM)*	Thane and Nashik	EDP organized by MITCON
• Opportunities in food processing *(Badgujar PM)*	Pune	EDP organized by Fruit & Vegetable Processing Mahasangh
• Opportunities in food processing for corporate sector in NE region *(Badgujar PM)*	Mumbai	Workshop on North East Connect 2011: From margin to centre stage - A promising business destination organized by NERAMAC, Guwahati and National Skill Foundation of India
• Opportunities in food processing *(Jyothirmayi T)*	Hyderabad	KVIC
• Primary processing equipment for millets *(Math RG)*	Hyderabad	Directorate of sorghum research in a seminar on post-harvest technologies of sorghum millets
• CFTRI technologies and services *(Sathiya Mala K)*	Hyderabad	Rural Technology Park, NIRD Hyderabad / EDP / BPL participants

Subject	Location	Institution/group
• CFTRI technologies and services *(Math RG)*	Hyderabad	Koti Womens College
• Opportunities in food processing *(Jyothirmayi T)*	Hyderabad	National Institute for Micro Small and Medium Enterprises (NIMSME) / EDP participants
• Quality control, physico-chemical properties and sensory evaluation of processed foods *(Satyanarayana A)*	Hyderabad	Society for Energy, Environment and Development (SEED)
• Technology transfer and sourcing with special reference to CFTRI technologies *(Satyanarayana A)*	Hyderabad	National Institute for Micro Small and Medium Enterprises (NIMSME), DICs of West Bengal
• Overview of food processing in India *(Satyanarayana A)*	Visakhapatnam	Khadi and Village Industries Commission (KVIC) / for the benefit of local entrepreneurs
• Food packaging *(Satyanarayana A)*	Hyderabad	National Institute for Micro Small and Medium Enterprises (NIMSME)
• Opportunities in food processing and the role of CFTRI in supporting food processing industries *(Jyothirmayi T)*	Hyderabad	ALEAP / EDP participants
• Opportunities in food processing and the role of CFTRI in supporting food processing industries *(Jyothirmayi T)*	Hyderabad	Confederation of Women Enterpreneurs / EDP participants
• Opportunities in food processing *(Jyothirmayi T)*	Hyderabad	Prospective Entrepreneurs Promotion Society of Youth
• Project ideas in food processing areas *(Gothwal PP)*	Lucknow	Organised by Entrepreneurship Development Institute of India, Northern Regional Office, Lucknow (EDII, NRO)

Subject	Location	Institution/group
• Scope of food and agro based industry in the state of Uttar Pradesh special reference to service offered by CFTRI and emerging trends and opportunities in food processing sector *(Gothwal PP)*	Lucknow	Organised by IED
• Future potential of food and agro based industry with a special reference to service rendered by CFTRI and emerging trends and opportunities in food processing sector *(Gothwal PP)*	Lucknow	Organised by CII
• Scope of CFTRI based technologies in the state of Uttar Pradesh *(Gothwal PP)*	Lucknow	AGRICON-2011 at Indian Institute of Sugarcane Research
• Development of a domestic waste water reclamation and reuse system *(Sridhar BS)*	Brazil	TUM alumni expert seminar, Sao Paulo
• Food biotechnology - Technology transfer and SMEs *(Sridhar BS)*	Tamilnadu	6th National seminar on biotech institute-industry interaction at Bannari Amman Institute of Technology
• *In vitro* secondary metabolite production and bioactive compounds (Renu Agrawal)	Tumkur	National conference on dissecting the complexities of plant biotechnology in the post-genomic era
• Developing value added products from jackfruit seed and byproduct recovery from jackfruit waste *(Shruti Pandey)*	Trivandrum	Workshop on Jackfruit –key to local food security, sponsored by Centre for Innovation in Science and Social Action (CTSSA)
• Processing and development of grain based health foods *(Manisha Guha)*	Tezpur University, Assam	National seminar on human health BIOFOODS2011

Subject	Location	Institution/group
• Preparation, nutritional composition, functional properties and anti-oxidant activities of multigrain composite mixes *(Vasudeva Singh)*	Nantes, France	6th International CIGR technical symposium
• Changes in the properties of starch, anti-oxidants and viscosity behavior before and after preparation of flakes from cereals and millets *(Vasudeva Singh)*	New Delhi	First ICC grain conference
• Food security: Role of food technology *(Jagan Mohan Rao L)*	Guntur, Andhra Pradesh	National seminar on food security - Organic farming the need of hour, at Hindu College
• Drying of herbs: Case studies *(Madhava Naidu M & Umesh Hebbar H)*	Bangalore	National conference on appropriate technologies for Indian food processing industries at GKVK campus, organized by MFPI and IICPT, Thanjavur
• Novel biochemical profiling of Indian black teas and development of green tea based radical scavenging conserve as natural antioxidant for health promotion *(Borse BB)*	Hyderabad	3rd world congress on bioavailability and bioequivalence - Pharmaceutical R&D summit, organized by OMICS group publishing
• Synthesis, bioactive attributes and therapeutic potential of novel derivatives of nutraceutical constituents of selected spices *(Srinivas P)*	San Francisco, USA	PHARMACEUTICA - 2012, Second World congress on pharmaceutics & novel drug delivery systems
• Advances in grain processing technology *(Vasudeva Singh)*	Chennai	International workshop on recent trends in food processing - The global scenario, organized by Institute of Food and Dairy Technology, Chennai and University of Nebraska, USA
• Global scenario on rice technology *(Vasudeva Singh)*	Bangalore	Dr. P. Sadananda Maiya Centre for Food Science and Research

Subject	Location	Institution/group
• Studies on the technology aspects of various kinds of rice *(Vasudeva Singh)*	Hyderabad	Rice Tech Expo, conducted by Shiny Trade Expositions
• Processing and value addition to small millets *(Vasudeva Singh)*	Dharwad	National seminar on millets
• Nutrient, physico-chemical and nutraceutical properties of Indian medicinal rice *Njavara* *(Vasudeva Singh)*	Kokata	26th Carbohydrate conference at Indian Institute of Chemical Biology (CSIR) in collaboration with NIPER, Chandigarh and ACCTI, Dehra Dun
• Omega-3 fatty acids in human nutrition and health *(Akhilender Naidu K)*	Davangere	Seminar on aging, secondary ageing lifestyle diseases & medicinal foods: Cures for all diseases at Davangere University, Shivagangotri
• Reduction in Cholesterol levels of rats fed a diet containing interesterified fats are mediated via upregulating the LDL-receptor pathway *(Lokesh BR)*	Lucknow	80th Annual meeting of SBC (I)
• Balanced levels of fatty acids and minor constituents of oils as ingredients necessary for promotion of cardiovascular health *(Lokesh BR)*	Pune	XXI ICFOST
• Developments in oils and fats-impact on health and diseases *(Lokesh BR)*	Mysore	Karnataka State Open University
• Structured lipids: Fats for the promotion of cardiovascular health *(Lokesh BR)*	B.G. Nagara	Adichunchanagiri Biotechnology and cancer Research Institute
• Recent development in carotenoid research *(Baskaran V)*	Mysore	Karnataka State Open University

Subject	Location	Institution/group
• Spices as potential nutraceuticals *(Kalpana Platel)*	Bangalore	Winter Course entitled "Nutraceutical: Challenges & opportunities in 21st century", University of Agricultural Sciences
• Food safety systems for dairy industries *(Vijayendra SVN)*	Bangalore	All India seminar on "Emerging technologies in dairy industry", Institute of Engineers

From the colloquium on current trends in protein structural biology organized by CSIR-CFTRI and SBC(I), Mysore chapter

22. LIBRARY AND INFORMATION

Apart from staff and students of the Institute, 108 external clients were provided library services.

Digital Archives

Document Type	Scope/Size (as on 31.3.2012)
• Ph.D. Theses	288
• M.Sc. dissertations / Project reports / investigations	1164
• CSIR-CFTRI research papers	3399

Library Holdings

Sl. No.	Items	New Acquisitions	Current Collections (as on 31.3.2012)
1	Books	213	27447
2	E- Books (CRC Foodnetbase & others)	Nil	373
3	Hindi Books	150	1704
4	Directories, Year books & Handbooks	Nil	3878
5	Bound Volumes of Periodicals	1100	44293
6	Current Periodicals	Nil	260
7	Indian Standards / Specifications	Nil	12187
8	Patent Specifications	Nil	83633
9	Theses / Dissertations / Investigations	26	2404
10	Investigation Reports	206	1304
11	Annual Reports	17	2113
12	CD-ROMs	26	567

E-Journals and Online databases

Access to 5195 journals through CSIR e-journal consortium were provided to library users. Similarly online access to BIS standards were made available. Other services comprised Chemical Abstracts (Web edition), Web of Science, Journal Custom Content for Consortia, Derwent Innovations Index and Delphion. Also trial access to e-journals / databases as part of the Consortium was facilitated.

National Database Resource Centre (NDRC)

The NDRC facilitated access to the following databases for Institute staff and students.

- Chemical Abstracts - Full Abstracts (since 1997)
- Chemical Abstracts - Collective Index (1992 - 2006)
- Food Science and Technology Abstracts (1969 onwards)
- Biotechnology Abstracts (1982 - 2001)
- Nutrition Abstracts (1990 - 1998)
- CAB-PEST CD (1973 - 2001)
- Pest Bank (2000 - 2002)
- Toxline (1981 - 2001)
- CSIR-CFTRI Research Papers Database (1950 onwards)

In-house databases

- Food Science Database (15060 records)
- Food Update (368 records)
- Indian Food Patents (320 records)
- Directory of Research Projects in Food Science & Technology in India, 7^{th} Rev. Ed. 2012 (371 records)
- CSIR-CFTRI Research Papers Citations Database (7521 records)

Other Services

The On-line Public Access Catalog (OPAC) of books, journals, theses, dissertations and student investigations were made available. Also the browsing facility for accessing the e-journals, standards, databases for staff, students, research fellows and project assistants was provided at library.

24. PUBLICITY, LIAISON AND SEMINARS

TECHNICAL SEMINARS BY VISITORS

Title	Speaker
• Importance of proper posture to be adopted in our day to day life-lecture cum demo	**Sri. Raghavendra TE** RSI Specialist and Ergonomist, & Head, Dept. of Physiotherapy AVIRA- euromusculoskeletal Physiotherapy Centre, Mysore
• Finding No. 1: Finding one number; Bibliometric -Thermodynamic consilience	**Dr. Gangan Prathap** Director, CSIR-NISCAIR, & Incharge Director, RAB, CSIR HQ New Delhi
• Your highest potential through wellness	**Dr. Pai BR** My-AYUSH Foundation Mysore
• Stress management and relaxation through yogic techniques	**Dr. Anil Kumar CS** My-AYUSH Foundation Mysore
• Back to the future: Reminisces of a vintage biochemist in the wonderland of medicine (Dr. D. Rajagopal Rao Endowment Lecture)	**Dr. Krishnaswamy PR** Adjunct Professor, Sri Devaraj Urs Medical School Kolar, Karnataka

Bharat Ratna Dr. B.R. Ambedkar Jayanthi Celebration : Lighting of lamp by Smt. Pushpa Latha T.B. Chikkanna, Mayor, Mysore City Corporation. Dr. G. Venkateswara Rao, Acting Director, CSIR-CFTRI and others are seen

INSTITUTE SEMINARS

Topic	Speaker
• Dietetic fats and oils	Sakina Khatoon
• Experimental histopathology an eye-witness parameter in food safety & toxicity studies	Ramesh HP
• Managing bibliographic citations using endnote web	Padmavathi T
• Downstream processing: Problems and prospects	Raghava Rao KSMS
• Atta processing history and recent trends	Aashitosh A Inamdar
• Microbiological food safety assurance and the Indian food control system	Prema Viswanath
• Automation in grain processing	Srinivas A
• Intermediate moisture foods (IMFs) from fruits and vegetables: An overview	Chauhan AS
• Fish oil as aquaculture ingredient or as biofuel: Issues, alternatives and prospects	Bhaskar N
• Reporter bacteria for biosensing applications	Prakash M Halami
• Advances in wheat milling technology	Suresh D Sakhare
• Arabinoxylans: Unique dietary fibre components	Muralikrishna G
• Bibliometric analysis of CFTRI research publications	Anita CS
• New era of food safety in India	Devendra J Havare
• Whole grains: Wonder grains for wellness foods	Jaydeep A
• Challenges ahead for the Indian meat industry	Sakhare PZ
• Grinding or size reduction: Importance in food processing	Indira TN
• Role of enzymes in value addition to spices	Sowbhagya HB
• Factors affecting global warming - A climate change	Usha Devi
• Functional ingredients/nutraceuticals in traditional foods	Baby Latha R
• Rice bran lipase inactivation: Structure - function relationship	Parigi Ramesh Kumar
• Technology business incubators at R&D institutes	Rajesh S Matche
• Electromagnetic field assisted food processing: An overview	Umesh H Hebbar

Visitors to the Institute

- As a routine awareness to public, guided tours for 70 groups for a total of 1720 visitors were conducted. The visitors included postgraduate and undergraduate students, farmers, trainees and trainee officials from various parts of the country.
- *Mauritius Researcher* **:** Mrs B. Esha Aumjaud, M.Sc. Food Technology, Department of Agricultural & Food Science, The University of Mauritius as Visiting Scholar from 7 December 2011 to 6 January 2012.

Participation in Exhibition

- ***Gulbarga Utsav*** - Organized by Government of Karnataka and Karnataka Food Ltd. Bangalore, Gulbarga, April 15-17, 2011
- ***Bangalore India Bio 2011*** - Organized by Department of Information Technology, Biotechnology and Science and Technology, Govt. of Karnataka, Bangalore, May 4-6, 2011
- ***Kisan Vigyan Mela & Kissan Vaigyanic Interaction Meet*** - Organized by Biotech Networking Facility Centre, Bakahsi Ka Talab, Lucknow, June 29, 2011
- ***AGRICON-2011*** - Organized by Indian Institute of Sugarcane Research, Lucknow, November 4-5, 2011
- ***XXI ICFOST*** - Organized by CFTRI, DFRL, AFST(I), Mysore, Pune, January 20-21, 2012
- ***Agrovision 2012*** - Organized by CSIR, New Delhi, Nagpur, January 27-30, 2012
- ***7th Nutra India Summit 2012*** - Organized by CSIR, IUFoST, Bangalore, March 15-17, 2012
- *Showcasing of Agricultural Technologies* - Organized by Central Institute for Subtropical Horticulture, Thawar Village in Mal Block, Lucknow, March 22, 2012

CFTRI staff at resource centre, Lucknow interacting with visitors during Kisan Vigyan Mela and Kisan Vaigyanic interation meet at Lucknow

25. ENGINEERING AND MECHANICAL MAINTENANCE

The department takes care of power, water, gas, steam and refrigeration requirements of the Institute and staff quarters. A 600 KVA DG set was commissioned to provide uninterrupted power supply to support ongoing R&D activities.

Solar panel and control system (inside view) at CFTRI

Various energy saving measures were also introduced such as the use of CFL, LED, Metal halide lamps and solar street lights. Also automatic phase reversal switches were installed to ensure uninterrupted power supply to water pumps. Maintenance work was undertaken by electrical, mechanical and refrigeration sections. Also cold storage facilities were maintained during this period.

26. CONSTRUCTION AND CIVIL MAINTENANCE

Renovation of the product innovation centre in the department of Lipid Science & Traditional foods was completed. The oval road infront of the main mansion was resurfaced and provided with footpath. Repair work were also undertaken for the canteen building.

27. CENTRAL INSTRUMENTS FACILITIES

Around 35,000 samples were analysed as part of the R&D support activities using GC, HPCL, Spectrophotometer, SEM and other instruments. Servicing and repair of instruments including internal telephones were also carried out during this period. A training programme entitled “Glassware calibration” was arranged and an intranet application for calibration-scheduling and alerting was initiated.

28. RESOURCE CENTRES

CSIR-CFTRI Resource centres at Hyderabad, Mumbai and Lucknow were involved in conducting EDPs, awareness programmes and liaisoning with user industries in terms of technical enquires, counselling and demonstrations of CSIR-CFTRI technologies. The Resource centre at Bangalore assisted in coordinating activities of the Institute.

Progress under R&D Projects

In-house & Grant-in-Aid Projects

Health Foods and Nutraceuticals

Nutrition

Trans-free fats products

Structured lipids containing behenic and medium chain (MC) fatty acids were prepared from palm stearin using 1, 3-specific lipase catalyzed acidolysis. The modified products of palm stearin were similar in melting characteristics as that of commercial bakery shortenings. Speciality fats suitable for use in salads or as cooking oils and as butter substitutes were also prepared by suitable modifications. Nutritionally superior palm olein containing MC fatty acids with reduced amounts of palmitic acid were also developed through lipase catalysed acidolysis reactions. Palm oil was fractionated to get stearin rich fraction which was blended with sunflower and flax seed oils in predetermined proportions and subjected to chemical and lipase catalysed interesterification reactions. The solid fat content of the modified fat was reduced and the resulting fats had similar melting characteristics as that of ghee. Hard fat like sal was blended with sunflower and flax seed oils to prepare plastic fats. The blended oil with small amounts of added hardened fat showed melting profiles similar to that of vanaspati. A high fat margarine containing essential fatty acids were developed which can be used in foods to replace hydrogenated fats. A cocoa based ready-to-eat spread having soybean oil was prepared .This product provided n- 3 fatty acids. Vanaspati and dairy products like ghee are the sources of trans fat in Indian diets. While elaidic acid was the trans fatty acid present in vanaspati ,it was vaccenic acid and conjugated linoleic acid in ghee.Elaidic acid containing fats enhanced serum LDL/HDL ratio, but vaccenic and conjugated linoleic acid from ghee maintained LDL/HDL ratio. Trans fatty acids also affected inflammatory responses in experimental animals. A novel delivery system in the form of nano particles was developed for increasing the bioavailability of n-3 fatty acid containing oils.

A commercially available product called Lipoid was found to be most effective for nano particle preparation and delivery of n-3 PUFA rich oils. Lipoid encapsulated α-linolenic acid was converted to long chain n-3 PUFA (Eicosapentaenoic acid and docosahexaenoic acid) in rats.

A laboratory scale vacuum frying system was developed and used for preparing snack foods with low oil content. The mechanism for oil absorption by fried products was worked out. The combination of oils was modified by interesterification reaction to enhance heat transfer property of oils. The changes occurring in the chemical composition of rice bran oil used for frying dishes were monitored. Rice bran oil was found to be good cooking oil for frying. The oils from wheat germ and wheat bran were extracted and the composition of these oils was determined. Wheat bran oil was found to contain γ-oryzanol like compound.

Studies were carried out on underutilized oil seeds such as Moringa and Niger. The

composition and nutraceutical contents of these oils were monitored. These oils also showed good scavenging activity for oxygen free radicals. While Moringa seed oil had high levels of oleic acid that from Niger seed had high levels of linoleic acid. The by-products from palm oil were utilized for preparing fractions containing high levels of nutraceuticals.

The enzymatic de-acidification of palm oil fractions was used for the preparation of low melting palm stearin (LMPS) fraction having high levels of nutraceuticals. This approach also minimized the loss of neutral oil during refining. Thus this study addressed the preparation of trans free speciality fats for utilization in various food products. The effect of different types of trans fatty acids on serum lipid profiles and on inflammatory mediators was also addressed. An efficient delivery system in the form of nano particles was developed for enhanced bioavailability of n-3 PUFA rich oils. Changes in the composition of oils during frying conditions were monitored for selecting most suitable oil for frying operations. The oils from underutilized oil seeds and from wheat germ and bran was characterized for increasing the edible oils pool to fill the gap in supply and demand of vegetable oils in this country to some extent.

Health foods based on rice bran

Bran from non-pigmented and pigmented variety of paddy were taken for studies. Bran from germinated paddy had lowest silica content. The protein content was high in bran prepared from germinated as well as parboiled paddy. Fat content in bran was highest in IR-64, lowest in the bran of pigmented variety and the content reduced after germination. Ash content was highest in fine rice bran (Sona masuri) and reduced after germination. Parboiled rice bran had highest oryzanol content. The content decreased after germination and increased after hydrothermal treatment. Total polyphenols (soluble and insoluble) were found four times high. Bioactive component and anti-oxidant properties were high in pigmented rice bran compared to non-pigmented one.

Biscuits were prepared by making use of the stabilized rice bran and amaranthus flour. Standardized conditions with 20% addition of rice bran and amaranthus flour, gave biscuits having good texture, taste and sensory properties.

Garden cress seed oil

Physicochemical properties of garden cress seed oil (GCO) was similar and comparable to other edible oils such as mustard and flax seed oil. GCO contained higher tocopherol and phenolic acid content compared to flax seed oil.

Microencapsulation of GCO with different wall materials were attempted. Whey protein and sodium caseinate showed good encapsulation efficiency. No significant loss of alpha linolenic acid (ALA) was observed in encapsulated

GCO powder. GCO encapsulated powder dispersed well in water and it can be supplemented in bakery products.

Garden cress seed oil (GCO) was blended with popular edible vegetable oils (rice bran, sesame, and sunflower oils) at different ratios separately to decrease n-6/n-3 ratio. Sunflower oil, rice bran oil, sesame oil was blended with GCO at 50, 40, 30 and 20% (w/w) with a n-6/n-3 ratios of 4.7, 4.5, 3.7 respectively in the blended oils. These blended oils were fed to weaned female Wistar rats for 60 days at 10% level. GCO and GCO blended oils did not show any toxicological effects in rats as evidenced by no significant changes in food intake, body weight gain, clinical enzyme such as SGOT, SGPT, ALP, LDH and no change in creatinine and urea was observed. GCO blended oils fed to rats also showed a significant decrease in serum total cholesterol (TC) and serum triglyceride levels as compared to their respective control groups. Similarly serum LDL- cholesterol levels were significantly reduced in GCO blended oil fed groups compared to their respective controls. ALA, EPA, DHA content was significantly increased while LA, AA levels decreased in different tissues of GCO and GCO blended oil fed rats.

Fish industry byproducts

The effect of fish oil on apoptotic death of HT22 mouse hippocamped neuronal cell induced by ER stress inducers were investigated. Apoptosis, reactive oxygen species (ROS) production and mitochondrial membrane potential (MMP) were measured. Expression level and phosphorylation status of ER stress-associated proteins and activation and cleavage of apoptosis-associated proteins were analyzed. Fish oil reduced TG- and BFA-induced apoptosis-associated proteins such as caspase-12 and -3 and poly (ADP-ribose) polymerase. Fish oil also reduced the TG - and BFA-induced expression of ER stress-associated proteins, including C/EBP homologous protein (CHOP) and glucose-regulated protein 78, the clevage of X-box binding protein-1 and activating transcription factor 6α, and the phosphorylation of eukaryotic initiation factor-2α and mitogen-activated protein kinases, such as p38, JNK and ERK. Knock-down of CHOP expression by siRNA transfection and specific inhibitors of p38 (SB203580), JNK (SP600125), and ERK (PD98059) as well as anti-oxidant (N-acetylcysteine) reduced TG- or BFA-induced cell death. Fish oil also reduced TG- and BFA-induced ROS accumulation and MMP reduction. These results suggest that fish oil could protect HT22 neuronal cells against ER stress-induced apoptosis by reducing CHOP induction and mitochondrial damage as well as ROS accumulation.

Health based bakery products

Kachori / Panipuri

Effect of gluten on the rheological characteristics of dough and *Kachori / Panipuri* product quality was studied. Semolina based

doughs showed minimum changes with added moisture and possesses minimum phase angle indicating more solid characteristics that are more suitable for *panipuri.*

Low-GI ingredients

In order to develop low-GI biscuits, natural ingredients such as chickpea flour and unripe banana flour were selected as ingredients and their chemical characteristic were studied. The low GI-ingredients were blended with wheat flour at different levels and rheological characteristics were studied. Rheological characteristics indicated that water absorption of the blend incorporated with banana flour remained same at 5% level where as it decreased on 15% level. Dough development time was decreased and stability also showed similar trend compared to control. Farinograph characteristics of chickpea and banana flours behaved differently. Increased dough development time was observed with increased levels of chickpea flour incorporation. Amylograph characteristics revealed increased maximum peak viscosity at 5% and 10% levels. Low GI-ingredients were replaced with wheat flour in biscuit preparation. Sensory parameters revealed that biscuits prepared with 10% level of banana flour and chickpea flour was comparable with control. Quality characteristics indicated that color of the biscuits incorporated with chickpea flour and banana flour along with gums and emulsifier had slightly higher values than that of control. Texture of biscuits showed that addition of HPMC in both chickpea flour biscuits and banana flour biscuits improved the breaking strength. Sensory scores of the biscuits showed that addition of guar gum improved the overall quality of chickpea flour substituted biscuits and addition of HPMC improved the overall quality of banana flour substituted biscuits.

Hypoallergenic pasta

Optimization of hypoallergenic pasta with the addition of xanthan gum and locust bean gum were carried out. Hypoallergenic pasta prepared with locust bean had higher cooked weight. The starch loss was found comparable to each other. Pasting characteristics revealed that the gelatinization temperature of the pasta was decreased. The maximum viscosity of hot paste, cold paste, breakdown and setback showed increasing trend. Highest hardness was observed for pasta samples with xanthan gum, while lowest stickiness and hardness was observed for control pasta samples. The sensory characteristics of hypoallergenic pasta were found comparable to that of control.

Hypoallergenic pasta

High protein, high fiber and zero trans fatty acids rusk

Effect of partially defatted coconut flour (PDCF) rich in protein, fat and dietary fiber on the quality of rusk was studied. The combination of additives (dry gluten powder and alpha amylase) with 20% PDCF decreased the breaking strength and increased the overall quality of rusk. Storage studies were carried out as no substantial change was observed in the moisture content and overall quality score after 30 days at room temperature. The experimental rusk had 1.4 and 5.5 times increase in protein and dietary fibre content respectively.

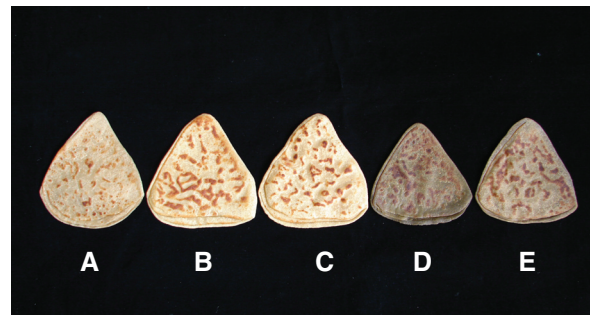
Enrichment of wheat-based products

Effect of green gram and black gram roller milled fractions namely straight run flour (SRF), protein rich fraction (PRF), fibre rich fraction (FRF), and protein and fibre rich fraction (P&FRF) on bread making characteristics of wheat flour was studied. Results showed that bread incorporated with 15% SRF, PRF, P&FRF and 10% FRF were acceptable. Addition of CA (dry gluten powder, sodium stearoyl-2-lactylate and fungal alpha-amylase) significantly improved the volume and texture of breads with green gram and black gram fractions. Also after 7 days of storage, increase is crumb firmness value was observed.

Rheological characteristics of whole wheat flour

Farinograph and amylograph characteristics of whole wheat flour with roller milled fractions of green gram and black gram were studied. Addition of 30% SRF and 30% PRF of green gram decreased water absorption while for all other fractions of green gram and black gram increase in work absorption was observed. The dough stability decreased with all the fractions. The amylograph pasting temperature decreased with the addition of 30% SRF and 30% PRF of green gram as well as black gram while increase was found with all other fractions. The peak viscosity decreased with all the green gram fractions, while SRF and PRF fraction of black gram showed increase.

The North Indian parotta making characteristics of different milled fractions of green gram and black gram showed that size of the parottas increased with all fractions except FRF. The shear force value except SRF, decreased for green gram indicating softer texture with these samples. Also the shear force for all the fractions of black gram showed decrease in values. The overall quality score for SRF, PRF and P&FRF was in the range 38.5-41 and 35-38 for FRF fractions in the scale of 50.



North Indian Parottas from Roller milled fractions of green gram A: Control; B: Straight Run Flour-30%; C: Protein Rich Fraction-30%; D: Fiber Rich Fraction - 15%; E: Protein & Fiber Rich Fraction-15%

Enriched bakery and traditional product

In order to prepare plant leaf enriched bakery and traditional products, green leafy vegetables namely dill leaves and fenugreek leaves were chosen for blending with whole wheat flour. Addition of dehydrated dill leaves and fenugreek leaves increased the water absorption, increased dough development time and mixing tolerance index while dough stability values decreased. Incorporation of green leaves marginally increased the gelatinization temperature, peak viscosity and cold paste viscosity. Parathas were prepared by mixing whole wheat flour, normal or dehydrated leaves, salt, oil and water. Based on the pliability, tearing strength, color and eating quality, addition of 25% normal and 7.5% dehydrated leaves were found to be optimum.

Gluten free cookies

The formulation of millet based gluten free cookies containing gluten replacer at the level 10% was optimized using additives. Additives and additive combinations improved the quality characteristics of millet based cookies. Shelf-life studies showed that cookies can be stored upto one month.

Green gram semolina on the characteristics of pasta

Effect of green gram semolina on pasta was carried out. The sensory characteristics of cooked pasta showed that pasta with 60% green gram pasta had the highest overall quality score. Similarly studies were carried out using black gram semolina on pasta at different levels. The black gram semolina was found optimum at 50% in pasta where as the protein content increased to 15%.

Bioaccessible iron from fortified flours

The bioaccessible iron content of control and fortified bread with added organic acids was determined by simulating gastrointestinal digestion *in vitro.* Addition of citric acid resulted in 20-40% increase in bioaccessible iron from fortified bread.

Germinated cereal flours in bakery products

Wheat flour was fortified with 1.4 ppm folic acid along with iron. The added folic acid was found retained in breads after baking found to be 80%. Influence of finger millets (with and without germination) flours for biscuit preparation was carried out. It was observed that germination of finger millet had significantly increased the *in vitro* protein digestibility.

Biscuits, Mathri and Khakre from composite flour

Four types of composite flours were developed from brown rice, Bengal gram, singhada and wheat. The storage studies revealed that the roasted flour samples were shelf stable and the initial moisture content was less than the critical moisture content. The biscuits prepared from these flour were sensoraly good and had no perceived off-odours or off tastes in the biscuits.

Paddy varieties like IR 64, jyothi and njavara were used to prepare *Idiappam* (String hopper).The conditions for processing were optimized and their physico-chemical properties were studied. This flour was ready -to -use convenience flour for the preparation of string hopper (*Idiappam).*

Traditional fermented dry mix of sorghum for *Idli* was prepared, it had higher protein content (14%), higher iron and zinc content (5.8 mg % and 2.6 mg %), lower carbohydrate digestibility (65%) higher dietary fiber, thus it is convenience flour as well as it had health benefits.

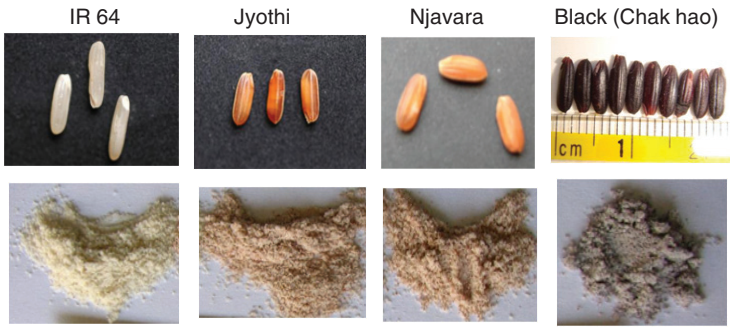
Maize was processed to grits subjected to different thermal treatments and biscuits were prepared. Biscuits from roasted whole grain appeared sensorily good compared to that from grits.

The composite flour from millets was processed to prepare ready-to-eat flakes and the physicochemical as well as nutritional properties of the flakes were studied. The flakes had good nutritional quality and 90% of the sensory panelist rated the flakes very good.

Ready-to-eat flakes made from composite flours of millets

Composite flour from maize, sorghum, Bengal gram, rice, black gram and horse gram flours were prepared. Effect of processing the grains on the functionality of composite flour for roti revealed that a combination of 60% raw and 40% steam processed flour gave rotis with better rolling quality and taste.

Pre-gelatinized Bengal gram and soy bean flour was incorporated to wheat flour to make protein rich chapati. Possibility of development of protein rich RTU chapati flour with a high sensory attributes was explored.



Whole grains and its flours

Idiappam (String hopper) made from red rice

Semolina

Foxtail millet, after dehusking was milled in a roller flour mill (laboratory model) to prepare semolina. Steaming this millet improved the dehulling to 99%. A maximum yield of 66% medium semolina and 30% fine semolina was obtained under optimized conditions and their pasting profile was studied. Semolina from finger millet, rice, wheat and in combination was prepared and their cooking time was < 2 minutes and their pasting profile was also studied.

Dhal analogues from underutilized pulses/ pulse flours (Cowpea, Horse gram, Pea) were prepared. Combination of Horse gram and Tur flour and pre-processed flours from these pulses gave better results than other samples (sensory scores 2.9 and 3.4 on 5 point scale, Tur dhal - 4.2). It can be stated that dhal analogues from underutilized pulses can be made and the quality of prepared popular products (*sambar)* from these analogs was well accepted.

Gadgets

Gadgets useful for processing and product development from grains were developed. These include - manually operated millet dehusker, *Ragi mudde* forming machine, gadget to measure coefficient of friction of grains and dhal polisher.

Shelf stable meat pastes

Shelf-stable paste for traditional meat products were prepared. Hurdle technology was used to preserve the product. The advantages of the paste includes tenderization of meat, better flavour, juiciness and convenience. Six month shelf-life was established for different pastes under ambient storage conditions.

Shrimp pasta

Influence of freeze-dried shrimp meat (SM) at different levels in pasta processing was studied. Rheological studies showed that increased amount of freeze dried SM improved the dough stability but decreased the amylograph peak viscosity and farinograph water absorption. Increased levels of freeze-dried shrimp meat resulted in higher protein levels in the pasta, though the cooking loss also became higher. Pasta with 5% SM had the highest mean score for all the attributes. Microstructure studies revealed that freeze-fried SM in the pasta increased the protein network of pasta and 5% SM incorporated pasta had increased levels of essential nutrients, fatty acids such as EPA, DHA and lysine.

Preparation of high quality chitin and chitosan from shrimp shell and their application as a bio-preservative for fresh meat was explored.

Low calorie sweetener

The fingerprints of sweetness by studying the amino acid composition and structure properties of sweetener proteins were explored. Structural analysis of monellin revealed that individual A or B chains of monellin are not contributing to sweetness. The native conformation and ionic interaction between AspB7 of monellin with active site of T1R2-T1R3 receptor, along with hydrogen bonding stability of IleB6 and IleB8 are responsible for the sweet taste. Based on structural similarity search, new hypothetical protein from *Shewanella loihica,* which has the presence of Asp32 with adjacent isoleucine residues was found. Further the lead protein by two-step docking was examined for the study of interaction of functionally conserved residues with receptors. The identified protein showed similar ionic and hydrophobic interactions with monellin. Results suggests potential health application for this protein in low calorie sweetener industry.

The genomic relation between human and rat genome with reference to type 1 diabetes mellitus (T1DM) was evaluated. Comparison of T1DM of human and rat genome found similarities and evolutionary relation between each other. Comparative genomic analysis predicted hypothetical protein LOC688090 *(R. norvegicus)* showed 80% sequence identity with MHC II. As MHC II genes are mainly involved in T1DM, the sequence similarity in rat gives a strong evidence of the presence of conserved regions in genomic composition and thereby chances to produce functionally similar proteins in T1DM pathway. The protein LOC688090 sequence showed 79% similarity with B chain of 2P24 (Mus musculus) structure and used as template for model building. By using homology modeling, 3D structure for protein LOC688090 was predicted using Swiss model and obtained the conserved domain.

Bioaccessibility & bioactive peptides

Bioaccessibility

The efficacy in enhancing the mineral bioaccessibility by casein phosphopeptides (CPP) was studied. The mineral absorption enhancing ability of CPP was tested in pure iron and zinc solutions and defatted soya flour. The CPP enhanced the bioaccessbility of iron by 10-70% from ferrous sulphate solution and bioaccessbile zinc by 40-50% from zinc sulphate solution.

Bioactive peptides

Whey protein hydrolysate (WPH) was investigated for its effect on hyper-cholesterolemic rats by measuring hepatic enzyme activity and mRNA expression of enzymes involved in lipid metabolism and subsequently by their effect on hypertension. Antihypertensive effect was studied through its inhibition against angiotensin converting enzyme. HMG-CoA reductase activity was suppressed in WPH treated group. The mRNA expression of HMG-CoA reductase was suppressed by WPH diet, whereas that of

cholesterol 7alpha hydroxylase was upregulated.

Protein isolates

Soybean

Protein isolate was prepared from soybean by membrane filtration. The protein content of isolates prepared by membrane filtration was similar to those prepared by isoelectric precipitation. The solubility of isolate prepared by membrane filtration was higher at different pH. Also the foaming capacity and foam stability of soya protein isolate prepared by membrane filtration was higher at neutral pH.

Mustard

Mustard protein isolate was prepared from defatted mustard flour by isoelectric precipitations and ultrafiltration. The isolates were prepared at isoelectric acidic pH and alkaline pH from defatted flour. The major protein fraction precipitated at acidic pH gave a better yield compared to the minor fraction obtained from precipitation at alkaline pH. The yield of both fractions were comparable. Membrane processing studies revealed better recovery of protein isolate compared to conventional processing.

Groundnut

Groundnut protein isolates were prepared from defatted groundnut flour by isoelectric precipitation and membrane filtration. The effect of membrane filtration method on protein isolate was studied. Results indicated that membrane filtration increased the nitrogen solubility of the isolate over all pH ranges. Protein isolate prepared by membrane filtration was less hydrophobic compared to acid precipitated protein isolate. Similarity was observed in subunit pattern of groundnut protein isolate prepared by membrane filtration and groundnut flour.

Oil-in-water nanoemulsions for enhancing the stability of beta-carotene through high pressure homogenization was attempted. Nanoemulsions of beta-carotene had better stability compared to control.

Roasted sesame oil as a health oil

Roasting the sesame seeds, before expelling increases the stability of oil due to breakdown of sesamolin to sesamol. Sesame seeds were roasted at optimized temperature and moisture conditions. The oil from roasted seeds was found to be more stable.

Protease inhibitor of legumes

Primers were designed to amplify open reading frame of 228 bp BBI gene from horsegram genomic DNA. *SapI* and *PstI* restriction site were engineered at the 5^1 and 3^1 ends of the amplicon respectively. The amplified PCR product was cloned using *SapI* and *PstI* site of the pTwin1 vector. The DNA sequence of the putative clone (p Twin-HGI-III) was determined and *E.Coli B ER 2566* strain was transformed by the expression plasmid pTin1-HGI-III. The fusion protein expressed as

a soluble protein. The trypsin inhibitory activity of the crude extract was 356 TIU/mg. The specific activity of the purified rHGI-III was 3.3.±0.8x10^5 trypsin inhibitory units/mg with a yield 1.5 mg protein / L of culture. Kinetic studies indicated that rHGI-III was a potent competitive inhibitor of bovine trypsin and the Ki for trypsin inhibition was 2.66 x 10^{-9}M and for chymotrypsin was 1.97x10^{-8}M, similar to horsegram seed inhibitor.

Enzyme processes

β-D-xylosidase from *Lactobacillus brevis* NCDC 01 grown on XOS was purified and characterized. Three sequential steps i.e ultra filtration, DEAE cellulose chromatography and Sephacryl S-100 gel filtration were employed to purify the enzyme to apparent homogeneity and it was found to be monomeric on SDS-PAGE with an apparent molecular mass of 58 kDa. The pH and temperature optima were 6.0 and 40ºC respectively. The enzyme remained stable over a pH range of 5.5 - 7.5 and up to 50 °C for 30 minutes. Under optimum pH and temperature with p-nitrophenyl β-D-xylopyranoside as a substrate, the enzyme exhibited a K_m of 0.87 mM. The enzyme does not require any metal ion for activity or stability but is completely inhibited by Hg^{2+}, oxalic acid and citric acid. The purified enzyme hydrolyzed xylo-oligosaccharides to xylose.

Proteases and lipases

Different extractants were used for extracting enzymes from chicken viscera. More protein was extracted from the broiler viscera than that of layer viscera. Acetone extracts showed maximum protease activity. Lipase activity was affected drastically in solvent extracts. Proteases and lipases of the viscera were found more alkaline in nature. Glandular stomach of the chicken exhibited acidic proteases. Whole viscera exhibited more enzyme activities compared to empty viscera. Purified extracts improved the texture of layer meat. Results indicated that chicken viscera may be employed as a tool for texture improvement.

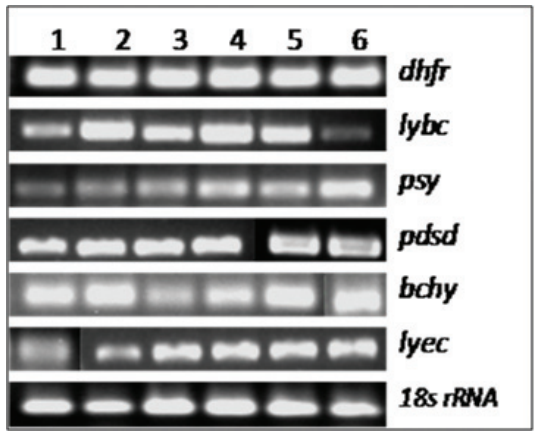
Nutritional metabolites from selected plants

Total carotenoids, beta carotene and folate contents were analysed in 10 different commercial varieties of coriander and 6 varieties of *Moringa oliefera* and 2 varieties of *Hibiscus cannabinus* during their growth cycle. The high carotenoid-folate-containing cultivars were grown as callus cultures *in vitro* and the biosynthesis of folates and carotenoids were followed. Many elicitor treatment conditions were tried to enhance carotenoids and folate contents where methyl jasmonate and salicylic acid were found to significantly enhance beta-carotene, lutein, alpha-tocopherol and folates. Drying methods for the stabilities of folates and carotenoids were analyzed and found that microwave drying results in good foliage dry biomass with least loss of the essential nutrients.

Nutraceuticals

Bioactive molecules

The extraction of bioactive molecules from Moringa flowers, pods and leaves were attempted using column and paper chromatographic techniques. The interaction study of amino acids and reducing sugars of Moringa leaves and flowers were attempted and a synthetic protocol for preparing Heyns and Amadori compounds of the form *N*-(2-deoxy-D-glucosyl) amino acid (amino acid = L-arginine, L-lysine) amadori compounds *N*-(1-deoxy-D-Fructosyl) amino acid (amino acid = L-arginine, L-lysine) was established.



Differential expression of carotenogenic gene under elicited conditions - 1. Control 2. MeJa 10 µM 3. MeJa 100 µM 4. SA 10 µM 5. SA 100 µM 6. SA 500 µM

Spice bioactives

Ginger flavoured sugar syrup, a byproduct from the process for ginger candy, was formulated into a ginger beverage concentrate, which on dilution and carbonation affords a refreshing beverage. This process has been standardized. Preparation of ginger bio-oleoresin using enzymes for pretreatment of ginger was studied. Ginger aqua oleoresin was effective in inhibiting the growth of *L.monocytogenes, P.aeruginosa, Y.enterocolitica* with maximum inhibition of 28 ± 1.2, 23 ±1.0 and 29 ±1 mm respectively. The spent extract rich in gingerol possessed significant activity as an antibacterial agent on bacteria namely *S.auerus, E.coli, B.subtilis, B.cereus, L.monocytogenes, P.aeruginosa and Y.enterocolitica.*

Zerumbone enriched powder was prepared by removal of starch in fresh zerumbet rhizomes. Enriched zerumbone powder was subjected to steam /hydro distillation to obtain pure zerumbone. Zerumbone derivatives - Zerumbol, Zerumbamide, and Zerumboneoxime- were synthesized and their anti-mutaegnicity attributes were investigated.

White variety of *Hibiscus cannabinus* plants grown in green house (a & b) and fully bloomed flower of white variety (c)

In-vitro mycotoxigenic activity of *Zingiberzerumbet*oil and its effects on ochratoxin producing *A. ochraceus and A.flavus*were determined.Purity of zerumbone was checked by HPLC and NMR studies. 6-Shogaol was synthesized from zingerone and its conversion to 6-gingerol was investigated.

The antimicrobial susceptibility investigations were conducted for essential oil, raw ginger, ginger aqua oleoresin, ginger spent (gingerol rich conserves) and Dehydrozingerone and its derivatives against food borne pathogenic bacteria and fungi. The organisms were susceptible for ginger extracts and growth inhibition was observed in the case of gingerol rich conserves. Further, *Zingiberzerumbet* oil was extracted from rhizomes using clevengers distillation method. The antifungal property of *Z. zerumbet* volatile oil was studied against mycotoxigenic fungi *A.ochraceus,* which was susceptible to *Zerumbone*. The minimum inhibitory concentration, fungicidal concentration, growth and sporulation with respect to *A. ochraceus* were studied and significant inhibition of mycelia and spore germination was observed. Reduction in the weight of the cell mass and biochemical changes with respect to carbohydrate, protein, chitin, DNA and RNA constituents in the fungal cells grown with *Z. zerumbet* oil were observed. The ochratoxin estimation was carried out by TLC and HPLC, 67% of OTA was inhibited with 100 ppm and 96.75 with 150 ppm followed with 100% inhibition with 200 ppm of zerumbone. *Z. zerumbet* volatile oil is effective antifungal compound and is elucidated by morphological alternations as well metabolisms of the fungal organism. Also, the antimicrobial activity of Dehydrozingerone (DZ) and its derivatives revealed efficient activity due to the carbonyl moiety.

Radical scavenging activity

Aqueous stem extract added in sweet lime (*Citrus limetta*) juice revealed a dose dependent increase in radical scavenging activity (RSA) as against that of unsupplemented juice (control). Pasteurization resulted in slight decrease in ascorbic acid content and RSA. Shelf stability of experimental juice was evaluated based on physico-chemical, sensory and microbiological attributes. In the same manner, aqueous leaf extract was added to grape (*Vitis vinifera*) juice, which also exhibited a dose dependent increase in RSA as against that of control devoid of leaf extract. Although shelf stability of experimental juice was evidenced by physico-chemical, sensory and microbiological attributes, upon pasteurization and subsequent storage, there was a slight decrease in ascorbic acid content and RSA.

Bioactive constituents

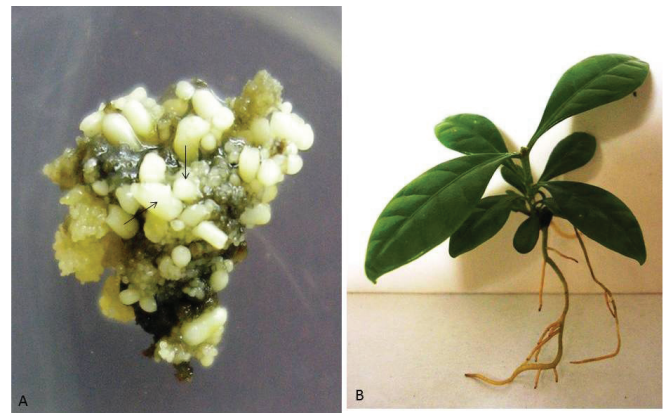
The biological activity associated with leaves of Indian borage (*Plectranthus amboinicus*) was evaluated by subjecting the leaves to extraction with solvents, individually and sequentially. Based on the outcome of sequential extraction, ethyl acetate and

acetone were used as individual solvents to obtain the extractives and the same were evaluated for biological activities. As evidenced by 1,1-diphenyl-2-picryl hydrazyl (DPPH) radical scavenging activity assay, acetone extract of leaves exhibited higher antioxidant activity as against that of ethyl acetate extract. Similar was for antibacterial activity against selected foodborne pathogenic bacterial species. At their respective MIC levels, the potent extractives could induce nucleic acid and protein leakage from sensitive bacterial cells. Chromatograms of HPLC revealed that these solvent extracts did contain phenolics that exhibited biological activity. In the case of stems of Indian borage, methanol extract appeared to be an antioxidant rich fraction as determined by *in vitro* assay systems. The same extract also exhibited antibacterial activity against selected food borne pathogenic bacterial species.

Microencapsulation of *Garcinia* fruit extract by spray drying with maltodextrin (MD) as the wall material had a higher efficiency than whey protein isolate (WPI) used individually and in combination with MD. Incorporation of maltodextrin encapsulated *Garcinia* fruit extract into bread resulted in softer crumb texture, volume increase, acceptable sensory attributes and higher free and net (-) hydroxy citric acid (HCA) retention. In the same manner, microencapsulation of fruit extract was also achieved by freeze drying, wherein the encapsulation efficiency was almost the same with both the wall materials and incorporation into bread resulted in acceptable quality attributes. In an approach to evaluate relationship between extraction methods and wall material used in encapsulation, it was observed microwave assisted extract encapsulated with both the wall materials showed higher free and net HCA recovery as against that of autoclaved extract.

Cafestol and Kahweol

Studies were carried out to find the influence of roasting and brewing methods on antinutritional diterpenes in coffee brew. Coffee bean samples roasted at different temperatures were analyzed for the lipid



Somatic embryos production from embryogenic callus of *Coffea canephora* on half strength MS medium containing 0.5 mg/l BA and 0.25mg/l IAA and Regenerated plant with reduced levels of cafestol and kahweol (Somaclonal variant)

fractions, cafestol and kahweol. Also diterpene profile was analyzed for brew prepared using mocha, filter, espresso and french press. Higher roasting temperatures and longer duration of roasting had significant influence on diterpene profiles in roasted beans. Cafestol and kahweol content was maximum when the brew was prepared in french press and minimum was observed with filter paper.

In vitro somatic embryo cultures of *Coffea canephora* were raised. Somaclonal variants that produce reduced levels of cafestol and kahweol were identified and tissue cultured plantlets were established.

Bioactives from seaweeds

Studies were carried out to assess the ACE inhibitory activity, antioxidant and antimicrobial activity of the hydrolysed seaweed. Seaweeds, tissues were degraded using acid hydrolysis. Crude oligosaccharides were prepared from the red Indian seaweeds *Kappaphycus alvarezi* and *Gracilaria verucosa* by acid hydrolysis. These oligosaccharides were able to scavenge the radicals like DPPH, ABTS, $H_20_{2,}$ Hydroxyl ion, singlet oxygen and nitric oxide. They also showed reducing and metal chelators and significant ACE inhibitory activities. In the case of HCL hydrolysed samples, the inhibition percentage showed a decreasing trend where as in the case of citric and acetic acids, the inhibition showed increase against the increase of time.

Fermented brown seaweed Sargassum

Dry seaweed suspended in water and supplemented with 0.5% glucose was inoculated with LAB isolates and incubated at 37°C for 4 weeks. Cell growth, pH change, reducing sugar and total sugar were analyzed at regular intervals. Anticoagulation activity using ATTP and PT assay (heparin standard) indicated maximum activity in the sample fermented with KB-2b and P1-2CB-w1 with a relative clotting factor of 125.85 and 57.55 U respectively.

Aspergillus carbonarius and Monascus purpureus

Xanthophyll microcapsules prepared by a spray drying method using a wall system consisting of whey protein or maltodextrins resulted in microcapsules with a regular spherical shape and the storage stability of 69-95%. Antioxidant property of microencapsulated xanthophyll was suggestively enhanced. The xanthophyll from *A. carbonarius* also exhibited insecticidal

Kappaphycus alvarezhi

Gracilaria verrucosa

activity against *Sitophilus oryzae* where in 500 ppm resulted in significant adult mortality of 93% at the end of 21days exposure. The total progeny production by *S. oryzae* was reduced to 19%. The water soluble pigments from *Monascus purpureus* were microencapsulated with whey protein as coat material. The antioxidant activity and total polyphenols showed significant increase in activity after encapsulation.

Nutraceuticals from plants

The antioxidant potential, peroxyl radical scavenging, anti-inflammatory and anti-atherogenic efficacies of *Scoparia dulcis* leaves were studied. The methanol extract showed potent antioxidant activity with IC_{50} value of 0.57 mg/ml and it caused hydrogen peroxide scavenging of 28.9 mg/ml. It also improved human erythrocyte membrane stabilization (86%) and inhibited lipid peroxidation and oxidation of LDL, thus preventing the formation of foam cells. The phytochemical analysis of *S.dulcis* leaves showed higher accumulation of flavanoids. The purification and characterization of flavanoids and its effect on the formation of foam cells are under progress.

The bulb and root samples of mangrove plant (*Rhizophora* sp) were extracted in different solvents and the concentrated extracts dissolved in methanol was assayed for antimicrobial activity. The ethanol extract from radicle, root and bulb showed antimicrobial activity against different pathogens.

Antimicrobial activity of hot water extract from different Indian seaweeds was also evaluated against various pathogens. The extract from the brown seaweed, *Sargassum tenerium* and the green seaweed *Halodule pinifoliata* showed considerable antimicrobial activity. Ethanol extract of brown seaweed (*Turbinaria conoides*) was prepared. Residues of the ethanol extract (EE) was extracted with hot water (HWE). Fish cubes prepared from deboned fish was treated with EE and HWE. Also fish cubes dipped in water and ethanol was used as control. Microbiological quality was analysed for different duration. In the EE treated samples the total plate count was reduced.

Sargassum

Halodule pinifoliate

Turbinaria

Probiotics

In vivo studies were done in male albino rats with PLB fermented milk. The body weight and vital organ weight like liver, spleen, heart, lungs, and kidney did not show any significant deviation from that of standard and positive controls. The feed intake in probiotic fed groups showed higher values when compared to those not supplemented with PLB. The moisture (%) of faeces showed significant reduction among supplemented groups. The serum analysis for SGOT, and creatinine showed decreasing trend while alkaline phosphatase showed increasing trend. The results indicated the favourable effect of serum enzymes in cellular integration and maintenance of homeogenesis. The microorganisms were enumerated for total plate count, coliforms and yeasts and molds from the colon. It was found that when PLB was supplemented in the feed it reduced the bacterial load of coliform count. A potent probiotic lactic acid bacteria with an active principle specifically against watery diarrhea causing *E. coli* O-8 was characterized.

Prebiotic exopolysaccharide

Lactic acid bacteria (LAB) isolated from traditional *Ayurvedic* fermented preparations used for the treatment of various gastro-intestinal disorders, were screened for the ability to produce exopolysaccharide (EPS) and the strain T5-1, isolated from *Takrarista*, was chosen for further investigations. Fermentative production of EPS by selected LAB isolate was carried out using modified MRS broth. The strain exhibited potent probiotic properties. Antibiotic resistance by minimum inhibitory concentration (MIC) test indicated that the strain showed high antibiotic resistance to commonly prescribed antibiotics such as streptomycin. LAB isolate was identified as *Lactobacillus plantarum* based on molecular characterization (16S rRNA gene sequencing). Different media were evaluated for EPS production by the selected strain *Lactobacillus plantarum* (T5-1) and the EPS yields were considerably higher in the simplified synthetic medium. The EPS produced was quantified by phenol-sulphuric acid assay for total carbohydrates using dextran as the standard. The yield of EPS was 1,059 mg/L and was found to be a heteropolysaccharide.

Functional foods

Fibrinolytic enzyme producing Bacillus sp.

Heat resistant *Bacillus* sp were isolated from different fermented samples of cereals and legumes. Among these non-hemolytic, Gram positive, catalase positive and spore formers were selected. Selected cultures were characterized and based on RAPD banding pattern, similar cultures were grouped. The representative cultures from each group were further screened for the ability to produce fibrinolytic enzyme using fibrin plate, fibrin zymogram and spectrophotometric assay. By partial 16S rDNA sequencing, the cultures were

identified. Production of fibre degrading enzyme from *Bacillus circulans* was detected after 18 hours of growth. Gel assay for inhibitors studies indicated that enzymes of *Bacillus circulans* CFR11 were inhibited by PMSF and EDTA.

Black gram husk

Black gram husk (BGH) extract had total polyphenol content of 59 mg of gallic acid equivalents (GAE). The phenolic acids identified in the extract using RP-HPLC were gallic, protocatechuic, gentisic and ferulic acids. The extract showed good antioxidant properties. The IC_{50} value for DPPH radical scavenging activity was found to be 3.92 µg of GAE. The BGH extract also showed α-glucosidase inhibition and the IC_{50} value was found to be 2.78 µg of GAE. The oxidative hemolysis caused by hydrogen peroxide in rat erythrocytes was inhibited by BGH extract in a dose dependent manner. The IC_{50} values for BGH extract and BHA for hemolysis were 11.5 µg and 14 µg of GAE, respectively. Morphological changes in erythrocyte membrane caused by hydrogen peroxide were protected by BGH extract. As BGH extract exhibited various antioxidant properties in different systems, it could be used as a functional food or nutraceutical product for health benefits.

Agri and marine wastes

In this work, preparation of protein hydrolysates having biological activity from agri-waste sources such as rice bran, red gram mill waste and palm kernel cake has been undertaken.

Diversity studies of lactic acid bacteria

Lactic acid bacteria were isolated from fermented vegetables of North East region of India and representative bacterial strains were identified. The isolates were considered as presumptive LAB as they were Gram-positive and catalase negative bacteria and broth culture showed pH3-4. Additional studies with respect to microbial diversity are underway.

Value Addition to Agri-Resources

Processing of fruits

Muskmelon pulp

Thermal processing of muskmelon pulp resulted in the decrease of total carotenoids, beta carotene and ascorbic acid content. Total carotenoids content of muskmelon pulp decreased during heat treatment of the pulp at specific temperature and duration. HPLC analysis of muskmelon pulp showed that beta carotene content of muskmelon pulp also decreased during heat treatment.

Also processing conditions for storage of muskmelon pulp in cans and retort pouches were evaluated. Detinning of cans was observed in muskmelon pulp canned in plain A 2 1/2 cans, where as pulp canned in lacquered cans showed no feathering. The pulp packed in retort pouches did not show any significant changes in the compositional quality.

Muskmelon beverage formulations

Cloud stabilization of muskmelon beverage formulations using different stabilizers was investigated. Process for muskmelon beverages and blended beverage formulations in glass bottles and PET bottles was developed. The storage life of the muskmelon beverages packed in glass bottles and stored at room temperature (RT) and low temperature (LT) was 4 and 6 months respectively. Beverage formulations packed in PET bottles were found to be acceptable for 3 and 4 months at RT and LT respectively.

Post-harvest and storage of other fruits

Pre-treatments and storage conditions for post-harvest quality of papaya was studied. Pre-treatment using 2.5% calcium chloride made considerable changes in the quality of papaya fruits. The shelf-life was extended to 32 days instead of 24 days in untreated fruits stored at same LT conditions. Sensory quality of ripened fruits were found comparable to that of freshly harvested, untreated fruits. The pulp quality of fully ripe fruits of the pretreated ones was of excellent quality.

Physicochemical characterization of ripe and unripe pepino (*Solanum muricatum*) and the quality changes during storage was studied. Pepinos packed in polyethylene bags stored in cold storage was found to extend the shelf-life. The antioxidant quality of unripe pepinos was higher compared to ripe fruits.

Wild edible fruits

Vitamin C content of banana passion fruit and hill raspberry collected from the Nilgiris were 318 and 75 mg / 100 g respectively. Glucose and fructose were found to be higher in banana passion fruit when compared to hill raspberry and negligible amount of sucrose was noted.

Sweet pepino

The extractions of phenolics from wild edible fruits were performed with solvents (methanol, ethyl acetate, water and ethyl acetate extracts and air dried). The highest total phenolic content was measured in methanolic extracts followed by ethyl acetate extracts and air dried, water extracts and ethyl acetate extracts of banana passion fruit and hill raspberry.

Banana passion fruit

Hill raspberry

Osmodehydrofreezing of Jack fruit

Effect of osmotic pre-treatments using sucrose and fruit juice concentrates (Jackfruit juice concentrate and papaya juice concentrates) on the quality attributes of cryogenically frozen IM (Intermediated moisture) jackfruit segments and papaya chunks was studied. The jackfruit segments and papaya chunks were osmotically dehydrated in sucrose (60°brix) and their respective fruit juice concentrates of 60°brix each at 40°C for a dipping duration of 2 h thereafter subjected to drying at 55°C for 3 h. The osmo-air dried jackfruit segments and papaya chunks were packed in low density polyethylene (LDPE) bags before immersing in liquid nitrogen for cryogenic freezing at -196°C whereas untreated samples were also used for comparison. The physicochemical properties of frozen jackfruit segments and papaya chunks were studied during storage at -18°C at 30 days intervals. Loss in ascorbic acid content of both the osmohydrofrozen jackfruit segments, papaya chunks and untreated samples were significantly different. Color of the frozen products was intact and unaffected by the thawing process. Sensory evaluation after 90 days of frozen storage, indicated that the fruits treated with their respective fruit juice concentrates and sucrose were more acceptable in terms of color, texture, flavor and overall quality than untreated samples. The process conditions for the preparation of IM (20% moisture) jackfruit and papaya fruit bar using fruit juice concentrates were optimized. The storage studies revealed that the products were found to be acceptable after 3 months of storage at room temperature.

Watermelon rind

Storage studies were undertaken for the selected formulation of pickle and candy from watermelon rind. The samples were evaluated for their colour, texture and sensory attributes. The candy had a shelf life of nine months whereas the pickle had a shelf life of six months, beyond which there was slight softening of the pieces.

Apple and carambola supplementation of bakery products

Based on supplementation of apple pomace, muffin, cookies and bun of acceptable quality were prepared. Bio-functional properties of the products were also established. Extract of the carambola pomace was demonstrated for its antimicrobial property. The bread prepared using carambola pomace was found sensorially acceptable.

Low calorie RTS fruit beverages

Stevia extract and steviol glycoside were found to be suitable as low calorie sweetener in RTS fruit beverages such as pineapple, pomegranate, jamun, purple grapes, mango and vegetable juices such as cucumber and carrot. Low calorie beverages were sensorily acceptable compared to carbonated beverages and jamun RTS with Stevia after a storage for six months. Mixed vegetable beverages with attractive colour and taste were prepared using 10 -12 vegetables including green leafy vegetables. Mixed vegetable beverages using beetroot was highly acceptable and stable in amber coloured glass bottles. Microwave assisted preservation of low acid vegetable beverages looks to be promising. Beetroot, cabbage and radish juices could be sterilised successfully using microwave at 4 minutes of holding time. Pumpkin was found to be suitable in making various products such as tutty fruity, jam, pickle, novel pumpkin chikki with incorporation of millets and nuts and pumpkin flour. Pumpkin flour can be incorporated in urad papads for vitamin and mineral enrichment.

Low glycemic vegetable blended beverages with and without beetroot

Kokum paste and lemon paste were developed. Various other lime and kokum based products such as kokum based RTS beverages and squash, lime based RTS beverages were also developed in laboratory scale.

Products from underutilized fruits

The proximate composition of value added products (with or without added herbal based micronutrients and nutrients) prepared from *Ramkela* mangoes, mulberry, *Karaunda*, banana *(Hari Chal)* variety and *Parwal* vegetables showed significant levels of essential micronutrients and nutrients. The storage studies of these products at room temperature (RT), 7°C and 37°C indicates that products stored at RT showed no significant changes with respect to total soluble solids, acidity and total sugar after 60 days of storage. Similar observations were noticed at 7°C and 37°C. The products were evaluated for sensory attributes at various intervals.

The storage studies of pickles, herbal jam, dehydrated cut pieces/dices and dried powder prepared from *Ramkela* mango stored at room temperature, 7°C and 37°C indicated that products stored at RT showed no significant changes with respect to moisture, total soluble solids, acidity and total sugar after 60 days of storage. Similar observation were noticed at 7°C and 37°C. These products were evaluated for sensory attributes at various intervals.

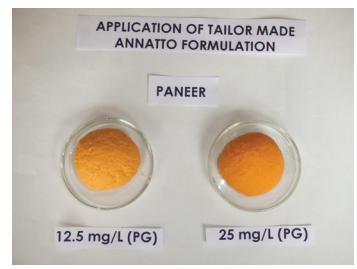
The storage studies of mulberry fruit Juice, RTS-beverages, nectar and squash at room temperature, 7°C and 37°C indicated that products showed no significant changes with respect to moisture, total soluble solids, acidity and total sugar after 60 days of storage. More cloudiness were formed in stored juice in all the temperatures. These products were evaluated for sensory attributes at various intervals.

The storage studies of *Karaunda* bars and toffees at room temperature, 7°C and 37°C indicated no significant changes with respect proximate composition after two months of storage. They remained in good condition with respect to aroma and consistency even after three months storage. However, during prolonged storage the significant reduction of total soluble solids and slight browning was observed. Level of total sugar and minerals remained nearly constant during the storage. Storage studies of khoa and dried fruits based *Parwal* sweets at room temperature and 37°C indicated no significant changes with respect to proximate composition after a storage of 3 days.

The storage studies of *Parwal* dehydrated slices indicated that products stored at RT, 7°C or 37°C showed no significant changes with respect to moisture, total soluble solids, acidity and total sugar after 60 days of storage. Chips prepared from banana (*Hari chal* variety) remained good with respect to aroma, color, mouthfeel, taste etc. even during storage period of three months. Slight browning was observed in the samples stored at ambient temperature. The proximate composition analysis of stored products showed better retention of micronutrients and nutrients. Significant change was noticed in non reducing sugars. Level of total sugar and minerals remained nearly constant during the storage.

Annatto dyes formulations

Different annatto dye formulations were prepared as water soluble powder, oil soluble liquid, sugar powder formulation containing water soluble annatto dye and a propylene glycol (PG) formulation. These formulations were used in various traditional and processed foods for preparing tailor-made formulations.



Water soluble (carbonate) and PG annatto dye formulations were selected for the application of annatto dye formulation in *Gold finger* (a yellow coloured 1" length tubular form of extruded product made out of Maida). Both the formulations were applied at the levels of 40, 50 and 100 mg/kg of dried product basis. Analysis of gold fingers revealed that the type of formulations did not affect the colour, however increase in the concentration of formulations increased the orange colour of the product. The PG and carbonate formulations at specified concentration provided the colour shades similar to sunset yellow colour. The product was sensorily acceptable in taste.

Coloring of vermicelli with water soluble annatto dye carbonate liquid formulations was attempted. The semiya, steamed and dried was compared against non-steamed products. The dried semiya was acceptable at various selected concentrations of the dye.

Antioxidant assay of annatto dye and extracts with ferric reducing powder showed good results. Also shelf-life studies carried out for the annatto dye and formulations were carried out for a period of 10 months. The losses were minimal in all dyes with antioxidants, however samples with propyl gallate was higher than in those with ascorbic acid.

Shrimp waste

Studies were carried out on isolation of carotenoprotein from shrimp wastes. Antioxidant activity of crude carotenoid extract from shrimp waste and its fractions was evaluated by *in-vitro* and *in-vivo* techniques. In-vitro assays indicated strong scavenging activity of shrimp waste extract and the astaxanthin fraction separated from crude carotenoid extract. The carotenoid extract also showed strong singlet oxygen quenching activity. The antioxidant activity of the extracts was also demonstrated *in-vivo*.

Carotenogenic bacteria was isolated from the marine environment and their ability to produce carotenoids was evaluated. The effect of different sugar sources, pH, light and aminoacids on the carotenoid production by *Flavobaterium* sp was standardized.

Ready-to-Eat (RTE) products

Fruits and vegetables were incorporated into the malt based RTE weaning food to enhance the sensory qualities and nutritional benefits. Ragi seed coat based drink mixes (Ready-to-cook and Ready-to-use) were prepared. The instant drink mix produced was found to be rich in dietary fibre, minerals, protein and antioxidants. *Idli* batter/*idli* was prepared by using small millets. Sensory analysis showed high overall acceptability for Kodo millet *idli*, whereas barnyard millet *idli* was found to be the whitest among the small millets. Addition of a hydrocolloid facilitated preparation of ragi dough with reduced stickiness. Modified ragi flour also had improved mechanical properties. Starch was isolated from little millet and the starch was modified by enzyme, microwave, frosting/thawing, acetylation and methylation

methods and their properties were studied. FTIR analysis showed profound structural differences among native and differently modified little millet starches. Detailed characterization analysis of native and modified little millet starch is under progress. Processing such as refining, malting, hydrothermal treatment and decortication showed significant effect on the content of polyphenols, tannins, flavonoids and nutraceuticals in *ragi*.

Karanja, simarouba and jatropha

Suitable methodologies were adopted for the removal of antinutritional factors such as tannins, phytates, trypsin inhibitors, saponins, alkaloids, phorbol esters and curcin from karanja, simarouba and jatropha seed meals. Also method for the detection of phorbol esters and curcin were standardized.

Mushrooms

Mushroom fruiting bodies of *Lentinula edodes* grown artificially on a pasteurized composite sawdust-rice straw were analyzed for their total phenolic content, phenolic acid profile and their anti-oxidant activities. The water extract *L. edodes* showed most potent radical scavenging activity.

Bamboo shoots

A flavored tender bamboo shoot candy and pickle preparation was subjected to storage studies at 40°C & RT (29±1°C) respectively for a period of six months. The physicochemical characteristics such as colour, TSS (°brix), pH, acidity, non-enzymatic browning, reducing sugar and total invert sugar were observed in tender bamboo shoot candy during storage, whereas changes in color, texture (in N) and salt (%) of RT stored tender bamboo shoot pickle were monitored. Nutritional quality including minerals like calcium, magnesium, sodium, potassium, iron and copper were estimated in the tender bamboo shoot products like candy and pickle. The tender bamboo shoot candy was a good source of minerals with special reference to calcium (237mg/100g). In addition, the candy was bestowed with substantial amount of crude protein (0.74%) and crude fiber (0.8%). Tender bamboo shoot candy has good calorific value (296 Kcal/100g) as compared to pickle (160 kcal/100g. Results of sensory analysis indicated that the tender bamboo shoot products such as candy and pickle were acceptable even after 6 months of storage.

The process conditions for the removal of HCN were optimized based on the thermal treatment for 30 minutes applied to the sliced tender bamboo shoot prior to processing. The HCN was estimated qualitatively and quantitatively using standard procedure. Results revealed that the HCN content was found to be absent

Tender bamboo shoot products; pickle, sweet chutney, spread & brine cured slices

in the thermally pretreated bamboo shoot slices and the standardized products (candy and pickle) were found to be acceptable and devoid of any acridness, as it was more prevalent in fresh tender bamboo shoot.

Cactus for food applications

Mucilage of mature cladode of *Opuntia dillenii* was extracted and purified. The mucilage extract (ME) was de-proteinized. The solubility of ME was studied using different solvents and the composition of sugar was determined.

The ME was fractionated and the yield was determined. Major fraction, (0.1N NaOH) was subjected to dialysis and lyophilized and analyzed for neutral sugars and uronic acid content. This was further purified and the average molecular weight of the fraction was found to be $1.33X10^6$Da. Gas liquid chromatography and FTIR studies of alkali soluble fractions showed that this fraction is a compound of arabinose, xylose and galactose.

Chitooligosaccharides

The actinomycetes cultures were identified as *Streptomyces globisporus* CA1 and *Streptomyces globisporus* CA2 based on morphological and 16S DNA homology analysis. *S. globisporus* CA1 and *S. globisporus* CA2 produced significantly ($p < 0.05$) high titres of chitosanase as compared to various other cultures (*F. oxysporum, A. flavus, P. monoverticillium*) in both SSF and SmF using different substrate. Crude chitosanase of CA1 and CA2 were optimum active at temperature of 37±2 °C and pH of 6.6. Crude chitosanase from CA1 and CA2 produced significantly ($p < 0.05$) high amount chitosan oligosaccharides from colloidal chitosan at 12 h hydrolysis. Results indicated the potential of CA1 and CA2 for enhanced production of chitosanase and their uses in the preparation of bioactive chitosan oligosaccharides.

Acid demineralization and alkali de-proteinization of shrimp processing chitosan by-products for the recovery of chitin by response surface methodology (RSM) was optimized. Soil samples collected from South Indian states were analyzed for chitosan degrading micro organisms and fungal isolates.

Waste utilization

Fresh water and marine fish processing wastes (FPW) as a source of quality lipid was assessed. Lipid from different body components of marine fish was found rich in EPA and DHA where as fresh water fish were rich in linolenic acid with a low concentration of EPA and DHA. Proteolytic lactic acid bacteria (LAB) isolated from FPW was used as starter culture for the fermentation of FPW. Studies showed LAB fermentation was effective for recovering lipids and protein simultaneously. Among the native LAB studied, *Pediococcus acidilactici* NCIM5368 was found to be the best starter culture that provided maximum yield of protein and lipids on fermentation. Commercial proteases were also evaluated for

simultaneous recovery of lipids and proteins. Fermentation yielded >90% oil and >74% protein where as enzymatic hydrolysis gave the yield of >80% oil and >62% protein. A fungal protease provided the maximum degree of hydrolysis and oil recovery. Both LAB fermentation and enzymatic hydrolysis were optimized for *P. acidilactici* and fungal protease using RSM studies. Large batches (>20 Kg FPW) of fermentation and enzymatic hydrolysis under optimized conditions were carried out. The protein hydrolysate showed good antioxidant activity and antibacterial properties against human pathogens. Animal experiments confirmed the safety of oil recovered from fish processing waste for using it as an animal feed.

Innovative Food Processes & Products

Downstream processing

Lipoxygenase from soybean was encapsulated using different carriers using spray drying and freeze drying techniques. The combination of sodium alginate, maltodextrin and polyethylene glycol (PEG) 6000 as carrier resulted in highest yield during spray drying and freeze drying.

An aqueous two phase extraction was explored for the isolation and purification of invertase from crude Baker's yeast. Influence of process parameters such as type of phase forming salts, PEG molecular weight, concentration of salt and polymer, tie line length and volume ratio on partitioning of invertase was studied. The process conditions were standardized for optimum recovery and purity of invertase.

Impregnation of curcuminoids in coconut slices using osmotic dehydration was studied. The rate of mass transfer of moisture, solid and curcuminoids were studied over a range of concentration of osmotic solutions with and without the application of ultrasound using water as the osmotic solute. HPLC analysis revealed the curcuminoids were fully infused into the coconut matrix.

Proximate analysis of coconut protein powder showed high protein and low fat content. Protein solubility of the powder was studied as a function of pH and ionic content of solvent. Functional properties such as water hydration capacity, fat absorption capacity, emulsifying properties, wettability and dispersibility of coconut protein powder were evaluated and compared with that of defatted soybean powder and skimmed milk powder. Results demonstrated that coconut protein had good emulsifying properties.

Extraction and purification of anthocyanins from red cabbage was explored. To obtain anthocyanins in purified form, adsorption was carried out using different adsorbents. Non-ionic acrylic ester adsorbent Amberlite XAD-7HP showed the highest adsorption. The resulting anthocyanin was free of sugars, which is the main cause for degradation.

Removal of phenol using a flat sheet supported liquid membrane impregnated with triglycerides was carried out. The mass transfer of phenol was found to be dependent on factors such as type of vegetable oil, support material, feed phase pH and concentration, stripping phase concentration and stirring speed. The extraction of phenol was found to be dependent on the composition of fatty acid in triglyceride.

Sterilization of black pepper *(Piper nigrum)* was carried out using infrared, MW and RF radiations. Processing by MW was found to be better in terms of degree of sterilization.

Membrane Processing

Soy milk extraction and processing of tofu-whey

Elevated temperature wet grinding of soybean in the presence of curcumin in its emulsion form

was demonstrated as an effective method of inactivating lipoxygenase without affecting the protein solubility during soymilk conversion. Further, the fortified soymilk obtained in the process exhibited greater polyphenolic and antioxidant activities, and reduced hexanal content signifying the multiple benefits.

Processing tofu-whey using a combination of ultrafiltration and reverse osmosis membranes revealed that the soy-whey concentrate obtained was completely devoid of proteins and suitable for further processing into high purity isoflavone products.

Membrane clarification of black tea extracts

Membrane clarification of tea extracts reduced tea cream formation and haze in RTD tea beverages and improved its stability during refrigerated storage while retaining most of the natural quality characteristics of tea. The antioxidant potential (DPPH) of reject stream tea solids of membrane process was comparable to the original tea solids of the crude extract (TEAC value ~0.4-0.5 µg/µg-tea solids), suggesting that the final retentate stream containing a substantial amount of tea solids could be converted in to a tea conserve.

Air incorporated foods

A method for the aeration of gels were developed. Aeration of agar and gellan gels at different concentrations were conducted and rheological characteristics of the product were determined to ascertain the changes due to aeration. The rheological characteristics determined for gel samples include the compression characteristics (fracture strain/ stress/energy, firmness and the total energy for compression) and stress relaxation characteristics (extent of relaxation and relaxation time).

Selected air incorporated foods like aerated gels, bread, *Idli*, puffed extruded corn balls and puffed rice were selected for studying their structural features by using imaging and image analysis technique. These aerated structures were categorized as open and closed cells, and several indices to characterize these structures were determined. These indices are the size of cells, average area of cells, eccentricity, density and the drainage factor.

A new method for determining the gelling temperature has been developed based on rheological studies. An algorithm has been developed using MATLAB along with C++ to calculate the features of aerated cells. A three-dimensional structural modeling of aerated product like puffed rice was completed.

Innovative processes

Supercritical mediated processes

A process for obtaining vanilla extract of 2-8% concentrations using super critical carbon dioxide (SCF CO_2) with vanilloids was standardized. Green tea leaves (fresh/frozen) were extracted with SCF CO_2 using ethanol as entrainer to obtain tea extracts rich in

Epicatechin gallocatechin. A method for obtaining mangosteen water-in-oil emulsions with different concentrations was evaluated for their stability. SCF CO_2 Seabuck Thorn (*Hipphophae rhamnoids*) leaf extract was incorporated as liposomes and their stability was studied. Similarly SCF CO_2 astaxanthin extract was also incorporated as liposomes and the stability was studied.

Field assisted processing of vegetables and spices

Dry blanching of red bell pepper using microwave and infrared was studied and their performance was compared with water and steam blanched samples. Microwave and infrared heating took longer time compared to water and steam blanching for enzyme inactivation at the desired level. Vitamin C retention in red bell pepper was found to be more in microwave blanching. Kinetics of peroxidase and polyphenol oxidase inactivation in red bell pepper was also studied. Results showed that the retention of nutrients was high in dry blanched pepper compared to water and steam blanching.

Microwave assisted extraction

Different approaches for the extraction of antioxidants, polyphenols, theaflavins (TF) and thearubigins (TR) by both microwave assisted extraction (MAE) and conventional extraction method were compared. The antioxidant activity of tea extracts measured with radical scavenging assay (RSA) and reducing power assay (RPA) highlighted that the activities of extracts obtained using MAE were marginally lesser or equivalent to those obtained by conventional extracts, being attributed to the less time and energy consumed. The analysis of total polyphenols of both the extracts obtained suggested that MAE method was more effective and economical compared to the conventional extraction method. In case of TF's and TR's, the MAE method showed better extraction than conventional extraction method which indicated the quality of tea extract. Also the MAE procedure required short time, low energy consumption and provided high extraction (yield).

Basil and coriander leaves were subjected to different drying methods i.e., low temperature low humidity (LTLH)- , IR-, sun- and oven drying. Later dried basil and coriander leaves were subjected to chlorophyll, carotenoids, ascorbic acid and colour estimation. Results showed that the LTLH dried sample was best in colour value, total chlorophyll, carotenoids, ascorbic acid compared to other drying methods. Therefore LTLH dried basil and coriander were further extracted with different solvents and estimated for RSA, RPA and TPP. Extract of 60% ethanol showed higher RSA, RPA and TPP compared to other extracts. The study helped in improving (standardizing) drying and extraction process for basil and coriander for obtaining improved products in terms of colour, aroma, keeping quality, TPP, RSA and RPA.

Microwave assisted extraction (MAE) process for ginger was compared with the conventional methods. Results showed that MAE allowed higher recoveries compared to conventional extraction process.

With the objective of studying effect of microwave on extraction of natural materials, studies on various aspects of extraction of coriander, mango ginger and fenugreek were carried out. Effect of microwave on coriander extraction was found insignificant. Effect of microwave on drying of mango ginger was very positive. Relationship between particle size and grinding energy were analyzed. Effect of particle size on oil yield in the case of fenugreek was studied. SCF extraction of mango ginger in terms of total yield and phenolics was studied in detail based on response surface methodology to identify optimum process parameters.

Superheated steam processing system

A superheated steam processing system, which can be operated under superheated steam at normal pressure and low pressure, infrared assisted superheated steam heating and infrared heating under vacuum was developed. The system can be used for different food processing applications. Superheated system (SHS) blanching of green capsicum was compared with normal steam blanching. Products were analyzed for enzyme, vitamin C, beta-carotene and protein content in blanched samples. Retention of nutrients was found good in SHS blanched samples.

Quality of conventional water and steam blanching on green capsicum was compared against dry blanching. Vitamin C content of the products was compared to assess the efficacy.

Studies on electromagnetic radiation based drying of onion slices were carried out. Results indicated that hybrid drying was better compared to IR drying with or without vacuum.

Microwave assisted drying

Effect of processing conditions such as microwave (MW) power, air velocity and temperature during MW - convective drying were carried out. The product quality in terms of color, volatile oil retention and textural properties were analyzed. Comparison of other drying methods such as low humidity air drying, radio frequency drying and hot air drying indicated that hybrid drying with MW was quicker. In terms of volatile oil retention, rehydration characteristics and color MW-convective drying with moderate air velocity resulted in a better yield.

Superheated steam processing system

The influence of drying methods on the volatile components of *Zingiber officinale* rhizomes was studied. The convection (CD) and microwave (MW) drying were employed. Results showed that the microwave drying substantially reduced drying time and the sample dried at microwave power level, PL100 retained maximum quantity of volatiles. The effect of microwave (MW) drying on total polyphenol content and antioxidant properties of ginger extract were evaluated using various methods. The results were compared to that of convective cross flow drying. The MW fried extract showed highest quantity in total polyphenol content and antioxidant activity compared to convective drying.

Effects of convectional drying (CD) and microwave drying on the physico-chemical constituents and antioxidant activity of *Mentha spicata* leaves was studied. Results showed that the drying method significantly affected polyphenols and flavonoid contents as well as their antioxidant activity. The microwave assisted drying for maximum retention of chlorophyll, flavonoid content and antioxidant properties of *M. spicata* were found.

Microalgae for hydrocarbon production

Two lipid producing algal strains were scaled up in outdoor ponds which yielded biomass and lipid in the range of 0.8 to 0.95g/L and 11-16% respectively. The outdoor cultivation conditions were optimized and a method to control rotifer (predator) infestation was developed. Flocculation studies were carried out using selected isolates using auto-flocculation by the adjustment of pH, addition of inorganic poly cationic salts like ferric sulphate, ferric chloride and the use of natural extracts such as moringa and tamarind for efficient harvesting. Sensitive algal isolates *Scenedesmus* and *Selenastrum* were scaled up in closed photobioreactors for adapting to outdoor conditions. By this technique, culture were scaled up in shorter duration without predator attacks.

Biocoagulants

The potential of an indigenous, naturally derived coagulant seed material from the multipurpose plants *Moringa oleifera* and *Tamarindus indica* and *Abelmoschus esculentus* produced under ambient and cryogenic conditions as a viable alternative for chemical salts in improving the water treatment process. Their effectiveness and mechanism were explored. Also the these coagulants affecting the quality of the treated water such as hardness, alkalinity, turbidity, nitrates, phosphates, microbial level, fluorides, BOD and COD and the interaction of various parameters were optimized.

Traditional foods and their evaluation

Bombay Halwa was prepared using alternate sweeteners such as sorbitol, maltitol and fructooligosaccharides (FOS). The formulations and process were standardized. Effect of these alternate sweeteners on colour, texture and sensory attributes were compared with *Halwa* made out of sugar. The color of

Halwa with sugar and sorbitol were similar, though FOS was slightly darker. Texture studies showed that the product with FOS was more cohesive. Sensory studies revealed that the overall quality of *Halwa* prepared with sugar and FOS were comparable.

Traditional popular snack, *Sev* was enriched with leafy vegetable such as pudina, betel, curry leaves and coriander. Experimental results showed that the product was sensorily acceptable and contained polyphenols and minerals. Also *Carrot Halwa* was prepared by partially replacing carrots with amla gratings. The product were found to be sensorily acceptable and nutritionally superior.

Groundnut husk concentrates was chosen for incorporation into biscuits. Biscuit dough impregnated with 200 and 500 ppm of antioxidant concentrates and baked. Biscuits were found to be comparable along with control and BHA impregnated samples. Antioxidants / polyphenols were found to be stable upto 95% after baking.

Experimental mixture design was used to characterize and optimize the formulation of *Halubai.* Wheat based *Halubai* had the highest overall quality followed by *ragi*-wheat and *ragi*-wheat-rice combinations. The preparation of *Kajjaya* was standardized. Also in order to reduce fat intake during frying, formulation of *Namkeen* was modified using wheat semolina, thermally treated wheat flour and corn flour.

Halubai

L-asparaginase

L-asparaginase from *Cladosporium* sp. grown on SSF was purified. The purified L-asparaginase showed two bands of ~37 kDa and one band of ~43 kDa. Molecular weight of the enzyme protein was found to be 117 kDa. The optimum temperature and pH for enzyme activity was found. With increasing substrate concentration, the enzyme showed a saturable kinetic pattern. L-asparaginase activity studied in the presence of thiols showed decrease in V_{max} values and an increase in K*m* values indicating non-essential mode of inactivation. Metal ions such as Na, K, Co, Cu, Mg, Zn and Ca decreased enzyme activity where as Pb and Fe enhanced the activity. Detergents such as Triton X-100 and Tween 80 enhanced the L-asparaginase activity. The thermal stability of L-asparaginase from *Cladosporium* sp. was found to be lesser.

Functional packaging for traditional foods

Dosa

Dosa was packed in PET/PP pouches and then subjected to steam flushing to remove headspace air. Hermetically sealed pouches were then subjected to heat processing in a

retort and stored in refrigerator. Samples were subjected to predetermined temperature abuse. And the periodic microbial, chemical, sensory and color measurements were taken for a period of 10 weeks.

Heat penetration studies on *Dosa* showed that F_{90} of 10 minutes required a process time of 19 minutes at 100°C. Refrigerated storage helped in lowering the counts of mesophilic aerobes, mesophilic aerobic spore-formers. Yeast and molds were also within permissible limits throughout the storage period. *Staphylococcus aureus*, *Listeria monocytogens*, Lactic acid bacteria and coliforms were completely absent in the processed and temperature abused samples upto a period of 10 weeks. Unprocessed *Dosa* samples were safe upto 9 weeks. Overall sensory quality rating of processed product during refrigerated storage period of 8 weeks was 9.4 and reduced to 8.4 and 8.5 by 9th and 10th weeks respectively. No significant change was observed in colour during storage. The study showed that stored *Dosa* was acceptable at the end of 10 weeks.

Functional packaging of *Idli, Dosa* and *Paddu*

Paddu

Paddu samples were packed in PET/PP and Foil laminate pouches were subjected to steam flushing to remove headspace air. Hermetically sealed pouches were then subjected to heat processing (100°C) in a retort and stored in a refrigerator. Samples were then subjected to pre-determined temperature abuse. Also scored samples were subjected periodic microbial, chemical, sensory and color measurements for a period of 10 weeks. Heat penetration studies on *Paddu* showed that F_{90} of 10 minutes required a process time of 11 minutes at 100°C. Refrigerated storage studies showed complete absence of *Staphylococcus aureus*, coliforms, *Listeria monocytogens* and lactic acid bacteria, with counts of mesophilic aerobes, mesophilic aerobic spore-formers, yeast and molds within permissible limits in processed and temperature abused samples upto 10 weeks. Unprocessed *Paddu* samples were microbiologically safe upto 7 weeks. Overall sensory quality rating of processed *Paddu* during refrigerated storage period of 10 weeks was 8.6 in PET/PP pouch compared to 7.6 of *Paddu* packed in foil-laminate. There was no significant change in colour of the products analyzed before and after storage of 10 weeks. The study showed that stored *Paddu* was acceptable at the end of 10 weeks.

Rice flour

Shelf-life of rice flour depended on the rice variety from which the flour was made. The

varieties IR 64, MTU 1001, Jyothi had acceptable quality when packed with 75 micron LDPE under normal storage condition at the end of six months.

Ragi flour

Storage studies were carried out for ragi varieties, GPU 66 and Indaf 5. GPU 66 had 150 days of shelf-life in LDPE and 180 days in PET laminate while Indaf had acceptable quality after 180 days of storage. Blackgram had 2 months shelf-life under accelerated storage conditions and a minimum of 6 months with 70 micron LDPE and PET laminate. Product quality of besan for the preparation of *Mysore pak* started dropping after 15 days of storage. Also under accelerated storage conditions 15 days, the *Mysore pak* was found not acceptable.

Functional packaging

Detection of plastic leachates

Estimation of acetaldehyde from polyethylene terephthalic (PET) bottles were carried out. Methodology was standardized for the estimation of acetaldehyde upto detectable limit of 0.1mg/ Litre by using standard calibration curve. However, acetaldehyde content was not found in few samples of PET bottles used, within the detectable limits.

Estimation of phthalic acid and isophthalic from PET

Methodology was also standardized by developing standard calibration curves for the estimation of phthalic acid and iso-phthalic acid in polyethylene terephthalate bottles (PET). Migration behaviour of these monomers was standardized.

Design of machinery

The design of the existing spouted bed roaster (SBR) was modified. The machine was modified by introducing controls such as temperature control, pressure monometer and anemometer. Material characteristics with regard to the stagnation height, stagnation weight, spouting height at different positions of the valve were studied. Introducing draft tubes of varied sizes, improvement in static bed height, energy consumption were achieved on commercial scale classical spouted bed. Compared to classical spouted bed, the draft tube spouted bed showed less energy consumption with a reduction of nearly 20%, which also indicated the increase in the heat transfer coefficient. Stagnation height of SBR and energy analysis work was initiated and the same to be compared with the commercial drum roasters.

Annatto seed separator

In order to design and fabricate a prototype model of annatto seed separator, the physical properties of annatto seed and pod as well as their relative humidity was studied. Initially three models were planned and fabrication has been initiated for one of the model and its performance studies are to be undertaken.

Continuous microwave pasteurization/ sterilization system

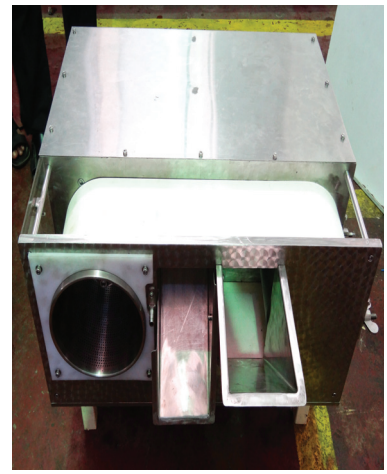
Four types of glass applications such as cylindrical, helical, conical and spherical shapes having 509-573 ml volume were fabricated for using in a microwave heating system. A 5L pressure cooker was modified for inserting an inlet pipe, temperature probe and pressure gauge for pressure sterilization domestic microwave unit was modified to hold these applicators in the cavity. The pressure cooker was insulated by using asbestos sheet for obtaining the required pressure. Also a pressure pump of 1 L/minutes capacity was used to pump water continuously. Experiments were conducted for calculating the insulation thickness to reduce the heat loss to surroundings in the system.

Fractions separated from annatto pods

Fish processing equipment

Designing and developing a cost-effective fish meat-bone separator on a continuous mode was undertaken. The compressive strength of fish meat, torque and electrical power required were estimated. Linear velocity of the conveyor belt used for imparting compression to the fish was set. Provision has been made in the equipment to channelize the flesh, scales and the bones separately. The estimated capacity of separation is around 50 kg per hour.

Attempt was made to develop fish meat based noodles from minced meat. Design of a fish scaler was also conceptualized. A PCR based method for detection of adulteration in fish meat is under progress.



Fish meat bone separator

Online instrument for quality control

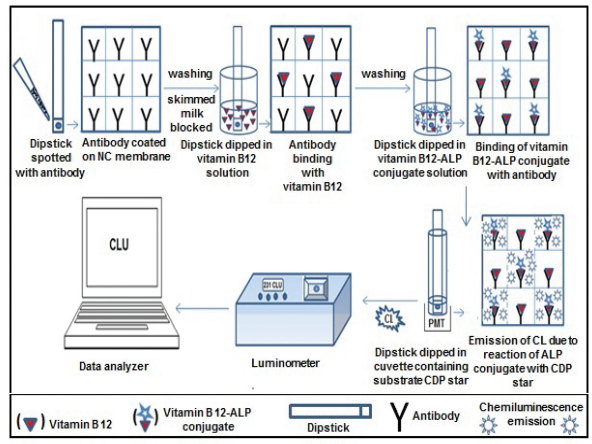
A prototype instrument named as "Edible Oil Quality Monitor" was developed in the project in collaboration with CEERI, Chennai and demonstrated to entrepreneurs.

Biosensors

Dipstick based immunochemiluminescence (immuno-CL) biosensor for the detection of vitamin B_{12} in energy drinks was developed. The method is a direct competitive type format involving the immobilization of vitamin B_{12} antibody on nitrocellulose membrane (NC) followed by treatment with vitamin B_{12} and vitamin B_{12}-alkaline phosphatase conjugate. The dipstick was further treated with substrate CDP-Star to generate chemiluminescence (CL). The number of photons generated was inversely proportional to the vitamin B_{12} concentration. The limit of detection was 1 ng mL^{-1}. Two different energy drinks samples were analyzed and a good correlation was observed when the data were compared with reference to ELISA method. The developed method is suitable for an accurate, sensitive, and high-throughput screening of vitamin B_{12} in energy drinks samples.

A gold nanoparticle (GNPs) based immunodipstick biosensor for vitamin B_{12} was tried. The membrane was coated with capturing reagents, that is, bovine serum albumin - vitamin B_{12} conjugate and dipped in different concentration of vitamin B_{12} solution containing vitamin B_{12} IgY antibodies labeled with GNPs. The intensity of color development was inversely proportional to the vitamin B_{12} concentration with maximum intensity at zero vitamin B_{12} concentration. The visible detection limit of vitamin B_{12} was determined to be 1 ng/ml. GNPs of definite size were synthesized and conjugation efficiency of the GNP-protein conjugates was confirmed qualitatively and quantitatively through gel electrophoresis, flocculation assay, UV–visible, fluorescence spectroscopy, fourier transform infrared spectroscopy and transmission electron

Edible oil quality monitor



Schematic representation of immuno-CL based dipstick technique for detection of vitamin B_{12}

microscopy. The detection limit of this method is higher than the conventional ELISA method.

Another simple and stable RNA aptamer based colorimetric sensor for the detection of vitamin B_{12} using GNPs was attempted. A highly stable RNA aptamer that bind to vitamin B_{12} was employed by structural modification at 2' hydroxyl group of ribose to 2' fluoro of all pyrimidines indicated in lower case in 35 bases length aptamer (5' GGA Acc GGu CAu AAc cAc cuc AGu GcG AGc AA 3'). Aggregation of GNPs was specifically induced by desorption of the vitamin B_{12} binding RNA aptamer from the surface of GNPs as a result of the aptamer target interaction, leading to the color change from red to purple. The level of detection of vitamin B_{12} was 100 ng/ml by successful optimization on the amount of the aptamers, GNPs, salts, and stability of aptamer. The results obtained were compared with those of the UV-vis spectrometry method. This colorimetric aptasensor would be advantageous for onsite detection with naked eye.

Gold nanoparticles (GNPs) were synthesized by aqueous methods to attain biocompatibility. GNPs were synthesized by reduction of tetrachloroauric acid ($HAuCl_4$) with sodium citrate in water according to the procedure by Turkevitch. To study the bioconjugation of gold nanoparticles with proteins bovine serum albumin was taken as a model. Gold nanoparticles were conjugated to BSA by reacting 10 mL colloidal gold solution (having 30 nm GNPs) of pH 9.0 with 100 mg of standard BSA. Solution of BSA was added drop by drop with gentle stirring. After overnight incubation at 4pC the mixture was centrifuged at 9,000 g for 30 minutes at 4pC. CdTe quantum dots (QD)s having emission peak at 523, 557, 576 and 601 nm with narrower full width at half maximum (FWHM) in the range 45-70 nm were synthesized. CdTe QDs having emission peak at 523, 557, 576 and 601 nm were conjugated to BSA by EDC-NHS protocol.

Media optimization for the production of bioluminescent bacteria producing luciferase was carried out.

Purification of caffeine

Isolation of caffeine biotransformation microorganism was carried out from coffee waste including husk, hull and spoiled coffee seed. Screenings of fungal cultures (designated as Tn1 to Tn10) for caffeine biotransformation were carried out in designed media having caffeine. The biotransformed compound in the media was compared with standard methyl xanthenes by analytical techniques as HPLC and TLC. Fungal strain Tn2 was found to be more potent in utilizing caffeine upto 56%. For the detection of theophylline, aptamer was designed and bioconjugation of theophylline to gold nanoparticles was done.

Cloning of caffeine demethylase gene in E.coli

Genomic DNA from four isolates SNP1 to 4 and CAS 1 were done. Primers for caffeine demethylase were designed using fast PCR software. Gradient PCR was first carried out between temperatures 40 to 60°C. Very good amplification was observed at 53°C annealing temperature. Concentration of template DNA was optimised to obtain a product size of 1200 bp. Large batch amplifications were done at the optimized conditions. The agarose gel bands were decised at the band region and purified using Gel band purification kit. The purified PCR product was cloned to pTZ57R/T vector and transformed to competent cells of *E.coli* DH5α. The transformed *E.coli* DH5α was plated on to Luria agar containing ampicillin. Transformants capable of growing on selection plates by 16h - 18h were selected and plasmids were isolated from these cultures. Agarose gel electrophoresis was done to identify the clone. Sequencing for the recombinant plasmid isolated from the recombinant *E.coli* DH5α showing a product size of ~ 1200bp is underway.

Detection of food borne pathogens

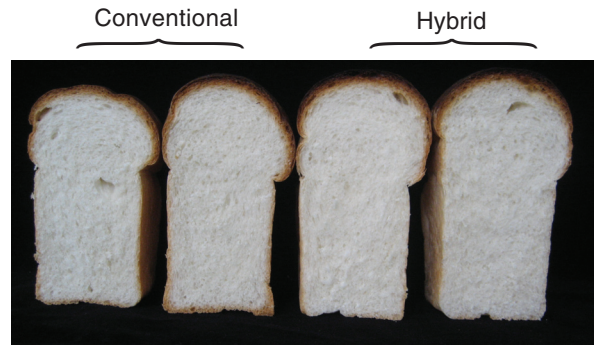
Gold and silver nanoparticles, spherical gold nanoparticles, gold nanorods, different shaped gold nanoparticles and silver nanoparticles were synthesized and characterized by UV-Vis spectroscopy and SEM.The GNP using 0.5% citrate had its absorption maxima at 540 nm. In contrast, the one with 1.25% citrate had its maxima at 530 nm. The gold nano rods absorb in two different wavelengths- the maxima in the 500-550 nm range corresponds to transverse oscillation, the one in 680-750 nm range to the longitudinal. Different shaped gold nano particles formed were having two absorbance maxima as nanorods. The difference here is that the longitudinal absorbance is in the range of 900-950 nm. Silver nanoparticles absorb in the 350-450 nm range. The size was determined by SEM.

Genomic DNA from *Staphylococcus aureus* MTCC 96 was prepared. The amplification of the toxin genes *Sec* A to *Sec* D was carried out at isothermal conditions. Bst 1 polymerase could amplify the toxin genes at 60°C by 60 minutes. The amplification could be observed by agarose gel electrophoresis and also visually by the addition of SYBR Green 1 where, the positive amplifications turned green and the negative reactions remained orange.

Computational fluid dynamics

The efficacy of baking process in the preparation of quality baked food products depend upon efficient and workable baking ovens. In this direction, a novel hybrid heating (infrared + electrical) baking oven was designed and fabricated. This oven was designed based on the experimental trials involving infrared and conventional electrical heating ovens. Hybrid heating oven conditions were optimized in terms of baking temperature, time, serial and hybrid heating modes. Bread

quality and energy efficiency of hybrid heating baking oven was assessed through analysis of specific volume, crumb firmness, colour values, sensory characteristics and moisture content. The results of this study indicated that bread baked in the hybrid heating oven exhibited higher specific volume, softer crumb texture, increased moisture content, desirable sensory and colour characteristics than the bread baked in the conventional electrical heating oven. Further, hybrid heating oven required only 18 minutes to bake the bread, whereas conventional electrical heating oven needed almost 25 minutes baking time. It was evident that hybrid heating oven could save energy during baking process as compared with conventional oven. The hybrid heating oven designed and fabricated in this study could be feasible to design large scale hybrid heating oven in a batch or continuous mode.



Breads (crumb) baked in conventional and hybrid heating oven

Long Term Strategic Research

Ameliorative studies

Diabetic nephropathy

Diabetic nephropathy is one of the causative factors of sustained hyperglycemia. Dietary factors play an important role in management of diabetes and impact diabetes-mediated remodeling of extracellular matrix components in kidney. The effect of banana flower and stem on diabetic nephropathy was studied. Banana flower and stem brought about changes in expression of glucose transporters (Glut 1, 2, 5, SGLT1 and 2) levels to various extents in kidney. Additionally, changes observed in extracellular matix components as a result of diabetes were modulated to various extents by banana flower and stem.

Chondroitin sulfate/dermatan sulfate (CS/DS) is one of the important extracellular matrix components of the kidney. It is one of the components involved in nephrogenesis. In order to decipher the extracellular remodeling by dietary factors during diabetes, elucidation of structure-function relationship of the CS/DS was attempted.

Experimentally-induced diabetic rats were used as a model. CS/DS was isolated and purified from age-matched control and diabetic rats. Fine structural studies in terms of disaccharide composition were carried out by strong anion exchange HPLC after tagging the reducing ends with a fluorophore, 2-aminobenzamide. Oligosaccharide analysis was carried out on a differentially-digested CS/DS using a Superdex peptide column. Functional studies in terms of binding of CS/DS to other extracellular matrix components were carried out by solid phase immunoassay.

Hypercholesterolemia

Cholesterol from dietary sources is one of the causative factors of hypercholesterolemia. Dietary factors such as oat bran and curcumin are known modulators of hypercholesterolemia. However, their effect on effectors of lipoprotein metabolism such as glycosaminoglycans (GAG)/proteoglycans is seldom known. This work was undertaken to elucidate primarily the changes in GAG metabolism in liver during hypercholesterolemia and its modulation by dietary factors such as oat bran and curcumin. Rats were induced hypercholesterolemia by supplementing AIN-76 diet with 0.5% cholesterol. At the end of 4 months, rats were sacrificed and liver was harvested. GAGs were isolated from liver, quantitated and partially characterized. Results indicated decrease in GAGs in liver of hypercholesterolemic rats which negatively correlated with increase in serum cholesterol levels.

Dietary compounds against ulcer and cancer

The efficacy of dietary compounds against ulcer and cancer were examined. Mode of action of multi-step active antiulcer compounds from dietary sources was elucidated. Studies provided the ability of modulation of several regulatory factors by black cumin pectic

polysaccharide - BCPP to heal the gastric ulcer caused by acetic acid. Results also showed the activation of MAP kinase by BCPP. Further, the role of phenolic and pectic polysaccharide fractions of Carrot (*Daucus carrota*) was examined against UV-DMBA-7,12-Di-Methyl Benzanthracene induced skin cancer. Since upregulated tyrosinase enzyme levels appear to be the crucial step in uncontrolled proliferation of melanocytes and melanin production, the ability of both phenolic and pectic polysaccharide fractions in inhibiting tyrosinase levels *in vivo* was examined. Free (CRFP), bound (CRBP) and pectic polysaccharide (CRPP) fractions of carrot inhibited tyrosinase activity at IC_{50} of 1.58, 2.3 and 1.6 µg/mL as opposed to standard gallic acid (IC_{50} ~ 2.8 µg/mL). Analogous to this, skin tumors were also reduced significantly as evaluated by total tumor volume /tumor Index. Tyrosinase enzyme has been shown as a major protein in the cancerous mouse skin homogenate as visualized as a major protein upon SDS-PAGE followed by comassie staining. Same band was also positive for periodic acid Schiffs reagent indicating the glycoprotein nature of the enzyme. Infact presence of this glycan structure may enable the binding of the CRPP and hence may result in the inactivation of the enzyme activity and therefore the normalization of tyrosinase levels and controlled melanin accumulation in CRPP treated animals. Further, CRPP also affected the release of galectin-3 and galectin-3 binding proteins which are important for the spread of cancer cells.

Retinol deficiency

Antioxidant potential of fucoxanthin with beta-carotene in relieving lipid peroxidation caused by retinol deficiency in rats were compared. Results demonstrated that fucoxanthin has greater potential than beta carotene in modulating lipid peroxidation, catalase and glutathione transferase in plasma and liver of retinol deficient rats.

Lutein bioavailability

Effect of micellar lipids, dietary fiber and beta carotene on lutein bioavailability in aged rats with lutein deficiency were studied. Tissue response of a pharmacologic dose of lutein solubilized in mixed micelles with fat (soybean oil), phosphatidylcholine, lysophosphatidylcholine, dietary fiber (pectin) beta carotene and micelles with no dietary components were administered in aged rats with lutein deficiency. Results indicated that soy bean oil and soy phospholipids swayed lutein absorption in aged rats with lutein deficiency. Also ingestion of lutein with pectin and beta-carotene suppresses lutein absorption. To improve the absorption of lutein, foods with sufficient fat, low dietary fiber and beta-carotene is suggested.

Cluster beans for weight management

Soluble fibre-rich cluster beans, along with capsaicin were evaluated for weight management in high-fat fed rats. Freeze dried cluster beans and capsaicin were included at 15% and 0.015% respectively in the high fat

diet of Wistar rats for 8 weeks rendering them hypolipidemic. Cluster beans and capsaicin additively decreased body weight gain in high-fat fed rats, without affecting feed intake. Dietary cluster beans significantly checked weight gain and adverse changes in lipid profile in high-fat fed condition. These effects were potentiated by co-administration of capsaicin.

Tender cluster beans, a rich source of soluble dietary fibre was explored for its potential in weight management in rats maintained on high fat diet. The cluster beans caused lowered fat absorption, higher diversion of dietary fats through feces, enhanced lipolysis through increased activity of hormone sensitive lipase causing lowered adipose weight and increased mobilization of accumulated fat. The study indicated that 15% cluster bean powder produced the maximum desired effect with respect to body weight management.

The gastrointestinal protective effect of soluble dietary fibre-rich tender cluster beans, with respect to activities of antioxidant enzymes and concentration of antioxidant molecules was examined in Wistar rats. Dietary intervention with tender cluster beans (15% freeze-dried powder in the diet for 8 weeks) significantly enhanced the activities of antioxidant enzymes-superoxide dismutase, catalase, glutathione reductase, glutathione-S-transferase and glutathione peroxidase and concentrations of antioxidant molecules in both gastric and intestinal mucosa. Further, in combination with capsaicin (0.01%), the beneficial effect was even higher. There is a strong indication that tender cluster beans offer a significant gastroprotective effect and a much higher effect when combined with capsaicin in this study in terms of increased antioxidant status. These dietary components were found to alleviate the diminished activities of antioxidant enzymes and antioxidant molecules in gastric and intestinal mucosa under conditions of ethanol-induced oxidative stress. The gastro-protective effect of cluster bean was also reflected in its positive effect on gastric mucosal glycoproteins, thereby lowering mucosal injury. Incidentally, serum and hepatic tissues also showed an elevated antioxidant status, thus indicating a desired inclination towards lowered oxidative stress by consuming tender cluster beans.

L-DOPA glycosides

Syntheses of L-dopa 1 glycosides 13-22 with D-glucose 2, D-galactose 3, D-mannose 4, D-fructose 5, D-ribose 6, D-arabinose 7, lactose 8, maltose 9, sucrose 10, and D-mannitol 11 have been carried out using amyloglucosidase from *Rhizopus* mold and β-glucosidase isolated from sweet almond and entrapped onto calcium alginate beads. Invariably, L-dopa gives very low to moderate yields of glycosides 13-23 at 3.3 - 57.6% range. Only mono glycosylated products are detected through glycosylation/ arylation at the 3rd or 4th OH positions of L-dopa 1. Arylation occurs at 6-O-positions with D-glucose 2 and D-galactose 3. Amyloglucosidase catalyzes the reaction with

all ten carbohydrate molecules employed with the exception of D-Sorbitol. Regio-selectivity was observed in case of D-mannose 4 to give 4-*O*-C1α, D-fructose 5 to give 4-O-2-O, ribose 6 to give 4-O-C1α, maltose 9 to give 4-O-C1α, sucrose 10 to give 4-O-6—O, and D-mannitol 11 to give 4-O-1-O. Immobilised β-glucosidase did not show any selectivity and catalyzed reactions with D-glucose 2, D-galactose 3, D-ribose 6 and lactose 8.

Neuromodulatory studies

Neuromodulatory potential of *Selaginella delicatula* which grows on wet rocks in western ghats of India was explored. Neuroprotective efficacy of the aqueous extract of *Selaginella delicatula* (SDAE) employing rotenone (ROT) drosophila model *in vivo* was studied. Ability of the SDAE-enriched diet to modulate the levels of endogenous oxidative markers and antioxidant defenses in *Drosophila melanogaster* was examined. Further the propensity of SDAE to protect flies against ROT-induced lethality, locomotor dysfunction, oxidative stress, mitochondrial dysfunctions and neurotoxicity were investigated. Adult flies were fed with SDAE-enriched diet. SDAE offered protection against ROT-induced lethality based on its concentration. The survivor flies performed better in the negative geotaxis assay suggesting attenuation of ROT-induced locomotor deficits. Biochemical analysis revealed SDAE completely restored ROT induced elevation in the levels of ROS, protein carbonyls and hydroperoxides in both head and body regions. Elevations in the activities of antioxidant enzymes and glutathione-S-transferase caused by ROT were also restored by SDAE. Further SDAE improved the activity levels of membrane bound enzymes. Also SDAE normalized the activity levels of acetylcholinesterase (AcHE) enzyme and ROT-induced dopamine-depletion. These results suggests neuromodulatory potential of SDAE.

Propensity of tomato seed aqueous extract (TSAE) to render protection against neurotoxicants employing *Drosophila* model was examined. Adult male flies maintained on TSAE enriched diet exhibited diminished ROS and enhanced GSH levels. Flies co-exposed to ROT + TSAE exhibited lower incidence of mortality and performed better in negative gravitactic behavior. ROT induced elevation of ROS levels was significantly ameliorated with increase in GSH levels. TSAE also attenuated acrylamide induced lethality and improved locomotion and restored GSH levels. The activity of AcHE with neurotoxicants was significantly reduced by TSAE. Neuroprotective effects of tomato extracts in mice model was also further explored. Results suggests the aqueous extract of tomato seeds, which are a rich source of bioactive compounds possesses significant neuroprotective action.

The propensity of fish oil (FO) supplements to modulate endogenous markers of oxidative stress and attenuate neurotoxicant-induced oxidative stress and mitochondrial dysfunction

in rat brain were examined. FO prophylaxis offered varying degrees of protection against ROT-induced mitochondrial dysfunctions. FO prophylaxis significantly enhanced GSH levels in brain regions and it could attenuate ROT induced oxidative stress as well.

Neuroprotective effect of fish oil (FO) in combination with quercetin (Q) against 3-nitropropinoic acid (NPA) induced stress in rat brain was examined. FO + Q combination completely normalized the elevated AcHE activity and protected against NPA-induced mitochondrial dysfunctions. NPA induced depletion of dopamine levels was restored among all groups. Also the motor deficits were significantly improved among FO + Q rats, which are NPA-induced.

Acrylamide -induced oxidative stress and the ameliorative effects of spice actives in *Drosophila melanogaster* was explored. The propensity of spice actives such as eugenol (EU) and isoeugenol (IE) to ameliorate acrylamide induced neurotoxicity was tested. EU/IE enriched diet offered marked protection against acrylamide induced mortality locomotor dysfunctions and oxidative stress. Further, the spice actives restored the depleted levels of reduced GSH, normalized the activity of AChE enzyme and dopamine levels in the head region. These findings have clearly demonstrated that acrylamide -induced neurotoxicity could be mediated and the potential of spice actives in abrogating oxidative stress. Investigations further in acrylamide-induced neuropathy in rats have also demonstrated the beneficial effects of spice bioactives.

Immunomodulatory studies

Guduchi (*Tinospora cordifolia*) immunomodulatory protein (ImP) was purified to homogeneity from dry stem powder extract as a single chain acidic protein (25 kDa) without glycans; The protein was noticeably absent in guduchi leaf, guduchi satwa and guduchi capsule preparations. Guduchi ImP at 1-10 μg/mL showed ~3-fold mitogenic activity compared to untreated murine splenocytes; 5-7 fold increase in mitogenic activity was seen in the case of murine thymocytes *vs.* control. The purified protein also induced nitric oxide production and yeast phagocytosis from murine macrophages, but was devoid of hemagglutination activity. Guduchi ImP is highly immunogenic in mice (mucosal administration without an adjuvant) as measured by its humoral IgG and IgA responses. Guduchi ImP possesses significant adjuvanticity (adjuvant effect) in enhancing the humoral IgG and IgA responses of co-administered weak antigen (ovalbumin) by mucosal route in BALB/c mice.

Based on the N-terminal sequence of the 21.6 kD protein from sapodilla (*Manilkara zapota*), primers were designed in order to obtain full length gene sequence of sapodilla thaumatin-like protein (TLP). Sapodilla genomic DNA was isolated using fresh leaves of sapodilla plant (cv. cricket ball); a PCR product of ~0.6 kb (603 bases) was cloned, which upon sequence

analysis corresponded to acidic thaumatin-like protein by homology analysis; this sequence represents the partial gene sequence corresponding to residues 8-207 of mature sapodilla acidic TLP, which is expected to have 207 amino acid residues. Sapodilla acidic TLP has a molecular mass of 21922 Da with a theoretical pI of 4.44. The partial sapodilla acidic TLP sequence contains the sequence GQGKCQTGDCNGLLQC (represents residues 56-71) which matches with the consensus thaumatin family signature. The sequence of sapodilla acidic TLP shows high homology towards known food allergenic TLPs.

Antibodies specific to ribitol and ribitol-5-P have been generated using the corresponding conjugates with BSA followed by caprylic acid precipitation of the antiserum and hapten affinity chromatography. Characterization of ribitol antibody revealed that it is highly specific for ribitol and showed <5% cross-reactivity with other sugar alcohols (erythritol, xylitol, arabitol, mannitol and sorbitol). Anti-ribitol antibodies also showed cross-reactivity to riboflavin (120%) indicating that the ribitol portion of riboflavin is recognized. Antibodies specific to ribitol and ribitol-5-P have been generated and characterized, which may find applications in the development of competitive ELISA for the quantification of riboflavin and its coenzymes in food samples.

Organophosphocarbamates

The effect of phosphine fumigant on the immature stages of *Tribolium castaneum* with different concentrations of phosphine over different exposure period was carried out. *T. castaneum* eggs exposed to 120 hours and 144 hours resulted in 100 % mortality at 1 mg/L dosage. Similarly 168 hours of exposure with a dosage of 0.50 mg/L were able to achieve 100% mortality. *R. dominica* eggs for an exposure period of 96 hours resulted in 100% mortality at lower dosage. Exposure of larval instars and pupae of *T. castaneum* revealed that LD_{50} concentration was dependent upon the period of exposure to phosphine fumigant. Also the studies showed pupal stage was more tolerant to phosphine fumigant followed by egg, late-larvae, mid-larvae and early larval instar. Experiments with mixed age cultures of *R. dominica* showed that LD_{50} concentration of 0.060 mg/L of phosphine for 168 hours of exposure was required to kill all the insects.

Organophosphocarbamates at different concentrations were sprayed on to filter paper and *Tribolium castaneum* stored-product insects were allowed to crawl over it. At the lower concentrations of 6.4 mg cm^{-2}, 100% mortality was observed in 24 hours. O,O-diethyl-O-[4-chloro-2-(5-chloro-2-hydroxybenzyl)phenyl] phosphorothioate was exposed for 24 hours to freshly emerged adults of *Rhzyopertha* at different concentration to arrive at LD_{50} and LD_{99} dosages. LD_{50} and LD_{99} values were 0.715 mg/cm^2 and 2.45 mg/cm^2 respectively. Phosphorothioates of eugenol tested against stored insects and fungi was found to be promising.

Bioactive compounds trans-anethole and beta-asarone were extracted from fruits of *Illicium verum* and rhizomes of *Acorus calamus* respectively. Trans anethole and *A. calamus* had insecticidal potential at 500 ppm for *S. oryzae* and 50 ppm for *C. chinensis.* F1 generation was totally inhibited. Trans-anethole with different concentrations was evaluated against *S. oryzae* on wheat and *C. chinensis* on green gram. In the case of *C. chinensis,* 100% mortality was observed by three days at the lowest test concentration. Also 87% mortality of insects was observed in the case of *S. oryzae* at 600 ppm by 7 days.

A. calamus extract and *trans*-anethole had no inhibitory effect on grain germination. *In vivo* and *in vitro* studies were carried out to determine the effect of trans-anethole on acetylcholinesterase activity. Increase in activity was observed in insects exposed to trans anethole / compared to unexposed control insects. But in *C. chinensis* decrease in activity was observed.

Organophosphorous pesticides toxicity studies

Effect of phosphine on the development of *C. elegans* was studied. Upregulation of key antioxidant enzymes in developmentally strained worms was observed. In the presence of diethyl maleate (DEM), the development was further delayed suggesting the role of glutathione (GSH) in the developmental toxicity of PH_3. Also the effect of sublethal concentrations of phosphine to L4 stage *C. elegans* and F1 and F2 generations was explored. Different response to three generations was noted. The multiple toxicities of monocrotophos to *C.elegans* and its progeny was explored. The body size, brood size, developmental time and hatchability were used for assessing the toxicity. It was found that F1 progenies were more affected compared to F2 progenies. Different life stages of *C. elegans* were exposed to sub-lethal concentrations of deltamethrin for different exposure periods. There was upregulation of carboxylesterase and acetylcholinesterase enzymes in deltamethrin exposed worms in all the stages. Also alteration in the antioxidant levels in all the life stages of *C. elegans* was observed.

Organophosphorus insecticide toxicity

Hyperglycemic and stressogenic effects of monocrotophos were explored. Pre-treatment with mifepristone was found to prevent induction of liver tyrosine aminotransferase activity, but was ineffective in attenuating hyperglycemia in monocrotophos-treated rats. Pre-treatment with Propranolol (PR) and Phentolamine (PA) were effective in abrogating monocrotophos - induced hyperglycemia. PR offered partial protection against hyperglycemia, while PA completely abolished the same. The monocrotophos-induced hyperlactacidemia was completely abolished by PR alone. Hyperglycemia and hyperlactacidemia induced by monocrotophos were completely abolished by pre-treatment with atropine. Exogenous epinephrine was

associated with hyperglycemia and hyperlactacidemia. The impact of adrenergic antagonists on epinephrine-induced hyperglycemia and hyperlactacidemia was similar to that of monocrotophos-induced. Hydrazine sulfate completely abolished hyperglycemia in monocrotophos-treated rats. It can be hypothesized that excessive stimulation of adrenoreceptors, probably elicited by increased plasma epinephrine mediates hyperglycemic outcomes induced by acute exposure to monocrotophos. Pattern of changes in plasma lactate suggests that beta-adrenergic activation mediates monocrotophos-induced hyperlactacidemia, while alpha adrenergic receptor mediates lactate utilization leading to hyperglycemia. Induction of liver TAT activity is attributable to glucocorticoid receptor activation as a result of hypercorticosteronemia.

Neurotoxic insecticides

The LC_{50} of parkinson's disease **(**PD) inducers, rotenone (24h exposure), MPTP (1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) (48h exposure) and monocrotophos (4h exposure) were determined. Conditions were standardized for behavioral studies in *C.elegans* for 48hours exposure basal slowing response (BSR) using MPTP (PD inducer) and MCP (organophosphorus insecticide). Dopamine levels in *C. elegans* homogenates were quantified to assess the extent of loss of dopaminergic neurons when exposed to MPTP and MCP for 48h exposure period. Conditions were standardized in mice to study parkinson-like toxic effects and behavioral studies to determine motor activities using chemical inducer MPTP by induction of catalepsy. Behavioral toxicity in mice subjected to sublethal concentrations of MCP was also assessed. The parkinson-like effects elicited by sublethal concentrations of monocrotophos in rat was determined. Dopamine levels in rodent brain homogenates was quantified to assess the extent of loss of dopaminergic neurons in experiments using MPTP and MCP.

Aflatoxins

Soil samples collected from Beligiri agricultural field in Mysore confirmed the presence of aflatoxigenic fungi at varied concentrations. Also the xylem sap of maize seedlings grown in these fields confirmed the presence of aflatoxins in xylem exudates, which indicates the ability of the seedlings to uptake aflatoxins through xylem. Further the hydroponics experiments also proved the uptake of aflatoxins in maize plants. Laboratory experiments indicated that aflatoxins was uptaken by plants though root and translocated at various parts of the plants.

Coffee pulp effluent biodegradation

Bio-degradation of complex molecules using whole cell cultures from coffee pulp effluents in field conditions was attempted. The combinations of yeasts used for the study had pectin and polyphenol degrading abilities. The COD level of the effluent was very high ranging from 17,000- 12,000 and in the inoculated samples there was a marked decrease in the COD values (approximately by 60%). Further acidity was neutralized with fungal isolates *Mycotypha spp*.

Societal Programmes

CSIR-NInC Programme for promotion of mango cluster at Krishnagiri

The mango cluster at Krishnagiri (Tamil Nadu) has no infrastructure facility for unit and bulk packaging of mango fruits for domestic and export trade. During the season, selling price of mangoes touch rock bottom, thus adversely affecting the mango growers. Except for processing of ripe fruits into canned pulp, which is facing lots of marketing problems, there is no other means of product development. Also, the utilization of mango fruit wastes from canning industries like fibre, peel and seed are not known to farmers in the cluster, which otherwise contribute to the environmental pollution. The Institute monitored the mango orchards requiring different pre-harvest schedules for protection of mango crop.

Demonstrations were conducted for developing processed products, such as beverage, nectar, squash, fruit bar, jam and toffee for value addition at the Institute. Similarly the preparation of pickle and preserve in salt and vinegar and chutney was demonstrated to the cluster at Krishnagiri. The entire cluster consisting of 25,000 farmers besides 65 processors and 50 exporters are the beneficiaries of this programme.

Participants from Mango cluster with CFTRI Staff in a training session

Display of pickle and sweet chutney from raw mangoes with participants of CSIR- NInC Programme at Krishnagiri

Progress under R&D Projects

Supra and Network Projects

NICHE FOOD PROCESSING TECHNOLOGIES FOR OUTREACH OF COST EFFECTIVE, SAFE, HYGIENIC, NUTRITIOUS AND HEALTH FOOD TO THE TARGET POPULATION

The supra institutional project was focused on providing a wide range of foods for meeting the nutritional needs of the society. The strategy was development of products into technology packages for large-scale production taking into consideration various factors. These factors include the deficiency to be treated/prevented, age group and their daily requirements, identification of nutrients sources, isolation, enrichment and/or encapsulation of the nutrients, formulations of fortified products using various unit operations - identification of the ingredients and additives to enhance acceptability, shelf life and stability; selection of product based on sensory attributes, stability of nutrients, shelf life, ease of processing and cost; nutritional labeling based on bioavailability; packaging, shelf life and sensory studies, efficacy and safety evaluation of the products; and process optimization for scale up and costing.

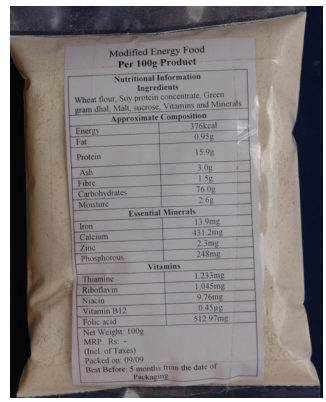
The products were formulated under various categories according to the requirements of the targeted population and feasibility studies for large-scale production have been undertaken. Also the quality and safety evaluation along with sensory studies were carried out.

Supplementary and complementary foods

These formulations are intended to augment nutrition and consisted of high density multiple nutritious products and specialty foods for outreach programmes. The products developed include Modified energy food, Roller dried supplementary food, Extruded supplementary food and Supplementary food (based on popped millets and legumes).

Nutrient fortification of staple and non-staple foods

Fortification of traditional and ethnic foods was aimed at combating micro and macronutrient deficiencies. The products developed include - Fortified flours (wheat and whole wheat flours), Shelf stable protein rich *chapatis*, High protein fortified brown bread and rusk, Beta-carotene and minerals enriched bun.



Food products enhancing bioavailability of nutrients

The bioavailability of nutrients depends on ingredients in a food product formulation and products were developed to enhance the bioaccessibility of zinc and iron from plant foods .

Food for changed life style habits

Current life style has posed challenges to all sects of population with respect to food intake and nutrients supplementation. The products such as Edible grade rice bran, Multigrain muesli, Multigrain supplementary foods, Low glycemic index food (reconstitutable) and whole grain porridge/drink were developed.

High density nutritious foods for targeted population

These products were aimed to provide proper nutritional support including immuno-modulatory components for selected sects of population. The products such as Nutri chikki, Fruit based snack bar, High protein extruded snacks (sweet and savory), Shelf stable egg yolk and albumen paneer, Whole egg paneer and Egg crunchy bite were developed.

Nutritious and low calorie foods for health and wellness

This category aimed at products for development and preventive aspects. The emerged products include Nutri-oil blend, Low fat snack, Lutein-rich multipurpose instant mixes, Vitamins and minerals enriched aerated and non-aerated beverages, De-bittered, biofunctional sweet orange juice and jelly, Nutra cereal bar and Low calorie gel.

DESIGN AND DEVELOPMENT OF EQUIPMENTS WITH APPROPRIATE AND ADAPTABLE AUTOMATION FOR HYGIENIC AND SAFE PRODUCTION OF PROCESSED AND SEMI PROCESSED FOODS IN LARGE SCALE

The network project was aimed at design and development of equipments with appropriate and adaptable automation for hygienic and safe production of processed and semi-processed foods in large scale. The major focus were on automation, integration of technology with machinery mechanization, production and energy conservation in the equipments for traditional foods.

Integrated garlic peeling machine

Performance evaluation of Mini *Chakki* Mill (improved), *Jilebi* forming unit, Pressure fryer, pneumatic lemon machine and continuous boondi frying machine were completed. *Laddu* making machine has been improved/modified to suit forming of besan *Laddu*. Also Integrated garlic peeling machine was designed and fabricated. Computational fluid dynamics (CFD) models were used for design improvement of equipments and energy conservation.

Technology/design drawings of poory forming and frying machine, lemon cutting machine, dough extruder/sheeting unit were transferred to the industry. All these equipments are in use at different places of the country.

Custom-made Microwave dryer for continuous operations

EXPLOITATION OF INDIA'S RICH MICROBIAL DIVERSITY

Screening for alpha glucosidase inhibitors

Screening of around 6365 extracts so far from five networking laboratories for alpha glucosidase inhibitors were completed. The 150 cultures previously isolated from soil samples from various ecological niches were subjected to submerged fermentation in potato dextrose broth. A crystal was produced by isolate CFR101 (CFTRI S 21) whose structure was found to be kojic acid. The structure of alpha glucosidase inhibitors from isolates C1 and S8 and FR102 are being elucidated using an enzyme inhibition guided assay.

BIOLOGICAL AND CHEMICAL TRANSFORMATION OF PLANT COMPOUNDS FOR VALUE ADDED PRODUCTS OF THERAPEUTIC / AROMATIC VALUE

The full-length cDNA encoding field bean PPO-haemagglutinin exhibiting both PPO and lectin activities was cloned. A single poly-A signal (AATAAA) was also recognized at the 63 base positions downstream to the coding region. The unusual binding properties of the PPO-haemagglutinin to galactose only in the presence of $(NH_4)_2SO_4$ was attributed to the lowering of the dielectric constant and an increased surface hydrophobicity, which reckons a "functional sugar binding site".

The gene encoding tamarinin, the catalytically inactive homolog of class III chitinase from tree legume *Tamarindus indica L*. (TamCh1) was cloned using PCR based protocols. RNA-ligase mediated rapid-amplification of cDNA ends (RACE) was performed to obtain the full length cDNA sequence and to obtain the transcription start site. The deduced sequence shows more than 65% identity with other legume Class III endochitinases. The alignment also shows the six highly conserved cysteine residues and the conserved amino terminal and carboxy terminal Family 18 glycosyl hydrolases signature sequences.

A recombinant rice bran lipase (RBL) was expressed as a secretory protein in *Pichia pastoris* and functionality was analyzed for lipase activity. The recombinant protein was purified by ion exchange chromatography using DEAE sepharose and a 32 kDa protein of expected molecular weight was obtained.

ENIVRONMENTAL CONTAMINANTS: NEW SCREENING TECHNOLOGIES AND EFFECT ON HUMAN HEALTH

Immunodetection of isoprothiolane in soil, food and water samples

A simple competitive immunoassay was developed for the measurement of isoprothiolane in rice, soil and water samples. The concentration of isoprothiolane in the rice, soil and water samples was quantified by an assay. The assay was specific to isoprothiolane with a limit of detection of 2 ng/mL. Mean analytical recovery of isoprothiolane in different rice matrices was 87.20% to 98.02%, for soil samples recovery was 74.24% to 111.20% and water samples recovery was 35.2% to 95.73%. The assay compared favourably with GC in its ability to accurately measure isoprothiolane in different rice, soil and water samples.

Detection of Cadmium by Immunoassay in water and food samples

An immunoassay that measured Cd(II) in aqueous samples and different food matrices at concentrations from approximately 2 to 1000 µg /mL was carried out. The assay was also able to measure cadmium in spiked food matrices. The assay compared favourably with ICP-AES in its ability to measure cadmium in spiked water and food matrices.

Analysis of Cd(II) in spiked food samples

Cd(II)-spiked food samples were prepared in the concentration of 0.2 - 10 mg $kg^{-1}$by spiking AAS grade Cd(II) sample into few Cd(II)-free food materials. These samples were analyzed for Cd(II) both by the immunoassay procedure and by atomic absorption spectrometry (AAS). The absolute limit of detection for Cd on this instrument with standard samples was 0.2 µg ml^{-1}. Although the ICP-AES method was not able to accurately determine spikes in dry fish and tea, the overall method was found satisfactory.

Risk assessment of Aflatoxin M_1 in sterilized milk

Aflatoxin M_1 in sterilized milk of various manufacturers was determined. 71.4% of low fat sterilized milk had aflatoxin M_1 less than 0.5ng/ml and 57.15% of whole milk sterilized samples were found to contain more than 0.5ng/ml. Aflatoxin M_1 was not detected in 62.5% of the flavored milk samples. However 12.5% were found in the above permissible limits. Percentage reduction of aflatoxin M_1 in milk on boiling was only $8\pm$ 0.6%.

Method validation for Aflatoxin determination in Azadirachta indica (Neem) and studies on production of aflatoxin in this substrate

The method for aflatoxin determination in *Azadirachta indica* were validated. The method of extraction and sample clean-up using silica gel column by AOAC Official method gave satisfactory results as the recovery was more than 85 % for all the four aflatoxins. Column clean-up of sample extracts using immunoaffinity columns showed recovery of more than 90% for aflatoxins B_1 and G_1 but poor recovery for B_2 and G_2.

COMPREHENSIVE TRADITIONAL KNOWLEDGE DIGITAL LIBRARY

Number of cuisine records in the database stands more than 2300. Digitized resources include more than 1700 cuisine images, around 1700 prior-art material, 2300 bibliographic records, 100 cuisine videos mainly sourced from public domain and around 80 publications related to traditional cuisines in the repository. Also cuisines were mapped to states and various regions. A supplementary portal has been developed towards creating a unified framework of the digitized content on traditional foods.

ZERO EMISSION RESEARCH INITIATIVES

Safety of delimed tannery fleshing (DTF) hydrolysates as animal feeds supplements were evaluated by animal studies. The feed intake, body and organ weights of rats fed with DTF hydrolysates were comparable to that of control rats. Also no significant changes were observed on hematological parameters, histology of vital organs and biochemical measurements of serum, liver or other groups. The study confirmed the safety of using DTF hydrolysates as ingredients in livestock feeds.

ADVANCEMENT IN METROLOGY

Cabbage powder spiked with Chlorpyriphos and alfa-endosulfan prepared as certified reference material (CRM). Reference material for dietary supplement were prepared by fortifying wheat flour with soya protein isolate, Iron, Calcium, Vitamin A and Vitamin C. Homogeneity and stability of the prepared CRMs were completed. Seventeen laboratories

(both accredited and non-accredited) participated in the first round of interlaboratory studies conducted for pesticide residues in cabbage powder.

Homogeneity test for a few metals/minerals in randomly selected pouches was carried out using nitric acid digestion followed by AAS / ICP-AES analysis. The sample sizes used varied from 0.5 g for ICP-AES to 2-3 g for AAS analysis. The results for minerals within and between-bottle testing provided the homogeneity. Stability tests for the samples stored at (25±2°C) for a period of 3 months did not show any significant changes in the levels of the minerals / metals analyzed.

LIST OF STAFF
AS ON
31-3-2012

Venkateswara Rao G Dr. . . . ***Acting Director***

Director's Office

Rajashekar KL
Ramesha CP
Rao PVR
Umashanker B

Biochemistry & Nutrition

Salimath PV Dr. ***(Head)***
Aijaz Ahmed
Akhilender Naidu K Dr.
Baskaran V Dr.
Jagadish L Urs
Kalpana Platel Dr.
Mahadevamma Dr.
Muralidhara Dr.
Muralikrishna G Dr.
Muthukumar SP Dr.
Prasada Rao UJS Dr.
Ramesh HP Dr.
Rita Das M
Shylaja M Dharmesh Dr.
Srinivasan K Dr.
Venkatesh YP Dr.
Vijaya Kumar BV
Vishwanatha S

Central Instruments Facility & Services

Vatcharavelu K ***(Head)***
Anbalagan K
Asha M
Harish Raj V
Jai Chand
Lokesha C
Mukund Lakman Padmere
Shivaswamy
Srirama R
Umapathi H

Food Engineering

Raghavarao KSMS Dr. ***(Head)***
Appukuttan A
Bharath
Chakkaravarthi A
Ezhil Murugan R
Francis JV
Gadigeppa Bammigatti
Girish Kempana Ghiwari
Jagannatha MK
Javaraiah K
Jayaprakashan SG
Kumar N
Mahesha I
Manohar B
Mukunda K
Nagaraju VD
Nanjundiah
Navin Kumar Rastogi Dr.
Prakash N
Puttaraju BV
Rajesh M
Rangaswamy KP
Shesha Narayana K
Shivakumara M
Sridhar BS Dr.
Subramanian R Dr.
Susainathan A
Suvendu Bhattacharya Dr.
Udaya Sankar K Dr.
Umesh Hebbar H Dr.
Venkatesh Murthy K Dr.
Venkatesha V

Food Microbiology

Umesh Kumar S Dr. ***(Head)***
Anu Appaiah KA Dr.
Joshi GJ
Katanna
Mahejibin Khan Dr.
Prakash M Halami Dr.
Renu Agarwal Dr.
Shamala TR Dr.
Vanajakshi V
Venkateswaran G Dr.
Vijayalakshmi G Dr.
Vijayendra SVN Dr.

Flour Milling, Baking & Confectionery Technology

Venkateswara Rao G Dr. ***(Head)***
Anthony S
Basavaraj Mundalmani
Crassina Shimray
Dhanashekar PS
Gangadharappa GH
Hemaraju R
Inamdar AA
Indrani D Dr.
Irudayaraj A
Jayaram HC
Jyothsna Rajiv S
Keshava Hegde
Kumara
Mahadev S Khanapuri
Mohammed Eliyas
Mohammed Peer
Mohan Kumar S
Naga Swami Kuthada
Nagamani S
Nagendra MA
Prabhasankar P Dr.
Raghavan CV
Rama Sarma PR
Sai Manohar R Dr.
Sheetal Gupta Dr.
Soumya C
Sourav Kumar
Sudha ML
Suresh D Sakhare
Venkatesha R

Food Protectants & Infestation Control

John Pereira *(Head)*
Akmal Pasha
Krishnaiah HE
Manivannan S
Rajini PS Dr.
Ramaswamy K Dr.
Shivaramaiah HM Dr.
Subbaraya N
Sumithra Devi S Dr.

Food Packaging Technology

Ranga Rao GCP *(Head)*
Baldev Raj Dr.
Indiramma AR
Keshava Murthy PS Dr.
Matche RS
Rama Prasad BS
Sathish HS
Srinivasulu K
Vijayalakshmi NS

Food Safety & Analytical Quality Control Laboratory

Lalitha R Gowda Dr. *(Head)*
Alok Kumar Srivastava Dr.
Amrutha Kala AL
Ankaiah KN
Aruna Kumar
Asha Martin Dr.
Devendra J Haware
Jinesh P
Lalitha HJ
Nanishankar V Harohally Dr.
Nanjunda
Prasanna Vasu Dr.
Prema Viswanath Dr.
Sathyabhoda JA
Shivappa S
Sreenivasa MA
Swaroopa Rani D Dr.
Umamaheswari P
Usha Rani M

Fermentation Technology & Bioengineering

Thakur MS Dr. *(In-charge)*
Avinash Prahlad Sattur Dr.
Manonmani HK Dr.
Prapulla SG Dr.
Somanna
Somashekar D Dr.
Varadaraju C

Fruit & Vegetable Technology

Rajarathnam S Dr. *(Head)*
Attar Singh Chauhan
Chikkabasave Gowda
Keshava Prakash MN
Kudachikar VB
Kulkarni SG
Mallikarjuna Aradhya S Dr.
Nataraja C
Rekha MN
Revathi Baskaran
Shashirekha MN Dr.
Uma AV
Vanitha T Dr.
Vijayalakshmi MR
Vijayanand P Dr.

Grain Science & Technology

Vasudeva Singh Dr. *(Head)*
Aswathnarayana KN
Jayadeep A Dr.
Manisha Guha Dr.
Meera MS Dr.
Pratape VM
Santhosh G
Sasikala VB Dr.
Sathyendra Rao BV
Shantha
Shruti Pandey Dr.
Sila Bhattacharya Dr.
Sreerama YN Dr.
Srinivas A
Umesha BA
Usha Dharmaraj Dr.

Human Resource Development

Varadaraj MC Dr. *(Head)*
Anandharamakrishnan C Dr.
Chaya Devi R
Hanumantha
Iboyaima Singh N Dr.
Joseph GS
Murali Madhav V
Negi PS Dr.
Praveena Bhat Mudliar Dr.
Renuka S
Shobha S
Singh RP Dr.
Velu V

Lipid Science & Traditional Foods

Lokesh BR Dr. *(Head)*
Asha Dinakar
Baby Latha R
Chethana R Dr.
Gopala Krishna AG Dr.
Jeyarani T Dr.
Mary Francis
Nagaraju M
Nasirullah Dr.
Ramprasad TR
Sakina Khatoon Dr.
Sukumar Debnath
Suresh Kumar G Dr.
Yella Reddy S Dr.

Meat, Fish & Poultry Technology

Modi VK Dr. *(Head)*
Achamma Thomas
Bhaskar N Dr.
Harish Prashanth KV Dr.
Lakshmamma
Madhava S
Rajappa
Rathina Raj K
Sachindra NM Dr.
Sakhare PZ
Suresh PV Dr.
Yashoda KP Dr.

Plant Cell Biotechnology

Ravishankar GA Dr. *(Head)*
Bhagyalakshmi N Dr.
Giridhar P Dr.
Karuna Venkataraman
Nandini Prasad Shetty Dr.
Sarada R Dr.
Shivanna K

Protein Chemistry & Technology

Sridevi A Singh Dr. *(Head)*
Anupama R
Basavanna K
Chikkaswamy S
Gopal C
Govindaraju K Dr.
Indira TN
Jyothi Lakshmi A Dr.
Lokesh
Mukesh Kapoor Dr.
Purnima Kaul Tikku Dr.
Radha C Dr.
Ramakrishnan P
Ramesh Kumar P Dr.
Sindhukanya TC Dr.
Uma V Manjappara Dr.
Venkatesh G

Plantation Product, Spices & Flavour Technology
Srinivas P Dr. *(Head)*
Bettadaiah BK Dr.
Borse BB Dr.
Chandrashekhar N
Hafeeza Khanum
Jaganmohan Rao L Dr.
Madhava Naidu M Dr.
Mohammad Ziaulla Y
Nagarajan S Dr.
Ningamma
Pura Naik J Dr.
Pushpa S Murthy
Ramalakshmi K Dr.
Somalatha B
Sowbhagya HB Dr.
Sulochanamma G

Sensory Science

Maya Prakash Dr. *(Head)*
Amudha Senthil
Asha MR Dr.
Ravi R Dr.
Roopa BS

Library

Vasu B *(Head)*
Anita CS
Chanchala Kumari N
Kempegowda N
Mahadevi
Padmavathi T
Ragavan I
Sanjay Lal KP
Shiva R
Somashekar KS
Suneetha R Bhanderkar

Information & Publicity

Sharma KVSAS *(Head)*
Imayagiri S
Manjula TC
Ravishankar AC
Suneetha Eipeson
Vishnu Kumar M

Planning, Monitoring & Coordination

Krishna GA *(Head)*
Jayakkannan M
Kusuma K
Lakshamma
Manilal P
Narasimha Murthy SJ
Shalini M Govinkop
Siluvainathan P
Udaya Kumara H

Technology Transfer & Business Development

Darly Thomas *(Head)*
Balasaraswathi M
Brahmalinga
Chauhan VS Dr.
Dinakar KR
Gangadhara Murthy C
Gupta PK Dr.
Kalpana SG
Manjunath N
Pattekhan HH
Suresh Prasad N
Ushadevi A
Vinod Kumar Huria

Computer Centre

Krishna Rao SN *(Head)*
Pulipaka Anil Kumar
Siva Naga Suresh Purama

Construction & Civil Maintenance

Ara Kalaimaran *(Head)*
Arulalan K
Chikkaiah C
Ganesha M
Mohan Rao P
Nagaraju HM
Prasantha

Engineering & Mechanical Maintenance

Jesuraj L *(Head)*
Aravind C
Chikkalingaiah
Dhaneesh K
Kamakshi AR
Lakkaiah
Mahesh D
Manjunatha Rao AR
Mohan Madaiah
Narasimhamurthy
Narayana Rao Sindhe D
Narayanan K
Naveen Kumar C
Pachaiah
Parashuram P
Putta Swamy
Puttaswamy Gowda HN
Rajashekara M
Ramesh RN
Ramesh T
Rangadhamaiah
Siddaiah
Suresha H
Vijay Prasad Raju G
Xavier M

Administration

Office of the Controller of Administration

Vidyanathan MS *(COA)*
Geetha S
Komala HC
Murali YN

Office of the Administrative Officer

Arunan CP *(AO)*
Mallika P Kumar *(AO)*
Lawrence A

Establishment - I

Chandra Mohan Tudu *(SO)*
Basavaraju C
Jyothi K
Jyothi S
Krishnamurthy R

Establishment - II

Chandra Mohan Tudu *(SO)*
Fernandez AF
Puttasiddappa

Establishment - III & VIII

Kannan CJ *(SO)*
Preetha K
Rajesh Chelle
Subramani

Establishment - IV

Gururaja S *(SO)*
Bushra Masrur
Sujatha Ravikumar
Suvarnalatha Devi

Establishment - V

Rajappa S *(SO)*
Bhuvaneshwar P
Malini TS
Mamatha
Narayana A
Padmavathi HR
Padmini M
Ramachandraiah M
Satheesha MR
Sathyanarayana HC
Srividhya CS
Vijayalakshmi J Rao

Establishment - VI

Antony Peter Raja S *(SO)*
Ananthakrishna K
Bharathi Murthy P
Chandrashekara R
Krishna Jayanthi
Parvathi
Ramesh S
Rathna R
Usha Kiran KA

Establishment - VII

Satheesh Kumar MD *(SO)*
Maheswara Murthy M

Printing Press

Umesh S *(In-charge)*
Ganesh Prasad PS

Finance & Accounts

Krishnamurthy M *(CFA)*
Sathyanarayana NS (FAO)
Anis Ahamed Pasha A *(SO)*
Divya MV
Janaky PL
Kunhi Raman P
Manikanta Swamy SN

Mathew George
Mohammad Naushad Basha R
Pradeep R
Raghavendra TK
Rajamallu M
Ramaiah
Ravi VK
Sathyanarayana K
Shashikumar P
Srinivasa Rao N
Vasantha UR

Transport

Antony Peter Raja S *(SO)*
Gangadharappa KC
Hemantha Krishna M
Mohammed Shauib
Raju P
Rangaswamy SK
Venkatesh K

Hindi Implementation Unit

Rama Reddy D Dr.
(Sr. Hindi Officer)
Ranu Kumar
Sanjay Kumar Mishra

Stores & Purchase

Meena LR *(CoS&P)*
Nandeesh MJ *(SO)*
Abhijna
Anil G Revankar
Gangamma
Jaya HS
Kamala Gopalan
Kavyashree L
Lakshmi K
Lakshminath Thakur
Masthamma M
Prasad T
Rahul Singh
Ravikumar C
Raviswamy HC
Savitha MP
Shenbaganathan A
Shiv Kumar CR
Shivashankar S
Somaiah PT

Canteen
Lakshminarayana V
Doddaiah
Krishna DR
Mahesh S
Narashimha
Ningappa K
Palakshan BV
Puttamadaiah
Ramakrishna
Suresh KS
Velu M

Guest House

Satheesh P
Papanna
Venkatesha P

Health Centre

Ramesh BN Dr. *(Chief Medical Officer)*
Kala R Swamy Dr. *(Lady Medical Officer)*
Chandramani
Devaraju P
Jayalakshmi MB
Naveen Kumar AV
Poornima N
Sangeetha Lal EP
Shivamallappa VM
Vittal Rao

Agri-horticulture

Umesh S *In-charge)*
Judhisti D
Shivaswamy

Security

Chandrashekar
(Security Officer)
Anseem Ahmed

CFTRI Resource Centres

Mumbai

Badgujar PM *(Head)*
Khadka Deo Bahadur Sher Singh
Krishnan AN
Nanjunda R
Santhanam PSPM
Shailaja R

Hyderabad

Satyanarayana A *(Head)*
Balaswamy K
Jyothirmayi T Dr.
Nagender A
Narasing Rao G
Prabhakara Rao PG
Ramesh G
Rudrayya G Math
Sathiya Mala B
Yadaiah M

Lucknow

Gothwal PP Dr. *(Head)*
Ahuja DK
Mercy Joseph
Mohanlal
Nandkishor
Suresha S
Walde Sudhir Gopal Rao

Bangalore

Prakash S
Ashok Raju G

Research Fellows & Others

Junior Research Fellows

Amritha Girish K
Angelina
Anindya Basu
Archana KM
Archer Ann Catherine
Arun Tapal
Bavisetty Sri Charan Bindu
Chandana T
Chinnu Salim
Darshan N
Divyashri G
Ezhilarasi PN
Indu Vasudevan
Jaimee George
Jayalakshmi S
Jeevitha GC
Kirti Rani Saad
Lalitha N
Leema Roseline T
Mahesh Mansing Patil
Manjula DB
Manjunath MJ
Meena Kumari
Mousami Shankar Addala
Musunuru Suneel Kumar Reddy
Nadiminti Vishruthi
Nidheesh T
Pavithra K
Prasanna Joglekar
Prasanna Kumar V
Priyanka P Sonbarse
Pynam Hasitha
Raghunandan P
Raksha Rao K
Ram Saran Chaurasiya
Ravi H
Roshan Mandrawalia
Sakthi Kumaran P
Sandeep MS
Santosh Kumar SC
Sathya TA
Shaik Akbar Basha
Sharavana G
Shruthi R Raju
Shweatha HE
Sindhuja HN
Sinjitha S Nambiar
Sowmya R
Swarnalatha GV
Varnashree BS
Vasanth Ragavan K
Vijay Kumar Reddy
Vijendra Kumar N
Yashaswini PS

Senior Research Fellows

Abhijith KS
Aduja Naik
Ajit Singh Bhatnagar
Akitha Devi MK
Akshatha HS
Amit Kumar Das
Amit Kumar Rai
Aruna Gorusupudi
Arunkumar R
Ashok Kumar HG
Ashwini N Bellary
Avinash Kumar
Bharath Kumar S
Bijesh P
Chandra Sekhar Jampani
Chanukya BS
Chhanwal Narayansing V
Daris P Simon
David HE
Deepa C
Deepak MB
Denny Joseph KM
Divya N
Divya P
Ganesh Prasad UG
Girish Chandran
Gobinath D
Gokul K
Gopirajah R
Hameeda Banu N Itagi
Harsha MR
Hithamani G
James Bound
Jamuna J. Bhaskar
Kalpana Devi C
Karthik P
Kavitha MD
Kiran G
Kumudha A
Lalith Kumar V
Lokesh V
Lyned Dafny Lasrado
Madhu AN
Mahendratath Gondi
Mallikarjun B Chougala
Mallikarjun Gouda KG
Mandappa IM
Manjulata Devi S
Manjunath JR
Mohammad Imtiyaj Khan
Mohan Kumar NS
Mukthamba P
Murugesh CS
Nagaprabha P
Nidhi Bhatiwada
Nithya V
Padma Mallaya N
Padmaja RJ
Poornachandra Rao Y
Prasanth Kumar PK
Praveen Kumar Srivastava
Raghavendra CK
Rajarajan RG
Rajeev Ranjan
Rajeswari Gubbala
Ramesh Kumar Saini
Ravi G
Roopesh S
Sabeeta Kapoor
Sagaya Selva Kumar L
Santhoshkumar M Shetty
Shakuntala S
Shankar Shetty Umesh
Shashidhar M Ghatnur
Shipra Tiwari
Shreeranga N
Shubra Pande
Shwetha N
Simmi P S
Snigdha M
Soumya Banerjee
Sowmya N
Sugasini D
Suresha BS

Surya Chandra Rao T
Susanna S
Vadivelan G
Vasantha KY
Veenashri BR
Vidyashankar S
Vijayakumar KR
Vinayaka AC
Vinod Kumar
Vishwanath SV
Vismaya
Vrinda Ramakrishnan
Yogesh D

Others (PDF, RA, QH, WS etc.)

Anil Kumar PK *(RA)*
Gunashree BS Dr. *(PDF)*
Hariprasad P *(RA)*
Jaba Debnath Dr. *(RA)*
Nandini K *(DST Inspire Fellow)*
Rajam R *(WOS)*
Sathya Prasad N *(DST WOS-A)*
Shaheen Jafri Ali *(DST WOS-A)*
Shobha Rani P Dr. *(RA)*
Sridevi V *(DST WOS-A)*
Swaroop Kumar HM Dr. *(RA)*

CSIR - CENTRAL FOOD TECHNOLOGICAL
RESEARCH INSTITUTE
MYSORE, INDIA

TRAINING PROFESSIONALS
TECHNICAL SERVICES
ANALYTICAL QUALITY TESTING
BIOTECHNOLOGICAL VISTAS
LONG TERM STRATEGIC RESEARCH
PROCESS ENGINEERING & PLANT DESIGN
TECHNOLOGY OPTIONS
INTERNATIONAL LINKAGES

CSIR- CFTRI

A ONE STOP CENTRE for GLOBAL FOOD TECHNOLOGY

An ISO 9001:2008 & ISO 14001:2004 Organisation and
NABL Accredited Laboratory

WHAT CSIR - CFTRI CAN OFFER ...

INTERNATIONAL LINKAGES

International linkages of CFTRI - then and now

The earlier interaction of CSIR-CFTRI, with the National Institutes of Health, the Indo-Canadian Freedom from Hunger programme and FAO, along with a number of other International bodies, paved the way for a firm footing for CSIR-CFTRI in the international scenario of Food Science and Technology. Some of the International agencies having linkages with CSIR-CFTRI currently include:

- FAO
- Indo-Norway
- UNIDO
- CIDA
- Indo-Vietnam
- UNICEF
- ISCB
- UNDP
- SAARC
- Indo-Swiss
- UN University
- EEC
- World Bank
- IAEA
- Indo-Italian

Facility comparable anywhere else in the world

- International School of Milling Technology
- Advanced Training Programme of UN University
- Policy shaping for a number of International organisations
- International collaboration with Universities abroad
- Exchange of fellow scientists and technologists with institutions and industries across the globe
- Participation as member of the Ministerial delegation to promote and advice in the area of food processing
- Members of the editorial board of many peer reviewed journals in the area of food science & technology
- Competitive technologies of international standard in specific areas

Technology know-how of international standards

- Transfer of technologies to Afro-Asian countries
- Doctoral studies in advanced topics of food and allied areas for personnel from the country and other developing nations

Web Presence

- Web site: www.cftri.com.

TECHNOLOGY OPTIONS

Processes & products for profits

CSIR-CFTRI has developed technologies for several commercially attractive, nutritionally superior and safe food products, for adoption by tiny, small, medium and large food processing sectors

Range of technologies

- Infant, supplementary and speciality food formulations
- Meat, fish and poultry products
- Canned and retort pouched products
- Dehydrated products
- Bakery products
- Fermentation products
- Convenience foods
- Food machinery
- Beverages
- Processed cereals and pulses
- Byproduct utilization
- Natural food additives (preservatives, flavours, colours)
- Value-added Spice products
- Fruits and vegetable products

Infrastructural facilities

- State-of-the-art pilot plant
- Food engineering centre
- Codex food laboratory
- Food packaging testing laboratory
- Sophisticated instrumentation facility

What does future hold?

CSIR-CFTRI is ever on the look out for innovation and novelty in food products and food ingredients :

- Custom-made food processing enzymes
- Natural, safe food colourants
- Speciality foods for target groups
- Nutraceuticals
- Design and fabrication of novel food processing machinery
- Scale up of processes & products

Technology transfer

Phase one	:	Define concepts and parameters
Phase two	:	Development of prototypes
Phase three	:	Determine consumer response
Phase four	:	Prepare test market samples
Phase five	:	Scale-up for production
Phase six	:	Total technology transfer

PROCESS ENGINEERING AND PLANT DESIGN

From lab concept to market reality

The CSIR-CFTRI has expertise and total infrastructural facilities in process engineering and plant design for taking the product from the conceptual stage at lab level through process scale-up and production trials for test marketing.

State-of-the-art facilities

The engineering facilities at CFTRI include an advanced design unit, a state-of-the-art pilot plant, a modern prototype fabrication workshop and a process engineering materials laboratory.

Pilot plant equipments comprise of :

- Twin-screw extruder
- Ultra-filtration/reverse osmosis units
- Super-critical fluid extraction units
- Freeze-dryer, spray dryer, infrared dryer and radio frequency dryer
- Wide range of centrifuges
- Aroma recovery unit
- Molecular distillation unit
- Can fabrication and canning lines
- Pilot roller flour mill and bakery
- Controlled Atmospheric Storage facility
- Scraped Surface Evaporator
- Cryogenic grinder
- Solid state cultivator
- On-line retort control system

Proven technologies

Successful CSIR-CFTRI technologies are :

- Spice oil/oleoresin plants
- Fruit juice evaporation plants
- Black pepper process
- Rice bran stabiliser
- Sunflower dehulling machine
- Versatile *dhal* mill
- *Papad* press
- Leaf cup/plate machine
- Fluidized bed roaster
- Virgin coconut oil
- Reverse osmosis and ultra-filtration units
- Automation of traditional food processing
- Total package for fresh produce transportation
- Ready-to-eat food products
- Computer aided package design
- Coconut milk powder
- Coconut dietary fiber
- High-protein biscuits
- Molecular distillation unit

Food engineering services

CSIR-CFTRI is an ideal resource centre to meet your process development needs, production trials and package development programmes. The service packages available include :

- Plant design
- Machinery design
- Process scale-up
- Project engineering
- Pilot plant facilities for production trials
- Test facilities for packages and packaging materials
- Package design and development
- Troubleshooting

LONG TERM STRATEGIC RESEARCH WHERE YOU CAN INVEST

From laboratory science to commercial enterprise

Long term strategic research with advanced instrumentation to face global challenge. Quality and Innovation are the watch-words for food industries for being the first to market a new product. CFTRI is a food research laboratory of highly skilled professional staff, with an eye on developing commercial processes and products. Utmost care is taken to keep strict confidentiality of your project details.

Expertise on basic food systems

- Molecular design
- System design
- Flavour targeting
- Food enzymes
- Biotechnology
- Molecular mechanisms of biomolecules
- Dietary factors as prophylactics

Facilities for basic studies

CSIR-CFTRI is equipped to address basic problems in understanding food system components (chemical, nutritional, toxicological, biomolecular, biophysical, microbiological, physiological and sensorial profiling and food engineering) to evolve commercially viable processes and consumer acceptable products.

Expertise on basic processes

- Molecular distillation
- Computer aided design and simulation
- Engineering properties of food
- Rheology of foods
- Energy minimization process
- Process optimization
- Environment-friendly processes
- Ribotyping
- Real time PCR

Instrumentation systems are available for:

- NMR spectrometer
- Fourier transform infrared spectrometer
- Spectrofluorometer
- Electronic nose
- Analytical and preparative HPLC
- Amino acid analyser
- LC-MS/MS
- Enzyme kinetics and mechanisms
- Proximate food analysis (microlevels)
- Toxicological data analysis
- Food safety evaluation
- Scanning electron microscope
- Texture measuring system

How to get on to your advantage

The Institute undertakes sponsored projects on specific problems of the industries, and strives to ensure timely delivery of solutions

BIOTECHNOLOGICAL VISTAS

Novel approaches

Biotechnologies offer entirely new and attractive options to food industries for value-added designer food products.

Interesting new possibilities

- Engineered functionally-improved proteins
- Natural colourants, flavours, additives and preservatives for quality products
- Modified fats for superior food products
- Engineered carbohydrates and enzymes
- Ensuring food safety by monitoring contaminants (microbial and chemical) and remedial measures
- Low calorie fats / Omega-3 fatty acid containing structured lipids / trans-free fats

Capabilities of CFTRI

- Recombinant DNA technology for molecular cloning and hyper-expression of food enzymes
- Metabolic engineering
- Tissue culture for high value plant products
- Modification of plant proteins and enzymes
- Evaluation of nutritional quality of custom-designed food products
- Safety and toxicological aspects
- Design and fabrication of food machinery
- Stabilisation of enzymes

Sophisticated facilities

- DNA sequencer
- Thermcycler (polymerase chain reaction)
- Tissue culture facility
- Scanning electron microscope
- Sophisticated analytical and preparative instrumentation for formulation and analysis of biotechnologically designed food products
- LC-MS/MS
- 500 MHz NMR
- Animal cell culture facility
- Genetically modified food referral facility

Achievements in view

Technologies in the pipeline for following products:

- Natural food colourants from plants and microalgae
- Pungent spice principles
- Steviosides
- Food Flavours
- Textured proteins
- Beta-carotene & Carotenoids
- Microbial transformation
- Neutraceuticals
- Structured lipids
- Fructooligosacharides
- Biosensors for tea polyphenols
- PCR based methods for food pathogens
- PHA
- Tissue culture techniques & Micropropagation

ANALYTICAL QUALITY TESTING

Meeting global Challenge

Customer Service Cell (CSC) of Food Safety and Analytical Quality Control Laboratory of CSIR-CFTRI is the nerve centre of analysis of food products for safety and quality. CSIR-CFTRI has been accredited by NABL under ISO 17025:2005 Quality Management System, with more than 300 tests under its scope and encompassing the analysis of a large variety of food raw materials, processed foods and also food packaging materials.

Professional Services Offered

Customer Service Cell is a Single Window System of CFTRI for interactions with the Customers for the Testing and Certification of their food products as per National/International Regulations such as PFA, BIS, Agmark, EU, US-FDA. CSC handles customer query on sample analysis, food regulations with reference to additives, contaminants and labelling. Strict confidentially is maintained in the business.

- Processed fruit and vegetable products
- Cereals and pulses
- Spices and condiments
- Dairy products
- Oils and fats
- Confectionery
- Beverages – alcoholic and non-alcoholic
- Packaged drinking water
- Packaging materials
- Neutraceuticals

Parameters Covered

- Nutritional composition
- Vitamins and minerals
- Fatty acid profile: saturated fats, MUFA, PUFA, and trans-fats
- Amino acid profile
- Dietary fibre & Cholesterol
- Contaminants: pesticide residues, aflatoxins and toxic metals
- Antibiotic residues
- Microbiological examination

Facilities

- Gas chromatograph with multiple detectors
- Atomic absorption spectrophotometer
- FTIR spectrophotometer
- Spectrophotometer (400 MHz, C,H)
- Scanning electron microscope
- Texture measuring system
- DNA sequencing system
- Scintiliation counter
- Automatic nitrogen analyzer
- Automatic fibre analyzer
- HPLC and GC-MS
- LC-MS/MS with ESI and MALDI-TOF

TECHNICAL SERVICES

A perennial source in technology service

The strong network of technical services at CSIR-CFTRI caters to the changing needs of food industry.

Technology transfer from concept to commissioning

Specially designed technology transfer packages through

- Identification of viable projects
- Licensing of intellectual property - patent / design
- Licensing of knowledgebase (know-how, process, technology)
- Consultancy services spectrum
- Preparation of project feasibility reports
- Project evaluation
- Market intelligence information for domestic and export markets

Contract research for product development

- User based R&D programmes
- Time-bound and result-oriented projects
- Exclusive technology rights for sponsors

Intellectual Property Portfolio

- Technologies patented in US, PCT and European countries for global competitiveness
- More than 1000 patents in food science and technology so far
- Legal protection for the technology

Timely solutions to your problems

Assistance that guarantees customized solutions :

- Technical troubleshooting
- Expansion and product diversification

Information and library services

- National Information Centre for Food Science and Technology (NICFOS) facilitate access to:
  - IFIS database
  - Food standards
  - Chemical abstracts
  - CSIR E-Journal consortium
- Information backup services to R&D
- Digital archives
- Open Public Access Catalogue (OPAC)

TRAINING PROFESSIONALS

Power to your manpower

Human resource with competence is the prime need of the industry today. CSIR-CFTRI, having a faculty of 200 experts in various fields, is an excellent centre for training professional manpower, all under one roof.

CSIR-CFTRI-trained technical personnel are occupying responsible positions in leading food industries. So far 8000 plus personnel from industries have been trained. More than 850 professionally trained degree holders and 450 Ph.Ds in advanced research are significant contributions to the nation from CSIR-CFTRI.

For your manpower needs

The national/international professional training programmes at CSIR-CFTRI include :

- Two year (four semesters) M.Sc. (Food Technology) course
- One year course in roller flour milling technology
- Doctoral/post-doctoral research in food science, food technology, biochemistry, bioscience, biotechnology, microbiology, chemistry, food engineering and other areas. Fellowships are offered by CSIR and similar scientific bodies
- Advanced food technology training under the United Nations University (UNU) for participants from developing countries
- Sponsored short-term advanced technology training programmes for sharpening the expertise and knowledge of personnel from food industries

Our programme and your advantages

The programmes assure :

- Enriching the scientific & technical knowledge
- Hands-on training
- Training the trainers
- Totally streamlined capability for conducting workshops/ seminars/symposia/conferences/colloquia/National and international conventions

Additional bonanza

- Strong and result-oriented linkages have been established with nodal agencies of the Government, FCI, Food & Nutrition Board, APEDA; Asian, African and Latin American nations; UN agencies like UNU, UNIDO, ESCAP, UNICEF, WHO, FAO, UNEP, UNCTAD, UNDP and SAARC.