# Central Food Technological Research Institute, Mysuru

**Ram Rajasekharan***

Central Food Technological Research Institute, Mysuru 570 020, India

**CSIR–CFTRI is one of the oldest CSIR laboratories that churns out several commercially viable technologies for the food industries and processing industries, apart from serving every humble home-maker with ready-to-eat and ready-to-serve technologies. This article focusses on some of our recent research findings in the area of GMO detection, phytoceuticals and food processing.**

**Keywords:** Food science, genetically modified organism, nutrition, phytoceuticals, processed food.

## About the institute

CSIR–Central Food Technological Research Institute (CFTRI), an NABL-accredited, ISO certified institution of CSIR, Government of India, is the only national food research institute in the country involved in innovative research in the area of food science and nutrition. The research programmes are inter-disciplinary in nature, and include value-addition to agri-resources, health foods and nutraceuticals, food testing and analysis, food processing, fruit and vegetable processing, food packaging, food preservation and post-harvest technologies, apart from basic research in biochemistry of proteins, carbohydrates and lipids, molecular nutrition, bioactives, spices and flavours. Besides publication and patent-oriented scientific research, the Institute is also aware of its social responsibility and has been working towards its commitment to the society.

## Traceability of GMOs in processed foods

It is known that PCR-mediated genetically modified organism (GMO) detection depends on the DNA quality, and detection of GMO in processed foods could be challenging since food processing can lead to degradation of DNA. Hence, the effect of various processing treatments such as heating, baking, microwaving, autoclaving and ultraviolet (UV) irradiation on the relative transgenic content of MON 810 maize was evaluated using pRSETMON-02, a dual-target plasmid as a model system. Amongst all the processing treatments examined, autoclaving and UV irradiation resulted in the least recovery of the transgenic (CaMV 35S promoter) and taxon-specific (zein) target DNA sequences. Although a profound impact on DNA degradation was observed during the various processing treatments, DNA could still be reliably quantified by real-time PCR. The results demonstrate that food processing may not alter the relative quantification of the transgenic content, provided the quantitative assays target short amplicons and the difference in the amplicon size between the transgenic and taxon-specific genes is minimal.

This model contributes to the accumulation of basic data necessary to consider implications of food processing on quantitative determination of GMO ingredients. It will enable the regulatory authorities and policy makers in India to take knowledge-based decisions and deal with scientific issues related to implementing the existing and forthcoming GMO-related legislation, ultimately facilitating monitoring and surveillance of the trans-boundary movement of GMOs. The approach adapted in this study is not only useful for tracing and quantifying GMOs in processed foods, but is also of valuable interest for any PCR-based diagnostics such as forensic science, identifying origin of species, food allergens, etc. that may be affected by DNA degradation.

## Yeast lipid regulation – a transcriptional approach

We have attempted to understand the actual mode of transcriptional regulation of yeast lipid metabolism. Some of the yeast gene deletions that have increased triglyceride content also expressed some lipid genes differentially. The key regulators of this expression have been identified and their binding to these genes has been confirmed and validated by gel shift assay (EMSA).

Some of the transcription factors that have been studied extensively are FKH1, PHO4 and IME4. These studies provide new insights into yeast lipid metabolism and its regulation in normal and nutrient-deprived conditions. The studies also led to the characterization of some unannotated yeast genes and their role in lipid metabolism.

Use of a eukaryotic model system like yeast to understand the regulation of lipid metabolism will help in

*e-mail: director@cftri.res.in

ascertaining the roles of the human homologs of these transcription factors.

### Alterations in chondroitin sulphate/dermatan sulphate in erythrocytes

Glycosaminoglycans (GAGs) such as chondroitin sulphate/dermatan sulphate (CS/DS) are complex molecules that are widely expressed on the cell membrane and extracellular matrix (ECM). They adhere to the erythrocytes and play an important role in a wide range of biological activities, especially during pathological conditions like diabetes. The present study was aimed at exploring the nature of GAGs present in erythrocytes and their role on adhesion of erythrocytes to major ECM components using control and diabetic rats. GAGs isolated from erythrocytes were demonstrated to be CS/DS and a two-fold increase was observed in erythrocytes from diabetic rats. Disaccharide composition analysis by HPLC after depolymerization by the enzyme chondroitinase ABC showed the presence of 4-O sulphated disaccharide units with small amounts of non-sulphated disaccharides, in both control and diabetic erythrocytes. Erythrocytes from diabetic rats, however, showed significantly increased binding to poly-L-ornithine (P-orn), type IV collagen, laminin and fibronectin, which was abrogated on treatment with chondroitinase ABC to various degrees. These studies have shown a novel role for CS/DS on erythrocytes and its possible role in diabetes-mediated atherosclerosis.

### Algal-mediated $CO_2$ sequestration

Seventeen microalgal strains were exposed to 20% v/v $CO_2$ to study $CO_2$ sequestration. *Chlorococcum* sp., *Scenedesmus dimorphus*, *Chlorella* sp., *Desmodesmus opolensis* and *Coelastrum asteroidum* exhibited higher $CO_2$ fixation rates up to 0.210 g $CO_2$/g biomass/day. The selected culture (CFTRI-1) was evaluated using experimental mini raceway ponds with $CO_2$ sparging arrangement. The results indicated enhancement in biomass content up to 15% in $CO_2$ sparged raceway pond. The culture has been acclimatized and scaled-up in outdoor open raceway ponds at 1000 L. Harvesting of the biomass using different coagulants was studied and chitosan was found to be most effective. The microalgal strains CFTRI-1 and CFTRI-3 exhibited high $CO_2$ tolerance with lipid accumulation up to 25%. The extraction of lipid from algal biomass indicated up to 88% recovery under optimized conditions. The selected microalgal species CFTRI-1 to CFTRI-4 were also tested with actual flue gas and the strains CFTRI-1 and CFTRI-3 showed high tolerance to flue gas along with high $CO_2$ sequestration potential. The algal remnants post-lipid extraction indicated favourable potential for biogas generation and as an adsorbent.

### Development of *nutra*-coconut oil rich in omega-3 and omega-6 fatty acids

Coconut oil is rich in saturated medium chain fatty acids, but lacks polyunsaturated fatty acids (PUFA) and bioactive phytoceuticals. *Nutra*-coconut oil (NCO) was prepared by blending coconut oil and flaxseed oil (70 : 30 v/v) with 3000 ppm extract of flaxseed cake, concentrated using ethanol, methanol and 20% aqueous ethanol. The different bioactive molecules in flaxseed concentrate based on maximum yield are polyphenols (39.04%), tocopherols (4.37%), $\beta$-carotene (2800 mg/100 g), antiradical activity (94%), ferulic acid (0.17 mg/g), *p*-coumaric acid (2.24 mg/g), chlorogenic acid (16.11 mg/g), gallic acid (8.58 mg/g), sinapic acid (0.64 mg/g) and secoisolariresinol (30.13 mg/g). The NCO was found to have polyphenols (2.86%), tocopherols (442.96 ppm), $\beta$-carotene (450 mg/100 ml) and antiradical activity of 85%. The PUFA content was found to increase in NCO from 2% to 22%. There was no significant difference in the physico-chemical properties of these oils. There was a significant ($P < 0.05$) increase of triunsaturated TAG content (0.83–6.86%) observed in NCO. The FTIR spectra of NCO revealed that the peaks at 3009 and 1651 $cm^{-1}$ were associated with the presence of unsaturated fatty acids. There was no significant ($P > 0.05$) difference in sensory attributes of snack food using coconut oil and NCO, indicating that the latter could be used as a frying medium.

The developed NCO is enriched with omega-6 and omega-3 fatty acids and bioactive phytoceuticals, which include sesamol, secoisolariceresinol and many other phenolic acids that are beneficial to health.

### Bioactive arabinoxylans from finger millet (*Eleusine coracana*) bran

Arabinoxylans, one of the major dietary fibre components are preponderant in cereal brans and pulse husks. They exhibit several health benefits in alleviating various disease symptoms such as diabetes, atherosclerosis and colon cancer. Arabinoxylans were sequentially extracted with saturated barium hydroxide (BE) and potassium hydroxide (KE) solutions from ragi bran. They consisted preponderantly of arabinose and xylose in different proportions (1.2 : 1.0 and 1.0 : 1.2 respectively). Further, sequential separations using different elution buffers on DEAE-cellulose column, gel filtration column, cellulose acetate membrane electrophoresis and capillary electrophoresis resulted in three fractions with an average molecular weight of 430, 1028 and 40 kDa. The structural

elucidation of the purified polysaccharides by NMR ($^{13}C$ and $^{1}H$) and FTIR, indicated the backbone to be 1,4-$\beta$-D-linked xylan with substitution mainly at O-2 or O-3 and/or both by $\alpha$-L-arabinose residues. In addition, uronic acid as well as phenolic acid residues were present in the side chain.

Mitogenic activity of purified arabinoxylans was carried out against splenocytes by MTT(3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) assay and their capacity to activate macrophages was analysed by quantifying the release of nitric oxide from murine peritoneal exudate cells (PECs), including phagocytosis. Purified arabinoxylans significantly stimulated proliferation of murine splenocytes and also elevated the level of nitric oxide production by peritoneal exudate cells (macrophages). Hence arabinoxylans can be considered as potent immunomodulators. Mitogenic activity of arabinoxylans is correlated with its bound phenolic acids as well as molecular weight, which are novel findings of the investigation.

## Extension of storage life of papaya

Papaya (*Carica papaya* L.) is a major popular dessert fruit of the tropical and subtropical regions, known for its fast growth and yield, with nutritional and biofunctional importance. The fruit is less acidic, sweet, rich in vitamins A and C, known for its exotic flavour and soluble fibre with many essential minerals. Annual Indian production is reported to be 3.9 million tonnes. Post-harvest losses are mainly attributed to mechanical damage, rapid flesh softening and decay. Using cactus mucilage as coating, ripening was retarded along with reduced softening; thereby shelf life was extended by approximately twofold at room temperature. The process is low-cost, organic, non-toxic, edible, biodegradable, eco-friendly, easily adaptable and most importantly, the raw material is waste-farm grown.

## Zerumbone crystals from shampoo ginger (*Zingiber zerumbet*)

Zerumbone is currently being explored for its effects on cancer in general, leukaemia in particular, as well as HIV. This invention provides an improved process for the preparation of Zerumbone crystals from shampoo ginger (*Z. zerumbet*). The method involves size reduction of the *zerumbet* ginger rhizomes, crushing, destarching, isolation of volatile oil by distillation and crystallization of zerumbone crystals. 'Zerumbone' is chemically a sesquiterpene.

Our facile process does not involve much heating, wherein raw *Z. zerumbet* ginger rhizomes were subjected to cleaning, size reduction, crushing, pressing, drying at air/low temperature, steam distillation, crystallization and filtration to obtain a bioactive compound, zerumbone. In this process starch and water solubles are removed in a single step from fresh rhizomes, which avoids drying of the rhizomes and channelling/clogging/foaming/bumping during distillation. Recovery of zerumbone crystals by this process is high compared to conventional methods. The by-products obtained, viz. starch and volatile oil are a good source of carbohydrates and antibacterial activity respectively. The process is amenable for scale-up.

## Introduction of new crops – 'changing the plate and palette of the common Indian'

In an attempt to improve the nutrition status of every Indian, and to overcome malnutrition, we have introduced two new crops, not common thus far in the Indian subcontinent, viz. chia from Mexico and quinoa from South America. While chia is the only known highest vegetarian source of omega-3 fatty acid ALA, quinoa is touted as the 'mother grain' with an enviable protein and fibre content coupled with a low glycemic load. After basic research on these crops, understanding and confirming their growing conditions in Indian soils, and after considerable work on developing a high-yielding chia variety, seeds of these crops were given free to farmers from across the country.

Since at present these seeds are being imported and sold at exorbitant prices, they have been earmarked only for the rich. Since it is the birthright of every Indian to have good nutrition, we have made the germ plasm available to all interested farmers and hope to see a revolution in the way food and nutrition is looked at in India.

This programme is getting an overwhelming response from the farming community. It is a moment of pride and satisfaction for CSIR–CFTRI in being able to stand by its commitment to the society.