

## NUTRITION

The National Institute of Nutrition (NIN), Food and Drug Toxicology Research Centre (FDTRC) and National Centre for Laboratory Animal Sciences at Hyderabad are engaged in studies on various aspects of nutrition *viz.* community studies, prevalence of nutrient deficiency disorders in tribal areas, clinical and basic studies in addition to food and drug toxicology studies. Periodical surveys by National Nutrition Monitoring Bureau (NNMB), development of low cost technologies for food fortification, transferring food fortification technologies to industries and government and to supply iodised salt and fortified foods to the community at an inexpensive cost through public distribution system are some of the efforts made by NIN in this direction.

### COMMUNITY STUDIES

#### National Nutrition Monitoring Bureau

In view of the emerging problem of diet related chronic degenerative diseases, the NNMB carried out studies on the assessment of the prevalence of obesity and hypertension among adults in the rural communities of 8 states in addition to the ongoing routine diet and nutrition assessment surveys. As per WHO cut-off levels for waist circumference, about 1% men and 7% women had abdominal obesity. Similarly, about 25% men and 69% women were found obese as per WHO criterion of waist/hip ratio. About 27% men and women had hypertension. About 4% men and 3% women in rural Andhra Pradesh were found having hyperglycemia.

Preliminary analysis of the dietary survey revealed that the average daily intake of the cereals and millets was less (412 g) than the recommended level (460g). The intake of proteins in the form of pulses and protective foods such as green leafy vegetables, milk and milk products was grossly inadequate. The median intake of all the nutrients in general was lower than the RDIs and as regards the intake of micronutrients such as iron, vitamin A, riboflavin and folic acid, it was grossly deficient.

The overall prevalence of underweight (weight for age < median – 2SD of NCHS standards) of 1-5 yr

age group was 55%, which was similar among boys and girls. The prevalence of stunting and wasting was about 52% and 14% respectively. About 34 % adult men and 37% women had chronic energy deficiency (CED: BMI <18.5). The prevalence of overweight and obesity was 8% and 11% respectively. About 54% adult men and 72% non-pregnant non-lactating women were found to be anaemic.

#### Nutrition Surveys in Tsunami affected Areas

Surveys were carried out to assess the diet and nutritional status of the tsunami affected communities living in rehabilitation centres in Andaman and Nicobar Islands. The study revealed that the food and nutrient intake of the households/individuals was in general less than the recommended levels. The average intake of various nutrients except proteins was less than the RDA. The intake of micronutrients such as iron, vitamin A, free folic acid and riboflavin was grossly inadequate.

The prevalence of vitamin A deficiency signs such as conjunctival xerosis among preschool children was 2.7%. The prevalence of underweight among preschool children was about 48%, while that of stunting and wasting was about 37% and 16% respectively. About 17% adult males and 19% adult females showed varying grades of CED. The prevalence of various forms of undernutrition was relatively high among the settlers compared to local Nicobarese population.

#### Prevalence of Iodine Deficiency Disorders in Tribals of Madhya Pradesh

The RMRC, Jabalpur conducted a study to assess the prevalence of iodine deficiency disorders (IDD) in school children of Baigachak area of district Dindori in M.P. The prevalence of goiter was found to be 20%. More than 87% school children were found to have low urinary iodine which is the most reliable indicator of IDD. Iodine was low in females (91.62%) as compared to males (83.5%). The results indicate that though the prevalence of IDD has decreased in M.P., iodine deficiency is still a public health problem in the study area.

## Nutrition Monitoring Survey in Jodhpur (Rajasthan)

Studies were conducted by DMRC, Jodhpur on a total of 28 villages from six *tehsils* covering 560 households. Socio-demographic and socio-economic information was recorded. All the members in the household were examined for nutritional deficiency signs, anthropometric measurements and dietary intake (24 h recall method) and history of nutritional morbidities in last 15 days was obtained. Dietary intakes of the individuals were recorded in alternate houses from each village. Protein calorie malnutrition (PCM) was higher in females compared to males. Undernutrition was very high in preschool children (81%) and was higher in SC and ST community (88 and 86%) compared to others (75%). Chronic energy deficiency in adults was observed to be higher in SC and ST community compared to others. Diet was grossly deficient in green leafy vegetables (GLV) followed by fats, pulses, legumes and other vegetables.

## Nutritional Status and Morbidity in Pregnant and Lactating Women in Rajasthan

Data from 10 villages of *Luni Panchayat Samiti* of Jodhpur *tehsil* covering 792 women comprising 174 pregnant, 286 lactating and 332 non pregnant and non lactating women was collected. Initial trends revealed high prevalence of iodine deficiency disorder in pregnant and lactating women (65-71 %). Consumption of normal iodized salt was very low. Severe anemia (12.9 %) was more in pregnant women. IDD and iron deficiency anaemia (IDA) were more prevalent in OBC and SC. IDA was higher in pregnant and lactating women (86%) as compared to controls (76.5%). Severe anaemia was high in pregnant women (13%) in comparison to controls (2.8%). IDA was more in OBC and SC (47.5% and 28.7%), illiterates (61.3%) and low income group (37.3%). Diet of pregnant and lactating women was highly deficient in protein, calories and iron.

## Nutritional Status of Dongria Kondh Tribe and Domb Scheduled Caste Populations of Orissa

Study has been carried out on nutritional status of *Dongria Kondh* primitive tribe and *Domb* scheduled caste populations of Orissa at RMRC, Bhubaneswar. The prevalence of underweight, stunting and wasting

was 69%, 62%, and 38% respectively among *Dongria* while it was relatively lower among *Domb* children. The prevalence of chronic energy deficiency (CED-BMI <18.5kg/m<sup>2</sup>) was about 60% for both *Dongria Kondh* and *Domb* populations, while about 30% and 10% were having below normal and normal BMI. Less than one percent of these populations were overweight or obese. Prevalence of grade III CED was greater in *Domb* (17.6%) compared to *Dongria* (13%) populations. About 10% adults were normal in both the study groups. The proportion of household salt samples having less than the recommended levels of iodine (<15 ppm) was 51.2% in the *Dongria Kondh* in comparison to 18.9% in the *Dombs*. The prevalence of anaemia was 86.4% and 76.9% among *Dongria Kondh* and *Domb* populations respectively.

## Intervention Study for Cholera, Intestinal Parasitism, Vitamin A deficiency and Scabies amongst Tribals of Orissa

A pilot study for cholera, intestinal parasitism, vitamin A deficiency and scabies amongst some primitive tribes of Orissa was undertaken by RMRC, Bhubaneswar in four identified primitive tribes *viz.* *Bondo*, *Didayi*, *Kondha* and *Juanga* residing in different geographical areas of Orissa. Findings revealed *V. cholerae* in 12.6%, *E. coli* in 40.5%, *Salmonella* spp. in 1% and *Shigella* spp. in 54% of the cases. A suitable intervention in the form of drugs, oral rehydration solution (ORS) and community awareness programme was undertaken. The rectal swab analysis showed a remarkable decline in *V. cholerae*. The prevalence of vitamin A deficiency in the form of Bitot's spot and night blindness among preschool (0-5 yr) and school going children (6-14 yr) reduced after intervention from 7.2% to 4.8% during follow up. A follow up examination of patients of scabies after appropriate intervention (both drug intervention and IEC) revealed that the disease has reduced from 20.3% to 9.5% in *Bondo*, 12.5% to 6.8% in *Didayi*, 14.8% to 8.6% in *Juanga* and 14.2% to 7.8% in *Kandha* population.

## CLINICAL STUDIES

### Effect of Supplementation of Micronutrients in Pregnant Women

A study was initiated to evaluate the effect of iron supplementation to pregnant women on haemoglobin

status and pregnancy outcomes. The data obtained from 600 pregnant women showed that the prevalence of anaemia was severe in early pregnancy (8% women) and late pregnancy (17.4% women).

Prevalence of intrauterine growth retardation (IUGR) and low birth weight is very high in India. A study was planned to measure body composition of newborn babies and relate it with maternal and cord blood trace element status. Two hundred newborns have been recruited and the study is in progress.

### **Clinical Trials of Protein/Zinc Supplementation to Full Term Infants**

Several studies have demonstrated body fat to be high among children who were undernourished in young age and rehabilitated at later age. A study was initiated in the nutrition ward at Niloufer hospital to study the effect of varying degrees of protein supplementation in severely malnourished children on their recovery and body composition. Thirty-six children (mean age 28.1 months) were followed up for one month and the interim analysis of data was carried out. Mean calorie intake at home before admission was 842 cal / day which increased to 1540 cal / day at the time of discharge (30<sup>th</sup> day after admission). Mean weight of the children increased from 6.2 to 7.7 kg, by 30 days and body fat percentage also increased from 6.8% to 13.46%. In absolute terms, the total weight gain was 1433 gm in 30 days. The weight gain contributed by fat tissue was 41.2% and fat free mass contributed 843 gm. Mid arm circumference also increased significantly from 9.8 cm to 11.6 cm.

Undernutrition and stunting are major public health problems among preschool children in India. A study was undertaken to assess the effect of supplemental zinc (5mg/day) on the growth, body composition, respiratory and diarrhoeal morbidities in infants. In 475 children (males 18.7% and females 26.4%), of which 22% were low birth weight (LBW) babies, Zn supplementation was given after randomization. All the anthropometric measurements were significantly low among LBW babies at all ages and significantly higher in boys at all ages as compared to NNMB data. Based on NCHS standards among infants with birth weights more than 2500 g (2 score classification), 10.2% and 19.6% were stunted at 12 and 18 months of age. Similarly, 35.1% and 45.5% were underweight at 12 and 18 months of age respectively.

### **Prevalence of Osteoporosis in Adult Population in India**

Preliminary results of the study indicated that the peak bone mass of the young adults from high-income group was comparable to the Western standards. Bone densities in adults were related to the intake of calcium, body weights and socio-economic status. High prevalence of osteoporosis was observed in the low-income groups. In addition, a study on pregnancy related changes in bone mass in women from low socioeconomic group was taken up to assess the extent to which bone mineral mobilization occurs in them. In addition, a study was initiated to assess the effect of overweight and obesity on the development of peak bone mass in 64 men and 36 women (age 20–35 yr) from high socioeconomic group. Their DEXA scans were generated at 3 sites *viz.*, hip, spine, forearm and whole body. Studies are in progress.

### **BASIC STUDIES**

#### **Establishment of Screening Method for Micronutrient Bioavailability**

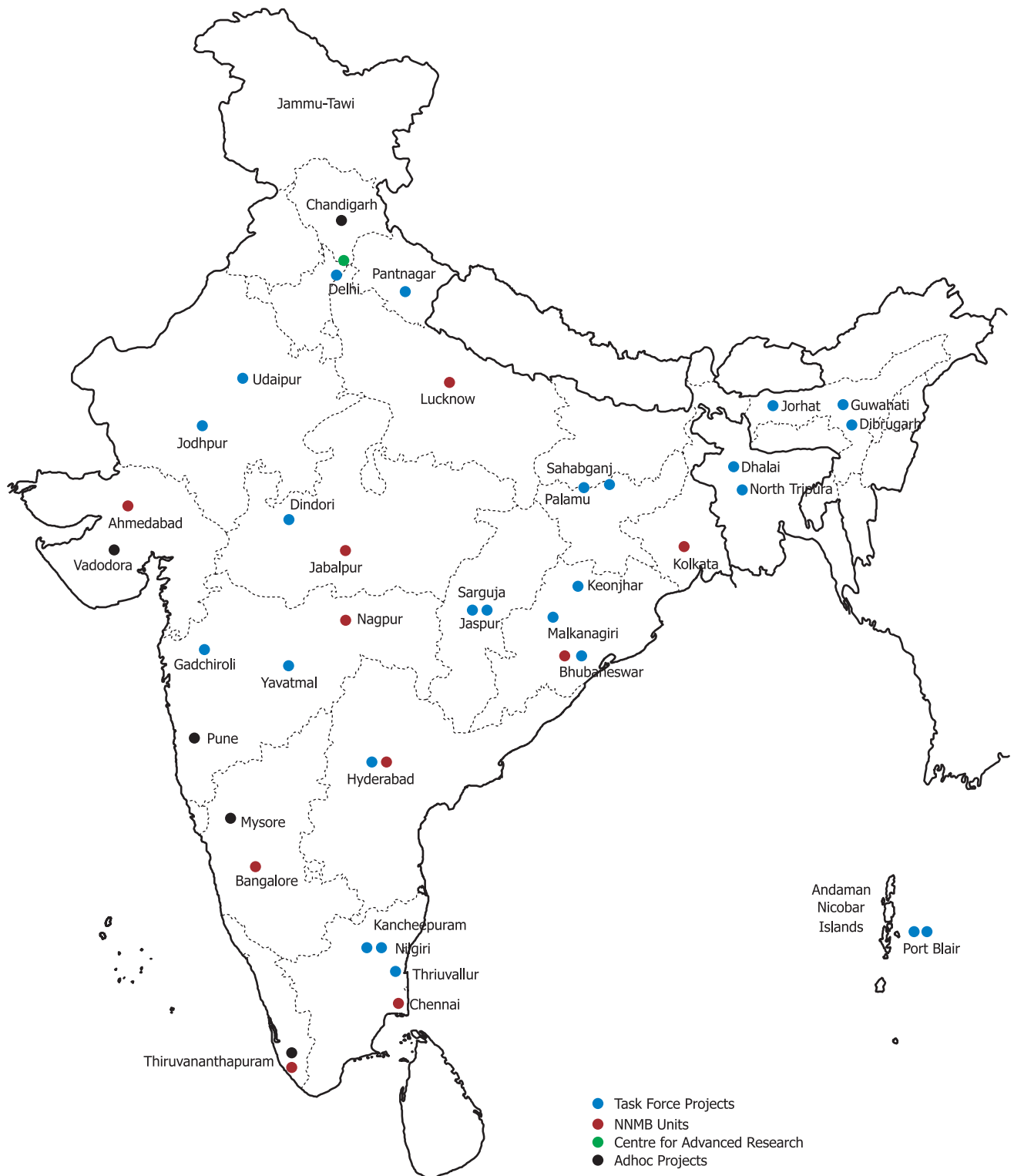
A state-of-the-art Caco-2 cell culture facility was established for the analysis of iron and zinc bioavailability under DBT's Crop-biofortification networking programme. The facility provides scientific and technical services for assessing bioavailability of micronutrients such as iron and zinc in staple foods.

#### **Country Investment Plan/Food Fortification**

The NIN has established a private-public partnership in food fortification of whole wheat flour with iron, folic acid and vitamin A and provided technical support in operationalizing Vijaya micronutrient fortified wheat flour, which is distributed through public distribution system (PDS) in two districts, *viz.* Ranga Reddy and Warangal on a pilot basis.

#### **Double Fortified Salt (DFS)**

Studies on the stability of iodine in DFS, which was developed as per the NIN's technology, showed the stability of iodine for more than 12 months with very little loss. The study also demonstrated that a modified method for iodine is essential for consistent and accurate estimation of iodine in DFS. Efforts are on to provide DFS through PDS at an affordable price in order



**MAJOR ICMR RESEARCH PROJECTS IN NUTRITION**

to make it easily accessible to the people belonging to low socioeconomic strata.

As part of research relevant to the community and also to meet the social obligation, the Institute provided low-cost technology know-how under technology transfer programme to an Industry of Andhra Pradesh Government for the production of quality iodized salt. As a result of technology transfer, quality iodized salt was made available for the public from June, 2006. through PDS in Andhra Pradesh @ Rs. 3.00 – 4.00 per kg.

## DIETARY FATS

### Role of Dietary n-3 PUFA or Trans Fatty Acids in Foetal Programming of Insulin Resistance in Rats

Nutritional deprivations/imbalances *in utero* alter physiology and metabolism of developing tissues/organs postnatally and increase the risk of chronic adult diseases. Long chain polyunsaturated fatty acids (LC PUFA) are integral components of cell membranes and are important determinants of foetal growth and development. Docosahexaenoic acid is one of the abundant fatty acids present in brain, other neural tissues and the retina. Earlier studies indicated that increasing  $\alpha$ -linolenic acid (18:3n-3, vegetable oil) or LCn-3 PUFA (fish oil) while keeping total PUFA constant in the diet, increased insulin sensitivity in target tissues of sucrose-induced insulin resistant rats. On the other hand, trans fatty acids (TFA) from Indian *vanaspati* decreased insulin sensitivity. Study was designed to evaluate the role of dietary fatty acids (TFA or 18:3n-3 or LCn-3 PUFA) in foetal programming of insulin resistance. The results showed that maternal n-3 PUFA or TFA did not alter insulin sensitivity in the offspring up to 100 days of postnatal life.

### Effect of Sesame Lignans on Oxidative Stability of Edible Vegetable Oils

Tocopherols in oils are protective against oxidative deterioration during storage. However, to prevent thermo-oxidative degradation of oils due to deep-frying at high temperatures, addition of more efficient antioxidants is needed. Though, PFA (Prevention of Food Adulteration Act) approved antioxidants are added at permissible levels to edible

oils and food products, at higher concentrations these synthetic antioxidants are toxic. In view of this there is a need to identify novel, natural components of foods with radical scavenging and antioxidant activity.

Lignans of sesame (*Sesame indicum*) seeds were isolated and tested for their effects on thermal / storage (at 180°C or 60 days at room temperature), stability of edible (soyabean-SBO, sunflower-SFO, rice bran-RBO and palmolein-POL) oils. The study included i) determining total free radical scavenging activity (RSA) using 2, '2', diphenyl picryl hydrazine (DPPH) ii) total free tocol content iii) lignan profile iv) PUFA composition. The order of the RSA of oils before heating was as follows: RBO=SBO>SFO>PO. Addition of 1.2-% lignans to SBO or POL increased percent retention of total tocols at the end of 120 min of heating. Heating of oils (at 180-200°C) increased sesamol and decreased sesamol, while sesamin was relatively resistant to heat. These results suggest that sesame ligands may have potential applications as natural antioxidants for the thermal stabilization of edible vegetable oils.

### Effect of Maternal Dietary Trace Element Restriction on Body Adiposity and Insulin Resistance in the Offspring

Studies on maternal magnesium restriction in WNIN rats showed an irreversible increase in the body fat % in the offspring by three months of age and also induced insulin resistance at 6 months. While the increased body adiposity, decreased lean body mass, fat free mass and reduced insulin response to glucose challenge persisted till 18 months of age in magnesium restricted offspring, insulin resistance observed in them at 6 months of age did not persist at later time points.

Although glucose tolerance and insulin sensitivity / resistance were comparable among the offspring of different groups at all the time points studied, pups born to Zn restricted mothers rehabilitated from birth or weaning had higher body adiposity (in males) and decreased insulin secretion (in females) compared to controls. However, changes seen at 3 – 6 months of age were transient in nature and no differences were observed among different groups of offspring at later time points. Adiposity changes were seen only in the males, whereas changes in insulin secretion were apparent in females born to Zn restricted mothers.

Feeding chromium-restricted diet for 3 months did not affect the body weight gain, glucose tolerance, insulin resistance and lipid profile parameters in WNIN female rats. Cr restriction *per se* had no adverse effect on the reproductive performance of the rats even when continued through pregnancy or supplemented from conception. The studies are in progress.

## DEGENERATIVE DISEASES

### MOLECULAR BIOLOGY

Dietary and lifestyle changes result in an unprecedented rise in obesity and insulin resistance. Using rat model, the role of dietary saturated fatty acids and trans fatty acids in inducing insulin resistance was demonstrated. Clustering of type II diabetes in certain families and analysis of ethnic populations indicate a strong genetic background of the disease albeit indirectly. The etiology of type 2 diabetes (T2DM) is multifactorial and studies indicated a major role of the genetic factors. Study was initiated to assess the role of polymorphism within PPAR $\gamma$ , ADRB 3, resistin and adiponectin genes in developing T2DM in Indian population.

### PHYSIOLOGICALLY ACTIVE NON-NUTRIENTS IN FOODS

#### Phenolic Content and Anti-oxidant Activity of Plant Foods :Vegetables and Fruits (including Dry Fruits)

Plant derived anti-oxidants such as flavonoids and related phenolics are considered powerful anti-oxidants. There is inverse relationship between fruit and vegetable intake and risk of degenerative diseases. Efforts are on to generate a database on the commonly consumed anti-oxidant plant foods of India and the contribution of the phenolic content to their anti-oxidant activity (AOA). The total phenolic content and AOA of some commonly consumed green leafy vegetables and fruits (including dry fruits) was determined.

Among green leafy vegetables, *Raphanus sativus* (raddish greens) and spinach had the highest and lowest amounts of phenolics respectively. Diphenyl picryl hydrazyl (DPPH) scavenging activity was the highest in fenugreek and the least in *gori methi* leaves. Mint

had the highest and *Moringa oleifera* lowest reducing power, while iron chelating activity was the highest in *Basella rubra* and the least in mint.

Among fresh fruits, black grapes had the highest and watermelon the lowest phenolic content while tomato had the highest reducing power and iron chelating ability. Red guava had the highest DPPH radical scavenging activity while lemon, fig and passion fruit had the least DPPH chelating ability and reducing power.

Among the dry fruits studied, walnuts had the highest anti-oxidant activity while cashew nuts, almonds and pial seeds had the lowest activity.

#### Development of Recipes Rich in Anti-oxidant Activity and Their Acute Effects

Seventeen AOA rich recipes (salads) based on green gram and bengal gram sprouts were developed. Addition of some vegetables decreased the AOA of the recipe while some of them did not affect it. It was found that addition of lemon juice, pepper and salt did not decrease the AOA of legume sprouts and the AOA of these salad recipes was higher than that of sprouted legumes. All the recipes were accepted reasonably well by human volunteers.

The consumption of these salad recipes had acute effects in apparently healthy adult, male human volunteers. Although they did not affect the oxidative stress (plasma thio barbituric acid - TBAR) in the subjects, they prevented the time dependent deterioration of the antioxidant activity (ferric reducing antioxidant power : FRAP) of their blood plasma on consumption of white bread. Also, they appeared to protect the plasma against exogenously induced oxidation *in vitro* with copper sulphate.

### STUDIES ON STEM CELLS

#### Nestin Positive cells/Pancreatic Progenitors

The islets isolated from adult mice were cultured for 48 h and subsequently overlaid onto matrigel to study the proliferation of nestin positive cells (NPC). The serum free medium consisted of combination of epidermal and fibroblast growth factors to promote the differentiation of progenitors. The results showed an appreciable number of immunospecific NPC (20-30%)

within a week of culture as compared to the direct seeding the islets on to the matrigel (5-10%). The confluency of the cultures was of greater magnitude by 2 weeks (50%).

### Immunolocalization of NPC

NPC were studied in different age groups of mice (3 d, 1 wk, 2 wk, 4 wk old and adult). To understand the localization profile of the NPC between exocrine vs endocrine fraction of the pancreatic tissue. NPC positive cells were present both in exocrine and endocrine fractions of the tissue. However, immunolocalization was more diffused in the lower age groups such as 3 d and 1 wk as compared to 6 wk. Distinct presence in both exocrine and endocrine tissue of the 6 wk adult mice was observed suggesting that pancreatic exocrine fraction can also be explored as the source of insulin secreting cells.

## CATARACT AND RETINAL DEGENERATION

### Expression of $\alpha$ -Crystallins under Pathological Conditions

Studies have been initiated to understand the expression of small heat shock protein,  $\alpha$ -crystallins, under various pathological conditions such as diabetes, cancer and nutritional deficiencies. Elevated expression of  $\alpha$ -crystallin in various diabetic tissues was reported for the first time.

### Role of Functional Foods and Nutraceuticals in Degenerative Conditions

Aldehyde reductase inhibitors (ARIs), antiglycating agents and antioxidants may ameliorate the eye complications in diabetes. Preliminary screening and *ex vivo* lens organ culture studies suggest that tannoids of *amla* have significant aldehyde reductase inhibitory potential. A few dietary agents are found to be effective in preventing protein glycation *in vitro*. Studies are in progress to understand the mechanism of inhibition and to understand their effect in animal models.

## FOOD AND DRUG TOXICOLOGY

### FOOD SAFETY

The Government of India has initiated projects to create awareness on food safety and strengthen food

safety monitoring system in India. The Ministry of Health and Family Welfare has identified NIN as the nodal centre to conduct a country survey.

A project on utilization of detoxified moldy sorghum using lactobacillus is in progress. A DST sponsored project on genotoxicological effects of pesticides in agricultural workers in Guntur district is being carried out to assess the toxic effect in occupationally exposed farmers.

Fluorosis is one of the major public health problem. Animal models to demonstrate the mitigating effects of divalent cations (magnesium, calcium) in fluoride-induced toxicity have been developed.

Detoxification of mycotoxins by lactic acid bacteria isolated from fermented *Sorghum* and *Cassia tora* was initiated based on earlier findings of reduction in mycotoxins by natural fermentation of mouldy sorghum with *Cassia tora* seeds.

## DRUG TOXICOLOGY

Non-nutrients in diet play an important role in prevention and management of chronic diseases. The antimutagenic properties of commonly consumed spices/condiments like turmeric, garlic and mustard have been demonstrated in animal and human studies. The results suggest their possible use as chemopreventers.

Ginger is widely consumed and known to possess anti-inflammatory properties. Experiments *in vivo* and *in vitro* showed antigenotoxic properties of the garlic.

Toxicity due to environmental lead exposure was investigated in pregnant women and children. Socioeconomic and nutritional status was correlated with lead toxicity.

## OTHER STUDIES

### Studies on Mutant Obese Rats

A DNA primer sequence OBP specific for GR-Ob strain was obtained last year. However, expression studies using the cloned PCR product did not show any difference between the parental WNIN and the GR-Ob mutant rat indicating that the cloned region was not unique to GR-Ob strain. With respect to microsatellite markers, a new set of 33 markers was attempted and out of these 17 markers showed amplification. Among the 17 markers, four showed inter and intra strain variations.

## Studies on Growth Parameters in Various Strains of Rats

Studies on baseline data of six different rat strains maintained at the Centre showed differences between them in terms of growth rate, total as well as percentage of body fat, lean body mass, day and night time activities and clinical chemistry parameters like glucose, triglyceride and total cholesterol. Growth rate was maximum in Sprague Dawley rats, which also showed higher total body fat, sodium and potassium. Among the strains body weight was lowest for Fischer 344N. The WNIN strain maintained for the last 84 yr in the NIN and at NCLAS has the highest percentage of body fat, lowest night time activity, increased resting time and increased plasma triglyceride. Both systolic and diastolic blood pressures were more in males than in females. In male rats, CFY strain had highest blood pressure followed by WNIN, WKY, F-344, Holtzman and Sprague Dawley in that order. However, in females the order was Holtzman, F-344, WNIN, CFY, WKY and SD. Heart rate was highest in WNIN rats followed by CFY, WKY, Holtzman, SD and F-344 rats.

## Isolation, Characterization and Maintenance of Primary Cultures of Pancreatic Islet Cells from NIN Wistar Mutant Obese Rats

WNIN Ob/Ob mutant obese rats showed euglycemic and Gr/Ob obese rats showed hyperglycemic response after intraperitoneal glucose injection. WNIN Ob/Ob mutant obese (Ob/Ob, Gr/Ob) and lean rats demonstrated immunolocalisation of insulin using DAB-HRP conjugate. The ultrastructure of islets isolated from three phenotypes has been characterized by scanning and transmission electron microscopy.

## NUTRITION EDUCATION

### Development of Communication Strategies to Improve Nutrition and Health related Knowledge of NSS Volunteers

Nutrition education is an important tool to bring awareness about good nutrition practices among the public. In the present education system students are exposed to nutrition related information to some extent

as part of their curriculum, mostly only up to high school level. Apart from the curriculum, mass media and interpersonal communication are the other sources available for the students to obtain information on health and nutrition. The National Service Scheme (NSS) is one of the major programmes run by the Ministry of Human Resource Development, to train and encourage the college going youth to take up some community welfare program. The NSS student volunteers spend about 120 h per year to carry out various social service activities in community level. It is important to impart nutrition information among the NSS volunteers. Hence, NSS volunteers (degree level) were selected as respondents.

One set of colour folders was developed on different nutritional themes such as energy, protein, vitamins and minerals, fat, nutrition during adolescent age, nutrition during pregnancy, and obesity. The folders were used in the first intervention while for the second intervention a CD with a folksong was developed on the nutritional themes, which are already identified. It is proposed to educate the women of reproductive age group (18-45 yr) about the importance of micronutrients like iron, vitamin A, and iodine. In addition, a colour flipchart was developed.

### Food Consumption Pattern of NSS Volunteers

Analysis of the data indicated that 50.3% of the NSS volunteers reported regular intake of meals and 20% of them reported to have the habit of consuming snacks between the meals. As regards the cereal intake 75% of them were consuming more than 1 cereal and remaining 25 % of them were consuming only rice as the staple diet. Regarding the intake of pulses, 33% of them were not consuming pulses daily. Most of them belong to agricultural family. Only 50% of them consumed milk and milk products daily.

The daily intake of fruits, vegetables and green leafy vegetables (GLV) was minimum. Only 9% of the NSS volunteers reported consumption of GLV daily while another 9% volunteers did not consume them. About 54% of them consumed GLV weekly twice. Similarly 49% consumed fruits twice a week and 21% never had fruit. Regarding the processed food intake the results indicated that 20% of them consumed

processed food weekly twice and 40% of them consumed aerated cool drinks once a week.

### **Nutrition Knowledge Improvement Levels of NSS Volunteers**

The knowledge levels were significantly different among the students of rural, urban and district headquarters. Significant improvement in nutrition knowledge levels was seen before and after intervention in all the three areas. A subgroup analysis of the data (district head quarters) indicates that increment in nutrition knowledge scores was significantly different between experimental and control group. Better nutrition education and suitable communication materials will improve the nutrition knowledge and food consumption practices of NSS volunteers of degree colleges. Since the NSS volunteers are involved in community education programmes, educating the students may help to educate the community on health and nutrition aspects.

### **Nutrition Knowledge and Impact of Nutrition Education on Adolescent Girls**

Maternal nutrition plays an important role in the development of foetus and the outcome of pregnancy. Poor nutritional status and lack of awareness of the nutrition during pregnancy and lactation among the low body weight expectant mothers in urban slums result in delivering low birth weight babies and other complications during delivery.

Analysis of baseline data revealed that 68% of adolescent girls were not aware of the physical and physiological changes that take place during the adolescent phase. With regard to the knowledge levels of breast feeding practices and complementary feeding, 81% girls expressed lack of awareness of the health benefits of mother's milk/colostrum while 77% mentioned lack of awareness about the food groups and balanced diet. With regard to the importance of micronutrients during the adolescent stage and pregnancy, 96% girls mentioned lack of awareness of the health benefits of vitamin A, 71% were unaware of the causes and consequences of anaemia, 92% had no knowledge of importance of iodine and iodine deficiency disorders and 74% were not aware of the causes of goitre.

Regarding the family life education, 95% adolescent girls indicated lack of awareness about the importance of nutritious diet and nutrients for women before marriage and 71% girls indicated that they were not explained about the various aspects of sex. As regards the exposure of these adolescent girls to information, education and communication (IEC) strategies to educate on the above themes, about 85% of the girls expressed that they were not given proper exposure to the educational outreach activities using different IEC methods by any organization. Based on the analysis of the data, 8 communication materials are being developed in order to use them for intervention.

### **Study of Nutritional Factors responsible for Positive Deviance in Child Nutrition in a Rural Setting**

The positive deviance (PD) approach is a strategy that identifies factors which enable some children to thrive in harsh environments. PD refers to the ability of some caretakers to encounter successful practices that enable them to raise well-nourished children in communities where there is poverty and malnutrition. It is an extremely practical approach, which may be applied to any field of child development. Studying what positive deviant families are doing, makes it possible for the community members to know that local solutions exist (certain foods, methods of feeding, health practices) and would convince them to search for these solutions in their own communities. In Bangladesh, a study had shown that family dietary habits, hygiene and psychosocial interaction had far greater impact on child nutrition than income. The positive deviance methods of enquiry have been tried in different countries like Bangladesh, Bolivia, Vietnam, Nepal and Bhutan.

In India there have not been extensive studies on the nutritional factors contributing to positive deviance among children. Hence, an investigation was initiated to identify the nutritional factors responsible for positive deviance. As part of the study, household survey for collection of data on the determinants (exclusive breast feeding, caregiving and health seeking behaviour of positive deviance from the mothers of children who were identified as positive (70 children) and negative (70 children) was undertaken from villages around Ibrahimpatnam rural ICDS Centres.