DOCUMENTATION, VALUEARIZATION AND PROMOTION OF UNDERUTILIZED FOODS FOR NUTRITION SECURITY OF SCHOOL CHILDREN

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C E R T I F I C A T E

This is to certify that the thesis entitled **DOCUMENTATION, VALUEARIZATION AND PROMOTION OF UNDERUTILIZED FOODS FOR NUTRITION SECURITY OF SCHOOL CHILDREN"**, submitted by **Miss. LATA R. KULKARNI** for the degree of **DOCTOR OF PHILOSOPHY** in **FOODS AND NUTRITION,** from the University of Agricultural Sciences, Dharwad, is a record of bonafide research work done by her during the period of her study in this University, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

Dharwad,
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Affectionately

Dedicated to

my father

Late Sri. R.N. Kulkarni

and my mother

Smt. Sulochana R. Kulkarni

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INTRODUCTION

I INTRODUCTION

"We the Ministers and Plenipotentiaries representing 159 nations, declare our determination to eliminate hunger and to reduce all forms of malnutrition. Hunger and malnutrition are unacceptable in a world that has both knowledge and the resources to end this human catastrophe".

These are the opening sentences of the World Declaration on Nutrition produced by the Food and Agriculture Organization (FAO) and World Health Organization (WHO) International Conference on Nutrition (ICN) held in Rome in December 1992.

Access to adequate food, which is one of the fore-most basic needs of life should be the birth right of every single human being on this earth. In its part, mother nature has provided this unique planet of ours with such abundant resources, and human beings with such intelligence that the global production can easily feed the present and future population of this entire world. Yet, the way human society has got organised, one fifth of the population of the developing countries ie., about 780 million people -20 per cent of their combined population still do not have access to enough food to meet their basic daily needs and suffer from chronic undernutrition (Anon, 1992).Many of them come at the threshold of starvation and one or two poor harvest can push them into the jaws of death.

There is a high prevalence and increasing numbers of malnourished children under five years of age in parts of Africa, Asia and Latin America and the Caribbean. Moreover, more than 2000 million people mostly women and children are deficient in one or more micronutrients, babies continue to be born mentally retarded as a result of iodine deficiency, children go blind and die of vitamin A deficiency and enormous number of women and children are adversely affected by iron deficiency. Hundreds of millions of people also

suffer from communicable and non-communicable diseases caused by contaminated food and water. At the same time, chronic non-communicable diseases related to excessive or unbalanced dietary intakes often lead to premature deaths in both developed and developing countries.

Protein Energy Malnutrition (PEM), Vitamin A Deficiency, Iodine Deficiency Disorder (IDD) and Nutritional Anaemia – mainly resulting from iron deficiency or iron losses are the most common serious nutritional problems in almost all countries of developing continents. The WHO report (Anon, 1995) suggest that one in every five persons in the developing world is chronically undernourished, 192 million children suffer from PEM and over 2000 million experience malnutrient deficiencies. These chronically undernourished million are trapped in a vicious cycle not getting adequate food regularly and therefore, not being able to lead a healthy and active life and without such a life, not being able to either produce or procure required food. Added to this crucial condition many more millions are mildly and moderately undernourished, under exhibiting clinically. In lay man's language all these millions can be said to be food insecure and others can be said to be enjoying food security.

The specific term **'food security'** is a recent origin, although in some form or other, adequate availability of food must have been one of the most primary concerns of the humans. Since time immemorial in recent years most of the experts like to define food security as an access by all people at all times to enough food for a healthy life. It was FAO committee on World Food Security which in a way, formalised the definition in 1983 and incorporated following three specific goals for food security i) ensuring adequacy of food supplies, ii) maximizing stability of supplies and iii) securing access to available supplies to all who need them.

The World Bank position paper on poverty and hunger (Anon, 1986) added an **"active level"** concept to these goals, stating that "food security

must assure access by all people at all times to enough food for an active and healthy life". In turn, food in security is defined as the lack of access to enough food for a healthy, active life style. It is now being increasingly appreciated that food security is primarily a matter of ensuring effective demand rather than a problem relating to food supply with such realisation, inter-relationship between poverty and hunger. Food security is gaining international recognition and serious attempts are being made to define and identify people at risk. It is therefore, important that every household should either have capacity to produce adequate food or have capacity to purchase the food for its family. This is a function of either production fluctuation or price fluctuation or both; These two fluctuations lead directly to a fluctuation in real income within the community. These fluctuation in real income, both direct and indirect affect the farmer, the agricultural labourers as well as other members of the society, will ultimately have an impact on household food consumption, that of the poorer householder being particularly sensitive (Alberto Valde, 1981). It is therefore, necessary to combat such fluctuations in order to ensure and maintain food security for which the country must hold highly liquid assets, either in shape of food stocks or monetary investments. Attaining food security is therefore a costly affair and this is why we find rich countries being food secure at any cost and poor ones food insecure.

It will be clear from the above that although national food security is important on providing a foundation, in the ultimate analysis what is more important is food security for each and every household and within it to every member of the family. Thus at household level, food security is defined as access to food that is adequate in terms of quality, quantity, safety and cultural acceptability for all household members (Gillespie and Mason, 1991).

Therefore, malnutrition or undesirable physical or disease conditions related to nutrition can be caused by eating too little, too much or an

unbalanced diet, which does not contain all nutrients necessary for better utilization of available nutrients for optimal nutritional status. Inadequate dietary intake and diseases particularly infection are immediate causes of malnutrition. It is obvious that such person must eat an adequate amount of good quality and safe food throughout the year to meet all nutritional needs for body maintenance, work and recreations and for growth and development in children. Similarly, one must be able to digest, absorb and utilize the food and nutrients effectively. Poor diets and diseases are often the result of insufficient household food security, in appropriate care and feeding practices and inadequate health care.

Thus in order to combat existing malnutrition, deficiency in particular and to have food and nutrition security, several strategies were suggested by Gopalan (2003). They include i) increase in agricultural production ii) population control, iii) utilization of available resources iv) basic health security, safe water supply and personal hygiene vl child feeding practices vi) economic improvement and vii) improving income generating vocational skills. Nevertheless, one of the strategies identified was also includes use of underutilized foods for nutrition security.

Plant wealth of about 80,000 species have been used by human beings for food, fiber, industrial, cultural and medicinal purposes. Of them, 30,000 species have so far been identified as edible and about 7,000 species have been cultivated and/or collected for food at one time or the other (Wilson, 1992). Only 30 crops are reported to feed the world, of which 10 crops provide 75 per cent of the total plant derived energy intake and only 3 crops *viz.*, rice, wheat and maize provide 60 per cent of the total food requirement. The underutilized plants, grown for centuries by the tribal and mountain people, play a harmonizing role of men with nature and perfectly match with the traditional food habits and lifestyles, socio-cultural and religious ethics. These are rich in

some of the essential amino acids, which are available only in animal protein, thereby enriching nutritionally the diet of vegetarian people.

But most of the world's food today comes from a mere 20 to 50 plant species. Throughout history man kind has used some 3000 plant species for food, but over the centuries the tendency has been to concentrate on fewer and fewer. The rejection of lesser known food crops has not been due to any inherent inferiority, many have been overlooked merely because they are native to the tropics, a region generally neglected because the worlds research resources are concentrated in the temperate zone. Others are neglected because they are scored as "poor people's plants" and other reasons to state are modernization, westernization, irrigation facilities which made farmers to shift there cropping pattern and lack of awareness regarding the importance of these underutilized foods and lack of processing technologies.

In general, these underutilized foods are rich sources of minerals and vitamins, inexpensive, easily available, can adopt to different agroclimatic condition, may not need the inorganic fertilizer and plant protection chemicals for the growth and are organically safe. As these underutilized foods are regional bound, there is an urgent need to document systemically the available foods and investigate the nutritional benefits. Thus the present study was attempted in this direction with the following objectives.

1. To document the underutilized foods available in the different agroclimatic zones of Northern Karnataka.
2. To investigate the dietary and nutrient profile of selected families.
3. To screen the nutritional composition of selected underutilized foods.
4. To explore the utility of selected foods to enrich the routine diets for nutrition security.
5. To develop Ready To Eat (RTE) snacks based on underutilized foods in terms of sensory attributes and shelf life.
6. To evaluate the efficacy of developed products for nutrition security in school children

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

India is a country, which is blessed with different agroclimatic regions, which enables to grow different types of crops. However, present nutritional situation is alarming in the country because 36 per cent of children affected with malnutrition in the world are Indians. Anaemia is prevalent in 60 per cent of our children and one third children are born underweight in India which is maximum in the world. Nearly 20,000 children become blind every year due to vitamin A deficiency. So, the food based dietary diversification approach is one of the sustainable strategies to combat malnutrition. Thus, there are many plant species which are nutritious but are not utilized to the extent it should be used due to lack of documentation, popularization and also lack of knowledge about the nutritive profile of these foods. The relevant references related to above aspects are critically reviewed in this section.

2.1 PREVALENCE OF MALNUTRITION

The prevalence of malnutrition at global level and in India are discussed here under.

2.1.1 Global prevalence of malnutrition

"Malnutrition kills, maims, and disables" : Malnutrition in its many forms persist in virtually all countries of the world in spite of a general improvement in food supply and health conditions and the increased availability of educational and social services.

An estimated 174 million under five children in the developing world are malnourished as indicated by low weight for age, and 230 million are stunted. Malnutrition results in poor physical and cognitive development as well as lower resistance to illness. It was reported that 6.6 million out of 12.2 million

deaths among children under five or 54 per cent of young children mortality in developing country was associated with malnutrition (Anon, 1996).

Over 800 million people still cannot meet basic needs for energy and protein, more than 2000 million people lack essential micro nutrients, and hundreds of millions suffer from diseases caused by unsafe foods or by unbalanced food intake (Anon, 1998).

The U.N. world population prospectus reported the prevalence of anaemia for 10 to 14 years age group in industrialized and developing countries during 1998 was 9.8 and 54 per cent, respectively (Anon, 1998a).

Estimated prevalence and number of stunted children in developing countries during the year 2000 and 2005 would be 33 and 29 per cent and 182 and 164 millions, respectively. Similarly, the estimated prevalence and number of wasted children in developing countries during 1995 was nine per cent and 51 million children, respectively (Anon, 2000).

Report of Anon (2000a) revealed that the prevalence of food-insecure population in developing countries regions was 18 per cent with 792 million food-insecure persons.

2.1.2 Prevalence of malnutrition in India

The prevalence of malnutrition in India with respect to anthropometry, diet, clinical and biochemical parameters among the school children are reviewed and presented in this section.

Bapat and Aspatwar (1973) studied the nutritional status of school children in slums of Bombay suburbs and recorded the mean daily nutrient intake of 41 school children of 10-12 years age group as 1582±249 Kcal of energy, 28±18 g of protein, 374±167 µg of Vitamin A, and 18±7 mg of Iron.

Usha *et al.* (1993) reported that 58.3 per cent of rural and 65 per cent of urban school going boys (6-12 years) from Coimbatore were found to be anaemic with the mean hemoglobin level 7.9±0.21 g/dl and 7.8±0.2 g/dl respectively.

According to NNMB report (Anon, 1997) in Karnataka the consumption of cereals and millets, pulses and legumes and sugar and jaggery was above the RDA, while that of green leafy vegetables and fats and oils was about a third of RDA. The intake of other vegetables was below RDA and showed wide variation. The consumption of vitamin A was less than half of recommended levels, while that of riboflavin and vitamin C was marginally lower.

Suman and Jaya (1997) conducted a study on 300 children of 7 to 14 years age group from 35 villages having varied tribal population in Coimbatore. The data revealed that, irrespective of the age and sex, almost three fourth of tribal children were found to be suffering from various levels of malnutrition. Only 30 per cent had normal height according to Waterlow's classification for height for age. Among those suffering from malnutrition, 57 per cent had marginal malnutrition, 26 per cent, moderate malnutrition, while 7 per cent of children were severely malnourished.

A study conducted on 1000 children of age group 6 to 15 year from the upper income group of Chennai studying in private schools and the gender split composed of 280 boys and 720 girls revealed startlingly high incidence of iron deficiency anaemia. The prevalence of anaemia was 85 per cent with mild and moderate anaemia in the range of 55 and 33 per cent and there was no difference in the prevalence among boys and girls and dietary intake data supported the low intake of iron and vitamin C among anaemic children (Anon, 1999).

Thanga Leela and Shanthi Priya (2002) studied iron status and morbidity pattern of 120 school children (55 boys and 65 girls) between the age groups of 5 to 10 years from Velandipalayan elementary school, Coimbatore.

The data revealed that, 80 per cent were anaemic, out of whom 46.67 per cent had mild anaemia and 33.33 per cent had moderate anaemia. Anaemia was uniformly prevalent among the children irrespective of sex and family size, parental education and living environment. The social class to which the children belonged appeared to be the important factors in the incidence of anaemia. In iron deficiency, there was a significant lowering of immunoglobulins, which inturn could be a potent cause for child mortality and morbidity among school children. There was a positive relationship between serum iron and Ig A level.

Asma *et al.* (2003) assessed the malnutrition status of 340 under privileged children between the age of 4-11 years residing in Ghousianagar, a densely populated area of Mysore city. Assessment by 'Z' score revealed that 50 per cent were under weight and stunted, 10 per cent of them exhibited wasting and only 11 and 18 per cent of children had normal weight/age and height/age, respectively. It was alarming to note that 72 per cent suffered from moderate and severe degrees of anaemia, and only eight per cent of the children had normal haemoglobin levels.

A sample of 150 preschool children (1-3 years) spreading over 24 villages, 12 blocks, six districts and three-agro-climatic regions of India ie., sub-mountain, central plain and south western were selected. Anthropometric measurements *viz.*, height and weight were recorded by using standard techniques. The data were classified according to Gomez and SD classification. The findings of the study revealed an absolutely non-prevalence of severe malnutrition (<60 % weight for age) among preschool children in all the regions. The overall prevalence of mild malnutrition (45%) was found to be higher than moderate malnutrition (21%). The percentage of malnourished preschool children was higher in south western region (28%) followed by central plain (20%) and sub-mountain region (14%) as measured by 75 per cent weight for age of NCHS standards. The magnitude of wasting among children (40%) was comparatively higher than stunting (26%). The prevalence rate of under weight, stunting and wasting was also found maximum in south western region and

prevalence of malnutrition increased from northern to southern districts of the state (Grover *et al.*, 2003).

Height and weight of 6-12 years old tribal children belonging to Ratlom district of Madhya Pradesh were determined for assessment of nutritional status (Manik, 2003). Thirty five per cent of boys had normal nutritional status compared to 21.2 per cent girls were upto 80 per cent, 3.03 per cent girls were in fourth degree of nutritional status according to Indian Academy of Pediatrics. Classification wt/ht^2 ratios of all boys and girls were below 0.0015. Anthropometric studies revealed that height for age and weight for age were slightly less as compared to the prescribed standard.

The anthropometric parameters of 1372 children of age group 6-11 years was assessed by Ranganath and Sheela (2003) and were compared with data for the National Centre for Health Statistics / Centre for Disease Control (NCHS/CDC) Reference Population of the children. The results of the household survey revealed that the great majority fell within ±2 standard deviation (SD) scores for height for age (59.9%) and weight for height (71.2%) and only 42 per cent were within ±2SD scores of the mean value for the NCHS/CDC Reference Population for both height for age and weight for height. The proportion of stunting was 40.2 per cent and that of wasting was 28.8 per cent and of both stunting and wasting was 10.8 per cent. A significant association was observed between malnutrition and father's level of education, father sector of activity, per capita income and number of siblings.

One hundred institutionalised children, both boys and girls between 7-12 years from Delhi were assessed for dietary and anthropometric parameters, haemoglobin and clinical status and morbidity profile. The diet of the children was purely vegetarian with a three meal pattern and a 7-day cyclic menu was followed. The mean intake of nutrients mainly calorie, vitamin C, vitamin A,

calcium and iron were lower than the RDA except for protein and B-Complex vitamins. The mean height and weight were lower than the NCHS standards. The mean haemoglobin level of a majority (75%) of the children was found to be lower than 12 g/dl, with prevalence of anemia being higher in girls than boys. Clinical examination recorded a high incidence of anaemia (63%), dental caries (52%), vitamin A deficiency (24%), xerosis of skin (11%) and vitamin C deficiency (23%) and poor personal hygiene. Morbidity profile endorsed frequent occurrence of fever, cough and cold and diarrhea among the children with parasitic infection of high order (Saran *et al.*, 2003).

Out of 2526 school children (1404 males and 1132 females) of age group 10-18 years assessed for malnutrition from 18 villages belonging to three ecological zones of the Thar desert of Rajasthan, 31.5 per cent children showed mild to moderate malnutrition and 20 per cent were severely malnourished as short term malnutrition, While with reference to long-term malnutrition, 24.7 per cent of boys and 20.3 per cent girls suffered from chronic malnutrition. Percentage of malnutrition was higher in girls than boys during the adolescent period, which was attributed to high percentage of illiteracy and low income of their parents (Singh, 2003).

2.2 IMPORTANCE OF TRADITIONAL FOODS FOR NUTRITION SECURITY

Traditional foods in India have a rich heritage of multi dimensional culture. These foods have been developed over century's mostly through trial and error and have contributed immensely to nutrition and well-being. India has a treasure of traditional foods.

Felicite *et al.* (1995) determined the nutritional value of traditional dishes consumed in the rural zones of Kack (extreme North of Cameroon) by chemical analysis. The dishes locally prepared were called *Baskodje* is made of

okra (*Hibiscus esculentum*), *Nebbi* is made of amaranthus leaves (*Amaranthus spinosus*), *Biridji* is groundnut soup (*Arachis hypogeae*) and *Woreba* is the soup of a non-determined vegetable. All the dishes analysed had an adequate protein balance meanwhile showed a general excess in carbohydrate and a deficit in lipids, being rich in fiber, iron, zinc and poor in phosphorus and calcium except Woreba dish.

Devadas (1999) documented the traditional foods of southern India, which include *Karevepaku podi, Fish pickle, Vadialu, Chegodilu, Gatti pakodi, Nuvulakaram, Kobbrikaram, Patharekalu, Gongara chatni* from Andra Pradesh, *Bisibelebhath, Vangibath. Obbattu, Chakkali, Badam feast, Adai dosa, Methi paratha, Sattu, Happala, Jamun, Puliyogera and Charoti* from Karnataka, *Adirasa,. Gheedar, Idiappum, Kolaputtu, Kombumeva, Palkolukatti, Pongal, Chola dosai, Kanjeevaram Idli, Omapodi, Paniyaram* from Tamilnadu and *Naranga* and *Nellikka Achar, Koliupperi, Sarkargari, Adapradhamam, Aviyal, Adapradham, Achappam Kozhalappam, Ellu Urunda, Aval Kesavi,* Unniappam from Kerala. On an average, all these items could provide $¼^{th}$ to $^{1}/_{5}^{th}$ requirement of an adult involved in sedentary activity. Items like *paniyaram dhal adani, Malayala adai, Cheroti* and *Bisibelebhath* could supply almost one third of the protein requirement and reasonable amount of calcium, iron and carotene.

2.3 DOCUMENTATION OF UNDERUTILIZED FOODS

The documentation of underutilized foods was broadly divided into millets pulses, leafy vegetables, seeds and fruits, which include their nutritional profile and related literature, is reviewed in this section.

2.3.1 Millets

A study conducted at National Institute of Nutrition on mineral and trace elements of six varieties each of two millets viz., barnyard and little millet revealed that, among the two millets, little millet had relatively higher

concentration of iron, zinc, copper and chromium whereas the latter had higher concentration of calcium phosphorus, magnesium and manganese. However, both millets accounted nearly similar amount of ionisable iron ie., 1.42 and 1.78 mg/100mg, respectively (Anon, 1983).

In another study conducted by the same institute (Anon, 1983a) on protein content of six varieties of italian millet and five varieties each of little, proso, barnyard and kodo millet, the proso millet had highest protein content (11.00 to 13.60%) whereas the kodo millet had lowest protein content (7.40 to 8.20%). On the other hand, in the other millets *viz.*, little, italian and barnyard millet, protein content ranged from 10.60 to 12.70, 10.30 to 11.70 and 7.90 to 10.70 per cent, respectively.

Lorenz and Hwang (1986) conducted a study on nine varieties of proso millet to determine the proximate principles and lipid composition of flours. They observed that, the protein content of millet varied from 5.60 to 16.00 per cent, crude fiber from 4.20 to 9.20 per cent which was quite high when compared to cereals. The major fatty acids of the free lipid in flours were linoleic acid, oleic acid and palmitic acid and major component of the free lipids of flours were triglycerides.

Sahu (1987) noticed highest carbohydrate content in little millet (73.40%) followed by kodo millet (72.20%), italian millet (69.20%) and lowest in common millet (68.30%). Little millet also had highest protein (12.50%) followed by common millet (10.50%). However, italian millet and kodo millets recorded lowest value (9.20 and 8.50%, respectively). On the contrary, the common millet registered highest fat and ash contents followed by little millet, kodo millet and Italian millets.

The protein content of five varieties of kodo millet showed minimum varietal differences in a study conducted by Sudharshana *et al.* (1988). The protein content ranged from 9.91 to 11.53 per cent with a mean of 10.52 per cent.

Similarly, analysis of five varieties of Japanese barnyard millet showed less significant varietal differences either in the protein content or in the amino acid composition. Protein content ranged from 11.05 to 13.93 per cent with a mean of 12.26 per cent (Monteiro *et al.*, 1988).

A study was conducted by Kulkarni *et al.* (1992), to screen the chemical composition of five minor millets viz., proso, kodo, italian, little and barnyard millet. The moisture content ranged from 9.89 to 10.62 g/100g. The protein content was highest in little millet (9.90 g/100g). The crude fiber and ash contents were 4.51 to 6.33 g/100g and 2.83 to 4.20 g/100g, respectively. A significant variation in calcium content was recorded and ranged from 12.36 to 29.17 mg/100g. The ionisable iron content were 1.47, 1.50, 0.55, 10.76 and 1.38 mg/100g in proso, kodo, italian, little and barnyard millets, respectively.

Nordeide *et al.* (1994) screened the nutrient composition and nutritional quality of wild gathered foods from Malian Gourma. The samples involved grain of *Cenchrus biflorus* and *Panicum lateum.* The *C. biflorus* recorded highest protein (22.1%), fat (7.3%), Iron (2.30 mg%) and zinc (6.5 mg%) compared to *P. lateum.* However, the chemical scores (CS) of *C. biflorus* and *P. lateum* judged by nutritional critics for adults and children of 2-5 years were too low to regard as good source of protein with the limiting amino acid being lysine.

Veena (2002) studied nine varieties of barnyard millet for nutritional qualities and revealed that mean moisture, crude protein, crude fat, starch, total carbohydrate and total minerals were 8.88, 12.28, 3.85, 54.83, 58.56 and 3.20 g/100g, respectively. The minerals *viz.*, calcium and iron were found to be 24.43 and 1.40 mg/100g, respectively.

2.3.2 Pulses

Six promising strains of rice-bean (*Vigna umbellata*), (GRRS-1 to GRRS-6) recently isolated by National Bureau of Genetic Research were analysed for important food constituents by Singh *et al.* (1980). Crude protein content ranged from 17.81 to 25.18 per cent, ash from 3.81 to 4.31 per cent, crude fiber from 3.3 to 4.8 per cent, calcium from 315 to 450 mg/100g, iron content was 0 to 5 mg/100g but rice bean appeared appreciably rich in tryptophan content and starch and low in total phenols.

Janardhanan and Lakshmanan (1985) studied the *Mucuna utilis* wal ex. wight, a grain legume growing wild in western ghats which was consumed by Kanikkars, a hill tribe of Kerala in South India. *Mucuna utilis* contained more protein, fat and the minerals such as calcium and iron when compared to commonly consumed pulses in India. However, the antinutritional factors such as trypsin inhibitor activity, haemaglutinating activity, tannins and L-DOPA were also detected.

Hira *et al.* (1988) studied the nutritional qualities of five varieties of rice bean and observed that total protein content ranged from 19.42 to 20.91g per cent, calcium from 0.36 to 0.47 mg per cent, iron from 5.0 to 7.1 mg per cent and protein digestibility ranged from 83.86 to 93.30 per cent.

Janardhanan and Nalini (1991) screened the tribal pulses, viz., *Entada scandens.* Benth which was known to be consumed as a pulse by the Indian tribal sections, the Grate Andamanese and Onges. The seed contained

fairly high amounts of crude protein, crude fiber and also ash and minerals when compared to common pulses of India. It also contained higher amount of anti-nutritional factors such as tannins, trypsin inhibitor activity and haemaglutinin activity.

Nutritional and chemical evaluation of raw seeds of the tribal pulse *Vigna trilobata* (L) *Verdc* was carried out by Siddharaju *et al.* (1992) and reported that crude protein, crude fat, crude fiber and ash were 20.31, 5.54, 8.81 and 2.71 per cent respectively. The seeds were found to be a rich source of minerals such as Magnesium, Iron, Copper, Zinc and Manganese compared to most common Indian pulses, however the seed contained negligible quantities of total free phenols, tannins, haemaglutinins and L-DOPA.

Raw seeds of tribal pulses, *Parkia roxburghii* and *Entada phaseoloides* were analysed for proximate and mineral composition and anti-nutritional factors. The seeds of *P. roxburghii* contained higher contents of crude protein and crude lipid compared to *E. phaseoloides* resulted in high energy value. Both seeds were rich in potassium and iron. The anti-nutritional factors such as total free phenol, tannins, L-DOPA and haemaglutinating activity were found to be less (Mohan and Janardhanan, 1993).

Neeraj Rani and Hira (1993) revealed Faba Beans (*Vicia faba*) contained 25.8±1.05 g/100g protein, 180±19.60 mg/100g calcium, 424±19.60 mg/100g phosphorus, 1.7±0.41 mg/100g ionisable iron, 0.7±0.01 mg/100g copper, 1.1±0.08 mg/100g manganese and 5.7±1.22 mg/100g zinc. It also contained the anti-nutritional factors such as phenol, tannins, phytin P and trypsin inhibitor activity 6.8±1.50 g/100g, 1.2±0.25 g/100g, 238±20.13 mg/100g and 39.5±8.05 TIU/mg protein, respectively.

Two germ plasm of the tribal pulse, *Canavalia gladiata* collected form Kalakad Wildlife Sanctuary and Mundanthwai Wildlife Sanctuary, Tamilnadu

and another tribal pulses *Canavalia ensiformis* collected from Mallai Nagar, Tamilnadu were analysed for proximate composition, minerals, anti-nutritional factors by Mohan and Janadharan (1994). The investigated seed materials contained higher amount of crude protein, crude fat and energy compared to commonly consumed Indian pulses and were rich sources of sodium, potassium and calcium. The total free phenols, tannins and L-DOPA were 6.5±0.1 to 73±0.9, 0.3±0.1 to 0.7±0.1, 25.0±1.7 to 30.1±1.1 respectively.

The nutrient composition and anti-nutritional factors of two under exploited Indian tribal pulses *Indigofera inifolia* (L.f) Retz. and *Sesbania bispinosa* (Jaeq) W.F. Wright were screened by Siddharaju *et al.* (1995). The mature seeds contained 296.6-321.2 g/kg crude protein, 47.2-64.2 g/kg crude lipid, 56.7-72.0 g/kg crude fiber, 27.6-31.9 g/kg ash and 531.3-550.6 g/kg carbohydrate. The seeds of *Indigofera linifolia* were rich in potassium, calcium, manganese and calcium, whereas *Sesbania bispinosa* were rich in phosphorus and zinc. Seed lipids of both legumes contained a large proportion of unsaturated fatty acids with citric acid as the predominant one.

Thirteen genotypes of winged bean [*Psophocarus tetragonolobus* (L.), DC] seeds were analysed for their nutrient and anti-nutrient composition by Chimmad *et al.* (1998). Significant variability in their concentrations was observed among the genotypes. On an average the seeds contained 9.57, 32.49, 17.95, 5.57, 30.11 and 4.33 per cent moisture, protein, fat, crude fiber, carbohydrate and total minerals, respectively, with a total energy of 412 Kcal/100g seed. On dry weight basis, calcium and iron contents were 21.7 and 12.4 mg/100g of seed, respectively, while the concentrations of antinutrients such as tannins, total free phenols and phytic acid were 12.93, 1.62 and 3.55 mg/100g seed. The trypsin inhibitor activity (TIA) was recorded as 1309 TIU/g seed.

The leguminosae is an extensive family consisting of more than 1300 species, of which, only 20 species are eaten by human beings regularly in appreciable quantities. Analysis of the nutrient composition of some less familiar grain legumes from North-East India viz. Rice bean (*Vigna umbellata*), wild Cowpea (*Vigna rexilleta*), Sword beans, Jack beans, Goa beans and Tree beans (*Parkia roxburghii*) showed that they were good sources of protein while some of them were rich sources of fat as well. The iron and calcium content ranged from -2.7 mg -23.7 mg/100g and 167 mg -234 mg/100g, respectively (Anon, 2000b).

2.3.3 Leafy vegetables

Pramila *et al.* (1991) reported the proximate composition of uncommon foods consumed in Kumaon and Garhwal hills of Uttar pradesh. The uncommon green leafy vegetables were Beng (*Basella alba* willd) and Bichhu (*Urtica dioica* L.). The crude protein, crude fat, total ash, carbohydrate and energy were higher in Bichhu compared to Beng. On the other hand; Iron, calcium, β-carotene and ascorbic acid were high in Beng.

Nordeide *et al.* (1994) studied the nutritional importance of green leaves and wild food resources of Koutiala district in Southern Mali. The information on underutilized foods were collected through questionnaire. The green leaves selected were *Adansonia digitata, Amaranthus viridis, Tamarindus indica, Allium cepa.* The chemical analysis revealed that the dried leaves had dry matter from 93.6 to 96.1 g/100g. Among the four dried leaves *Amaranthus viridis* had high protein content (28 g/100g) and less carbohydrate (39.3 g/100g). The gross energy among the leaves ranged from 1520 KJ to 1860 KJ. The ash and iron and zinc content was highest in *Allium cepa* (23.9g/100g, 340 mg/100g and 9.2 mg/100g, respectively). The β-carotene content was highest in *Amaranthus virids* (3290 µg/100g) and least in *Adansonia viridis* (670 µg/100g). The amino acid composition and protein quality of green leaves revealed that the

lysine was the limiting amino acid and chemical score was highest in *A. digitata* (81%) followed by *Tamarindus indica* (79%), *A. viridis* (51%) and *Allium cepa* (47%).

Chandrashakar *et al.* (1995) studied the nutritive value of selected uncommon green leafy vegetables consumed by Oraons of Bihar. The green leafy vegetables studied were *Beng sag* (*Centella asiatica*), *Chata sag* (*Marsilea quadrifolia*), *Muchri sag* (*Ranunculus hydrophylla*), *Chakor* dust (*Cassia tora*), *Chimti sag* (*Polygonum plebejum*), *Laruait sag* (*Cessus repens*), *Golgola sag* (*Portulaca quadrifolia*), *Sarauchi sag* (*Wedelia calendulacea*), and *Putkal sag* (*Ficus cordifolia*). The chemical analysis was carried out on dry weight basis. The protein content of greens ranged from 5.0 to 21.9 g per cent highest in *Chimti sag*. All greens were found to be a good source of fiber which varied from 4.6 to 16.1 g per cent. *Laruait sag, Chakor* dust and *Chimti sag* had high calcium content (2365mg, 3421mg and 981.5 mg/100g respectively). *Chakor* dust also contained maximum total carotene (1016.6 mcg/100g) in comparison to other greens. *Chimti sag* was found to be a good source of thiamine whereas *Golgola sag* was found to be rich in riboflavin. Despite analysing dried *Chakor* leaves in the form of dust, it was rich in vitamin C (224.6 mcg per 100g). Zinc content of *Savauchi sag* was highest and *Chakor dust* also contained 2.4 mg copper and 0.9 mg manganese.

Prakash *et al.* (1995) screened the foliage of 62 specimens of *Amaranthus* belonging to 10 species of grain and four of vegetable type for vitamin C content. The overall range of vitamin C was from 69 (*A. cruentus*, *AG-122*) to 258 mg/100g (*A. hypochondriacus Rasna*) in the grain type and 62(*A. tricolor, Amar-peet*) to 209 mg/100g (*A. tricolour,* AV-101, exp) in the vegetable type (fresh weight).

Shingade *et al.* (1995) analysed the proximate composition of 10 unconventional leafy vegetables from the Konkan region of Maharashtra and reported that, drumstick leaves, *math, katemath, bharangi* and *kawale* contained comparatively higher amount of crude protein, crude fat, ash, crude fiber and total carbohydrates. Drumstick leaves could be rated the best among all the leafy vegetables studied as it also contained higher ascorbic acid and β-carotene as well as lower oxalates. The unconventional vegetables, in general, contained less oxalates compared to cultivated vegetables.

Guerrero *et al.* (1996) screened the nutritional composition of leaves of Amaranth (*Amaranthus viridis* L.) which is a wild plant which grows in South Eastern of Spain. The nutrient composition of the tender leaves revealed that it had a good source of protein (4.82 g/100g), vitamin C (140 mg/100g), carotenoids (15.3 mg/100g), calcium (45.1 µg/100g) and iron (5.43 µg/100g). Content of oxalic acid was found to be high (958 mg/100g). Essential fatty acids were also found in high percentage (46.75%).

Jose and Maria (1997) studied the nutritional composition of tender leaves of three species of *Chenopodium* (*C. album* L., *C. murale* L. and *C. opulifolium,* shraeder) from different locations of Sourthern Spain (Almeria). The proximate composition, mineral elements, fatty acids, vitamin C, carotenoids and oxalic acid contents were determined. Low proportion of available carbohydrate were found. Vitamin C contents were high, especially in *C. album* (155 mg/100g). Carotenoids were found in high proportion (12.5 mg/100g) in *C. album*. The oxalic acid content ranged from 763±56 mg/100g to 1099±139 mg/100g. The iron content was higher in *C. opulifolium* (8.63±0.46 mg/100g). Alpha-Linolenic acid, a fatty acid (C18:3 w3) was found to be high in all the three analysed species.

Cauliflower leaves (*Brassica oleracea*, var. Botrytis) which was less commonly consumed and inexpensive leafy vegetable was studied for its nutrient composition by Kowsalya and Sangeeta (1999). They reported that cauliflower leaves had 75 g/100g moisture, 7.69 g/100g carbohydrate, 6.56 g/100g protein, 1.53 g/100g fat and 2.34 g/100g crude fiber, total ash 845 mg/100g, calcium 490 mg/100g and ascorbic acid 32 mg/100g. On the other hand, tannin, oxalate and phytates found to be 1.6, 26.0, 45.0 mg/100g, respectively.

Ladakh, the land between earth and sky, is known for its remoteness, difficult terrain and a short agriculture season. Over the years of experience perhaps by hit and trial method the locals of the area identified certain wild plants which are used as vegetables. The nutritional value of these wild leafy vegetables of Ladakh was studied by Chaurasia *et al.* (2000). The leafy vegetable reported were *sagani* (*Chenopodium botrys*), *dyat* (*Fagopyrum esculentum*), *khala* (*Lactuca dolichophylla*), *dittander/shangsho* (*Lepidium latifolium*), *lamanchu*(*Oxyria digyna*), *shoma* (*Rumex patientia* ssp. tibeticus) and *Zacchout* (*Urtica hyperborea*). The protein content ranged from 18.3 to 31.3 per cent, fat from 3.2 to 6.4 per cent, minerals recorded 12.3 to 29.8 per cent, carbohydrates from 25.7 to 36.0 per cent. The calcium was highest in *Oxyria digyna* which recorded 4.29 per cent. The iron content of these leaves ranged from 19 to 120mg/100g and highest being in *Oxyria digyna*.

Masti (2000) studied the nutritive value of underutilized vegetable, *karchikai* (*Luffa tuberose*. Roxb) and results revealed that, *karchikai* contained 84.53 per cent moisture, 160.77 mg/100g of ascorbic acid, 244.9 mg/100g β-carotene on fresh weight basis and 3.26, 1.61, 5.13, 1.25 and 3.72 per cent of protein, fat, crude fiber, ash and carbohydrate, respectively and 35, 130 and 5.5 mg/100g of calcium, phosphorus and iron, respectively on dry weight basis.

Bharathi and Umamaheshwari (2001), conducted a study on non-traditional leafy vegetables, which are grown in and around the field, near canals and waste land of Nellore and Prakasam districts of Andhra Pradesh, and proximate composition was estimated as per standard procedures. The analytical data of 10 selected non-traditional leaves *viz., chenchalaku* (*Digera arvensis*), *elukajemudaku* (*Merremia emarginata*), *avisaku* (*sesbania grandiflora*), *guregaku* (*celosia argentia*), *duradagundaku* (*Ischnemone indica*), *thummikura (Leucas aspera*), *payilaka* (*Boerhaavia diffusa*), *boddaku* (*Tinospora cordifolia*) and *pippintaku* (*Acalypha indica*) revealed that they were good sources of moisture (69.60±1.05 to 90.17±0.69 g/100g), proteins (6.89 to 2.17 g/100g), crude fiber (0.58 to 2.69 g/100g), β-carotene (3.90 to 17.05 mg/100g) and ascorbic acid (22.24 mg/100g to 119.06 mg/100g). The selected leaves had lower amounts of fat and moderate amounts of oxalic acid. The data on proximate composition revealed that they had promising nutritive value and were nutritionally good.

Raghuvanshi *et al.* (2001) studied the nutritional composition of uncommon leaves viz., *Fagopyrum esculentum Moench, Bauhenia purpurea Linn., Chenopodium album Linn.,* and *Gleichema linearis.* Moisture content of analysed samples ranged between 72.64 to 92.86 per cent, crude protein content in samples was in the range of 1.74 to 4.93 g/100g. Fat content in sample was low and ranged between 0.23 to 1.11 g/100g. Leafy vegetables were good sources of iron and calcium and fair sources of phosphorus and manganese. The iron content in *Fagopyrum esculentum, Chenopodium album, Bauhenia purpurea* and *Gleicheme linearis* was 6.20, 5.25, 4.59 and 1.22 mg/100g, respectively. Oxalic acid content in samples was found in the range of 46 to 356 mg/100g. The ascorbic acid ranged from 31.03 to 173.13 mg/100g. The β-carotene content was highest in *Fagophyram esulentum* (3020 μg/100g) with a range of 447 -3020 μg/100g among four leafy vegetables. The *in vitro*

protein digestibility of these leafy vegetables was 10.94 to 14.48 per cent and bioavailability of minerals was 7.30 to 3.48 per cent for calcium and 4.66 to 6.20 per cent for iron.

Thirty two edible forest Green Leafy Vegetables (GLV) consumed by tribals were documented by Rajalakshmi *et al.* (2001) from three districts *viz.*, Vizianagaram, Vishakapatnam and East Godavari from North East Andra Pradesh, South India. These GLV were analysed for total carotenoid and β-carotene content using HPLC following the procedure as described by Nelis and Deleenher (1983). The GLV analysed were *Gaju kura* (*Solanum nigrum*), *Mullu kura* (*Amaranthus spinosus*), *Pindi kura* (*Aerva lanata*), *Chipuru kura* (*Cocculus* sp.), *Daggula kura* (*Amaranthus polygamus*), *Ponnaganti* (*Alternanthera sessillis*), *Adavi kanda* (*Amorphophallus sylvaticus*), *Siliera kur* (*Physalis minima*), *Nela benda* (*Hibiscus abelmoschus*), *Puvnu tota kura* (*Oxalis corniculata*), *Ambali koda kura* (*Trianthema portulacastrum*), Drumstick leaves (*Moringa oleifera*), *Sikaya chiguru* (*Accacia concinna*), *Tella tota kura* (*Amaranthus* sp.), *Pedda tantem kura* (*Cassia occidentalis*), *Gurum kura* (*Celosia argentia*), *Podi kura* (*Lepidium satibum*), *White kura* (*Gynandropsis pentaphylla*), *Nagali surekura* (*Allamenia nodiflora*), *Amsukura* (*Adiantum punulatum*), *Chinna tantem kura, Tentebu kura* (*Cassia tora*), *Garisa kura* (*Dryopeteris cochleata*), *Adavi gummadi kura* (*Gmelina arborea*), *Gongura* (*Hibiscus cannabinus*), *Elukachevula kura* (*Convolvulus* sp.), *Venneduru kura* (*Commelina benghalensis*), *Bodanten kura* (*Bauhinia purpurea*), *Pulleru kura* (*Antidesma acidus*), *Chinnatummi kura* (*Leucas aspera*), *Simmadri kura* (*Alternanthera sessillis*), *Chitti kura* (*Ficus cunia*) and *Seshapkura* (*Globba bulbifera*). The contents of total carotenoids and β-carotene content in fresh forest GLVs ranged from 6.39 to 35.63 and 0.95 to 14.12 mg/100g, respectively.

Seven varities of GLVs *viz.*, *Dhantu* (*Amaranthus gangeticus*), *Khirahire* (*Amaranthus paniculatis*), *Honagone* (*Altenanthera triandra*), *Chakota* (*Atriplex hortensis*), *Palak* (*Beet vulgaris*), *Kachi* (*Solanum nigrum*) and Fenugreek (*Trigonella fernumgracuem*) of good quality matured leaves were procured from local market and analysed for vitamin C and expressed as mg per cent. Out of seven varieties *Dhantu* recorded highest 72.1 followed by *Khirkhire* 64.6 mg per cent with a range of 9.8 to 72.1 mg per cent (Premavalli *et al.*, 2001).

Chandrashekhar and Kowsalya (2002) studied provitamin A content of 10 green leafy vegetables and reported that drumstick leaves had maximum total carotene (41, 984 mcg/100g) and β-carotene (28, 160 mcg/100g) and also reported that 10 to 35 g of green leafy vegetables would be sufficient to meet the dietary β-carotene requirement of 1.600 and 2.400 mcg/day in pre-school and adults, respectively.

Rao and Tuhina Vijay (2002) determined iron, calcium, β-carotene, ascorbic acid and oxalic acid content of five less common leafy vegetables consumed by the tribal of Purnia district of Bihar. *viz.*, *saronchi sag* (*Alternanthra philoseeroides*), *patangi sag* (*Mollugo penthaphyla*), *kokra sag* (pteris sp.), *kataiyya sag* (*Amaranthus spinosus*) and *karmi latti* (*Ipomea aquatica*) and reported that none of these leafy vegetables were rich sources of iron, but better sources of calcium and β-carotene compared to commonly available leafy vegetables. Except for *kataiyya* (783.6mg/100g) all other vegetables had low (163.16 to 373.94 mg/100g) content of oxalic acid.

2.3.4 Seeds

Sanjeevkumar *et al.* (1988) screened two varieties of jack fruit seeds for proximate composition and reported that, protein, fat, starch, total sugar, total minerals and energy ranged from 6.25 to 6.75 per cent, 0.78 to 0.89

per cent, 14.35 to 15.50 per cent, 6.36 to 6.71 per cent, 1.16 to 1.22 per cent and 140 to 146 kcal/100g, respectively.

A basic study was conducted to evaluate the protein quality of *adda* seeds (*Bauhinia vahilli*) predominantly grown in rural areas of afforestation purpose. Even though, it contained 27 g/100g protein on dry weight basis, had poor growth promoting quality (Sudhamani and Kaminidevi, 1999).

Anon (2000b) estimated the nutrients of underutilized oil seeds viz., *Hanshi* (*Perilla frutesceus*), *Hazelthei* (*corylus avallena*), Niger (*Guizotia abyssinica*), Pumpkin seeds (*Cucurbita maxima*) and wild walnut (*Juglan* ssp.). These oil seeds were rich sources of protein (16.6 to 23.9%) and fat (39.0 to 54.7%).

2.3.5 Fruits

West Indian cherry popularly known as Barbados cherry or Puertoricon cherry was reported to be one of the richest sources of vitamin C among fruits. It was reported to be not popular for direct consumption because of its acidic taste and suitable for value addition (Muthukrishanan and Paliniswamy, 1972).

The chemical composition of underutilized fruit *Flacourtia jaggomas* grown in Tripura was screened by Dinda *et al.* (1989) and reported that it had a good amount of total ash (3.46 g/100g), total iron (18.37 mg/100g), phosphorus (16.28 mg/100g) with least amount of ascorbic acid (2.12 mg/100g).

Bilimbi or cucumber tree is a native of south east Asia and belongs to the family Averrhaceae. It is an evergreen tree producing fruits in clusters. In Kerala, India it is cultivated as a home food crop. Sweet and acidic forms of Bilimbi are reported to be available. It is reported to have three main fruiting

seasons *viz.*, March, April, August to September and December to January (Mathews *et al.*, 1993).

Ascorbic acid content was analysed in 22 wild fruit species grown in Malawi by Saka *et al.* (1993). Highest ascorbic acid content was observed in *Adansonia aigntal* (179.1 mg/100g of fruit weight). The ascorbic acid content of the other species ranged from 6.2 (*Diospyros kerkii*) to 39.8 mg/100g, fruit weight (*Annona shegalensis*).

The underutilized fruits of arid zone was documented by Meghwal (1997). *Viz., gonda* (*Cordial mgxa*), ker (*Capparis deciden*), karonde (*Carissa carandas*), custard apple (*Annona squmosa*), bael (*Aegle marmelos*), wood apple (*Feromia limonia*), phalsa (*Grewia subimequalis*), *pilu* (*Salvadora oleoides*), malberry (*Morm spp.),* tamarind or *imly* and *khejri* (*Prosopis cineraria*).

Underexploited fruit species (n=36) in western ghats region were reported by Nalini (1998). They include *Garcinia indica, Garcinia cambogia, G. Morella, G. xanthochymus, Citrus medica, C. jambheri, C. aurntium, C. grandis, C. limon, C. sinensis, Spondias pinnata, Flacourtia indica, Terminalia chebula, Mangifera indica, Eleagnus conferta, Artocorpus lakoocha* and *Buchnania lanzen.*

Madhkakri (*Citrus medica*), an under exploited fruit grown in Assam valley plains was reported to contain lots of vitamin C, 270 mg calcium, 487 per cent moisture by Mehta *et al.* (1972). However, 22.0 mg vitamin C and 33.16 mg calcium and 88.90 per cent moisture were reported in the fruits of Uttar Kannada district (Nalini, 1998). Further, nutrient content as reported was 0.10 per cent fat, 0.04 per cent ash, 0.11 per cent protein, 0.13 mg crude fiber, 10.72 g carbohydrate, 3.43 mg total phenols and 2.83 mg Tannin in the *C. medica* fruits.

Carambola, an underexploited fruit tree, native of Indonesia is now distributed throughout the tropics. The tree bears fruits during May and June. It was reported to be one of the most popular minor fruit crops of Assam and at maturity, fruit contained 91.4 per cent moisture and 13.8 per cent ascorbic acid (Neog and Mohan, 1991). In Karnataka Carambola is called *Kamardrakshi, Kamarkhor, Kobrikayi.* The fruit is highly perishable and fully ripe fruits were reported to get spoilt with in 3-4 days (Angadi, 1999).

Nutrient composition of the four underutilized fruits *viz.,* Bilimbi (*Averrhoea bilimbi*), Carambola (*Averrhoea carambola*), Rough lemon (*Citrus jambheri*) and Shaddock (*Citrus grandis*) revealed that the Bilimbi had higher moisture content (96.58%) than Carambola (89.83%) and the two citrus fruits had about 85 per cent moisture. Ascorbic acid content was higher in citrus fruits ie., 30.31 and 27.00 mg/100mg in rough lemon and shaddock, respectively compared to Bilimbi (6.33) and Carambola (11.60). Crude fiber content was high in Carambola (2.83%) compared to Bilimbi (1.53%), Rough lemon (1.24%) and Shaddock (0.96%). Potassium content was 126.66, 108.33, 125.00 and 79.50 mg/100g in Bilimbi, Carambola, Rough lemon and Shaddock fruits, respectively. Calcium content was 26.66 and 28.88 mg/100g in Rough lemon and Shaddock respectively whereas it was 14.22 and 19.55 mg/100g in Bilimbi and Carambola fruits (Banahatti, 2000).

George *et al.* (2000) reported that Lovi is a minor under exploited fruit crop with very attractive colourful berries borne in great proforma. It is an indigenous crop of Malaysia homes. Scientifically it is known as *Flacourtia cataphracta* producing sweet fruits and *Flacourtia intermis* with sour fruits.

Andaman and Nicobar Islands have a vast variety and diversity in tropical underutilized fruit plants Singh *et al.* (2000) documented the underutilized fruits of these Islands *viz.,* Carambola (*Averrhoea carambola*),

Goernor's plum (*Flacourtia ramontchi*), Sapida (*Baccuarea ramiflora*), Elephant apple or Chalta (*Dillenia indica*), Kewra/Bread fruit (*Pandanus leram*), Modhuphell (*Salacima chinensis*), Bakul or Khaya (*Mimusops elengi*), wild ber (*Zizyphus glabra*), Wild lemon (*Atakutia spinosa*), Wild jamun (*Syzygium claviflorum*), Wild rose apple (*Syzygium samarangenoe*), Wild mango (*Mangifera andamenica*), Alligator's apple (*Anona glabra*), Sour sop (*Anona muricata*) and Bread fruit/Bvelaitikathal (*Artocarpus altilis*). The nutrient analysis revealed that ascorbic acid content of these fruits ranged from 11.42 to 176 mg/100g and carotenoids was maximum in *Artocarpus integrifolia* (1485 µg/100g).

2.4 VALUE ADDITION TO TRADITIONAL FOODS FOR NUTRITION SECURITY

Rice is known to be low in protein but occupies an important place as a staple food in Southern and Eastern parts of India. Thus, nutritive quality of rice fortified with dehydrated leaf powders (DLPs), *viz., colocasia*, coriander, *mayalu*, radish and *shepu* was evaluated by Naik *et al.* (1978) and observed that the rice fortified with dehydrated leaf powders of *colocasia*, coriander and *shepu* gave 70 to 77 per cent PER value of casein diet.

Rao *et al.* (1979) investigated the characteristics of *roti*, *dosa* and vermicelli prepared from maize, sorghum and bajra flour instead of commonly consumed wheat and rice at Mysore. The data revealed that, the maize *roti* was soft and less chewy than *roti* from other grains particularly after keeping for 6-8 hrs. but the maize did not give a satisfactory *dosas* because of higher cold paste viscosity and lower hot paste viscosity better compared with the other grain flour, Sorghum gave *dosa* with good consumer acceptance scores. Vermicelli made from maize, sorghum and *bajra* flours completely disintegrate upon cooking.

Beet (*Beta vulgaris*), Khol-khol (*Brassica oleracea*) and Turnip (*Brassica rapa*) are winter vegetables of Northern India, especially in Punjab. These vegetables bear extensive leaves which are removed prior to cooking. Sawhney and Kawatra (1986) investigated the acceptability of *Sag* prepared from beet, khol-khol, turnip and mixed *sag* (turnip and khol-khol leaves in 3:1) on seven point hedonic scale by panel of 10 judges and found that the mean scores for overall acceptability of beet and khol-khol *sag* were higher ($P<0.05$) than those of turnip and mixed *sag*. Turnip *sag* had bitter taste and hence was not acceptable.

Jayalakshmi and Neelakantan (1987) studied the proximate composition and acceptability of sorghum soya blends in South Indian dishes *viz.*, *methu pakoda, roti, upama, savai, laddu* and *murukku* following the traditional methods. The soya flour was incorporated with sorghum flour at 15, 30 and 50 per cent level and the products were evaluated organoleptically. The results revealed that, the proximate composition of the blends *viz.*, protein, ash, fat and calorific value of the blends increased as the soya incorporation increased and acceptability scores showed that soyaflour could be incorporated upto 30 per cent for preparation of *roti, laddu, upama, puttu* and *savai* and upto 50 per cent for *methu pakoda* and murukku.

Kaur *et al.* (1988) conducted a study to know the effect of musk melon (*Cucumis melo*) seed supplementation on nutritive value of wheat *chapathi* and reported that, musk melon seed flour was acceptable upto 20 per cent level in *chapathis* and resulted in an increase in protein by 4.46 per cent and fat content by 9.98 per cent.

Sevian (*khara sev* like product) traditionally prepared by bengalgram flour was prepared by combination of rice and cooked colocasia

(30:30) by Kulkarni *et al.* (1994) The product was acceptable by sensory attributes.

Luthra and Sadanand (1995) investigated the supplementary effect of *bathua,* carrot and radish leaves on protein quality of wheat *chapathi. Sags* supplemented with wheat chapathi in the ratio of 1:4 improved the Protein Efficiency Ratio (PER) of wheat chapathi. Among the experimental diets, PER, plasma proteins, total liver weight and liver nitrogen were maximum when chapathi was supplemented with *bathua sag* and chemical scores of lysine and tryptophan in case of wheat chapathi also improved from 37 to 57 and 81 to 87 respectively, when supplemented with these *sags.*

Goyal and Gujral (1996) studied the nutrient composition of biscuits prepared from wheat and bengalgram with and without 7.5 per cent colocasia leaf powder and reported that incorporation of colocasia leaf powder had markedly enhanced the protein, calcium, phosphorous, iron-total, soluble and ionizable, thiamine and riboflavin contents of the biscuits.

Kotrareddy and Kaminidevi (1997) developed β-carotene rich extruded maize product by incorporating vegetable like carrot and curry leaf powder at 30 per cent using red palm oil in combination with groundnut oil at 30:70 preparations. The product with supplementation of 30 per cent of curry leaf powder and carrot powder were accepted by the sensory panel as well as pre-school children. The analysis showed that the energy content of the product was 387-483 kcal/100g and would fulfill one-third of the RDA for pre-school children for β-carotene.

Laboratory studies on the preparation of high protein biscuits indicated that some of the unconventional protein sources such as Mustard Protein Concentrate (MPC), Cottonseed Flour (CSF) or Cottonseed Protein Isolate (CSPI) could be used to increase the protein content in biscuits from 5.9

to 11.3-18 per cent. The incorporation of different protein concentrates affected the crispness, taste and overall acceptability as indicated by the sensory scores but increased the spread ratio and spread factor, which depended on the level of incorporation. The optimum level of incorporation was found to be 15 per cent in case of MPC or CSPI and 10 per cent in case of CSF (Rajput *et al.*, 1998).

Incorporation of jack fruit seed flour, in two deep fat fried products decreased the fat absorption to a remarkable extent. In the savoury product *khara sev* none of the sensory attributes were affected whereas in sweet product *jamun*, the quality of texture and flavour was affected. Since jack fruit seeds are comparatively cheaper, and protein rich the flour can be incorporated in savoury product successfully (Sri Rajarajeshwari and Jamuna Prakash, 1999).

The cauliflower leaves (*Brassica oleracea* Var. Botrytis) which is usually discarded was incorporated in common south Indian recipes and acceptability was assessed by Kowsalya and Sangeeta (1999). The result showed that cauliflower leaves were accepted well in its meal form *viz., poriyal* and *kootu* as well as in the incorporated recipes (10% and 20%) such as *vadai* and *chapathi.* It was also reported that products were nutrient rich in terms of macro and micronutrients.

Devi *et al.* (2000) reported that the nutritious supplementary biscuits *viz., nonkatai, melting moments, tricolour* and *salt biscuits* could be prepared by incorporating greengram dhal in order to improve the protein content of the products (12.10 to 20.28 g/100g).

Masti (2000) developed value added products *viz.,* pickle, *balaka* and chips from underutilized vegetable, *karchikai* (*Luffa tuberose.* Roxb). The sensory scores revealed that, all the developed value added products were between highly acceptable to acceptable range. The consumer acceptability trial

showed that maximum number of consumers (94.97%) liked *balka,* followed by salt treated chips (93.33%), lemon based pickle (90%) and curd treated chips (88%) while 73.33 per cent of consumer liked vinegar based pickle.

Proso–millet based convenience mix by malting and popping processing technique was developed by Srivastava *et al.* (2001) for infants and children. From the convenience mix, sweet and salt gruel, halwa, *burfi* and biscuits and salt gruel were prepared. All the products were found to be acceptable with 7.16g protein, 41.24 mg calcium, 2.10 mg iron, 4.42 mg ascorbic acid and 31.95 µg β-carotene from 50 g of convenience mix.

The potential use of two varieties of *Muccuna* beans flour in high protein biscuits was studied by Ezeagn *et al.* (2002). Incorporation of *Muccuna* seed flour at 15 per cent replacement level in wheat flour increased the protein content from 7.36 to 10.0-11.29 g/100g dry matter. While there was no significant difference in the sensory qualities of biscuits with two varieties of *Muccuna* beans being however, differed significantly from the control wheat biscuits. The overall acceptability of the *Muccuna* biscuits was appreciable (60.75 – 62.00 units) but inferior to the control (71.6 units) due to slight off flavour and deviation in colour.

Veena (2002) investigated the substitution of barnyard millet in rice based foods *viz., dosa, idli* and *chakkali* and revealed that substitution improved the nutrients per serving in terms of dietary fiber and minerals but reduced calorific value and hence suggested that barnyard millet could be used in most common cereal based traditional foods.

Vishalakshi and Mohansundari (2002) reported that incorporation of Whey Protein Concentrate (WPC) in maida based snacks *viz.,* ghee biscuits, cheese biscuits, diamond cuts and pizza at 10 and 20 per cent improved the protein and calcium content of the product. The consumer acceptability showed

that the product developed with WPC at 10 per cent level recorded highest acceptability when evaluated by the penal except for pizza which was acceptable even at 20 per cent substitution of WPC.

Swami and Goyal (2003) evaluated the scope of utilizing *sangari* (*Prosopis cinevaria*) for the development of supplementary food, a need for the vulnerable groups of arid region. Products like *mathari*, sweet and salty biscuits, *laddoo* and *kasar* prepared by addition of 20 per cent sangari powder to the basic recipes improved the nutritional value of the products with special reference to protein and crude fiber contents.

Jain and Sankhala (2003) reported that biscuits prepared from less familiar foods *viz., kangani* (*Setaria italica*), a millet, *kulathi* (*Dlichos biflorus*) a legume and dried *Lunakia* (*Postuleca oleracia*) an iron rich leafy vegetable recorded highly acceptable scores when assessed by a panel of six members on nine point hedonic scale.

Kharayat *et al.* (2003) developed different value added products based on incorporation of underutilized soy green (leaves and pods). Soya leaves vegetable gave good amount of energy, protein and iron ie., 344 kcal, 10.02g, 10.68 mg, respectively, while soya potato curry provided 316 kcal, 12g, 4mg of energy, protein and iron, respectively. Maximum amount of fat (21g) and calcium (208mg) were found in *Shgah* soya. Though all the recipes showed overall good acceptability, the *shahi* soya scored highest (8.5) on nine point hedonic scale.

Mane *et al.* (2003) developed the value added cereal and millet gruels with the incorporation of oyster mushroom mycelium powder rich in protein, vitamin, minerals and cellulose and amylase rich food in order to enhance nutritional value and to reduce viscosity of gruel, respectively. Plain gruels were considered as control samples. All the samples were standardised

and subjected to sensory evaluation on hedonic scale on three consecutive days by a panel of eight judges. The results revealed that all the experimental samples were significantly superior than control ones in respect of sensory and nutritional qualities.

2.4.1 Shelf life study

Kulkarni *et al.* (1994) studied the shelf life of *sevian* prepared from a blend of 30 parts of rice flour and 70 parts of cooked *colocasia* with different packaging materials. The result revealed that the product was acceptable upto 60 days storage at room temperature (22-35°C) when packed in 250 gauge Low Density Poly Ethylene (LDPE) and 120 gauge polypropylene bags. Whereas *sevian* packed in 100 gauge LDPE bags remained well upto 30 days only beyond which it became rancid and soggy due to increased in moisture content. However, peroxide value and free fatty acids ranged from 0.50 to 2.17 and 0.52 to 0.55 per cent and 0.50 to 2.32 and 0.52 to 0.56 per cent and 0.50 to 3.70 and 0.52 to 0.69 per cent, respectively for different packaging of products.

Kotrareddy and Kaminidevi (1997) developed β-carotene-rich extruded maize product by incorporating β-carotene rich vegetables like dehydrated carrot and curry leaves and were stored in high density polyethylene bags for four weeks as at temperature of 38.2°C and relative humidity of 56 per cent. The organoleptic evaluation revealed that the products stored for four weeks were not significantly different from fresh samples, except for flavour.

Pattan (1999) developed the Ready to Eat *madeli* a sweet product from different wheat varieties and stored for 21 days in aluminium box and polythene covers at room temperature to study the shelf life of the product. The result revealed that, the moisture, peroxide value and free fatty acid increased with storage period (21 days) and developed hard and gritty texture, rancid flavour, bitter taste and faded colour at the end of 21 days period.

A shelf life study was conducted by Satyanarayana *et al.* (2001) on instant *chutneys* prepared from *pudina* and *gongura*. The products were packed in low density polyethylene pouches (200 gauge) and stored at 28-37°C for three months. The results revealed that moisture content of instant *chutneys* had increased by 0.8 per cent in *gongura* and remained almost constant in *pudina* where as the free fatty acid content had increased by 0.7 and 0.8 per cent, respectively in two chutneys. However, the instant *pudina chutney* was rated very good (8) and good (7) and *gongura chutney* was rated good (7) and above average (6) during the storage period of three months with respect to colour, texture, flavour and taste.

2.5 IMPACT OF VALUE ADDED UNDERUTILIZED FOODS TOWARDS NUTRITION SECURITY

Devadas *et al.* (1978) conducted a supplementation study on 90 children from Vadamodurai, Coimbatore districts feeding 50g of fenugreek leaves and 20g of drumstick leaves for a period of two and a half months. Results indicated that serum retinol levels increased significantly in the experimental groups (13.78 to 21.34 µg/100ml in fenugreek leaves and 12.25 to 20.39 µg/100 ml each in fenugreek and drumstick leaves fed groups, respectively) and level reduced slightly in the control group (11.53 to 10.2 µg/100ml).

A study was planned with 40 pre-school children to estimate the availability of β-carotene from papaya fruit and amaranthus compared with pure retinol solution. There was a significant increase in serum vitamin A after the supplementation period of three months. The mean increments of serum retinol level in papaya and amaranth group were 15.9 and 14.8 µg/100ml, respectively while it was 22.7 µg/100ml for the pure retinol group. The mean haemoglobin

level of the target children fed with amaranthus recorded higher values (2.12%) over the rest (Devadas *et al.*, 1980).

Effect of dietary fat on the absorption of β-carotene derived from spinach was investigated in 70 pre-school children belonging to low socio-economic group by Jayaranjan *et al.* (1980). The children were divided into three groups. A daily supplementation of 40g of spinach was given to all the children. In addition, 5 and 10 grams of groundnut oil were added to the groups second and third, respectively. The first group was kept as control without inclusion of any fat. After five weeks period serum retinol levels were found to be significantly increased in all the three groups. The mean increase was higher in the group who received additional fat in the diet.

Charoenkiatkal *et al.* (1985) conducted a study on 15 pre school children in rural northern Thailand. Children were fed daily with green leafy vegetable (ivygourd) containing 1,081µg β-carotene for two weeks. Results indicated that serum retinol level increased significantly from 24.9 to 49.2 µg/dl.

Giri and Nandini (1985) conducted a supplementary study on 70 children (4-6 years) belonging to low socio-economic group from an urban community in Pollachi town Coimbatore district. They reported that the serum retinol level of the group supplemented with amaranthus leaves increased significantly from 13.49 to 27.37 µg/100ml and the increase was highest in the group supplemented with 20 g of groundnut (12.74 to 29.51 µg/100ml).

The fruit of *buriti*, a palm tree that grows wild in some regions of Brazil, contains β-carotene in its oily fraction in a concentration 10 times higher than that of red palm oil. The effectiveness of *buriti* sweet in the treatment and prevention of xerophthalmia was tested in 44 children aged between 43-144 months through daily supplementation with an amount corresponding to 134µg retinol equivalent over 20 days. The results demonstrated that this natural food

source of vitamin A can reverse clinical xerophthalmia and restore liver reserves of the vitamin (Mariath *et al.*, 1989).

Chandrashekhar and George (1990) conducted a study on 426 children (0 to 6 years) from six urban slums of Coimbatore. The children were divided into different groups, first group being control, received only home diet without any supplementation, second group was supplemented with 150g of papaya providing 1200 µg β-carotene and the third group was orally administered 2 ml of retinol equivalent to 1200 µg of β-carotene, supplementation was carried out for a period of three months, the results indicated that serum retinol level increased significantly in both the experimental groups (11.5 to 18.9, 10.2 to 25.2 µg/100ml).

To know the impact of supplementing iron rich indigenous sweet *laddoo* on hemoglobin level of anaemic children, Sarwate *et al.* (1994) selected 90 children having hemoglobin level of less than 10 g/dl from Indore. The subjects were divided into two groups, the experimental group received two laddoos of 60 g each, prepared from jaggery, sesame seeds, bengalgram flour and dates. The *laddoos* supplied a total of 40.28 mg iron/day. The supplementation was carried out for a period of 30 days. Another group served as control. The children of experimental group showed significant improvement in their hemoglobin (8.82 to 11.48 g/dl) after 30 day whereas, control group did not show any improvement.

Vijayalakshmi and Devadas (1994) conducted a study to determine the effect of incorporation of greens in convenience mix on hemoglobin and serum retinol levels of selected school children and adolescent girls and found that supplementation of greens incorporated through *vada* mix and *bhaji* mix for 3 months improved the hemoglobin level from 11.05±0.18 to 11.73±0.07 g/dl and

serum retinol from 11.03±0.03 to 20.05±0.05 µg/100ml in experimental group and the increase was statistically significant from control group.

Agarwal (1998) selected 45 children having tale a tell symptoms of protein energy malnutrition in Indore. He divided them into three groups, group A was supplemented with calorie (179 kcal), protein (8.09g) and iron 3.35 mg),group B received some supplement with addition of vitamin C (20mg) daily for 45 days and group C served as control. The food was prepared from defatted soya flour, jaggery, gardencress and amla powder. Blood hemoglobin level was estimated for 1st, 30th and 45th days. Supplementary feeding has increased hemoglobin level significantly in group A and B after 30 and 45 days compared to control. But the increment was significantly high in group A (5.37 g/dl) compared to group B (2.99 g/dl).

A supplementary feeding programme was conducted in Khanpur village near Parbhani city (Maharashtra). The study included children of 7 to 9 years age group (Anon, 1999a). Iron rich supplementary foods *viz.*, sesamum *chikki*, roasted rice flakes *chiwda*, coriander and drumstick *dhapata* and spinach *paratha* were provided to children interchangeably for a period of about 90 days continuously, each food providing 8 to 9 mg iron per day. The results revealed that mean hemoglobin content increased in experimental group from 7.69 g/dl to 12.53 g/dl while in control there was a slight decrease (9.83 -9.15 g/dl). There was also an increase in weight in supplemented group.

An intervention programme was carried on rural school children of age group 6 to 12 years in villages of Ludhiana district (Anon, 1999b). Iron and carotene rich recipes such as sweet *rice*, *phobha, bhelpuri, marunda* and methi were given as supplements for a period of four months. It was observed that there was a significant increase in height and weight of children. The

hemoglobin level in children of supplemented group also increased by about 4g/dl.

A supplementary feeding programme was conducted in two villages of Kotnur Mandal of Andhra Pradesh (Anon, 1999c). School children of age group 7-12 years were selected for the study. Foods were given to supply 10 mg of β-carotene daily for a period of 120 days. Results of this study indicated that experimental group showed a significant increase in hemoglobin level and increase in height and weights of the experimental group over control.

A nutrition intervention programme for prevention and control of vitamin A and iron deficiency in 7-12 year old children was carried out in Shahapur village of Hissar district (Anon, 1999d). Recipes like *shakarpara* and biscuits were prepared by adding iron and β-carotene rich underutilized cauliflower powder for supplementation and each child received 100g of supplement daily for 100 days. The results revealed a significant increase in height and weight and blood hemoglobin level of experimental group compared to control.

Aggarwal and Khanna (2003) studied the efficacy of supplementation with Leaf Protein Concentrate (LPC) fortified foods on iron and vitamin A status of 95 pre schoolers (1-3 years) of rural area of West Delhi. LPC was prepared with less consumed cauliflower leaves (blanched cabinet dehydration technique). Children were divided into Control Group (CG) with 30 children, Experimental Group-1 (EG-1) with 32 children and EG-2 with 33 children. CG received supplementary food from ICDS centre, EG-1 received non-LPC fortified supplementary food and EG-2 received LPC fortified supplement. Food supplements (Biscuits/buns/breads) were isocaloric (300 kcal) and isoprotein (8-10g) in all the three groups. However, LPC fortified (lg/serving) for EG-2 subjects provided an additional amount of 28 mg iron and 1,925 µg

carotene. Six months of supplementary feeding led to a significant decrease ($P<0.05$) in the number of undernourished subjects (wt for age z score of <-250) in only EG-2. Similarly, abnormal conjunctival impression cytology, an indicative of subclinical vitamin A deficiency, decreased significantly ($P<0.05$) only in EG-2. Supplementation with LPC fortified products led to decrease in anaemic subjects, especially of severe anaemia, though the results were not significant statistically.

MATERIAL AND METHODS

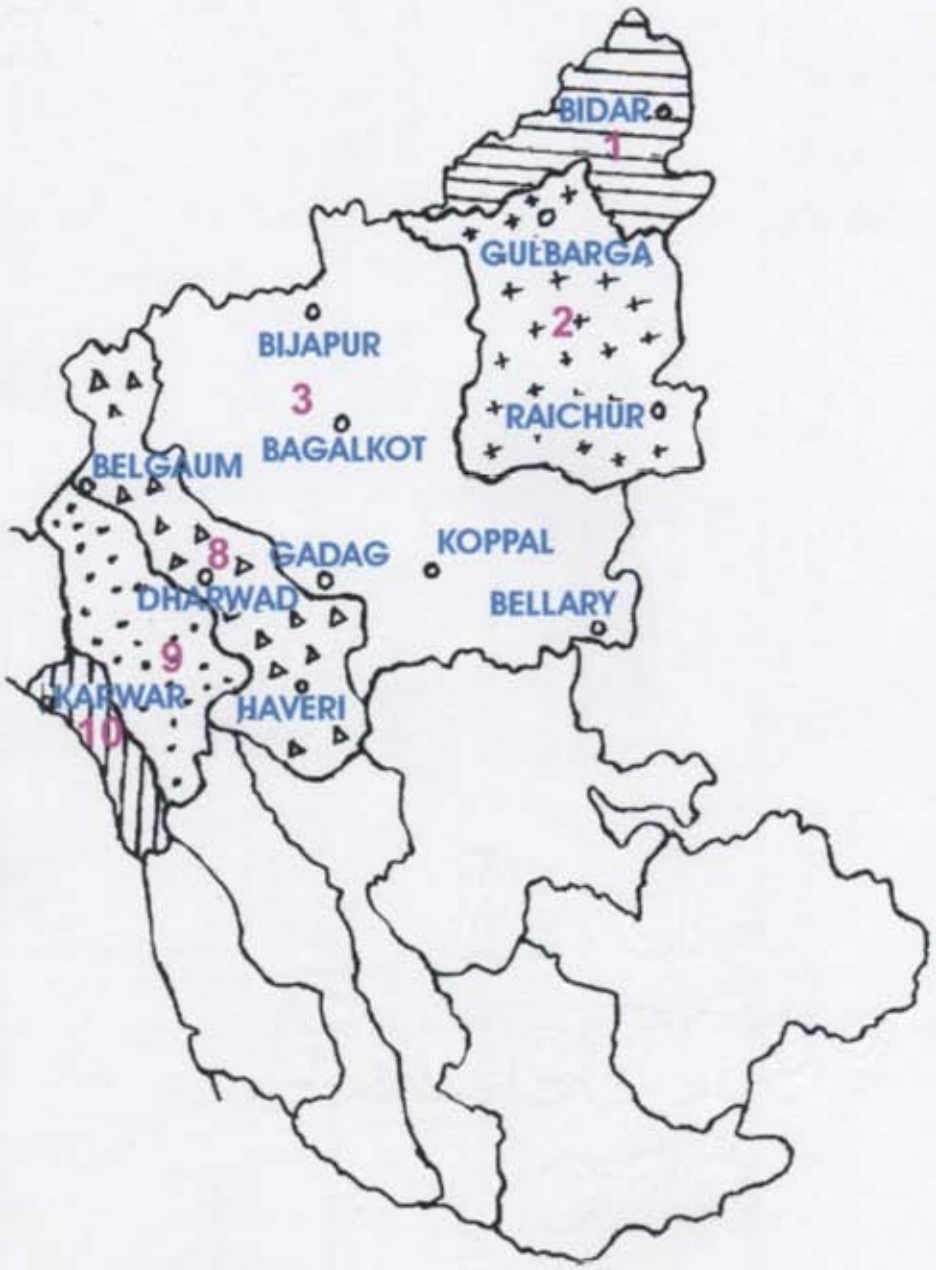
III MATERIAL AND METHODS

The world population is growing at alarming rate. In the face of this there is a pressing need to provide nutritional security to all, not only in terms of energy and protein but also for micro nutrients. Especially at this juncture where resources are limited, the common sources may not be able to overcome the pressure exerted by the growing population. It will thus become highly desirable to research for economic, easily available, nutritious low cost substitute for the seasonal and routine crops. There is great diversity of flora and fauna in the world and there is lots of potentialities for enormous plant material which is not explored for mass consumption as they are regional specific and due to lack of awareness. Thus the documentation of these underutilized foods and development of value added traditional product utilizing these foods to combat malnutrition is the sustainable strategy.

This chapter deals with details of material used and methodology adopted in documentation and development of value added products and efficacy of these products on biochemical parameters of school children.

3.1 LOCALE OF THE STUDY

The Northern Karnataka was considered as the study area for the research purpose to cover the different agro climatic zones (Fig. 1). One village each nearby Krishi Vigyan Kendra (KVK) / Main Research Station (MRS) / Regional Research Station (RRS) of University of Agricultural Sciences, Dharwad was selected thus comprising totally 27 villages, covering six zones *viz.*, i) North Eastern Transition zone ii) North Eastern Dry zone iii) Northern Dry zone iv) Northern Transitional zone v) Hilly zone and vi) Coastal zone and nine districts. A total of 375 families were selected randomly from 27 villages, representing 12-16 families from each village (Fig. 2)



1. North Eastern Transitional zone
2. North Eastern Dry zone
3. Northern Dry zone
8. Northern Transition zone
9. Hilly zone
10. Coastal Zone

Fig. 1: Selected Agroclimatic zones of Northern Karnataka

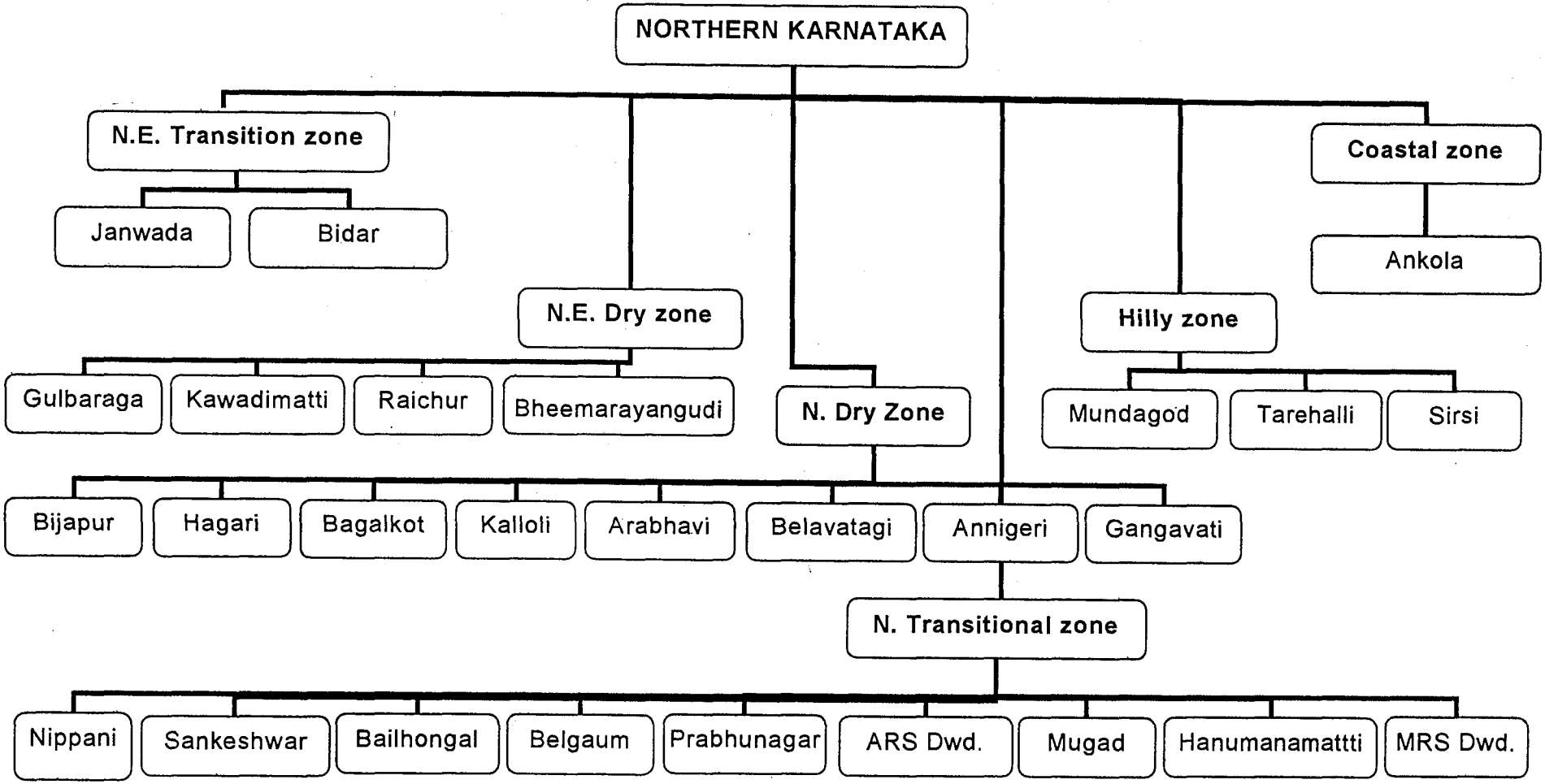


Fig. 2: MRS/ARS/KVKs SELECTED FOR THE STUDY

3.2 BASELINE SURVEY

A baseline survey of selected villages and families was carried out to elicit the basic information.

3.2.1 Baseline survey of village

The basic information of the village regarding the total number of households, infrastructure, access to safe drinking water, communication and transport facilities, presence of hospitals and basic crops grown in the village were collected from village panchayat office through the structured questionnaire (Plate 1 and Appendix-I).

3.2.2 Baseline survey of families

3.2.2.1 Socio-economic status of families

The general information of all the selected families were documented using the pretested questionnaire by personal interview technique (Appendix-II). The information regarding family size, education, caste, occupation and family income were collected. Families were classified into different categories of income as follows.

The monthly income of the respondents was assessed and grouped according to Kuppuswami (1991).

Kuppuswami income group (1991) was updated by using consumer price index as suggested by Prasad (1991) as per social classification:

$$\text{The conversion factor} = \frac{\text{The value of All India consumer price index}}{100} \times 5.16$$

$$= \frac{306 \times 5.16}{100}$$

(Rs. 100 in 1961 is equivalent to 15.78 in 2001, June)

Income per month (Rupees) were grouped as below,

Class I	– > Rs. 1585
Class II	– Rs. 785 – 1575
Class III	– Rs. 465 – 784
Class IV	– Rs. 240 – 474
Class V	– < Rs. 240

Plate 1: Interviewing the subjects

3.2.2.2 Diet survey

Diet survey indirectly reflects the actual quantity of individual foods consumed by the family thus facilitate in estimating daily intake of essential nutrients.

Food consumption pattern of all the selected families was studied using 24 hour recall method. To assist responds to recall the amount of food cooked for entire day, standardized vessels of 12 different volumes and measuring spoons were used (Pai, 1987). Further, consumed foods were computed for raw ingredients. The nutrient content of the food consumed by each family was computed using Annapurna version 2, software developed by M. R. Chandrashekar of Bangalore and expressed as adult consumption unit and compared with Recommended Dietary Allowances (RDA) suggested by Indian Council of Medical Research (Anon, 2000c) for sedentary male.

Per cent adequacy of nutrients *viz.,* energy, protein, fat, carbohydrate, iron, calcium, thiamine, riboflavin, niacin, carotene and ascorbic acid were computed for sedentary male worker using the formula given by Gopalan *et al.* (1993)

$$\text{Per cent nutrient adequacy} = \frac{\text{Nutrient intake}}{\text{RDA of the nutrient}} \times 100$$

3.3 DOCUMENTATION OF UNDERUTILIZED FOODS

India is a treasure of plant wealth each region has specific and/or particular type of plant foods. So documentation helps to know the type of plant foods available and consumed in particular region.

The underutilized food was defined for operational purposes as the food which is gathered / less cultivated / rarely used / weed. The documentation was accomplished from 375 families through the personal interview method (Appendix-II). The data collected included type of food, seasonal availability, part of the plant used as food, method of procurement and shelf life. The

specimens collected were brought to the laboratory and were classified botanically wherever required with the help of a Botanist.

3.3.1 Nutrient analysis

Twenty five samples of underutilized foods were analysed for proximate principles such as moisture, protein, crude fiber, fat, ash and total carbohydrate. Further, samples were also analysed for calcium, iron, β-carotene and ascorbic acid by standard procedures. All the samples were collected in two batches in same season and were analysed in triplicates.

3.3.1.1 Moisture

Moisture content was determined by the difference between the accurately weighed samples before and after drying in an oven at 105°C (Anon, 1990).

3.3.1.2 Crude protein

Total nitrogen was estimated by micro-kjeldhal method. Protein content was obtained by multiplying the total nitrogen by the factor 6.25 (Anon, 1990).

3.3.1.3 Crude fat

Crude fat content was estimated by solvent extraction method by circulating petroleum ether over the sample in Soxlet's apparatus for 14 hours (Anon, 1990).

3.3.1.4 Crude fiber

Crude fiber was estimated by the acid-alkali digestion method. The residue obtained after digestion was dried in a crucible and its weight was recorded. The dried residue was then ashed in a muffle furnace and its weight was recorded. The difference in these two weights was taken as the weight of crude fiber (Jacobs, 1959).

3.3.1.5 Ash

A sample of known weight was taken in a weighed crucible and ignited in a muffle furnace for three hours at 600°C, cooled and weighed. The difference in weight was taken as the weight of ash (Anon, 1990).

3.3.1.6 Total carbohydrates

The content of the available carbohydrate was determined by difference, by subtracting from 100 the sum of the values (per 100g) for moisture, protein, crude fat, crude fiber and ash (Raghuramalu *et al.*, 1980).

3.3.1.7 Calcium

Calcium was precipitated as oxalates and titrated against standard potassium permanganate (Raghuramalu *et al.*, 1980).

3.3.1.8 Iron

Powdered sample of known weight was digested in diacid mixture of Nitricacid: perchloric acid (10:4 proportion) at 150-200°C until it turns colourless. The digested sample was filtered through Watmann filter paper (No. 42) for estimation of iron in atomic absorption spectrophotometer (Shimadzne 630-11) according to the methods described by Lindsay and Norwell (1978).

3.3.1.9 β-carotene

The β-carotene content was estimated according to the method of Association Of Vitamin Chemists (Anon, 1951), utilizing acetone hexane solvent for extraction. The β-carotene was separated on a column of aluminium oxide and the absorbance of the elutes was measured spectrophotometrically at 450nm for calculating the concentration of β-carotene.

Preparation of standard curve for β-carotene

Ten milligrams of β-carotene standard (SD Fine chem. pvt. Ltd., Mumbi) was dissolved in 1.0 ml chloroform and the volume made upto 50 ml with

hexane. An amount of 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml and 2.5 ml of the solution was loaded on the column and the intensity of the yellow colour of the β-carotene content was measured at 450nm. The β-carotene content of the sample was calculated using the formula.

$$\mu g\,\beta\text{-Carotene}/100g = \frac{SR}{SR1} \times C \times VE \times \frac{V}{VE1} \times \frac{100}{S}$$

Where,

SR = Absorbance of sample
SR1 = Absorbance of standard
C = Concentration (μg) of the standard
VE = Total volume (ml) of the elute
VE1 = Volume of aliquot (ml) loaded on column
V = Volume (ml) after extraction and
S = Weight (g) of sample

Preparation of the column

The clean sintered glass column was filled with slurry of aluminium oxide in hexane to obtain a 10cm length column. The absorbent was pressed down firmly once or twice with a plunger. The column was always kept wet with hexane. The column was washed thoroughly with 25 to 30 ml solvent when the last one cm of the solvent was remaining on top of the column, 5 ml of sample extract was loaded on the column and subsequently elutions were collected using a mixture of acetone and hexane (9:91 v/v) as an elute. Washings were given till elute was colourless. All the coloured elutes were collected together and the total elute volume was measured. Absorbance was measured at 450nm using the acetone hexane mixture (9:91 v/v) as a blank.

Extraction of β-carotene

Ten grams of the fresh sample was homogenised in an electrical blender with an equal volume of acetone. The homogenate was then transferred to a 100 ml beaker soaked in 30 ml of acetone and hexane mixture (3:7 v/v) and kept overnight in a dark place for extraction. The extract was filtered through

glass wool and the volume of the extract was measured. If the volume was much more than that needed for loading on the column then 5 ml of aliquot was taken.

3.3.1.10 Ascorbic acid

Ascorbic acid content of fresh fruits and vegetables was estimated titrimetrically using 2, 6-dichlorophenol indophenol dye (Ranganna, 1986).

3.4 VALUE ADDITION TO TRADITIONAL RECIPES THROUGH UNDERUTILIZED FOODS

Traditional foods are known for their wholesomeness, high nutritional quality and cultural acceptance. To solve the prevailing nutritional problems one of the approach was enrichment of traditional foods by incorporating the various underutilized foods, which already exist but are not utilized for diverse reasons, which are good sources of protein, minerals and vitamins.

3.4.1 Development of value added traditional foods

Out of the documented underutilized foods, four millets, two pulses and five leafy vegetables were selected for value addition to traditional routine foods based on ease of availability and suitability to the particular recipe. The recipes selected were based on methods of processing *viz.,* fermentation, boiling, pan baking, shallow and deep fat frying. The main ingredient of the selected recipe was substituted with underutilized foods in varying levels and/or incorporated additionally according to suitability to improve the nutritional quality in terms of energy, protein, iron and β-carotene.

3.4.2 Sensory evaluation of the product

The perception of a food product is a combination of different senses that contributes to the sensory quality. These include characteristics like appearance, colour, texture, taste, aroma and overall acceptability.

3.4.2.1 Development of score card

The score card on nine point hedonic scale, developed for organoleptic evaluation was based mainly on the appearance and colour, taste, texture, aroma and overall acceptability for different value added traditional product with underutilized foods (Appendix III). All the products were evaluated in triplicates for acceptability.

3.4.2.2 Selection of sensory panel

Ten semi trained judges experienced in quality testing, possessing good health and interested in sensory evaluation were selected from Rural Home Science College, Dharwad. The panels were briefed about the product and were instructed individually to evaluate the product without consulting each other.

3.4.2.3 Sample presentation for judges evaluation

Prior to the presentation of the product, each product was coded and were placed in Sensory Evaluation Chamber with adequate amount of light at the Food Science laboratory along with a glass of water to rinse the mouth (Plate 2). The selected panels were made to sit comfortably in the chamber and were asked to score for different sensory characters according to their importance in evaluating the acceptability of the product. The mean score was obtained for all the characters and the data were statistically analysed.

3.4.3 Cost evaluation

The cost determines economic feasibility of production and purchase and sale of a food product. Cost of the value added traditional product varies with the price fluctuation in the market or on the source of availability of the underutilized food. Cost of the developed product per 100g and per serving of 10-12 years age group was calculated, which included the cost of raw materials and processing (cleaning, milling and cooking).

Plate 2: Sensory evaluation of value added products

3.4.4 Nutrient composition of value added traditional products

Nutrient composition of value added traditional products were computed using the Standard Food Table (Gopalan *et al.*, 1996). Values for nutrients of underutilized foods which are not available in Standard Food Tables were considered according to the values obtained in the present study during the nutrient analysis.

3.4 5 Shelf life study

The five Ready To Eat (RTE) value added traditional products *viz.,* Foxtail millet *chakkali,* Little millet green *sev,* Garden cress *laddoo,* soya *hurigalu,* and little millet *khara* gritters were developed by substitution and or incorporation of foxtail and little millet, garden cress seeds, soyabean and *chakramuni* leaves and recipe was standardized. They were prepared in a single lot and were divided into 150g portion, packed in Low Density Poly Ethylene (LDPE) covers, heat sealed and stored at ambient conditions (30±1°C). Samples were drawn on zero, 7^{th}, 14^{th}, 21^{st} and 28^{th} days and analysed for various quality parameters. LDPE covers were selected because of high impact strength, low cost and good heat sealability characters.(Plate 3)

3.4.5.1 Moisture

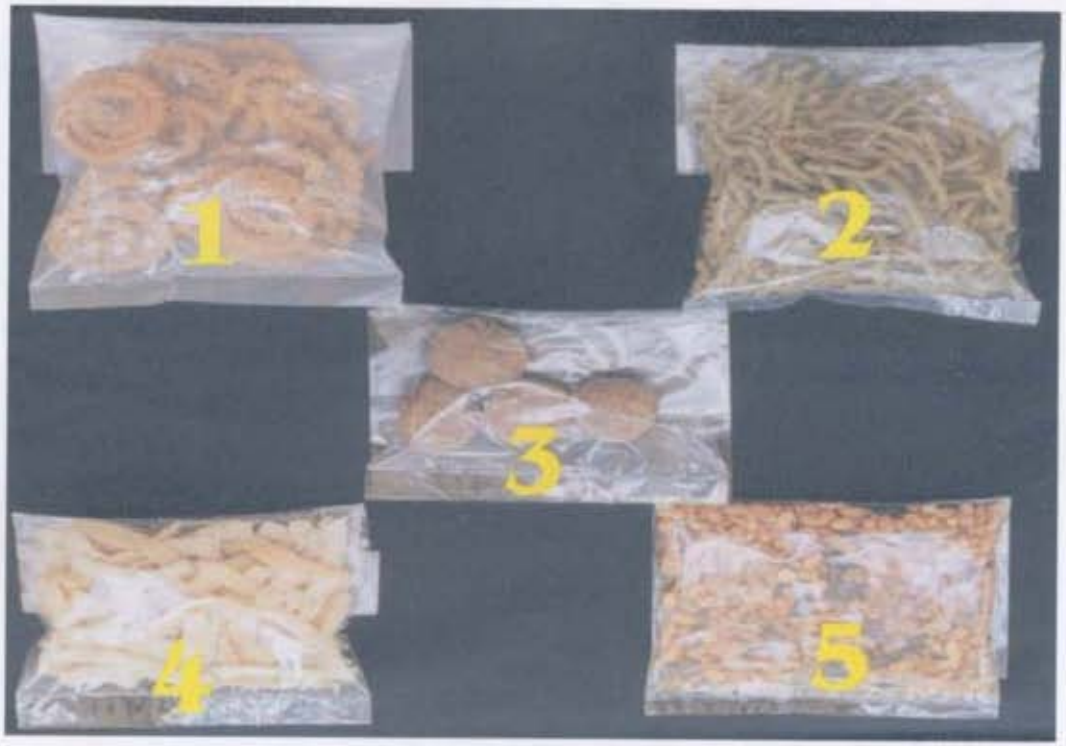
Moisture was estimated in the stored RTE value added traditional foods as outlined in 3.4.1.1.

3.4.5.2 Free fatty acid (FFA)

The FFA was estimated by titrating the chloroform extract of sample against potassium hydroxide in the presence of phenolphthalein indicator. The amount of FFA was expressed as oleic acid equivalent (Anon, 1983b)The detailed procedure is outlined in Appendix-IV.

3.4.5.3 Sensory evaluation

Sensory evaluation of the stored product was done as outlined in 3.5.2 (Appendix-V).



1. Foxtail millet *chakkali* 2. Little millet green *sev* 3. Gardencress *laddu*

4. Little millet *khara* gritters 5. Soya *hurigalu*

Plate 3: Developed Ready To Eat foods under storage study

Micro nutrient deficiencies are the most prevalent in the world affecting an estimated 2000 million people both in developed and developing countries. In India 30 to 40 thousand children go blind every year due to vitamin A deficiency and in Karnataka 68 per cent school children were suffering from nutritional anemia. The food based approach seems to be a practical solution for combating the deficiencies rather than a drug based approach. On the other hand, many plant foods that are abundantly available but have been under rated as non-prestigious foods are in the rich sources of micro nutrients. Hence, an intervention study was carried out to asses the impact of value added traditional products on nutrient and health status in general and growth status, morbidity, vitamin A and iron deficiency in particular among school children (Fig. 3).

3.5.1 Selection of village and subjects

Two villages *viz.,* Mugad and Mandihal which are 15 kms away from main campus of University of Agricultural Sciences, Dharwad and having similar agroclimatic condition, socio economic status and food habits were selected for the study (Fig. 4). In each village, 30 boys of age group 10-12 years who were attending government primary schools were randomly selected for the intervention study.

3.5.2 General information

General information such as name of the respondent, address, education, type of family, number of family members, and caste were collected through personal interview using structured questionnaire. The age of the boys were recorded as per the school register (Appendix-VI).

3.5.3 Anthropometric measurements

Anthropometric study deals with the comparative measurements of the body. The anthropometric measurements *viz.,* body weight and standing height were measured and recorded as per the guidelines suggested by Jelliffe (1966) (Plate 4).

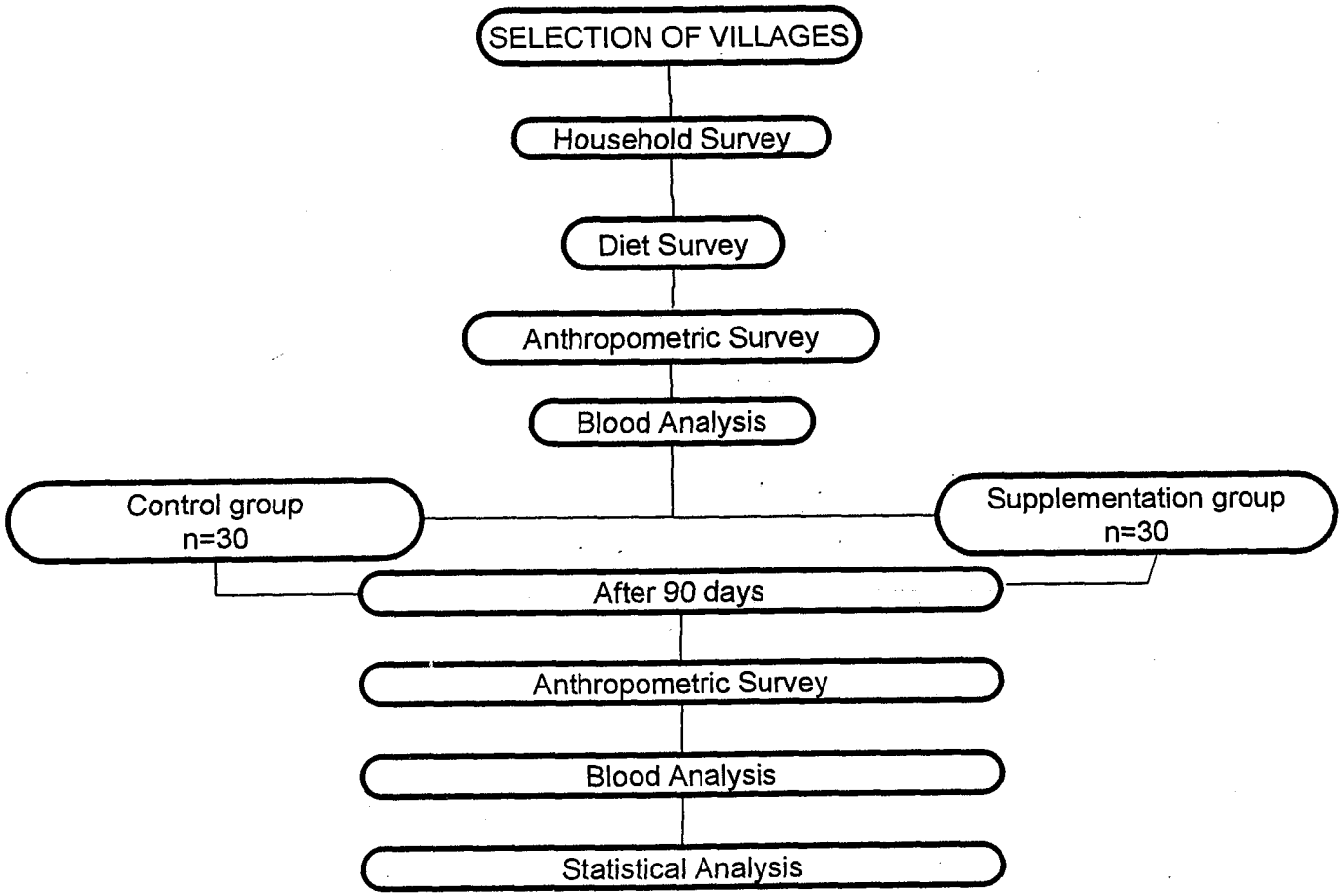


Fig 3: EXPERIMENTAL PLAN FOR THE INTERVENTION STUDY of SCHOOL CHILDREN

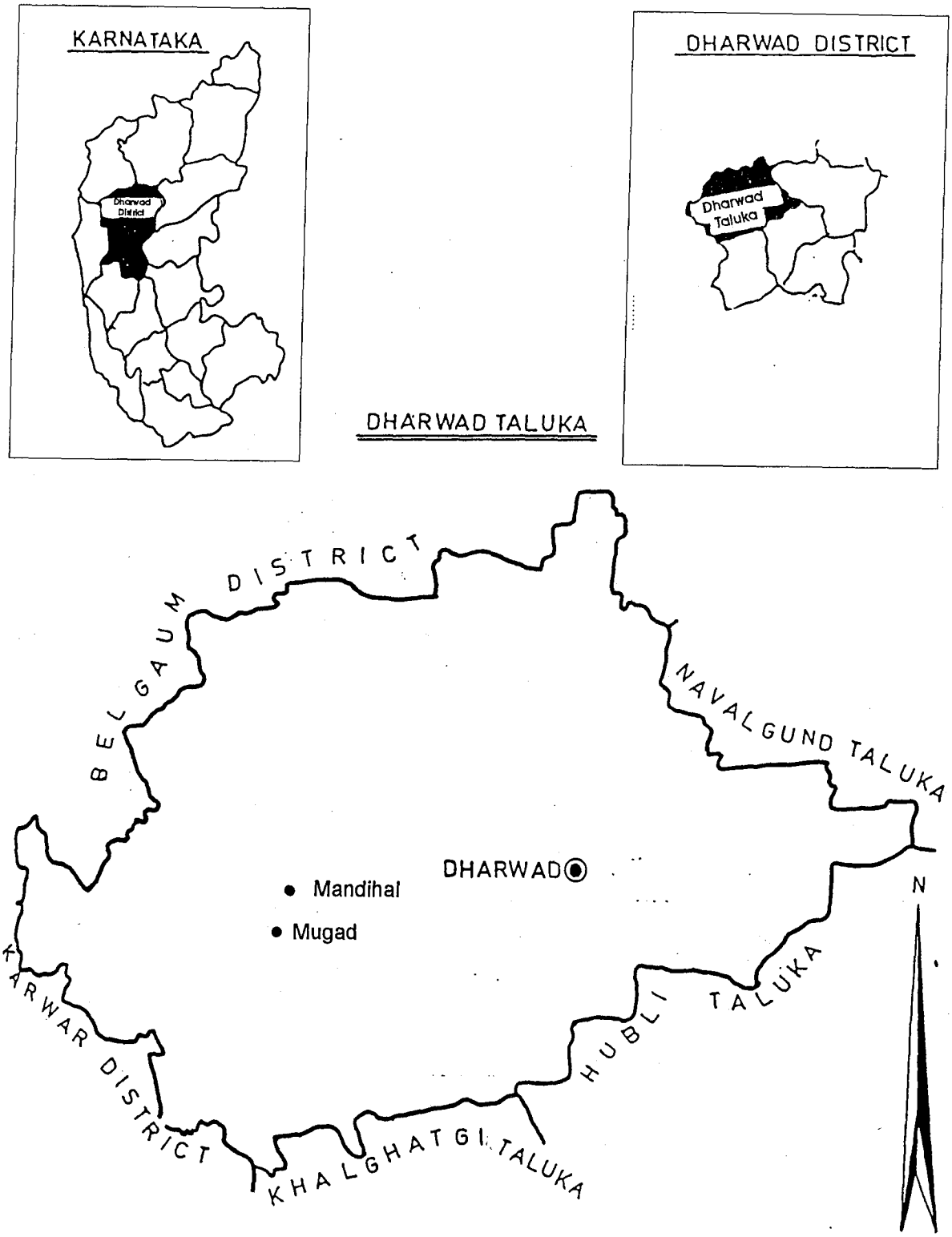


Fig. 4: Villages selected for intervention study

Plate 4: Anthropometric recording of school children

3.5.3.1 Height

Height indicates long term nutritional status. The standing height was measured with an anthropometric rod to the nearest of 0.1cm.

3.5.3.2 Weight

Weight indicates acute nutritional status. The weight was measured on the portable square spring balance with light clothing and shoes removed and recorded to the nearest 0.5 kg.

3.5.4 Diet survey

Dietary studies are generally an integral part of most of these nutritional surveys which aims to discover what the person under investigation is in the habit of eating over the long range and in the short run.

Information regarding the food consumption of each selected boy was collected by 24 hours recall method (Appendix-VI) with the help of standardised vessels of 12 different volumes and measuring spoons (Pai, 1987). Further consumed foods were computed for their raw ingredients. The nutrient content of the food consumed by each child was computed using Annapurna version 2, a software developed by M.R. Chandrashakar of Bangalore.

The nutrient adequacy was calculated by comparing the intake with RDA for Indian children of age group 10-12 years as given by Indian Council of Medical Research (Anon, 2000c) Per cent adequacy of energy and nutrients *viz.*, protein, fat, iron, calcium, thiamin, riboflavin, niacin, β-carotene and ascorbic acid were computed for children of age group 10-12 years using the formula given by Gopalan *et al.* (1996).

$$\text{per cent nutrient adequacy} = \frac{\text{Nutrient intake}}{\text{RDA of the nutrient}} \times 100$$

3.5.5 Assessment of morbidity pattern

Morbidity in terms of number of episodes and frequency of diarrhoea and upper respiratory infection (fever, cough and cold) were recorded for each child for the previous three months (Appendix-VI) by interview method.

3.5.6 Assessment of Biochemical status

Biochemical assessment indicates the subclinical status of an individual. The estimation of hemoglobin and serum retinol level were included under this section (Plate 5).

3.5.6.1 Collection of blood sample

Random venous blood sample (5ml) was drawn using disposable syringes (No. 22) with the assistance of a qualified laboratory technician from a reputed clinical laboratory in the city. Twenty microlitres (ml) of blood was pipetted out on to Whatmann No. 1 filter paper immediately for the purpose of hemoglobin analysis. Further, the serum was separated from blood by centrifugation at 2000-3000 rpm for 10 minutes and used for the analysis of serum retinol.

3.5.6.2 Analysis

Haemoglobin was analysed by cyanomethemoglobin method (Varley, 1976) and serum retinol was analysed by using Spectrophotometer method suggested by National Institution of Nutrition (Anon, 1983c).

3.5.6.2.1 Haemoglobin estimation

Twenty microlitres of blood was accurately pipetted out with hemoglobin pipette on to 1.5 × 1.5cm Whatmann No. 1 filter paper and was allowed to dry. The filter paper was marked with lead pencil and kept in polythene cover. The blood stained area was cut and placed in culture tube containing 5 ml Drabkin solution for 60 minutes, contents were mixed thoroughly using the vertex shaker and read at 540nm under spectrophotometer using




Plate 5: Blood collection and biochemical analysis

Drabkin solution as blank. The values were compared with a standard table to get hemoglobin values and expressed as g/dl. The subjects were classified as per WHO into four groups based on the hemoglobin level (Anon, 1986a).

Category	Classification (Hb level)
Normal	12 and >12 g/dl
Mild anaemia	10-11.9 g/dl
Moderate anaemia	8-9.9 g/dl
Severe anaemia	<8 g/dl

3.5.6.2.2 Serum retinol estimation

The serum retinol was estimated according to the method suggested by National Institute of Nutrition (Anon, 1983c). The difference in the absorbance at 328 nm before and after irradiation with ultraviolet light was used as a measure of serum retinol level.

Extraction and saponification

In a glass stoppard test tube 2ml serum and an equal volume of alcoholic KOH (25%) were mixed well. The tube was incubated in a water bath at 60-65°C for 20 minutes and then cooled at room temperature. The unsaponifiable matter was extracted three times with 10ml of light petroleum ether. The petroleum ether extract was washed with water to remove alkali, passed through anhydrous sodium sulphate and evaporated to dryness under vacuum at 40°C. The dry residue was immediately dissolved in 2ml cyclohexane (equal volume as serum).

The absorbance of the cyclohexane solution was measured at 328 nm in a Spectrophotometer. The solution was then transferred to a soft glass tube with stopper and irradiated for five minutes with ultra violet light. The tube was kept at a distance of 30cm from UV lamp. The optical density at 328 nm was

once again read and the difference in optical density before and after irradiation was taken as a measure of retinol in the solution.

Calculation:

$$\mu g \text{ of retinol/100ml serum} = (\text{Initial absorbance at } 328nm - \text{Final absorbance at } 328nm) \times 645$$

The subjects were classified into 3 groups based on serum retinol level (Anon, 1982)

Category	Classification
Acceptable	>20µg/100ml
Low	10-20µg/100ml
Deficient	<10µg/100ml

3.5.7 Intervention study

3.5.7.1 Selection of food

Out of the 25 developed value added products, (20 value added traditional products and 5 Ready To Eat value added traditional products) 3 products rich in iron, β-carotene, energy and protein *viz.,* Foxtail millet *Bisibelebath* with Bengalgram leaves, Little millet *Upama* with Bengalgram leaves and Gardencress *laddu* were selected for intervention study for school children of age group 10-12 yrs. to provide nutrition security (Plate 6). These foods were selected based on simple cooking procedures, convenience in transportation and also availability of underutilized foods for intervention during the study period.

3.5.7.2 Intervention

Totally 60 school children of age group 10 -12 yrs. who were willing to participate in intervention study were selected for the study. In order to study the impact of supplementation, the subjects were divided into two groups. Children of Group I formed the control group without supplementation of nutrition rich food and were on the routine home diet. The second group formed the experimental group which received the nutrient rich food which supplied good amount of protein and energy and nearly $^1/_3$ of the daily requirement of iron and β-carotene, Foxtail millet *Bisibelebath* with Bengalgram leaves, Little millet *Upama* with Bengalgram leaves and Gardencress *laddu* were prepared daily in

Little millet *upama* with bengalgram leaves

Foxtail millet *bisebelebath* with bengalgram leaves

Gardencress *laddu*

Plate 6: Foods selected for intervention study

laboratory and served in clean plates in the school premises of selected villages under the supervision of investigator. Children were carefully observed for their attitude, body response such as vomiting, indigestion and stomach pain and overall health (Plate 7).

The supplementation was given for three months duration. All the selected subjects were dewormed before intervention by Albendole tablet one week prior to the study. The children were guided to wash their hands before taking food. The classroom where the food was served was cleaned daily prior to feeding. The plates which were used for feeding were washed daily and rinsed with hot water and dried.

3.5.7.3 Parameters studied after intervention study

The changes in height and weight, hemoglobin and serum retinol levels were recorded initially and after the completion of intervention study.

3.6 STATISTICAL ANALYSIS

The responses were quantified, classified, tabulated and expressed in frequencies and percentages. The results obtained were analysed employing different statistical methods.

a. The DMRT was employed to test the significance of nutrients among different agroclimatic Zones.

b. The correlation test was employed between nutrients and family size, education and monthly per capita income.

c. Mean and standard deviation were calculated for anthropometric measurements, nutrient intake, nutrient adequacy and biochemical parameters like hemoglobin and serum retinol of the selected subjects.

d. The student 't' test was used to test the significance of mean nutrient intake, per cent adequacy of nutrient, anthropometric and biochemical parameters of selected subjects.

Washing

Serving value added food

Feeding children at school

Plate 7: Supplementation of value added foods for nutrition security

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{S^2\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}}$$

Where,

$\bar{x}_1$ = mean of first group

$\bar{x}_2$ = mean of second group

S^2 = Pooled variance

n_1 = total number of observations in the first group

n_1= total number of observations in the second group

S_1^2 = variance of first sample

S_2^2 = variance of second sample

$$t = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2^{-2}}$$

$$S_1^2 = \frac{1}{n_2 - 1}\left(\frac{\sum x_1^2 - \left(\sum x_1\right)^2}{n_1}\right)$$

$$S_2^2 = \frac{1}{n_2 - 1}\left(\frac{\sum x_2^2 - \left(\sum x_1\right)^2}{n_2}\right)$$

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

There is an ever increasing gap between food supplies and population growth particularly in the developing countries. The search for novel high quality foods but inexpensive, good resources of macro and micro nutrients continues to be a major concern of all agencies involved in providing adequate food and improving the nutritional status of the population in the developing countries. Available data on less familiar plant foods suggest that they are comparable or even superior in some instance to normally cultivated crops. Yet, the nutrient composition of less familiar plant foods is not adequately documented. Thus, an attempt has been made in this study to evaluate the nutritional composition and value addition to underutilized foods and to investigate the efficacy of such products on the biochemical and nutritional parameters of school aged children. The results pertaining to these aspects are presented in this section.

4.1 BASELINE SURVEY

4.1.1 Baseline information of study areas

The selected 27 villages with different rainfall, soil type and cropping pattern were distributed in six agroclimatic Zones (Table 1). The maximum area was available in North Dry Zone (N. Dry Zone) covering 48.74 lakh hectare and least was in North Eastern Transition Zone (N.E. Transitional Zone). The Coastal region revealed highest rainfall ie., >4000mm and least by N. Dry Zone (600 – 700mm).

In all the six Zones studied, variety of soil types was observed. The laterite type of soil was found in Hilly Zone, Coastal Zone and part of the N. E. Transitional Zone and North Eastern Dry Zone (N.E. Dry Zone). The medium black soil and red sandy soil was observed in N. Dry Zone and North Transition

Table 1: Basic information of different agro-climatic zones of UAS, Dharwad covered in the study

Sl. No.	Name of the zone	Name of MRS/ARS/KVK	Zonal area (Lakh ha.)	Rainfall (mm)	Soil type	Cropping pattern
1.	N. E. Transitional zone	Janwada, Bidar	8.74	700-900	Medium blackish laterite soil	Jowar, Pigeon pea, Black gram, Sugarcane
2.	N. E. Dry zone	Gulburga, Kawadimatti, Bheemarayangudi, & Raichur	17.59.	600-900	Laterite growing, medium black, shallow black soil	Groundnut, Pigeon pea, Jowar, Bajra & Cotton
3.	N. Dry zone	Bijapur, Bagalkot, Kalloli, Arabhavi, Belavatagi, Annigeri, Gangavati, Hagari.	48.74	600-700	Medium black, mixed red black, red sandy soil.	Jowar, Maize, Chilli, Groundnut, Sunflower, Bengal gram & Onion
4.	N. Transitional zone	Nippani, Sankeshwar, Bailhongal, Belgaum, Prabhunagar, ARS – DWD, MRS – DWR, Mugad & Hanumanamatti.	11-30	700-2000	Medium black, red sandy soil.	Jowar, Wheat, Cotton, Tobacco, Sapota, Sugarcane & Soyabean
5.	Hilly zone (Malnad zone)	Mundgod, Tarehalli, Sirsi (Paddy)	22.89	2000-4000	Red loamy, laterite soil.	Paddy & Pepper
6.	Coastal zone	Ankola	9.84	>4000	Coastal alluvial laterate soil	Paddy & Groundnut

Zone (N. Transitional Zone). The medium to shallow black soil was more prominent among the six Zones studied.

The Jowar and Groundnut were the major crops in N. Dry and Transitional Zones and Paddy and Groundnut were the main crops of Hilly and Coastal Zone due to high rainfall. The commercial crops were scattered in all the Zones.

All the selected villages were within the vicinity of Krishi Vidyan Kendra (KVK), Regional Research Station (RRS), Main Research Station (MRS) of the University of Agricultural Sciences (UAS), Dharwad (0.5 – 25 kms). The population of study area ranged from 300 – 15,000 with households of 25 – 8000. More than 75 per cent of the villages had hospitals and education facilities upto high school. The communication facilities such as telephone and post offices were found in 95 per cent of the villages. All the villages had electricity and drinking water facility through bore wells. For irrigation purpose open and bore wells were mostly used. Seventeen villages were connected with asphalted roads and 10 had mud roads. The closed drainage was observed in 17 villages. The gobar gas facility was present in only 12 villages out of 27 villages. The vicinity of forest ranged from 0.5 to 20 kms. from the selected villages (Table2).

The profile of villages covered under survey according to agro-climatic Zone was presented in Table 3. The maximum number of villages (N=9) were in N. Transitional Zone followed by eight in N. Dry Zone, four in N. E. Dry Zone, three in Hilly Zone, two in N. E. Transitional Zone and only one in Coastal Zone. The N. Dry Zone had maximum number of population (2500-26620) followed by N. Transitional Zone (450-2500), N.E. Dry Zone (1550-15000), N. E. Transitional Zone (3090-7000) and Hilly Zone (462-2400) and very less population was recorded in Coastal Zone. Among the number of households selected, majority were from Upper Cast (UC) followed by Other Backward Castes (OBC) and Schedule Caste (SC). Schedule Tribes (ST) were found in

Table 2 : Profile of villages covered under study

Sl. No.	Variables	Information	
1	Villages selected for survey	27	
2	Vicinity (Km) from KVK/RRS/ MRS	0.5 – 25	
3	Population	300 – 15,000	
4	No. of households	25 – 8000	
5	Hospitals	Yes– 20	No. - 7
6	**Schools and Colleges**		
	a) Anganwadi	Yes – 27	No. - 0
	b) Primary	Yes - 26	No. - 1
	c) Middle	Yes – 22	No. – 5
	d) High School	Yes – 18	No. – 9
	e) College	Yes – 6	No. – 21
7	Post office	Yes – 25	No. – 2
8	Telephones	Yes – 25	No. – 2
9	**Source of water**		
	a) Domestic		
	Lake	0	
	Open well	19	
	Bore wells	27	
	Municipal	4	
	b) Farm		
	Tube	27	
	Open	27	
	Ponds	3	
	Canals	7	
10	Electricity	Yes – 27	No. -0
11	**Type of Road**		
	Asphalted	17	
	Mud	10	
12	Vicinity to forest (Km)	0.5 to 20	
13	Sanitation (Closed drainage system)	Yes – 17	No. – 10
14	Gobar gas	Yes – 12	No. - 15

less number only in N.E. Dry Zone, N. Dry Zone, N. Transitional Zone and Hilly Zone.

All the selected villages from N.E. Transitional Zone, N. Dry Zone and Hilly Zone had hospital facilities while two villages each from N.E. Dry Zone, and N. Transitional Zone and one village from Coastal Zone did not register hospital facilities.

The Anganawadies and primary schools were found in all the selected 27 villages, whereas middle and high school were present only in villages of N.E. Transitional Zone, N. Dry Zone and Transitional Zone. However, college education was available only in N.E. Dry Zone, N. Dry Zone and N. Transitional Zone villages.

The post office, telephone and television facilities were available in all the selected villages.

The source of safe drinking water was through bore wells and municipal water connection in all the villages except for Hilly Zone and Coastal Zone, where open wells were also available for drinking water purpose.

All the selected villages were dependent on rain for irrigation and the other source was tube wells. Only few villages from N. E. Transitional Zone, N.E. Dry Zone and N. Dry Zone had canal facilities.

All the selected villages were well equipped with electricity and transport facilities through road. Most of the villages had asphalted roads.

The major cereal crops of North and N.E. Dry Zone and Transitional Zone were Jowar and Rice, where as wheat was grown as major crop only in N. Dry Zone and N. Transitional Zone and Rice in Coastal and Hilly Zone.

The major pulses grown in selected villages were blackgram, greengram, bengalgram, redgram and cowpea. Cowpea was grown only N.E.

Table 3 : Profile of study villages

Variables	N.E. Transitional zone	N.E. Dry Zone	N. Dry Zone	N. Transitional Zone	Hilly Zone	Coastal Zone
Villages	2	4	8	9	3	1
Population	3,690-7,000	1,550-15,000	2,500-26,620	450-25,000	462-2,400	300
Number of Households	46	56	136	86	38	13
a) Upper Caste	24	24	78	27	30	Nil
b) Schedule Caste	10	13	20	36	1	13
c) Schedule Tribe	Nil	4	8	1	3	Nil
d) Other Backward Castes	12	15	30	22	4	Nil
Hospitals	2	2	6	7	2	Nil
Schools and colleges						
a. Anganwadi	9	18	37	50	3	1
b. Primary	9	12	20	25	3	1
c. Middle	5	6	18	20	2	Nil
d. High School	3	3	5	17	2	Nil
e. College	Nil	3	1	2	Nil	Nil
Post Office	2	4	8	9	2	1
Telephone	yes	yes	yes	yes	yes	yes
Television	yes	yes	yes	yes	yes	yes

Contd....

Variables	N.E. Transitional zone	N.E. Dry Zone	N. Dry Zone	N. Transitional Zone	Hilly Zone	Coastal Zone
Villages	2	4	8	9	3	1
Source of water						
a) Domestic						
Lake	Nil	Nil	Nil	Nil	Nil	Nil
Open wells	1	Nil	8	2	3	1
Bore wells	2	4	8	9	Nil	Nil
Municipal	2	4	8	9	Nil	Nil
b) Farm						
Tube	2	4	8	9	3	1
Open	2	Nil	Nil	6	Nil	1
Ponds	1	Nil	Nil	1	Nil	Nil
Canals	2	4	1	Nil	Nil	Nil
Rain	2	4	8	9	3	1
Electricity	2	4	8	9	3	1
Transportation (Bus)	2	4	8	9	3	1
Type of Road						
a) Asphalted	1	Nil	5	9	Nil	Nil
b) Mud	2	4	1	Nil	3	1
Major Crops						
a) Cereals						
Jowar	2	4	8	9	Nil	Nil
Wheat	Nil	Nil	8	9	Nil	Nil
Rice	2	4	8	9	3	3

Contd....

Variables	N.E. Transitional zone	N.E. Dry Zone	N. Dry Zone	N. Transitional Zone	Hilly Zone	Coastal Zone
Villages	2	4	8	9	3	1
b) Pulses						
Blackgram	1	1	2	4	3	1
Greengram	2	4	4	6	3	1
Bengalgram	2	4	4	6	3	1
Redgram	Nil	4	4	6	3	1
Cowpea	2	4	Nil	Nil	Nil	Nil
c) Oil seeds						
Groundnut	Nil	4	6	9	3	1
Sunflower	2	4	6	9	Nil	Nil
Safflower	1	Nil	6	9	Nil	Nil
d) Leafy vegetables						
Fenugreek	2	4	4	9	3	1
Pundi	2	4	4	9	3	1
Coriander	2	4	4	9	3	1
Cabbage	Nil	Nil	Nil	4	Nil	1
e) Roots and tubers						
Garlic	2	4	6	4	Nil	Nil
Onion	2	Nil	6	4	Nil	Nil
Potato	Nil	Nil	6	4	Nil	Nil
Radish	2	4	4	9	3	1

Contd....

Variables	N.E. Transitional zone	N.E. Dry Zone	N. Dry Zone	N. Transitional Zone	Hilly Zone	Coastal Zone
Villages	2	4	8	9	3	1
f) Other vegetables						
Cauliflower	Nil	Nil	Nil	3	Nil	Nil
Ladies finger	2	4	6	9	3	1
Green chilly	2	4	6	9	3	1
Pumpkin	2	4	6	9	3	1
Bottle gourd	2	4	6	7	3	1
Cucumber	2	4	6	7	3	1
g) Fruits						
Guava	2	4	8	9	3	1
Lemon	2	4	8	7	3	1
Tomato	Nil	4	8	9	2	1
Sitaphal	2	4	8	Nil	Nil	Nil
Jamun	2	4	8	9	3	1
Mango	2	4	8	9	3	1

Transitional Zone and N.E. Dry Zone villages. The redgram was grown in all Zones except in N.E. Transitional Zone and cowpea was grown only in N.E. Transitional Zone and N.E. Dry Zone villages.

Among the oilseeds, groundnut was grown in all the villages except N.E. Transitional Zone villages, the sunflower and safflower was not grown in Hilly and Coastal Zones.

The leafy vegetables *viz.*, fenugreek, *'pundi'* and coriander were grown in all the villages whereas cabbage was found only in N. Transitional Zone.

The roots and tubers such as garlic, onion, potato and radish were grown in all the villages of N. Dry Zone and N. Transitional Zone whereas only radish was grown in all the six Zones.

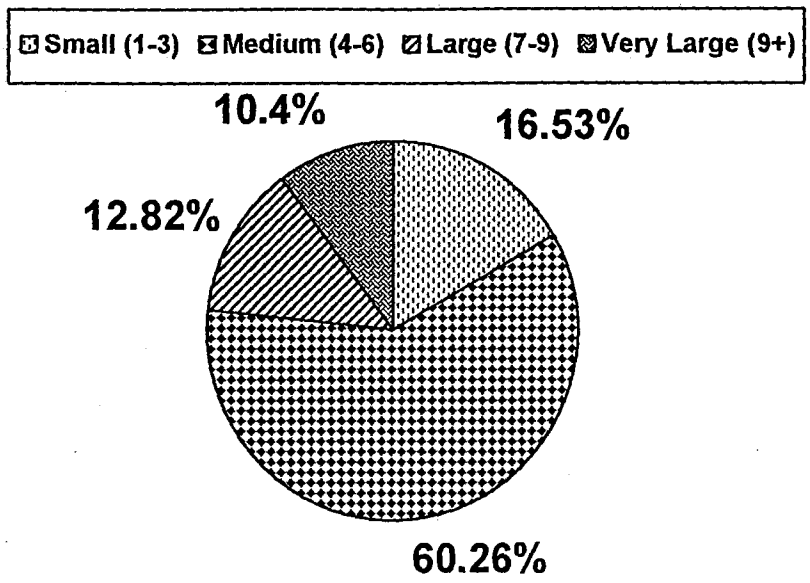
The other vegetables such as ladies finger, green chilly, pumpkin, bottle gourd and cucumber were grown in all the selected villages whereas cauliflower was grown only in three villages of N. Transitional Zone.

Among the fruits, guava, lemon, *jamun* and mango were cultivated in all the Zones whereas tomato was not found in N.E. Transitional Zone and *'Sitaphal'* (*Custard apple*) was not grown as major fruit in N. Transitional Zone, Hilly Zone and Coastal Zones.

4.1.2 Baseline information of households

The distribution of families according to family size and religion are depicted in Fig (5).

Out of the 375 families, majority of families (60.26%) had medium family size followed by small families (16.53%), large families (12.82%) and around 10.4 per cent by very large families.



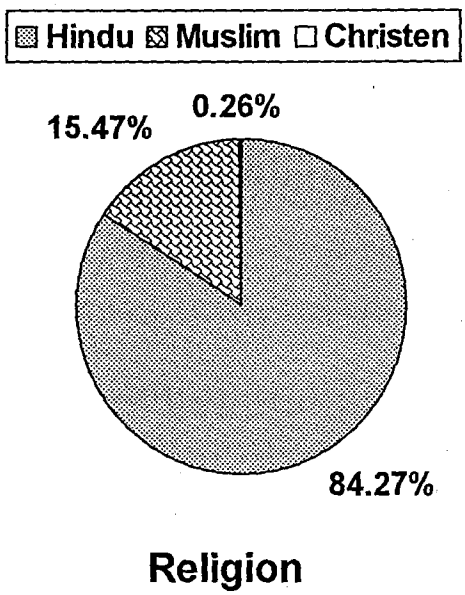


Fig 5: Distribution of families according to family size and religion

About 84.2 per cent families belonged to Hindus, followed by Muslims (25.47%) and Christens (0.26%) were the least.

The distribution of families according to education, occupation and monthly per capita income are depicted in Fig (5).

Out of 375 families, 55.22 per cent of head of the families were illiterate, 14.05 per cent of men were educated upto primary school, followed by high school (12.7%) and middle school education (10.54%), while only 7.84 per cent families had education upto college level.

The higher number of families (42.66%) were from Agriculture labourer, followed by agriculture as main occupation (30.66%), working in private firm (13.60%) and government employees (8.26%), the least (4.80%) number were from business.

Classification of families according to monthly per capita income revealed that the maximum number of families (N=131) were having monthly per capita income of Rs. 240-464 followed by 108 families with Rs. 465-784, 80 families with Rs. 785-1584 and 33 families with Rs. <240 (Fig. 6 and Appendix-VII).

4.2 NUTRIENT PROFILE OF SELECTED HOUSEHOLDS

The results of the diet survey of the families which is expressed in terms of nutrients as per Adult Consumption Unit are presented here.

Based on the information on the quantities of various foods consumed per day by selected families obtained through the diet survey and were computed to nutrients and adequacy of nutrients were calculated and the results are presented in this section irrespective of income and agro-climatic Zones variations.

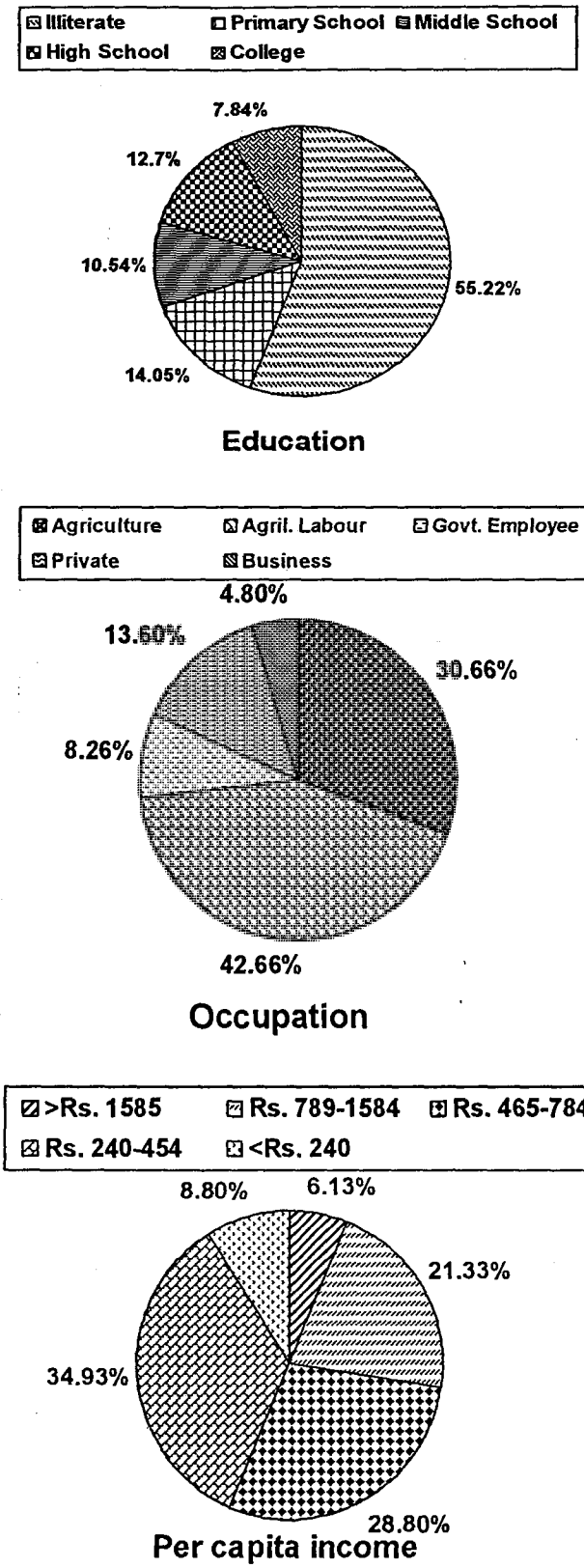


Fig 6: Distribution of families according to Education, occupation and per capita income

The mean intake and adequacy of nutrients by the families are presented in Table 4. The mean intake of energy was 1992 Kcal per day accounted 83 per cent adequacy.

The mean intake of protein was 53.79 g per day with 82.83 per cent adequacy. Though there was much variation in the intake of fat, the mean intake was 37.51g per day with an adequacy of 84.68 per cent.

The mean intake of calcium among the families was 476.13 mg per day and accounted for more than 100 per cent adequacy. Whereas the mean intake of iron was very less ie., 18.02 mg/day and this provided only 64.36 per cent of day's requirement for a sedentary male worker with Recommended Dietary Allowance (RDA) of 28 mg/day.

Similarly, the mean intake of β-carotene was very less with much variation among the families (626.13±487.76 mg/day) which accounted only 26.09 per cent of adequacy.

The mean intake of B complex vitamins *viz.*, thiamine, riboflavin and niacin were found to be 1.40±0.72 mg, 0.83±0.42 mg, and 14.88±8.14 mg per day, respectively. The per cent adequacy of these nutrients when compared to RDA was 100.00, 51.88 and 82.67 per cent, respectively.

The ascorbic acid intake was less than 70 per cent of the day's requirement with the mean intake of 29.75±17.64 mg/day.

4.2.1 Nutrient adequacy profile of families according to agro-climatic zones

The mean nutrient intake of families in terms of adult consumption unit according to different agroclimatic zones is reported in Table 5. The mean energy intake ranged from 1801 to 2343 Kcal. A significantly higher intake of energy (2343 Kcal) was recorded in families belonging to N.E. Dry Zone compared to N.E. Transitional Zone (1801 Kcal), N. Dry Zone (1845 Kcal) and

Table 4 : Mean nutrient intake and per cent adequacy of the study population

N = 375

Nutrients	RDA*	Mean	Per cent adequacy
Energy (Kcal)	2400.00	1992.73 ± 716.92	83.30
Protein (g)	60.00	53.79 ± 23.84	82.83
Fat (g)	40.00	37.51 ± 18.73	84.68
Calcium (mg)	400.00	476.13 ± 301.24	119.03
Iron (mg)	28.00	18.02 ± 10.74	64.36
β-carotene (µg)	2400.00	626.13 ± 487.76	26.09
Thiamine (mg)	1.40	1.40 ± 0.72	100.00
Riboflavin (mg)	1.60	0.83 ± 0.42	51.88
Niacin (mg)	18.00	14.88 ± 8.14	82.67
Ascorbic acid (mg)	40.00	29.75 ± 17.64	69.38

* ICMR, (Anon, 2000c)

Hilly Zone (1953 Kcal). However, not significant variation in the intake of energy was observed between the families of N.E. Dry Zone, N. Transitional Zone and Coastal Zone and also between N.E. Transitional Zone, N. Dry Zone, N. Transitional Zone, Hilly Zone and Coastal Zone.

The mean protein intake of families was highest in N.E. Dry Zone (58.57 g/day) and least in Hilly Zone (51.60 g/day). However, no significant difference was observed in the intake of protein between the different Zones.

The mean intake of fat among the selected families from different Zones ranged between 30.10 to 43.96 g/day. A significantly highest intake was in N.E. Dry Zone (43.96 g/day), N. Transitional Zone (40.23 g/day) and Coastal Zone families (43.86 g/day) when compared to N.E. Transitional Zone (30.10 g/day) and N. Dry Zone families (30.73 g/day).

The mean carbohydrate intake among the families of different agroclimatic zones ranged from 333.37 to 407.68 g/day. A significantly higher intake of carbohydrates was observed in families of N.E. Dry Zone compared to N.E. Transitional Zone. Apparently no significant difference was evident in the intake of carbohydrates between the families of N. Dry Zone, N. Transitional Zone, Hilly Zone and Coastal Zone.

The mean calcium intake was highest in the families of N.E. Dry Zone (712.71 mg/day) and least in the families of N. Dry Zone (416.31 mg/day). A significant difference in the intake of calcium was noticed between the families of N.E. Transitional Zone, N.E. Dry Zone and N. Transitional Zone. However, a not significant difference was recorded in the intake of calcium between the families of N.E. Transitional Zone and N. Dry Zone and between N.E. Dry Zone, N. Transitional Zone, Hilly Zone and Coastal Zone families.

The mean intake of iron ranged from 17.31 to 24.04 mg/100g, however, a significantly higher intake was seen in families of N.E. Dry Zone

Table 5 : Mean nutrient intake⊗ of families according to different agroclimatic zones N=375

Agroclimatic Zones	Number of families	Mean nutrient intake														
		Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)	β-carotene (µg)	Vit A (µg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	pyridoxine (mg)	Folic acid (µg)	Vit B_{12} (µg)	Ascorbic acid (mg)
N.E. Transitional zone	46	1801^{a}	50.57^{a}	30.10^{a}	333.37^{a}	389.46^{a}	17.31^{a}	505.40^{a}	129.40^{a}	1.48^{bc}	0.79^{a}	14.80^{a}	0.58^{b}	111.44^{bc}	0.15^{a}	17.53^{a}
N.E. Dry Zone	56	2343^{b}	58.57^{a}	43.96^{b}	407.68^{b}	712.71^{c}	24.04^{b}	798.03^{b}	211.68^{c}	1.72^{c}	1.05^{b}	19.67^{b}	0.60^{b}	126.58^{c}	0.62^{b}	17.29^{a}
N. Dry Zone	136	1845^{a}	51.74^{a}	30.73^{a}	339.72^{ab}	416.31^{a}	18.17^{a}	743.17^{b}	194.25^{bc}	1.47^{bc}	0.84^{a}	15.06^{a}	0.47^{b}	120.78^{bc}	0.33^{ab}	15.42^{a}
N. Transitional Zone	86	2014^{ab}	55.29^{a}	40.23^{b}	357.53^{ab}	552.94^{b}	19.59^{a}	656.33^{ab}	169.29^{abc}	1.53^{c}	0.93^{ab}	15.79^{a}	0.48^{b}	118.45^{bc}	0.32^{ab}	19.54^{a}
Hilly zone	38	1953^{a}	51.60^{a}	39.76^{b}	348.11^{ab}	592.06^{bc}	18.58^{a}	744.38^{b}	187.88^{abc}	1.22^{ab}	0.95^{ab}	16.57^{ab}	0.10^{a}	94.86^{ab}	0.48^{ab}	14.97^{a}
Coastal zone	13	2026^{ab}	56.69^{a}	43.86^{b}	350.64^{ab}	533.63^{bc}	17.35^{a}	508.83^{a}	136.15^{ab}	1.31^{a}	0.95^{ab}	16.71^{ab}	0.10^{a}	77.79^{a}	0.20^{a}	19.37^{a}
	F value	4.299	1.451	8.595	2.030	12.120	3.720	2.880	3.280	4.210	4.030	3.820	110.65	2.51	3.27	0.99

⊗ Computed values

Note: Non identical superscripts indicates significance at 5% level, as per DMRT.

compared to all other five Zones. No significant difference was evident between the families of N.E. Transitional Zone, N. Dry Zone, N. Transitional Zone, Hilly Zone and Coastal Zone.

The mean intake of β-carotene was highest in families of N.E. Dry Zone (798.03 µg/day) but comparable with N. Dry Zone (743.17 µg/day), N. Transitional Zone (656.33 µg/day) and Hilly Zone (744.38 µg/day) families. However, a significantly lower intake was recorded in the families of N.E. Transitional Zone and Coastal Zone.

The mean thiamine intake of families ranged from 1.22 to 1.72 mg/day. The lowest intake was recorded in Hilly Zone families and highest intake in N.E. Transitional Zone families and varied significantly. No significant difference was visible in the intake of thiamine among the families of N.E. Transitional Zone, N.E. Dry Zone, N. Dry Zone and N. Transitional Zone and also among the families of N.E. Transitional Zone, N. Dry Zone and Hilly Zone. The intake of thiamine in the families of the Hilly Zone and Coastal Zone were also comparable.

The mean intake of riboflavin was highest in families of N.E. Dry Zone (1.05 mg/day) followed by Hilly and Coastal Zone (0.95 mg/day), N. Transitional Zone (0.93 mg/day), N. Dry Zone (0.84 mg/day) and least by N.E. Transitional Zone families (0.79 mg/day). A significantly higher intake was in N.E. Dry Zone families compared to N. Dry Zone and N.E. Transitional Zone families.

The mean intake of niacin among the families of different Zones ranged from 14.80 to 19.67 mg/day. The highest intake was recorded by families of N.E. Dry Zone (19.67 mg/day) and varied significantly with N.E. Transitional Zone (14.80 mg/day), N. Dry Zone (15.06 mg/day) and N. Transitional Zone families (15.79 mg/day).

The mean intake of pyridoxine (Vitamin B_6) was lowest in Hilly and Coastal Zone families (0.10 mg/day) and varied significantly from N.E. Transitional Zone (0.58 mg/day), N.E. Dry Zone (0.60 mg/day), N. Dry Zone (0.47 mg/day) and N. Transitional Zone families (0.48 mg/day).

The mean intake of folic acid ranged between the families of different Zones from 77.79 to 126.58 µg/day. No significant difference in the intake of folic acid was observed among the families of N.E. Transitional Zone, N. Dry Zone, N. Transitional Zone and Hilly Zone.

The intake of cyanocobalamine (Vitamin B_{12}) was highest in the families of N.E. Dry Zone (0.62 mg/day) followed by Hilly Zone (0.48 mg/day), N. Dry Zone (0.33 mg/day), N. Transitional Zone (0.32 mg/day), Coastal Zone (0.20 mg/day) and least by N.E. Transitional Zone families (0.15 mg/day). A significantly lower intake was recorded in the families of N.E. Transitional Zone and Coastal Zone compared to N.E. Dry Zone families.

The mean ascorbic acid intake of the families ranged from 14.97 to 19.54 mg per day. It was interesting to note that there was no significant difference observed among the families of different agroclimatic Zones of Northern Karnataka.

4.2.2 Nutrient intake of families (per Adult Consumption Unit) based on monthly per capita income

The mean nutrient intake of the selected families were classified according to their monthly per capita income irrespective of agroclimatic Zones and the results are presented in Table 6.

It was observed from the table that as the income level increased, energy consumption level was also increased, while such trend was not evidenced for other nutrients. Only energy (2207 Kcal) calcium (562.27 mg) and ascorbic acid (55.93 mg) intake was highest in I group and protein (50.61g) and

Table 6: Mean nutrient intake of families[⊗] based on monthly per capita income

Nutrients	Mean Nutrient intake				
	Monthly per capita income [⊗⊗]				
	I (Rs. 1585 & above)	II (Rs. 785-1584)	III (Rs. 465-784)	IV (Rs.240-464)	V (<Rs.240)
Energy (Kcal)	2207±764	2099 ± 742	1971 ± 743	1953 ± 677	1815 ± 658
Protein (g)	48.90 ± 33.96	50.61 ± 29.47	49.92 ± 20.13	49.71 ± 21.32	47.67 ± 22.26
Fat (g)	34.11 ± 23.40	31.15 ± 19.62	38.71 ± 20.90	32.88 ± 15.02	28.14 ± 15.99
Carbohydrate (g)	291.33 ± 215.29	333.16 ± 198.09	333.40 ± 137.16	333.36 ± 120.09	316.55 ± 148.05
Calcium (mg)	562.27 ± 449.19	435.35 ± 294.89	494.69 ± 288.90	498.20 ± 294.50	366.73 ± 225.66
Iron (mg)	17.42 ± 12.24	12.86 ± 11.62	18.03 ± 9.56	18.49 ± 11.43	16.85 ± 8.55
β-carotene (µg)	502.97 ± 364.31	534.84 ± 506.09	731.81 ± 573.37	627.61 ± 423.54	578.28 ± 390.12
Vitamin A (µg)	132.05 ± 93.11	141.23 ± 133.36	188.35 ± 145.12	162.63 ± 107.65	153.14 ± 110.34
Thiamine (mg)	1.22 ± 0.82	1.41 ± 0.88	1.45 ± 0.67	1.40 ± 0.65	1.34 ± 0.67
Riboflavin (mg)	0.80 ± 0.54	0.83 ± 0.50	0.85 ± 0.35	0.85 ± 0.42	0.72 ± 0.35
Niacin (mg)	13.22 ± 9.85	14.61 ± 9.42	15.82 ± 7.80	14.91 ± 7.52	13.50 ± 6.93
Pyridoxine (mg)	0.32 ± 0.29	0.47 ± 0.36	0.39 ± 0.26	0.58 ± 0.50	0.51 ± 0.39
Folic acid (µg)	95.56 ± 84.04	116.64 ± 90.65	106.93 ± 54.78	106.70 ± 57.79	99.29 ± 55.25
Ascorbic acid (mg)	55.93 ± 39.95	33.63 ± 31.34	29.53 ± 24.85	30.27 ± 18.09	23.21 ±18.58

[⊗] Based on adult consumption units.

[⊗⊗] According to Prasad (1991).

folic acid (116.64 mg) were highest in II group. On the contrary, most of the nutrients *viz.*, fat (38.71 g), carbohydrate (333.40 g), carotene (731.81 µg), vitamin A (188.35 µg), Thiamine (1.45 mg) and riboflavin (0.85 mg) intake was highest in III group. In general, it was observed that the intake of most of the nutrients were very less in V group whose monthly per capita income was <Rs. 240.

The nutrient adequacy of subjects belonging to different monthly per capita income categories is presented in Fig. 7 and Appendix-VIII.

The per cent adequacy of energy was more than 80 per cent for all the income groups except V group which was 75.62 per cent. The protein adequacy ranged from 79.45 to 84.35 per cent. The adequacy for fat was highest in the income group III (96.76%) followed by I group (85.26%), IV group (82.20%) and II group (77.58%) and least by V group (70.35%). The adequacy for calcium was more than 100 per cent for all the groups of income categories except V group. However, there was not much difference in the per cent adequacy of iron which ranged from 60.18 to 66.04 per cent. The β-carotene adequacy was less than 30 per cent in all the five income groups. On the contrary, the thiamine adequacy was more than 85 per cent highest being in III group (103.57%) and least in I group (87.14%). The riboflavin adequacy ranged from 45 to 53.13 per cent among different income groups, highest recorded in III & IV group and least in V group. A similar trend was also noticed for niacin adequacy. However, the per cent adequacy of ascorbic acid was highest in I group which was more than 100 per cent followed by II group (84.07%), IV group (75.68%), III group (73.83%) least in V group (58.03%).

The adequacy of selected nutrients *viz.*, energy, protein, iron and β-carotene by the families were further classified into ≥100 per cent, <100-75 per cent, <75-50 per cent and <50 per cent according to their monthly per capita

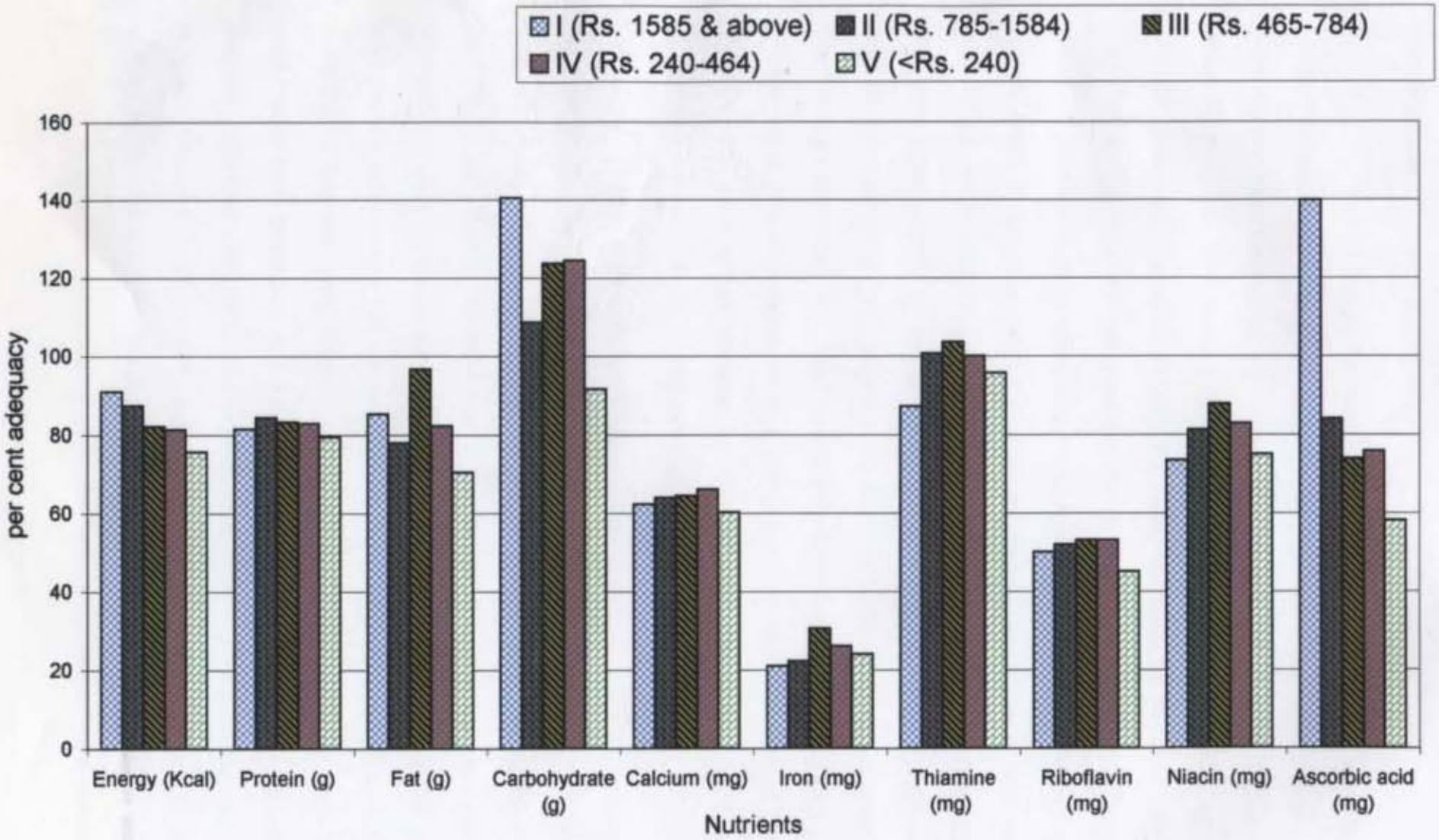


Fig. 7: Nutrient adequacy of families based on monthly per capita income

income classification. The results are depicted in Fig. 8,9,10 and 11, respectively.

Out of the 23 families in I group, four families had adequacy more than 100 per cent, while equal number (n=4) had energy <100-75 per cent and <75-50 per cent adequacy and only three families had energy adequacy less than 50 per cent. In income group II, maximum number of families (n=29) had energy adequacy between <75-50 per cent, followed by families with (n=19) families in the <100-75 per cent adequacy and equal number of families (16 families) had the energy adequacy >100 and <50 per cent. A similar trend was documented in III group, with maximum number of families in energy adequacy <75-50 per cent followed by <100-75 per cent, <50 per cent and least in >100 per cent adequacy. In IV group, out of 131 families, majority of families (n=57) had energy adequacy <75-100 per cent, followed by 32 families with <100-75 per cent energy adequacy and least (n=20) were in <50 per cent adequacy group. A similar trend was also observed in V group with maximum number of families in <75-100 per cent group followed by <100-75 per cent group, ≥100 per cent group and only one family in <50 per cent group (Appendix IX).

The adequacy for protein when observed for different per capita income groups showed that maximum number of families (47.82%) in I group had adequacy ≥100 per cent followed by <75-50 per cent adequacy (26.08%) and 13.04 per cent of families had <100-75 per cent and 50 per cent protein adequacy, respectively, similarly in II group, out of 80 families 62.50 per cent had protein adequacy ≥100 per cent followed by 33.75 per cent with <75-50 per cent, 23.75 per cent with <100-75 per cent protein adequacy and only 5.00 per cent had protein adequacy less than 50 per cent, whereas in III group, maximum number of families (37.04%) had protein adequacy <75-50 per cent followed by protein adequacy <100-75 per cent, ≥100 per cent and least in <50 per cent group. In IV and V group maximum number of families had protein adequacy

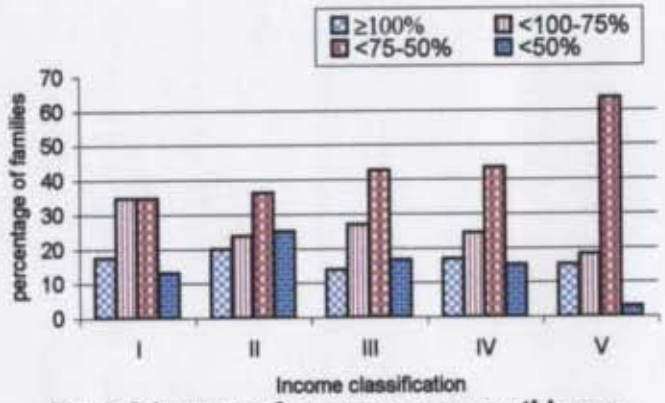


Fig. 8:Adequacy of energy as per monthly per capita income classification

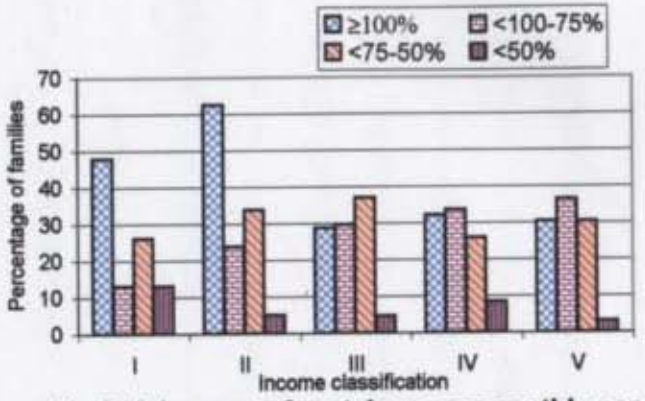


Fig 9: Adequacy of protein as per monthly per capita income classification

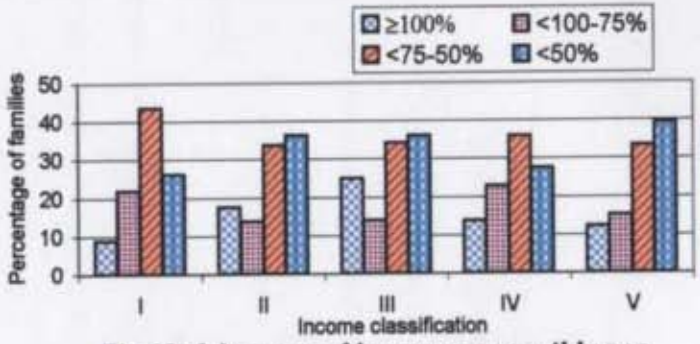


Fig 10: Adequacy of iron as per monthly per capita income classification

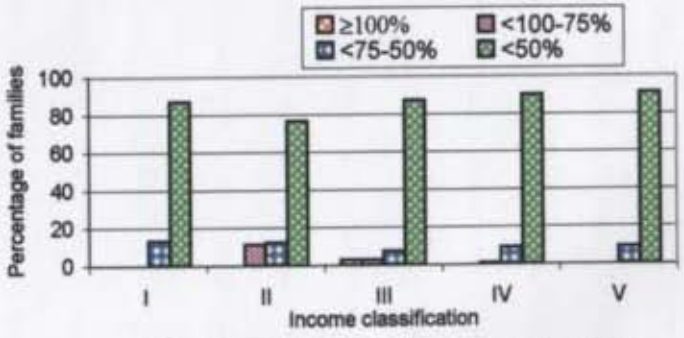


Fig 11: Adequacy of β-carotene as per monthly per capita income classification

<100-75 per cent (33.59 and 36.36%, respectively) and least number of families with protein adequacy of <50 per cent (8.42 and 3.03%, respectively) (Appendix-X).

The adequacy of iron among the families of different income levels revealed that, I and IV group had maximum number of families (N=10 and 47, respectively) with iron adequacy of <75-50 per cent followed by <50 per cent adequacy, <100-75 per cent and least with ≥100 per cent adequacy, however, in II, III and V group the maximum number of families had adequacy less than 50 per cent followed by <75-50 per cent adequacy and less number of families had iron adequacy ≥100 per cent in V group. In II and III group, 13.75 per cent and 13.88 per cent of families had adequacy <100-75 per cent (Appendix-XI).

The adequacy of β-carotene when compared with per capita income of family, a general trend was observed irrespective of income classification. The maximum number of families in all the income groups had β-carotene adequacy less than 50 per cent followed by <75-50 per cent. Only three families in III group had β-carotene adequacy ≥100 per cent and none from I and V group had adequacy <100-75 per cent (Appendix-XII).

4.3 DOCUMENTATION AND NUTRIENT ANALYSIS OF UNDERUTILIZED FOODS

The underutilized foods were defined in the present investigation as the foods which are less available, less utilized or rarely used or region specific. The documentation and nutrient analysis of selected underutilized foods are presented here.

4.3.1 Documentation of underutilized foods

The underutilized foods were documented and grouped as millets, pulses, oilseeds, vegetables, leafy vegetables, fruits, spices and condiments and others (Table 7).

Table 7: Documentation of Underutilized foods of Northern Karnataka

Sl. No.	Name	Season	Source of collection	Market availability	Use	Reasons for use	Storage period
MILLETS							
1	Foxtail millet (*Setaria italica*)	*Kharif*	Less cultivated	Yes	Rice, *Holige*	Cheaply available	1 Year
2	Little millet (*Panicum miliare*)	*Kharif*	-do-	Yes	Rice	-do-	1 Year
3	Proso Millet (*Panicum miliaceum*)	*Kharif*	-do-	No	Rice	-do-	1 Year
4	Kodo millet (*Paspalum scrobiculatum*)	*Kharif*	-do-	No	Rice	-do-	1 Year
5	Maize (*Zea mays*)	*Kharif*	-do-	Yes	Roti, *Upama*	-do-	1 Year
6	Ragi (*Eleusine coracana*)	*Kharif*	-do-	Yes	*Roti, Ambali, Dosa*, Porridge, Malt	-do-	1 Year
7	Bajra (*Pennisetum hyphosdeum*)	*Kharif*	-do-	Yes	*Roti*	-do-	1 Year
8	Barnyard millet (*Echinochloa frumentacea*)	*Kharif*	-do-	No	Rice	-do-	1 Year
PULSES							
1	Horse gram (*Dolichos biflorus*)	*Rabi*	From market	Yes	*Bhaji, Sangati*, Curry	Good for health	1 Year
2	Cowpea (*Vigna catjang*)	*Rabi*	From market	Yes	*Bhaji, Vada*	Cheaply available	3 months
3	*Channangi* (*Lathyrus satius*)	*Rabi*	From market	Yes	Curry	-do-	-do-
4	*Lenki* (*Lens culanaris*)	*Rabi*	Less cultivated	No	Curry, *Junaka*	-do-	-do-
5	*Aware* (*Dolichos lablab*)	*Rabi*	From market	Yes	*Bhaji*	-do-	-do-
6	Soybean (*Glycine max*)	*Rabi*	From market	Yes	*Vada*	Good for health	6 months
7	Black green gram (*Phaseolus aureus*)	*Rabi*	From market	Yes	*Bhaji*	Easily available	3 months

Sl. No.	Name	Season	Source of collection	Market availability	Use	Reasons for use	Storage period
OIL SEEDS							
1	*Linseed* (*Linum usitatissimum*)	*Kharif*	From market	Yes	*Chutney*	Good for health	1 Year
2	*Niger* (*Guizotia abyssinica*)	*Kharif*	-do-	Yes	*Chutney*	-do-	1 Year
3	Gingally (*Sermum indicum*)	*Kharif*	-do-	Yes	*Chutney*	-do-	1 Year
4	Sunflower (*Helianthus annus*)	All season	-do-	Yes	*Chutney*	-do-	1 Year
5	Safflower (*Carthamus tinctorius*)	Winter season	-do-	Yes	Milk extracted from safflower is used for preparation of Rice *payasam*	Festival food	1 Year
VEGETABLES							
1	*Karchikai* (*Luffa tuberosa*)	Rainy season	Gathered, from market	Yes	*Bhaji, sandige*	Good for health	4 days
2	*Mekkikai* (*Cucurbitace spp.*)	Rainy season	-do-	Yes	*Bhaji*, pickle	Cheaply available	1 week
3	*Tondekai* (*Coccinia indica*)	Rainy season	From market	Yes	*Bhaji*	Easily available	3 days
4	*Padavalkai* (*Trichosanthes anguina)*	Rainy season	-do-		*Bhaji, Bhajje*	-do-	3 days
5	*Adavi hagal* (*Momordica dioica*) bittergourd small	Rainy season	Gathered, from market	Yes	*Bhaji*	Good for health	5 days
6	*Mulangi kai* (*Raphamus sativa*)	Winter season	From market	Yes	*Bhaji*	Easily available	3 days
7	*Challikai*	Summer season	Gathered, from market	Yes	Pickle	-do-	4 days
8	*Gulladkai* (*Cucurbitace spp.*)	Rainy season	From market	Yes	*Bhaji*	-do-	3 days
9	*Tottlakai*	Rainy season	Gathered	No	*Bhaji*		4 days

Sl. No.	Name	Season	Source of collection	Market availability	Use	Reasons for use	Storage period
10	*Tuparikai* (*Luffa cylindrica*)	Rainy season	From market	Yes	*Bhaji, bhajje*	Easily available	3 days
11	*Gonchal hirekai*	Rainy season	From market	Yes	*Bhaji*	-do-	3 days
12	*Mogekai* (*Cucurbitace spp.*)	Rainy season	Cultivated & from market	Yes	*Huli Dosa, sambar* & curry	-do-	6 months
13	*Sorekai* (Bottle gourd) (*Lagenaria vulgaris*)	Rainy season	-do-	Yes	*Bhaji, Halwa*	-do-	4 days
14	*Halsinakai* (Jackfruit raw) (*Artocarpus heterophyllus*)	Rainy season	-do-	Yes	*Bhaji*	Easily available	1 week
15	*Sandige Kumbal* (Ash gourd) (*Benincasa hispida*)	Winter season	-do-	Yes	Curry, *Sandige*	-do-	9 months
LEAFY VEGETABLES							
1.	*Ondelaga* leaves (Bhrami) (Centella a*siatica*)	All season	From Kitchen garden	No	*Tambuli*	Good for health	2 days
2.	*Honaganne* (*Alternanthera sessilis*)	Rainy season	Gathered	No	*Bhaji*	Cheap, easily available	-do-
3.	*Hakkaraki* (*Lactnca sativa*)	Rainy season	From field, market	Yes	Salad	-do-	-do-
4.	*Anni soppu* (*Celosia argentea*)	Rainy season	Gathered	No	*Bhaji*	-do-	-do-
5.	*Doddagoli soppu* (*Portulaca oleracea*)	Rainy season	Gathered	No	*Bhaji*	-do-	-do-
6.	*Sannagoli soppu* (*Portulaca quadrifida*)	Rainy season	Gathered	No	*Bhaji*	-do-	-do-
7.	*Kiraksali* (*Amranthus volygonoides*)	Rainy season	From field, market	Yes	*Bhaji*	-do-	-do-
8.	*Haravi* (*Amaranthus voridis*)	All season	From field, market	Yes	*Bhaji*	-do-	-do-
9.	*Mulla Haravi* (*Amaranthus spinosus*)	All season	Gathered	No	*Bhaji*	-do-	-do-

Sl. No.	Name	Season	Source of collection	Market availability	Use	Reasons for use	Storage period
10.	Bengalgram leaves (*Kadli soppu*) (*Cicer arietinum*)	Winter season	From market	Yes	*Bhaji*	-do-	-do-
11.	Safflower (*Kusubi soppu*) (*Carthamus tinctorius*)	Winter season	From field, market	Yes	*Bhaji*	-do-	-do-
12.	Cowpea leaves (*Alasandi soppu*) (*Vigna catjung*)	Winter season	From field	No	*Bhaji*	-do-	-do-
13.	*Gorgi soppu* (*Digeria arvensis*)	Rainy season	Gathered	No	*Baji*, Curry	-do-	-do-
14.	*Hunasik* (*Rumex vesicarius*)	All season	From market	Yes	*Bhaji, Tambuli*	-do-	-do-
15.	*Kesuvin soppu* (*Colocasia anti-quorum*)	All season	From Kitchen garden	No	*Vada*	-do-	-do-
16.	*Kolani soppu* (*Polygonum spp.*)	Rainy season	Gathered	No	*Bhaji*	-do-	-do-
17.	*Dagadi soppu* (*Cocculus villosus*)	Rainy season	Gathered	No	*Bhaji*	-do-	-do-
18.	*Basale soppu* (*Basella rubra*)	All season	From Kitchen garden	Yes	*Bhaji*. Curry	Good for health	-do-
19.	*Nuggi soppu* (*Moringa olifera*)	Rainy season	From field	No	*Bhaji*	Good for health	-do-
20.	*Buttal haravi*	Rainy season	From field, market	Yes	*Bhaji*	Easily available	-do-
21.	*Kempu haravi*	Winter season	From field, market	Yes	*Bhaji*	Easily available	-do-
22.	Onion stalk (*Allium cepa*)	Rainy season	From field, market	Yes	*Bhaji*, Salad	Easily available	-do-
23.	*Chakramuni* leaves (*Sauropus androgynans*)	All season	Collected	No	*Bhaji*	Good for health	-do-
24.	*Tortagi soppu* (*Cassia sereccea*)	Rainy season	Gathered	No	*Bhaji*	Easily available	-do-
25.	*Elevarege* (*Cassia sophova*)	All season	Gathered	No	*Tambuli*	Easily available	-do-

Contd...

Sl. No.	Name	Season	Source collected	Availability in market	Form used	Reasons	Storage period
26.	*Chadanabatt* leaves (*Chenopodium album*)	Winter season	From market	Yes	*Bhaji*	Easily available	-do-
27.	*Garlic leaves* (*Allium sativum*)	Rainy season	From market	Yes	*Bhaji*	Easily available	-do-
28.	*Vibhooti soppu*	Rainy season	Gathered	No	*Bhaji*	Easily available	-do-
29.	*Gulgulki soppu*	Rainy season	Gathered	No	*Bhaji*	Easily available	-do-
30.	*Uttarani soppu* (*Achyranthus aspera*)	Rainy season	Gathered	No	*Bhaji*	Easily available	-do-
31.	*Hallad soppu*	Rainy season	Gathered	No	*Bhaji*	Easily available	-do-
32.	*Sambar soppu*	All season	From Kitchen garden	No	*Tambuli, Chutney*	Good for health, Easily available	-do-
33.	*Munchikudi soppu* (*Artemisia nilagivica*)	Rainy season	From Kitchen garden	No	*Bhaji*	Easily available	-do-
34.	*Kannekudi* (*Commelina nudiflora*)	Rainy season	From Kitchen garden	No	*Bhaji*	Easily available	-do-
35.	*Pundi soppu* (*Hibiscus cannabinus*)	All season	From market	Yes	*Bhaji, Chutney*	Cheaply available	-do-
36.	*Rajagira* (*Amaranthus paniculatus*)	Rainy season	From market	Yes	*Bhaji*	Cheaply available	-do-
37.	*Chunchal soppu*	Rainy season	Gathered	No	*Bhaji*	Easily available	-do-
38.	*Kalla Sabbasigi*	Rainy season	Gathered	No	*Bhaji*	Easily available	-do-
39.	*Arthagundige soppu*	All season	From Kitchen garden	No	*Bhaji, Tambuli*	Easily available	-do-
40.	Mustard leaves (*Sasive soppu*) (*Brassica campestrus*)	*Kharif*	From field	No	*Bhaji*	Easily available	-do-

Sl. No.	Name	Season	Source of collection	Market availability	Use	Reasons for use	Storage period
FRUITS							
1.	Ber (*Zyzyphus jujuba*)	Winter season	Gathered, market	Yes	Fruit	Easily available	5 days
2.	Banana (Red)	All season	Market	Yes	Fruit	Good for health	2 days
3.	*Neeral hannu* (Jamoon) (*Syzygium cumini*)	Rainy season	Gathered, Market	Yes	Fruit	Good for diabetes	4 days
4.	*Paragi hannu* (*Z. oenophlia*)	Summer season	Gathered, Market	Yes	Fruit	Easily available	4 days
5.	*Sitaphal* (*Anona squomosa*)	Rainy season	Gathered, Market	Yes	Fruit, jam	Good for health	4 days
6.	*Nellikai* (Amla) (*Emblica officinalis*)	Winter season	Gathered, Market	Yes	Fruit, jam	Good for health	1 week
7.	*Damani hannu*	Rainy season	Gathered	No	Fruit	Good for health	4 days
8.	*Sampige hannu* (*Flacortia spp.*)	Rainy season	Gathered	No	Fruit	Easily available	3 days
9.	*Mulla hannu* (*Zizyhus rugosa*)	Rainy season	Gathered	Mo	Fruit	Easily available	3 days
10.	*Halasina hannu* (Jackfruit)	All season	From Kitchen garden, Market	Yes	Fruit, *papad*	Easily available	3 days
11.	*Kavali hannu* (*Carissa curundus*)	Summer season	Gathered, Market	Yes	Fruit	Easily available	3 days
12.	*Hippali hannu*	Rainy season	Gathered	No	Fruit	Good for health	3 days
13.	*Kaki hannu* (*Diospyros kaki*)	Winter season	Gathered	No	Fruit	Easily available	3 days
14.	*Kari hannu* (*Canthium sps.*)	Rainy season	Gathered	No	Fruit	Easily available	3 days
15.	*Nurkal hannu* (*Buchannia latifolia*)	Rainy season	Gathered	No	Fruit	Acidulant	5 days
16.	*Madal hannu* (*Citrus medica*)	Rainy season	Gathered	No	Fruit	Easily available	3 days
17.	*Echal hannu* (*Pheoenix humilis*)	Rainy season	Gathered	No	Fruit	Easily available	4 days

Sl. No.	Name	Season	Source of collection	Market availability	Use	Reasons for use	Storage period
18.	*Salle hannu*	Rainy season	Gathered	No	Fruit	Easily available	4 days
19.	*Holedasal hannu*	Rainy season	Gathered	No	Fruit	Easily available	4 days
20.	*Bikki hannu*	Rainy season	Gathered	No	Fruit	Easily available	2 days
21.	*Gerhannu*	Summer season	Gathered	No	Fruit	Easily available	2 days
22.	*Majjigekai*	Rainy season	Gathered	No	Fruit	Easily available	4 days
23.	*Ramphala (Annona reticulate)*	Winter season	From Kitchen garden, Market	Yes	Fruit	Good for health	3 days
24.	*Aatti hannu (Ficus carica)*	Summer season	Gathered	No	Fruit	Easily available	3 days
25.	*Kanchi kai*	Rainy season	From Kitchen garden, Market	Yes	Fruit	For pickle	1 week
26.	*Bael hannu (Aegle marmelos)*	Winter season	Gathered	No	Fruit, pickle, juice	Easily available	1 week
27.	*Ilachi hannu*	Summer season	Gathered, Market	Yes	Fruit, jam	Easily available	3 days
28.	*Golgolake hannu*	Summer season	Gathered	No	Fruit	Easily available	2 days
29.	*Bidarin hannu*	Summer season	Gathered	No	Fruit	Easily available	2 days
30.	*Simbal hannu (Strychnos potatorum)*	Summer season	Gathered	No	Fruit	Easily available	2 days
31.	*Dobbagolli hannu*	Summer season	Gathered	No	Fruit	Easily available	1 days
32.	*Sunnad hannu*	Rainy season	Gathered	No	Fruit	Easily available	3 days

Sl. No.	Name	Season	Source of collection	Market availability	Use	Reasons for use	Storage period
33.	*Tumari hannu*	Rainy season	Gathered	No	Fruit	Easily available	2 days
34.	*Bugudi hannu*	Rainy season	Gathered	No	Fruit	Easily available	2 days
35.	*Huli hannu* (*Flueggca sps.*)	Rainy season	Gathered	No	Fruit	Easily available	2 days
36.	*Avate kai*	Rainy season	Market	Yes	Fruit, pickle	For pickle making	5 days
37.	*Amate kai*	Rainy season	Market	Yes	Fruit, pickle	For pickle making	5 days
38.	*Kekkar hannu* (*Cucurbitace sps.*)	Summer season	Market	Yes	Fruit	Good for health	4 days
39.	*Godambi*	Winter season	Market	Yes	Fruit, juice	Good for health	3 days
40.	*Rasapuri hannu*	Summer season	Market	Yes	Fruit, juice	Good for health	3 days
SPICES AND CONDIMENTS							
1	*Jumman kai*	Rainy season	Market	Yes	As a spice for fish curry	As a spice for fish curry	1 year
2	Tamarind (*Tamrindus indica*)	Summer season	From field, market	Yes	As Acidulant	Easily available	-do-
3	*Huli soppu* (*Mangifera indica*)	Summer season	From field	No	As Acidulant	Easily available	-do-
4	*Amasol* (*Garcinia indica*)	Summer season	From field, market	Yes	As Acidulant	Easily available, Good for health	-do-
5	*Vatehuli* (*Artocarpus lakoocha*)	Summer season	Gathered	No	As Acidulant	Easily available	-do-
6	*Ambi kombe* (mango ginger) (*Curcuma amada*)	All season	From Kitchen garden	No	Flavouring agent	Easily available, Good for health, for flavour	1 week
OTHERS							
1	*Kalale* (Bamboo shoot)	Rainy season	Gathered	Yes	*Bhaji*, Pickle, *Vada*	Easily available	1 day
2	*Alambi* (Mushroom)	Rainy season	Gathered, Market	Yes	*Bhaji*	Good for health	1 day
3	Honey	All season	Gathered, Market	Yes	Honey	Good for health, and as a medicine	1 year

4.3.1.1 Millets

A total of eight millets were documented as underutilized foods from different agroclimatic Zones of Northern Karnataka. They were usually grown in *kharif* season, and were cultivated in lesser amounts and available in nearby market except proso and kodo millet. The millets were used in the form of rice except bajra which was used in the form of *roti* (unleavened bread). These documented millets were in expensive and could be stored for one year without any processing (Plate 8).

4.3.1.2 Pulses

Seven underutilized pulses were documented *viz.*, Horsegram, Cowpea, Channagi, *Lenki*, Aware, *Soya*bean and Black green gram. All the pulses were grown in *Rabi*. Except *Lenki* rest were available in the nearby market. These pulses were generally used for making *bhaji* and curry. However, *Lenki* was used for preparing *'junaka'* a gelatinized gram flour savoury dish. These documented pulses were used because they were available at low cost and horsegram were used because it is good for health. These pulses can be stored for three months except *soya*bean and horsegram which could be stored for six months and one year, respectively (Plate 9).

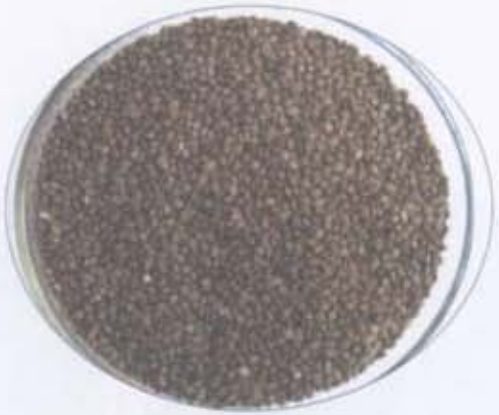
4.3.1.3 Oil seeds

The underutilized oil seeds documented were Linseed, Nigerseed, Gingily seed, Sunflower and Safflower seeds. The Linseed, Nigerseed and Gingily seed were grown in *kharif* season and Safflower in winter season and Sunflower generally in all seasons. These were collected from the nearby market. All the oilseeds except the safflower seeds were used for *chutney* powder preparation whereas the Safflower seed was used for preparing rice *payasam,* a sweet dish. These oilseeds were used mainly because they were good for health and can be stored for one year.

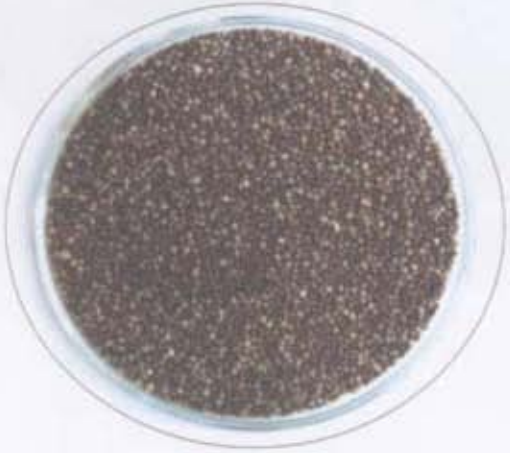
Millets

Foxtail millet

Little millet



Kodo millet



Ragi

Barnyard millet

Proso millet

Plate 8: Documented underutilized millets

Pulses

Horsegram | *Aware* | Winged bean | *Lenki*

Plate 9: Documented underutilized pulses

4.3.1.4 Vegetables

A total of 15 underutilized vegetables were documented from the different agroclimatic regions. Most of the vegetables were grown in rainy season except Radish *kai* (*Mulangikai*) and Ashgouard which were available in winter season. All the documented vegetables were available in the respective local markets and generally used for *bhaji* preparation whereas *Mekkikai, Karchikai, Challakai* were used for preparing pickles, *Mogekai* and Ashgourd for curry preparation. The *Mogekai* was also used for preparation of *Hulidosa* (fermented *dosa*). The vegetables were used mainly because they were inexpensive and good for health. These vegetables could be stored for 3-4 days at ambient condition except the *Mogekai* and Ashgourd which can be stored even for six and nine months, respectively (Plate 10).

4.3.1.5 Leafy vegetables

Most of the leafy vegetables were available in the rainy season except *Ondelaga, Haravi, Mulla Harvi, Hunasik, Kesnuvinsoppu, Basale soppu, Sambar soppu, Pundi soppu, Arthgundige soppu, Chakramuni* and *Yelevarage* which were available through out the year. The green leafy vegetables such as Bengal gram leaves, Safflower leaves, Cowpea leaves and *chandanbatta* leaves were available in winter season. The leafy vegetables were picked and procured from different sources such as kitchen garden, gathered, for fields cultivated and also purchased from local markets. However, many leafy vegetables were not available in the market and procured from nearby agricultural lands and were mostly used for *bhaji* preparation and were consumed because available at low cost and considered good for health. These vegetables could be stored only for two days without processing at room temperature (Plate 11).

4.3.1.6 Fruits

Varieties of fruits were available in the Northern Karnataka and the underutilized fruits documented were 40 in number. These fruits were available

Vegetables

Karchikai

Adavi hagal

Mogekai

Plate10: Documented underutilized vegetables

Leafy vegetables

Ondelga leaves

Honaganne soppu

Hakkaraki

Sannagoli soppu

Doddagole soppu

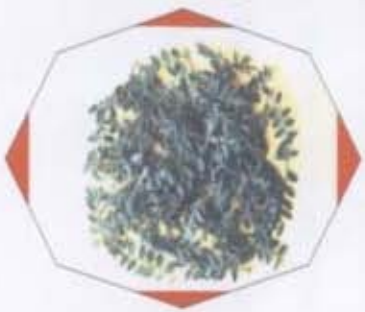
Arthagundige soppu

Sambar soppu

Chakramuni leaves

Chandanabatta soppu

Yelewaragi



Bengalgram leaves

Plate 11: Documented underutilized leafy vegetables

either in summer, winter or rainy season and were definitely season bound. Most of the fruits were gathered from the nearby forest; very few fruits were available rarely in the local market. In general, fruits were consumed for table purpose whereas *Kanchikai, Awatekai* and *Amatekai* were used for making pickles. The utility of fruits was based on easy availability in nearby forest for people of particular region. In general, the fruits were stored without any processing for 2-5 days (Plate 12).

4.3.1.7 Spices and condiments

The spices and condiments documented as underutilized foods were '*Jumman kai*', Tamarind, *Amasol, Vatehuli* and Mango ginger. They were available only in particular agroclimatic areas. All the spices and condiments were available in summer except the *Jumman kai* and Mango ginger, which were available in rainy and throughout the year, respectively. The *Jummankai,* Tamarind and *Amasol* were procured from the local markets while *Valehuli* from nearby forest and Mango ginger from kitchen gardens. All the spices and condiments were used as acidulent except the *Jummankai* as spices for fish curry and mango ginger as flavouring agent in *chutney* preparation. This group of foods were stored with processing as powder for one year and Mango ginger as fresh for short period ie., for one week (Plate 13).

4.3.1.8 Others

The foods such as tender bamboo shoots and wild mushrooms were also recorded as underutilized foods because these were region and season specific. The tender bamboo shoots and wild mushrooms were available in rainy season. The utility was in the preparation of *bhaji* and could be stored for one day without any processing.

4.3.2 Nutritive value of selected underutilized foods

The different underutilized foods from Northern Karnataka were documented. A selected 25 foods were further analysed for nutrients such as

Fruits

Damani hannu

Maggigekai

Simbal hannu

Kari hannu

Ilachi

Jolada hannu

Atti hannu

Plate12: Documented underutilized fruits

Spices and condiments

Amasol

Huli soppu

Vatehuli

Jumman kai

Others

Mushroom

Bamboo shoots

Plate 13: Documented underutilized spices, condiments and others

moisture, protein, fat, fiber, ash, carbohydrate, calcium, iron, β-carotene and ascorbic acid by standard procedure and data is presented in Table 8.

Out of the four millets *viz.*, proso millet, foxtail millet, little millet and barnyard millet, the moisture content ranged from 10.24 to 11.80 g/100g. The protein content was highest in proso millet followed by little millet, barnyard millet and least by Italian millet. The fat content ranged from 2.56 to 5.57 g/100g with highest being recorded in little millet (5.57 g/100g). The ash content was almost less than 2 g per cent and the total carbohydrate ranged from 67.25 to 71.86 g/100g. The calcium content was highest in italian millet (79.13mg/100g) and least in little millet (41.84 mg/100g), whereas the iron was highest in little millet (3.35 mg/100g) and least in proso millet (1.17 mg/100g). The β-carotene content was in least amount only in proso millet and italian millet (4 µg and 3 µg/100g, respectively).

Among the two pulses analysed the moisture, protein, fiber, ash, calcium and iron were highest in horsegram and *lenki* had registered highest only in fat and carbohydrate.

Out of five vegetables screened, the moisture content was highest in *mogekai* (96.19 g/100g) and least in onion *stalks* (70.25 g/100g). The protein content ranged from 0.37 to 2.42 g/100g. Similarly, the fat content ranged from 0.81 to 2.48 g/100g highest being in *karchikai and* least in *mogekai.* The fiber content of vegetables varied drastically from 0.30 to 5.63 g/100g, the *karchikai* recorded highest (5.63 g/100g). The ash content was lowest in *mogekai* (0.34 g/100g) followed by *adavi hagal* (0.72 g/100g) and highest in *mulangikai* (11.82 g/100g). The wide variation was also observed in the carbohydrate content of the vegetables, the least was recorded in *mogekai* (1.99 g/100g) and highest in onion stalk (23.04 g/100g).The similar trend was observed for calcium, iron and β-carotene which showed wide variation in the content, the ascorbic acid was highest in *karchikai* (172.92 mg/100g) and least in *mulangikai* (30 mg/100g).

Table 8: Nutritive value of selected underutilized foods (per 100g)

Sl. No.	Name	Nutrients									
		Moisture (g)	Protein (g)	Fat (g)	Fiber (g)	Ash (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)	β-carotene (µg)	Ascorbic acid (mg)
A	**Millets**										
1	Proso millet	10.31	9.22	2.56	4.94	1.11	71.86	53.12	1.17	4.00	-
2	Foxtail millet	11.80	8.69	3.77	4.24	1.48	70.02	79.13	1.18	3.00	-
3	Little millet	10.82	9.16	5.52	5.20	1.50	67.25	41.84	3.35	0.00	-
4	Barnyard millet	10.24	8.86	4.41	5.34	1.90	69.25	69.37	1.52	0.00	-
B	**Pulses**										
5	Horsegram	10.28	21.19	6.86	5.16	3.00	53.51	221.76	5.22	0.00	-
6	*Lenki*	8.32	16.18	7.97	4.69	2.86	59.98	97.65	1.80	6.00	-
C	**Vegetables**										
7	*Karchikai*	83.92	1.89	2.48	5.63	1.28	4.80	27.33	2.32	274.30	172.92
8	*Mulangikai*	69.25	2.42	1.34	3.08	1.82	22.04	262.29	28.64	192.00	30.00
9	*Adavi hagal*	87.80	1.84	1.54	1.92	0.72	6.13	22.47	0.22	47.00	81.10
10	*Mogekai*	96.19	0.37	0.81	0.30	0.34	1.99	8.00	0.56	38.00	41.66
11	Onion stalk	70.25	1.37	1.73	1.97	1.64	23.04	90.66	3.19	192.00	34.49
D	**Fruits**										
12	*Ilachi*	82.16	2.42	3.02	0.35	0.45	11.60	141.10	0.62	94.00	148.60
13	*Atti hannu*	78.24	1.15	3.66	1.01	1.72	14.22	36.33	0.14	181.69	41.66
14	*Damani hannu*	47.17	3.16	6.57	1.05	4.17	41.88	89.52	1.86	28.00	71.64
15	*Kawalekai*	82.42	1.22	5.21	0.63	0.74	9.78	19.77	3.54	49.00	71.87

contd...

Sl. No.	Name	Nutrients									
		Moisture (g)	Protein (g)	Fat (g)	Fiber (g)	Ash (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)	β-carotene (µg)	Ascorbic acid (mg)
E	**Leafy vegetables**										
16	*Honegone*	85.64	4.02	1.66	1.03	2.74	4.91	237.25	13.93	1829	35.66
17	*Hakkarki*	90.92	1.64	0.23	0.67	1.56	4.43	67.39	7.66	1622	38.66
18	*Chandanbatta* leaves	86.61	3.93	0.20	1.08	3.18	4.94	152.38	3.25	2021	44.25
19	Bengalgram leaves	81.60	5.34	2.64	0.47	1.91	8.04	301.54	24.83	2561	127.50
20	*Sambar soppu*	95.90	0.63	0.94	0.30	0.91	1.54	165.83	1.19	1322	109.13
21	*Ondelaga* leaves	82.40	2.96	2.53	0.55	1.78	1.78	44.90	17.48	821	84.75
22	*Yelawaragi* leaves	82.19	2.03	1.75	0.42	1.50	12.11	267.55	18.35	982	69.22
23	*Chakramuni* leaves	73.91	6.85	3.03	1.76	2.64	11.71	513.27	26.63	5600	175.00
24	*Sannagoli soppu*	91.29	1.18	0.51	0.43	0.60	5.99	54.12	1.09	1809	87.00
25	*Doddagoli soppu*	92.14	1.99	0.38	0.29	0.46	4.74	56.63	0.83	1709	45.00

Out of the four fruits analysed for nutrients, highest moisture was observed in *kavalekai* (82.42 g/100g) followed by *ilachi* (82.16 g/100g) and least in *damani hannu* (47.17 g/100g). The protein content ranged form 1.15 to 3.16 g/100g with highest in *damani hannu* followed by *ilachi*, *kavalekai* and *atti hannu*. Similarly, the fat ranged 3.02 to 5.21 g/100g. The highest was found in *kavalekai*. The fruits contained less fibern and ranged from 0.35 to 1.05 g/100g. The ash and carbohydrate contents were highest in *damani hannu* (4.17 g/100g and 41.88 g/100g, respectively). A wide range was observed in the calcium content of fruits. The highest was in ilachi (141.10 g/100g) and least in *kavalekai* (19.77 g/100g). On the contrary the *kavalekai* had highest iron content (3.54 mg/100g) and least in *atti hannu* (0.14 mg/100g). The β-carotene content was highest in *atti hannu* (181.65 µg/100g) followed by *ilachi* (94 µg/100g), *kavalekai* (49 µg/100g) and least in *damani hannu* (28 µg/100g). The ascorbic acid content of fruits showed maximum content in *ilachi* (148.60 mg/100g) and least in *atti hannu* (41.66 mg/100g). The *damani hannu* and *kavalekai* recorded 71.64 and 71.87 mg/100g, respectively.

Ten leafy vegetables analysed for the nutrient content revealed that, the moisture content of leafy vegetables ranged from 73.91 g/100g in *chakramuni* leaves to 95.90 g/100g in *sambar soppu*. There was wide range in protein contents of leafy vegetables which ranged from 0.63 to 6.85 g/100g. The bengalgram leaves and *chakramuni* leaves contained more than 5 g/100g. The leafy vegetables studied contained fat content from 0.26 to 3.63 g/100g with maximum fat in *chakramuni* leaves. The fiber content was highest in *chakramuni* leaves (1.26 g/100g) and least in *sambar soppu* (0.30 g/100g). The total carbohydrate which was computed as 100 minus moisture, protein, fat, fiber and ash was very low in leafy vegetables because they contain higher moisture per cent and ranged from 1.54 to 12.11 g/100g. All the leafy vegetables studied contained calcium content more than 100 mg/100g except *hakkarki, ondalega,*

sannagoli and *doddagoli soppu*. The iron content of *chakramuni* leaves was highest (26.63 mg/100g) followed by bengalgram leaves (24.83 mg/100g). All most all the leafy vegetables were rich in iron except *sannagoli* and *doddagoli soppu*. Similarly all the leafy vegetables were rich in β-carotene and recorded more than 1000 µg/100g except *ondelaga* and *yelevaragi* which recorded less than 1000 µg/100g. With respect to ascorbic acid content, the highest was recorded by *chakramuni* leaves (175 mg/100g) followed by bengalgram leaves (127.5 mg/100g). However, all the leafy vegetables were good source of ascorbic acid.

4.4 VALUE ADDITION TO TRADITIONAL RECIPES THROUGH UNDERUTILIZED FOODS

Each region has its own traditional food habits. One of the ways to combat the malnutrition is through enriching the traditional recipes, which are liked and accepted by the population. Thus, the value addition was given to traditional recipes by incorporating the underutilized foods for nutrition security.

4.4.1 Development and standardization of value added traditional recipes through underutilized foods

Most commonly used 13 traditional recipes *viz.*, *chapathi, bisebelebath, pongal, upama, rice, idli, dosa, paddu,* turdhal *bhaji,* groundnut *chutney* powder, sprouted mothbean *bhaji,* coconut *chutney* and *talipattu* were selected for value addition through underutilized foods. Out of the documented underutilized foods, four millets *viz.*, foxtail, proso, little and barnyard millet and pulses *viz.*, *lenki*, *soya*bean and green leaves *viz.*, *'chandnabatta'*, bengalgram leaves, *chakramuni* leaves and *sambarsoppu* were used for value addition to provide protein, iron and β-carotene security to population. Twenty products were developed, standardised and nutrient analysis was carried out by computation method and the sensory attributes were characterized by using nine points hedonic scale from semi trained panel of 10 judges. The list of products

developed is presented in Table 9. The detailed standardised procedure is recorded in Appendix-13 (Plate 14 and 15).

4.4.2 Nutrient composition of value added traditional products

Totally 20 value added traditional products were developed and standardised, the nutritional composition of all the developed products were assessed by using computation method. The millet and legume based value added products are presented in Tables 10 and 11.

Table 10 deals with nutritive value of millet based value added products. The energy content of 10 products ranged from 155 Kcal to 460 Kcal per 100 g. Only little millet *talipattu* (155 Kcal/100g) and foxtail millet *bisebelebath with* bengalgram leaves (196 Kcal/100g) had energy value less than 200 Kcal/100g. The highest energy content was observed in little millet *dosa* with *chakramuni* leaves (460 Kcal/100g) followed by little millet *paddu* with bengalgram leaves (275 Kcal/100g) and rest of the products had energy value between 200-308 Kcal/100g). When the energy content was expressed on the basis of per serving size, a wide range was evident. The highest was recorded by prosomillet sweet *pongal* (462 Kcal) and least were recorded by little millet *talipattu* (124 Kcal). Rest all ranged between 245 to 397 Kcal per serving.

The protein content of millet base value added products ranged from 5.41 to 12.83 g/100g. The highest was recorded by foxtail millet *dosa* with *chakramuni* leaves (11.65 g/100g). All the other products recorded less than 10 g/100g with a range of 4.99 to 9.82 g/100g. Similarly, a wide variation was observed with the protein content on per serving size basis and ranged from 4.01 to 15.71 g. More than 10g protein per serving was observed in proso millet, sweet *pongal*, little millet *masala* idli and barnyard millet *upama* with drumstick leaves.

Table 9: The details of value added traditional recipes

No.	Name of the traditional products	Food incorporated	Food substituted	Name of the value added product
1	Sweet *pongal*	-	Proso millet to rice by 100%.	Proso millet sweet *pongal*
2	*Chapathi*	Drumstick leaves by 25%	-	*Chapathi* with drumstick leaves
3	*Idli*	Carrot by 25% Methi leaves by 25%	Little millet to rice by 100%	Little millet *masala idli*
4	*Paddu*	*Chakramuni* leaves by 25%	Little millet to rice by 100%	Little millet *paddu* with *chakramuni* leaves
5	*Dosa*	*Chakramuni* leaves by 25%	Little millet to rice by 100%	Little millet *dosa* with *chakramuni* leaves
6	*Bisebelebath*	Bengalgram leaves by 50%	Foxtail millet to rice by 100%	Foxtail millet *bisebelebath*, with Bengalgram leaves
7	*Vada*	-	Foxtail millet to rice by100%	Foxtail millet *vada*
8	*Talipattu*	-	Little millet to rice by 100%	Little millet *talipattu*
9	*Upama*	Bengalgram leaves by 50%	Little millet to wheat sooji by 100%	Little millet *upama* with bengalgram leaves
10	*Upama*	Drumstick leaves by 50%	Little millet to wheat sooji by 100%	Little millet *upama* with drumstick leaves
11	*Chapathi*	Drumstick leaves by 25%	Soyabean to wheat flour by 20%	Soya based *chapathi*
12	*Idli*	Carrot by 25% Methi leaves by 25%	Soyabean to blackgram dhal leaves by 50%	Soya based *masala idli*
13	*Dosa*	*Chakramuni* leaves by 25%	Soyabean to blackgram dhal leaves by 50%	Soya based *dosa* with *chakramuni* leaves
14	*Paddu*	*Chakramuni* leaves by 25%	Soyabean to blackgram dhal by 50%	Soya based *paddu* with *chakramuni* leaves
15	*Upama*	Drumstick leaves by 50%	Barnyard millet to rice by 100%	Barnyard millet rice with drumstick leaves
16	Turdhal *bhaji*	*Chakramuni* leaves by 50%	-	Turdhal *bhaji* with *chakramuni* leaves
17	Turdhal *bhaji*	Chandanabatta leaves by 50%	-	Turdhal *bhaji* with chandanabatta leaves
18	Sprouted pulse *bhaji*	-	Sporuted *lenki* to moth bean by 50%	Sprouted *lenki bhaji*
19	Ground *chutney* powder	Dried *chakramuni* leaves by 10%	-	Groundnut *chutney* powder with *chakramuni leaves*
20	Coconut *chutney*	Sambar soppu by 25%	-	Coconut *chutney* with sambar soppu

Proso millet sweet *pongal*

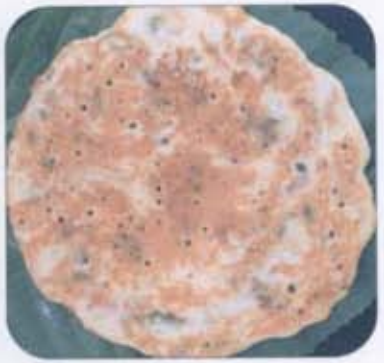
Little millet *upama* with bengalgram leaves

Foxtail millet *bisebelebath* with

Little millet *talipattu*

Little millet *masala idli*

Little millet *paddu* with *chakramuni* leaves



Little millet *dosa* with *chakramuni* leaves

Foxtail millet *vada* with *chakramuni* leaves

Plate 14: Millet based developed value added traditional products

Proso millet sweet *pongal*

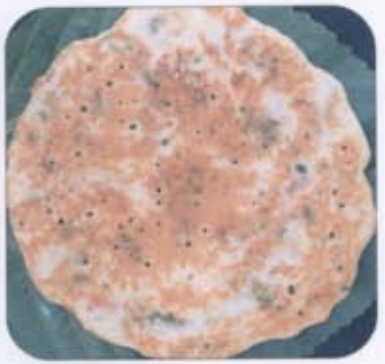
Little millet *upama* with bengalgram leaves

Foxtail millet *bisebelebath* with

Little millet *talipattu*

Little millet *masala idli*

Little millet *paddu* with *chakramuni* leaves



Little millet *dosa* with *chakramuni* leaves

Foxtail millet *vada* with *chakramuni* leaves

Plate 14: Millet based developed value added traditional products

A drastic variation was observed in fat content of millet based value added products which ranged from 1.65 to 19.64 g/100g. The little millet *Idli* recorded lowest value (1.65 g/100g) and highest was recorded by little millet *dosa* with *chakramuni* leaves (19.64 g/100g) followed by little millet *talipattu* (15.63 g/100g), foxtail millet *vada* (13.95 g/100g), proso millet sweet *pongal* (11.91 g/100g) and least in little millet *paddu* (11.68g/100g). All the other products recorded fat content less than 10 g/100g. The higher value of fat was due to visible fat used during cooking of the product. Similarly, when the fat content of the product was assessed on per serving basis, the fat content of 10 products ranged from 1.93 g to 15.71 g. The *idli* recorded least fat content (1.93 g). All the other products had fat content more than 10g per serving, highest being recorded in little millet *dosa* with *chakramuni* leaves.

There was not much variation with respect to mineral content among the 10 value added millet products. The value ranged from 1.08 g/100g to 3.12 g/100g. All the products except little millet *dosa* with *chakramuni* leaves (2.73 g/100g) and foxtail millet *vada* (3.12 g/100g) documented mineral content less than 2 g/100g. Whereas on the basis of per serving, wide variation was observed. The highest content was registered in foxtail millet *bisebelebath* with bengalgram leaves (3.18g) followed by foxtail millet *vada* (2.18g) and little millet *dosa* with *chakramuni* leaves (2.18 g). The least was recorded by little millet *talipattu* (0.86 g).

A similar trend was obvious with respect to fiber content of value added millet based products. A wide variation was evident with a range of 0.59 g to 6.48 g/100g. The high fiber content was recorded in little millet *dosa* with *chakramuni* leaves (6.48 g/100g) followed by little millet *upama* with drumstick leaves (5.18 g/100g). Rest of the products recorded fiber content less than 4 g/100g. But when the fiber content was analysed on per serving basis, the fiber content ranged from 0.89 g to 8.29 g. Out of ten value added products five

Table 10: Nutrient composition of millet based value added traditional products (per 100g)

Sl. No.	Name of the product	Serving size (g)	Nutrients									
			Energy (Kcal)	Protein (g)	Fat (g)	Minerals (g)	Fiber (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)	β-carotene (µg)	Ascorbic acid (mg)
	Millet Based											
1	Proso millet Sweet *pongal*	150	308 (462)	6.88 (10.32)	11.91 (17.87)	1.20 (1.80)	0.59 (0.89)	46.31 (69.47)	39.97 (59.96)	2.09 (3.14)	53.23 (9.335)	0.07 (0.10)
2	Little millet *masala idli*	118	252 (297)	8.91 (10.51)	1.65 (1.93)	1.53 (1.88)	2.28 (2.69)	50.36 (58.89)	110.25 (131.11)	4.61 (5.46)	668.06 (790.98)	8.59 (10.17)
3	Little millet *paddu* with *chakramuni* leaves	90	275 (248)	7.12 (6.41)	11.68 (10.51)	1.69 (1.52)	3.60 (3.24)	35.08 (31.52)	136.20 (122.58)	9.91 (8.92)	1077.09 (969.38)	73.25 (65.93)
4	Little millet *dosa* with *chakramuni* leaves	80	416 (368)	11.65 (9.32)	19.64 (15.71)	2.73 (2.18)	6.48 (5.18)	59.24 (47.39)	226.08 (180.86)	16.18 (12.94)	1795.72 (1436.58)	82.22 (65.78)
5	Little millet *talipattu*	80	155 (124)	5.02 (4.01)	15.63 (12.50)	1.08 (0.86)	2.95 (2.36)	29.57 (23.66)	79.25 (63.40)	3.79 (3.03)	340.06 (272.05)	16.34 (13.68)
6	Little millet *upama* with bengalgram leaves	160	221 (354)	5.41 (8.66)	9.20 (14.72)	1.33 (2.13)	3.85 (6.16)	28.78 (46.05)	105.48 (168.77)	16.59 (10.54)	598.62 (957.79)	11.53 (18.45)
7	Little millet *upama* with drumstick leaves	160	217 (347)	5.45 (8.72)	9.43 (15.09)	1.37 (2.19)	5.18 (8.29)	28.55 (45.68)	119.98 (191.96)	3.26 (5.21)	1217.19 (1947.50)	34.29 (54.86)
8	Foxtail millet *bisebelebath*, with bengalgram leaves	200	196 (397)	4.99 (9.98)	5.42 (10.84)	1.59 (3.18)	2.68 (5.36)	19.62 (39.24)	101.68 (203.36)	5.97 (11.94)	784.70 (1589.40)	16.08 (8.04)
9	Foxtail millet *vada*	80	434 (304)	12.83 (8.98)	23.95 (16.76)	3.12 (2.18)	3.98 (2.79)	39.23 (27.46)	259.84 (181.88)	10.80 (7.56)	72.97 (51.08)	131.68 (92.18)
10	Barnyard millet *upama* with drumstick leaves	160	214 (343)	9.82 (15.71)	8.17 (13.09)	1.79 (2.86)	3.13 (5.01)	25.49 (40.78)	154.20 (246.75)	1.61 (2.58)	1197.62 (1916.19)	41.53 (67.08)

Note: Figures in the parenthesis indicate nutrient per serving.

products had fiber content more than 5 g per serving. However, the highest was recorded by little millet *upama* with drumstick leaves (8.29 g) followed by little millet *upama* with bengalgram leaves (6.16g).

The carbohydrate content of value added traditional products ranged from 19.62 g/100g in foxtail millet *bisebelebath* with bengalgram leaves to 59.24 g/100g in little millet *dosa* with *chakramuni* leaves. Out of the 10 products, five products were having carbohydrate content more than 25 g/100g, on the contrary, on per serving basis all the products except little millet *talipattu* (23.66g) had carbohydrate content more than 25g. The carbohydrate content ranged from 23.66 to 69.47 g.

A wide variation was noticed for calcium content among the 10 value added millet based products, ranged from 39.97 to 259.84 mg/100g. Out of the 10 products, two products *viz.*, little millet *dosa* with *chakramuni* leaves (226.08 mg/100g) and foxtail millet *vada* (259.84 mg/100g) reported calcium content more than 200 mg/100g. A value less than 100 mg/100g was recorded by proso millet *pongal* (39.97 mg/100g) and little millet *talipattu* (79.25 mg/100g). Rest of the products reported between 100-200 mg/100g. But when the products were analysed on per serving basis, the calcium content of foxtail millet *bisebelebath* with bengalgram leaves (203.36 mg) and barnyard millet *upama* with drumstick leaves (246.72mg) had higher calcium content compared to all other products. Remaining all the products had calcium content less than 200 mg per serving.

A drastic variation was noticed in the iron content of millet based value added products. The iron content ranged from 1.61 to 16.59 mg/100g. The products with green leafy vegetables had higher iron content compared to others. All the products with bengalgram leaves had higher iron content compared to rest. Even on per serving basis, a wide variation in iron content of products was noticed (2.58 to 12.94 mg/100g). Out of 10 products, three

products *viz.*, little millet *dosa* with *chakramuni* leaves and little millet *upama* with bengalgram leaves and foxtail millet *bisebelebath* with bengalgram leaves recorded more than 10 mg per serving.

The β-carotene content of products ranged from 53.23 µg to 1795.72µg/100g. The products such as proso millet sweet *pongal* (53.23 µg/100g) and foxtail millet *vada* (72.92 µg/100g) had lowest β-carotene content. All other products had β-carotene content in the range of 340 to 1795.72µg/100g. The leafy vegetable based products had higher β-carotene values. The same trend was also noticed for per serving basis. The β-carotene content of products on per serving size ranged from 57.08 to 1947.50 µg. The highest β-carotene quality was observed in little millet *upama* with drumstick leaves (1947.50 µg) followed by barnyard millet *upama* with drumstick leaves (1916.17 µg) ,foxtail millet *bisebelebath* with bengalgram leaves (1589.40 µg) and little millet *dosa* with *chakramuni* leaves (1436.58µg). All the other products had β-carotene content less than 1000 µg per serving and very much lower contents were noticed in foxtail millet *vada* (51.08 µg) and proso millet sweet *pongal* (79.35 µg) and rest of the products ranged from 272.05 to 969.38 µg per serving.

The nutritive composition of legume based value added products is provided in Table 11. The energy content of seven products ranged from 190 to 445 Kcal/100g the highest was recorded in *soya* based *dosa* with *chakramuni* leaves (445 Kcal/100g) followed by *soya* based *chapathi* (405 Kcal/100g) and lowest was recorded in sprouted *lenki usali* (190 Kcal/100g). On per serving basis, the energy content ranged from 104 to 356 Kcal/100g. The highest was recorded in *soya* based *dosa* with *chakramuni* leaves (356 Kcal/100g) followed by *soya* based *paddu* with *chakramuni* leaves (277 Kcal/100g) and least was recorded in *soya* based *masala idli*.

Table 11: Nutrient composition of legume and other value added traditional products (per 100g)

S. No.	Name of the product	Serving size (g)	Nutrients									
			Energy (Kcal)	Protein (g)	Fat (g)	Minerals (g)	Fiber (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)	β-carotene (µg)	Ascorbic acid (mg)
I	**Legume Based**											
11	Soya based *masala idli*	60	248 (104)	9.87 (5.92)	7.55 (4.53)	1.34 (0.80)	0.83 (0.50)	44.07 (26.44)	307.90 (102.63)	6.64 (2.21)	3507.15 (1169.05)	115.55 (38.52)
12	Soya based *dosa* with *chakramuni* leaves	80	445 (356)	11.6 (9.28)	18.18 (14.54)	1.70 (1.36)	0.81 (0.65)	19.39 (15.51)	32.87 (106.30)	7.41 (5.93)	934.75 (747.80)	38.59 (30.87)
13	Soya based *paddu* with *chakramuni* leaves	90	263 (237)	6.87 (6.18)	10.76 (9.69)	1.01 (0.90)	0.47 (0.43)	34.44 (30.59)	78.60 (70.75)	4.38 (3.99)	553.37 (498.03)	22.84 (30.87)
14	Turdal *bhaji* with *chakramuni* leaves	100	204 (204)	9.12 (9.12)	7.11 (7.91)	1.72 (1.72)	1.50 (1.50)	28.32 (28.12)	150.14 (150.14)	6.26 (6.22)	1200.87 (1200.87)	46.80 946.80)
15	Turdal *bhaji* with *chandanabatta* leaves	100	203 (203)	8.78 (8.78)	7.40 (7.40)	2.02 (2.02)	1.41 (1.41)	26.94 (26.94)	86.18 (86.18)	2.13 (2.13)	517.64 (517.64)	14.15 (14.15)
16	Sprouted *lenki usali*	100	190 (190)	6.27 (6.27)	9.22 (9.22)	0.72 (0.72)	2.40 (2.39)	29.81 (29.81)	47.29 (47.29)	1.08 (1.08)	172.11 (172.11)	10.06 (10.06)
17	Soya based *chapathi* with drumstick leaves	80	405 (324)	18.15 (14.52)	21.71 (17.37)	3.58 (2.86)	2.54 (2.03	55.09 (44.70)	256.58 (205.26)	5.53 (4.42)	2922.62 (2338.09)	96.29 (77.03)
II	**Others**											
18	Ground *chutney* with *chakramuni* leaves	8	657 (52)	30.42 (2.43)	46.34 (3.78)	4.32 (0.34)	14.84 (10.10)	86.18 (6.89)	447.70 (35.81)	17.52 (1.40)	195.46 (15.63)	132.04 (10.56)
19	Coconut *chutney* with *sambar soppu*	50	239 (119)	5.04 (2.52)	21.00 (10.50)	4.40 (2.20)	10.84 (5.12)	7.78 (3.89)	164.80 (82.40)	3.62 (1.81)	2214.00 (1107.50)	0.80 (0.40)
20	*Chapathi* with drumstick leaves	80	267 (147)	8.85 (7.08)	18.11 (14.40)	2.32 (1.86)	1.73 (1.38)	48.79 (39.03)	124.50 (99.60)	3.61 (2.89)	1433.34 (1146.69)	50.26 (40.21)

Note: Figures in parentheses indicate nutrients per serving.

The protein content of legume based value added products ranged from 6.87 to 18.15g/100g. The highest was recorded in *soya* based *chapathi* (18.15g/100g) followed by *soya* based *dosa* with *chakramuni* leaves (11.6 g/100g), *soya* based *masala idli* (9.87 g/100g), turdhal *bhaji* with *chakramuni* leaves (8.78 g/100g) and least was recorded by *soya* based *paddu* with *chakramuni* leaves (6.87 g/100g) and sprouted *lenki bhaji* (6.27 g/100g). However, on per serving basis, such variation was not noticed. The protein content ranged from 5.92 to 14.52 per serving. The highest protein content on per serving size basis was recorded in *soya* based *chapathi* (14.52g) and least in *soya* based *masala idli* (5.92g). The protein content ranged from 6.27 to 9.28g per serving.

A wide variation was noticed in fat content of legume based value added products and ranged from 7.81 in turdhal *bhaji* with *chakramuni* leaves to 21.71 g/100g in the *soya* based *chapathi*. The *soya* based *masala idli* (7.55 g/100g) and turdhal *bhaji* with *chandanabatta* leaves (7.4 g/100g) had almost similar amount of fat. On per serving basis, a wide variation was obtained among the different products. The highest fat content was noticed in soya based *dosa* with *chakramuni* leaves (14.54 g) with a range of 7.40g to 14.54 g. Rest all the products ranged less than 10g.

The mineral content of legume based value added products ranged from 0.72 g to 3.58 g/100g. The highest was recorded in soya based *chapathi* (3.58g/100g) followed by turdhal *bhaji* with *chandanabatta* leaves (2.02 g/100g), same *bhaji* with *chakramuni* leaves (1.71 g/100g) and least in soya based *dosa* with *chakramuni* leaves (1.70 g/100g). However, soya based *masala idli*, soya based *paddu* with chakramuni leaves, and sprouted *lenki bhaji* recorded less than 1.5 g/100g. On the other hand, on per serving size basis, such wide variations were not registered. The mineral content ranged from 0.72 g to 2.02 g.

The highest mineral content was recorded in soya based *chapathi* with drumstick leaves (2.86 g) and least was recorded by sprouted *lenki bhaji* (0.72 g).

The fiber content of legume based value added products ranged from 0.81 g to 2.54g/100g. All *soya* based products except *soya* based *chapathi* recorded fiber content less than 1g/100g. Whereas turdhal *bhaji* with *chakramuni* leaves, turdhal *bhaji* with *chandanabatta* leaves and sprouted *lenki bhaji* recorded 1.50 g, 1.41 g and 2.40 g/100g, respectively. But on per serving size basis, fiber content of the products ranged from 0.81 to 2.40 g. Similarly, the soya based product except *chapathi* recorded lower fiber content on per serving size basis also. Not much variation in two turdhal based *bhaji* with *chakramuni* leaves and *chandanabatta* leaves (1.50 and 1.41 g, respectively). The sprouted *lenki usali* was recorded highest fiber content among all the legume based value added products.

The carbohydrate contents of legume based value added product ranged from 19.39 to 55.09g/100g, highest being recorded in soya based *chapathi* (55.09g/100g). There was not much variation among turdhal *bhaji* with *chakramuni* leaves (28.32 g/100g), turdhal *bhaji* with *chandanabatta* leaves (26.94 g/100g) and sprouted *lenki usali* (29.81 g/100g). However, there was a wide variation in carbohydrate content of soya based products. But on per serving size basis the carbohydrate content ranged from 15.15 g to 44.07g. The highest was recorded in soya based *chapathi* with drumstick leaves (44.07g),followed by soya based *paddu* with *chakramuni* leaves(30.99g), turdhal *bhaji* with *chakramuni* leaves (28.12 g), turdhal *bhaji* with *chandanabatta* leaves (26.94 g) and least by soya based *dosa* with *chakramuni* leaves (15.51 g).

The calcium content of legume based products varied very widely with a range of 32.87 mg to 307 mg/100g. Only soya based *masala idli* (307.9 mg/100g), soya based *chapathi* (307.9 mg/100g) had calcium content more than 300 mg per 100 g. Others ranged from 32.87 to 256.58g/100g. But when

assessed on per serving basis, all the products had calcium content less than 150.14 mg except soya based *chapathi* with drumstick leaves which recorded more than 200mg. Out of the seven products, three products *viz.*, soya based *masala idli*, soya based *chapathi*, and turdhal *bhaji* with *chakramuni* leaves had calcium content more than 100 mg.

The iron content of value added legume based products ranged from 1.08 to 7.41 mg/100g. All soya based products and turdhal *bhaji* with *chakramuni* leaves recorded higher iron content 4.38 to 7.41 mg/100g. Whereas turdhal *bhaji* with *chandanabatta* leaves and sprouted *lenki usali* recorded lesser iron content 2.14 and 1.08 mg/100g, respectively. Whereas on per serving basis, products with *chakramuni* leaves such as *soya* based *dosa*, *paddu,* and turdhal *bhaji* and *soya* based *chapathi with* drumstick leaves recorded higher iron content 5.93 mg, 4.38 mg 6.22 mg and 4.42mg, respectively. The other products recorded between 1.08 to 2.13 mg per serving.

A wide variation of 172.11 to 3507.35 µg was evidenced for β-carotene content among different legume based value added products. The highest amount was recorded in soya based *chapathi* and *soya* based *masala idli* (3507.15 µg/100g), followed by *soya* based *chapathi (*2922.62 mg/100g), turdhal *bhaji* with *chakramuni* leaves (1200.87 µg/100g), soya based *dosa* with *chakramuni* leaves (553.37 µg/100g), turdhal *bhaji* with *chandanabatta* leaves (517.64 µg/100g) and least was recorded by sprouted *lenki usali* (172.11 µg/100g). A similar type of variation was also observed when considered on per serving basis and the β-carotene ranged from 172.11 µg to 2338.09µg. The highest β-carotene on serving basis was recorded by *soya* based *chapathi* (2338.09µg) followed by turdhal *bhaji* with *chakramuni* leaves (1200.87 µg), *soya* based *masala idli* (1169.05 µg). All the other products recorded less than 1000 µg per serving.

The ascorbic acid content of value added legume based products ranged from 10.06 to 115.55 mg/100g. The highest ascorbic acid content was recorded by *soya* based *idli* (115.55 mg/100g) followed by soya based *chapathi* (96.29 mg/100g) , turdhal *bhaji* with *chakramuni* leaves (46.80 mg/100g), soya based *dosa* with *chakramuni* leaves (38.59 mg/100g), soya based *paddu* with *chakramuni* leaves (22.84 mg/100g), turdhal *bhaji* with chandanabatta leaves (14.15 mg/100g) and least was recorded by sprouted *lenki bhaji* (10.06 mg/100g). However, on per serving basis, all the products served less than 50 mg with highest ascorbic acid content in turdhal *bhaji* with *chakramuni* leaves (46.80 mg/100g) and least was recorded in sprouted *lenki bhaji* (10.06 mg/serving).

4.4.3 Sensory attributes of value added traditional foods

The sensory evaluation was carried out for all the value added traditional products by semi trained panel of 10 judges on nine point hedonic scale. The result is presented in Table 12.

The sensory attributes scores included colour and appearance, taste, texture, aroma and overall acceptability. Out of 20 value added products, only *little millet upama* with bengalgram leaves, and groundnut *chutney* powder with *chakramuni* leaves, scored less than 7 points (6.90 points) and all the other products scored more than 7 points depicting very good at colour and appearance. The mean scores for taste ranged from 5.8 to 8.00 points. The least score 5.8 was recorded for soya *masala idli* as it was sour in taste. Similarly, for texture, the highest score was recorded by *little millet upama* with drumstick leaves (7.70). The scores ranged between 5.3 to 7.7. The least was recorded by sprouted *lenki bhaji* because the texture was little hard. The mean scores for aroma of value added products scored more than six indicating the products had 'moderately good' aroma except *soya masala idli* which scored slightly less than six (5.9). The overall acceptability scores for all the value added products

Table 12: Sensory scores⊗ and cost of the developed value added traditional products

Sl. No.	Name of the product	Sensory attributes					Cost/serving (Rs.)
		Colour and appearance	Taste	Texture	Aroma	Over all acceptability	
1.	Proso millet sweet *pongal*	7.20✦ ± 0.88	7.40 ± 0.82	7.20 ± 1.08	7.50 ± 1.02	7.20 ± 0.79	5.35
2.	Little millet *masala idli*	7.00 ± 1.03	7.20± 1.62	7.10 ± 1.20	6.90 ± 1.35	6.90 ± 0.89	1.25
3.	Little millet *paddu* with *chakramuni* leaves	7.50 ± 1.26	7.30 ± 0.88	7.20 ± 1.29	7.00 ± 1.10	7.50 ± 1.14	1.90
4.	Little millet *dosa* with *chakramuni* leaves	7.40 ± 0.79	7.00 ± 0.90	7.20 ± 1.35	6.90 ± 1.43	7.20 ± 1.12	1.70
5.	Little millet *talipattu* with bengalgram leaves	7.00 ± 1.20	6.30 ± 1.30	6.40 ± 1.65	6.00 ± 1.35	7.00 ± 1.14	2.50
6.	Little millet *upama* with bengalgram leaves	6.90 ± 0.89	6.80 ± 0.83	6.90 ± 1.03	6.90 ± 1.02	7.00 ± 0.83	2.00
7.	Little millet *upama* with drumstick leaves	7.80 ± 1.13	7.30 ± 1.26	7.70 ± 1.33	7.30 ± 0.92	8.20 ± 0.78	2.00
8.	Foxtail millet *bisebelebath* with bengalgram leaves	7.70 ± 1.25	7.40 ± 0.88	7.60 ± 0.82	7.80 ± 1.33	7.90 ± 1.29	2.35
9.	Foxtail millet *vada*	7.50 ± 1.64	6.00 ± 1.20	7.00 ± 1.34	7.20 ± 1.35	7.20 ± 1.35	2.00
10.	Barnyard millet *upama* with drumstick leaves	7.00 ± 1.34	6.30 ± 1.08	7.00 ± 1.16	6.20 ± 1.10	6.30 ± 1.14	2.00
11.	Soya based *masala idli*	7.00 ± 1.25	5.80 ± 0.90	6.60 ± 1.20	5.90 ± 1.35	6.10 ± 0.62	1.25
12.	Soya based *dosa* with *chakramuni* leaves	7.00 ± 0.79	6.20 ± 0.88	7.10 ± 1.26	7.30 ± 1.33	6.80 ± 1.29	1.70
13.	Soya based *paddu* with *chakramuni* leaves	7.30 ± 0.74	6.10 ± 1.03	6.90 ± 0.88	6.60 ± 1.55	6.80 ± 1.35	1.90
14.	Turdhal *bhaji* with *chakramuni* leaves	7.00 ± 1.25	7.00 ± 1.35	6.90 ± 1.26	7.50 ± 1.43	7.50 ± 1.34	2.60
15.	Turdhal *bhaji* with *chandanabatta* leaves	7.20 ± 1.03	7.00 ± 1.25	7.40 ± 1.34	6.20 ± 1.10	7.00 ± 1.14	2.60
16.	Sprouted *lenki bhaji*	7.00 ± 1.34	6.20 ± 1.08	5.30 ± 1.16	6.30 ± 1.03	6.20 ± 0.79	1.50
17.	Soya *chapathi* with drumstick leaves	7.20 ± 1.25	7.40 ± 0.88	7.30 ± 1.34	7.00 ± 1.55	7.10 ± 1.35	1.90
18.	Groundnut *chutney* with *chakramuni* leaves	6.90 ± 1.20	7.00 ± 1.34	7.10 ± 1.43	7.30 ± 1.35	7.00 ± 1.34	0.45
19.	Coconut *chutney* with *sambar soppu*	7.40 ± 0.64	8.00 ± 1.03	7.60 ± 0.88	7.70 ± 1.10	7.80 ± 0.94	2.45
20.	*Chapathi* with drumstick leaves	7.10 ± 0.96	6.70 ± 0.88	6.10 ± 0.82	6.70 ± 1.33	6.50 ± 1.20	1.65

⊗ Average scores of ten judges on 9 point hedonic scale.

✦ Maximum score for 9 point hedonic scale is 9.

ranged from 6.10 to 8.20 indicating 'moderately good' to 'extremely good'. The highest overall acceptability score was recorded by *little millet upama* with *drumstick leaves* and least by sprouted *lenki usali*.

4.4.4 Cost analysis

The cost per serving of the value added traditional product is presented in Table 12. The cost of the products ranged from Rs. 0.45 to Rs. 5.35 per serving. The cost included the rate of ingredients and processing charges, which depended mainly on the type and quality of ingredients used in the preparation of the products. Most of the products were less than Rs. 3 per serving except the proso millet sweet *pongal* which had a cost Rs. 5.35 per serving because of ghee, raisins and cashewnuts in it. Out of the 20 products developed, 12 products were in the range of less than or equal to Rs. 2 per serving.

4.5 DEVELOPMENT OF READY TO EAT (RTE) VALUE ADDED TRADITIONAL PRODUCTS

The RTE foods are gaining popularity in today's world. Hence, the RTE products were developed by substitution and or incorporation of the millet *viz.*, foxtail and little millet, oilseed *viz.,* gardencress seeds and soyabean and *chakramuni* leaves and analysed for the nutritive value and tested by panel members for acceptability and cost per serving size and shelf life study were carried out for 28 days period.

4.5.1 Development of RTE value added traditional products

The products developed (Table 13) were *viz.*, *chakkali* with substitution of 75 per cent foxtail millet flour to the rice flour, *sev* with substitution of little millet flour at 50 per cent to bengalgram flour and incorporation of 25 per cent of *chakramuni* leaves, *laddu* with incorporation of 50 per cent gardencress seeds to the coconut *laddu*, *khara* gritters with substitution of 50 per cent little millet flour to the maida flour and *hurigalu* prepared out of

Table 13: The details of Ready To Eat (RTE) value added products developed from underutilized foods

Sl. No.	Name of the traditional product	Food incorporated	Food substituted	Name of the value added product
1.	*Chakkali*	-	Foxtail millet to rice by 50%	Foxtail millet *chakkali*
2.	*Sev*	*Chakramuni* leaves by 25%.	Little millet to bengalgram flour by 50%	Little millet green *sev*
3.	Coconut *laddu*	Gardencress seeds by 50%	-	Gardencress *laddu*
4.	*Khara* gritters	-	Little millet to maida by 50%	Little millet *khara* gritters
5.	*Hurigalu*	Soyabean by 100%	-	Soya *hurigalu*

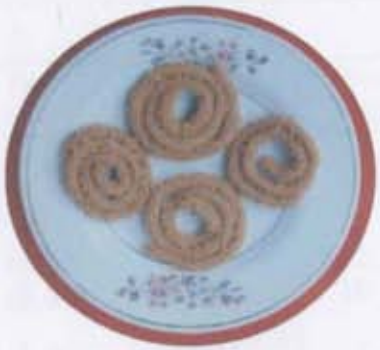
soybean (100%). The standardised procedure is detailed in Appendix-XIV (Plate 16).

4.5.2 Nutrition value of RTE value added products

The nutrition composition of developed RTE products were calculated by computation method and expressed as per 100 g and per serving size in Table 14. Out of the five value added RTE products the *soya hurigalu* registered highest energy (737 kcal/100g), followed by little millet green *sev* (587 Kcal/100g), little millet *khara* gritters (570 Kcal/100g), gardencress *laddu* (560 Kcal/100g) and least by foxtail millet *chakkali* (472 Kcal). However, when portion size was considered, the gardencress *laddu* (308 Kcal) provided maximum energy followed by *soya hurigalu* (295 Kcal), little millet *khara* gritters (228 Kcal), little millet green *sev* (205 Kcal) and least by foxtail millet *chakkali* (141 Kcal).

Wide variations in protein content of RTE value added products was evidenced and ranged from 6.80 in little millet *khara* gritters to 36.30 g per 100g in soya *hurigalu*. Similarly, a wide variation was also observed when per serving size basis was considered. The little millet *khara* gritters recorded least protein content per serving (2.72g) and highest by *soya hurigalu* (14.52 g) and protein content was 5.29g, 3.55g, 4.39g for foxtail millet *chakkali*, little millet green *sev* and gardencress *laddu*, respectively.

The fat content of products varied widely from 12.92 g/100g in foxtail millet *chakkali* to 52.83 g/100g in *soya hurigalu* . However, the fat content of little millet green *sev*, little millet *khara* gritters and gardencress *laddu* were 40.23, 37.87 and 34.3 g/100g, respectively. On the other hand on per serving basis, the fat content of products varied widely from 21.13 g in *soya hurigalu* to 3.88 g in foxtail millet *chakkali*. The fat content in other products were found to be between 10.32 to 13.98 g on per serving basis.



Foxtail millet *chakkali*

Little millet green *sev*

Gardencress *laddu*

Little millet *khara* gritters

Soya *hurigalu*

Plate 16: Developed Ready To Eat value added traditional products

Table 14: Nutritive value of developed RTE value added products (per 100g)

Name of the product	Serving size (g)	Nutrients								
		Energy (Kcal)	Protein (g)	Fat (g)	Minerals (g)	Fiber (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)	β-carotene (µg)
Foxtail millet *chakkali*	30	472 (141)	17.64 (5.29)	12.92 (3.88)	3.43 (1.03)	6.00 (1.80)	71.22 (21.37)	149.10 (44.73)	4.01 (1.20)	109.09 (32.72)
Little millet green *sev*	35	587 (205)	10.13 (3.55)	40.25 (13.98)	2.25 (0.78)	4.36 (1.53)	48.15 (16.74	186.50 (64.90)	12.57 (4.50)	1128.48 (389.12)
Gardencress *laddu*	55	560 (308)	7.99 (4.39)	24.30 (13.32)	2.29 (1.26)	3.33 (1.83)	78.18 (42.99)	143.33 (78.83)	25.05 (13.78)	6.08 (3.34)
Little millet *khara* gritters	40	570 (228)	6.80 (2.72)	37.87 (15.15)	0.73 (0.29)	2.97 (1.18)	50.50 (20.30)	25.17 (10.07)	4.39 (3.07)	9.41 (3.76)
Soya *hurigalu*	40	737 (295)	36.30 (14.52)	52.83 (21.13)	2.97 (1.87)	5.44 (2.18)	29.09 (11.63)	205.75 (82.30)	9.88 (3.95)	426.73 (170.69)

Note: Figures in parentheses indicate nutrients per serving.

The mineral content of the RTE value added products did not differ much among each other. The mineral content ranged from 0.73g/100g in little millet *khara* gritters to 3.43 g/100g in foxtail millet *chakkali.* However, on per serving basis, the little millet *khara* gritters recorded least (0.27g) and *soya hurigalu* being highest in mineral content (1.87 g) wherein the mineral content of foxtail millet *chakkali*, gardencress *laddu* and little millet green *sev* recorded 1.03, and 0.78 g, respectively on per serving basis. On the contrary, the foxtail millet *chakkali*, provided higher fiber (6.00 g/100g) compared to all other products followed by *soya hurigalu* (5.44 g/100g), little millet green *sev* (4.36 g/100g), gardencress *laddu* (3.37 g/100g) and least by little millet *khara* strips (2.97 g/100g). But on per serving basis the *soya hurigalu* recorded highest fiber (2.18 g) followed by gardencress *laddu* (1.83 g), foxtail millet *chakkali* (1.80 g), little millet green *sev* (1.53 g) and least by little millet *khara* gritters (1.18g).

A wide variation was observed for carbohydrate content among five RTE value added products which ranged from 29.09 g/100g to 78.18 g/100g. The highest value was evident in *gardencress laddu* (78.18g/100g) followed by foxtail millet *chakkali* (71.22 g/100g), little millet *khara* gritters (50.50 g/100g), little millet green *sev* (48.15 g/100g) and least in *soya hurigalu* (29.0 g/100g). However, when per serving basis was considered, the carbohydrate content ranged between 10.83 to 21.37g. The carbohydrate contents were 10.83 g, 11.63 g, 16.74 g, 21.37 g and 21.37g for gardencress *laddu*, soya *hurigalu*, little millet green *sev*, foxtail millet *chakkali* and little millet *khara* strips, respectively.

The calcium content of RTE value added products per 100g ranged from minimum in little millet *khara* gritters (25.17 mg/100g) to maximum in *soya hurigalu* (205.75 mg/100g). The other three products recorded between 143.33 mg to 186.53 mg/100g. On the other hand, it was found that on per serving basis also, the little millet *khara* gritters had less amount of calcium 10.07 mg and

highest was in soya *hurigalu* (82.30 mg) followed by gardencress *laddu* (78.83 mg), little millet green *sev* (64.90 g) and foxtail millet *chakkali* (44.73 g).

A wide variation was registered in the iron content of five RTE value added products, which ranged from 4.01 to 25.05 mg/100g. The iron content of foxtail millet *chakkali*, little millet green *sev*, gardencress *laddu*, little millet *khara* gritters and *soya hurigalu* were 4.01, 12.57, 25.05, 4.39 and 9.88 mg/100g, respectively. A similar trend was also evident for products on per serving basis, which ranged from 1.20 to 13.78 mg/100g. The gardencress *laddu* recorded highest on per serving basis (13.78 mg) followed by little millet green *sev* (4.50 mg), *soya hurigalu* (3.95 mg), little millet *khara* gritters (3.07mg) and least by foxtail millet *chakkali* (1.2 mg).

The β-carotene content of five RTE value added products varied widely and ranged from 6.08 µg to 1128.48 µg/100g. The highest β-carotene was evident in little millet green *sev* (1128.48 µg/100g) which contained *chakramuni* leaves, a β-carotene rich leafy vegetable followed by soya *hurigalu* (426.73 µg/100g), foxtail millet *chakkali* (109.09 µg/100g), little millet *khara* gritters (9.41µg/100g) and least by gardencress *laddu* (6.08 µg/100g). The exactly similar trend was also observed for per serving basis and ranged from 3.34 µg to 389.12 µg per serving.

4.5.3 Sensory evaluation of Ready To Eat (RTE) value added traditional products

The RTE value added traditional products were evaluated by 10 semi trained judges of Rural Science College for their organoleptic quality on 9 point hedonic scale score card and the results are presented in Table 15.

The sensory evaluation scores for the different RTE value added traditional products are presented in Table 15. The five RTE value added traditional products developed were foxtail millet *chakkali,* little millet *green sev, gardencress laddu, little millet khara* gritters and soya *hurigalu*. All the

Table 15: Sensory scores⊗ and cost of the developed Ready To Eat (RTE) value added traditional products

Sl. No.	Products	Sensory attributes					Cost/ serving (Rs.)
		Colour and appearance	Taste	Texture	Aroma	Over all acceptability	
1	Foxtail millet *chakkali*	8.00✦ ± 0.94	7.30 ± 1.03	7.90 ± 0.88	6.60 ± 1.55	7.60 ± 1.35	1.70
2	Little millet green *sev*	8.00 ±1.25	8.10 ± 0.88	8.30 ± 0.82	8.50 ± 1.33	8.10 ± 1.29	1.25
3	Gardencress *laddu*	7.80 ± 0.79	7.50 ± 1.35	7.55 ± 1.26	7.66 ± 1.43	7.50 ± 1.34	1.90
4	Little millet *khara* gritters	7.30 ± 1.64	7.90 ± 1.20	6.70 ± 1.34	7.20 ± 1.35	7.20 ± 1.35	1.25
5	Soya *hurigalu*	7.30 ± 1.34	7.50 ± 1.08	7.30 ± 1.16	7.10 ± 1.10	7.20 ± 1.14	1.90

⊗ Mean scores of 10 judges on 9 point hedonic scale.

✦ Maximum score for 9 point hedonic scale is 9.

characteristics except in little millet *khara* gritters which scored less (6.7) for texture and in foxtail millet *chakkali* for aroma (6.6).

4.5.4 Cost of the RTE value added traditional products

The cost of the RTE value added traditional products depends on the type of ingredients used. The cost per serving is presented in Table 15. Out of the five products, the cost per serving of gardencress *laddu* and soya *hurigalu* was highest (Rs. 1.90) followed by foxtail millet *chakkali* (Rs. 1.70) and least by little millet green *sev* and *little millet khara* gritters (Rs. 1.25).

4.5.5 storage quality of Ready To Eat (RTE) value added products

The RTE value added products were stored in Low Density Poly Ethylene (LDPE) pouches at ambient conditions and analysed for moisture, free fatty acids and orgaloleptic qualities at weekly intervals for 28 days storage period and the results are presented below.

4.5.5.1 Moisture

The changes in moisture content of RTE value added products over the storage period of 28 days are given in Fig. 12 and Appendix-XV.

The mean initial moisture content of foxtail millet *chakkali* was 3.44 per cent which was doubled to 6.75 per cent at the end of storage period of 28 days The trend was similar for little millet green *sev*, little millet *khara* gritters and soya *hurigalu*. However, in gardencress *laddu*, the mean moisture content increased upto 14 days (16.88%) and further reduced slightly to 15.34 per cent at the end of storage period.

4.5.5.2 Free Fatty Acid (FFA)

The change in FFA content of RTE value added products over the storage period of 28 days is given in Fig. 13 and Appendix-XV

The FFA content expressed as per cent oleic acid was found to increase steadily in all the stored RTE value added products packed in LDPE

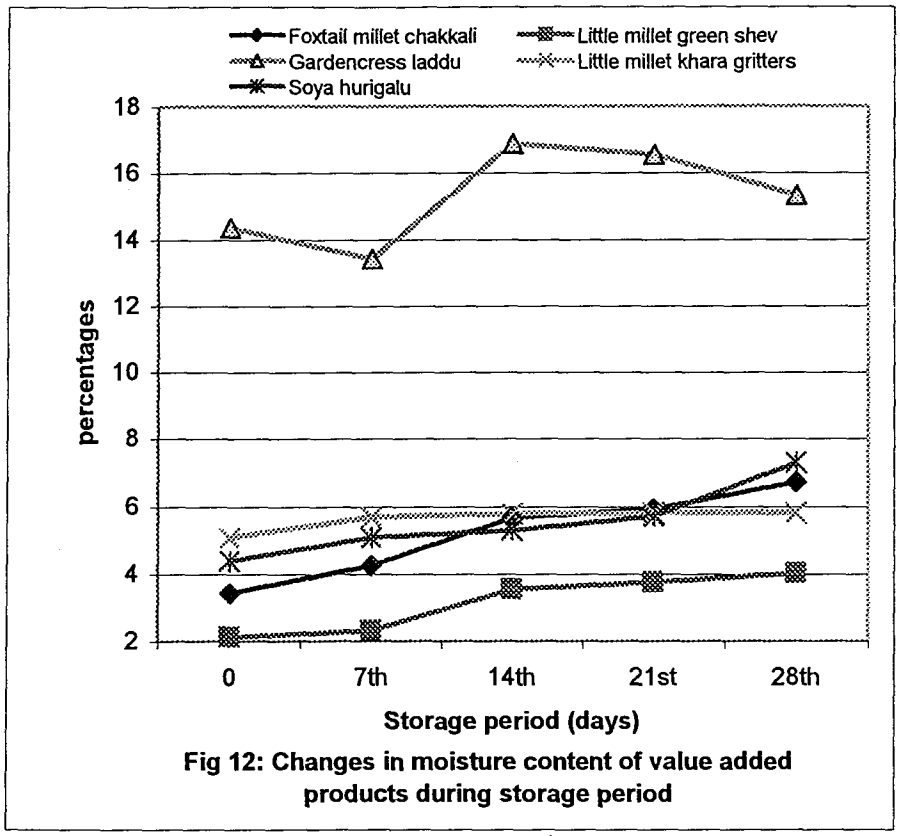


Fig 12: Changes in moisture content of value added products during storage period

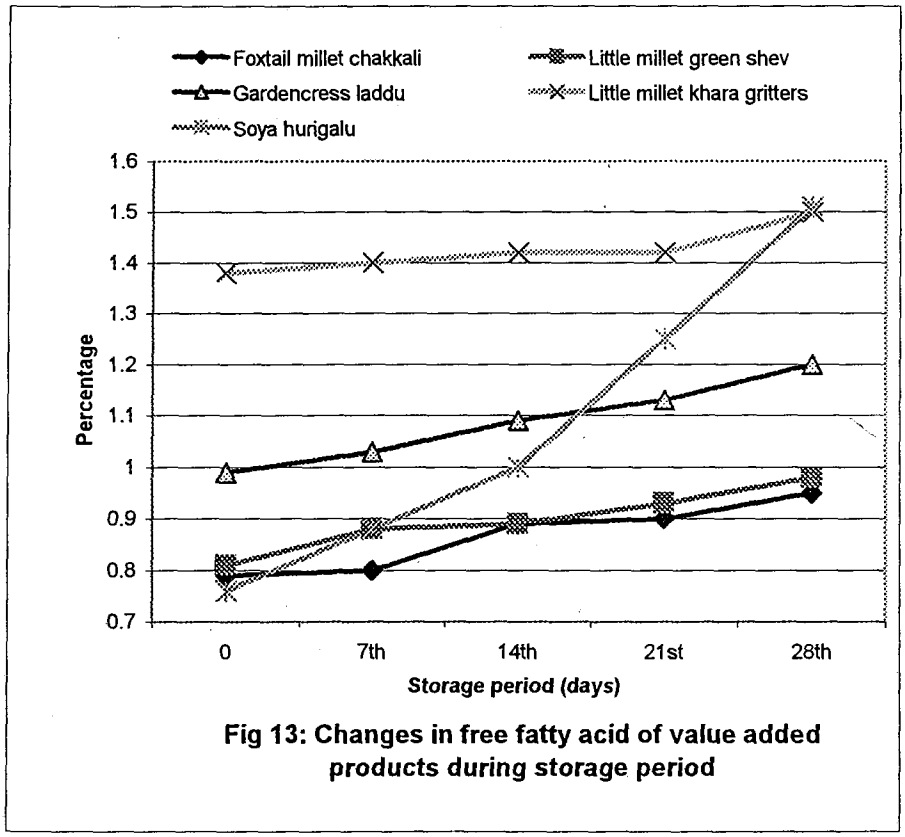


Fig 13: Changes in free fatty acid of value added products during storage period

pouches. The initial FFA value was highest in little millet *khara* gritters (1.38%) and lowest in soya *hurigalu* (0.76%), whereas at the end of storage period, the FFA was highest in soya *hurigalu* (1.51%) and lowest in foxtail millet *chakkali* (0.95%).

4.5.5.3 Sensory evaluation of RTE value added traditional products during storage period

Changes in sensory scores of RTE value added products over the storage period of 28 days are given in Fig. 14, 15, 16, 17, 18. The detailed data are provided in appendix- XVI, XVII, XVIII, XIX and XX.

The foxtail millet *chakkali* scored highest for colour and appearance at the initial period (8 points) which reduced to 7.0 point at the end of 28 days showing extremely good at the initial to very good at the end of 28 days. Similarly for taste which scored between very good to moderately good (7.2) reduced gradually during the storage period and at the end scored 5.6 resulting in moderately good to good. However, the textural quality was changed drastically from 7.3 scores to 4.1 score showing fair quality at the end of storage period. A similar trend was observed for aroma and over all acceptability. However, upto 21 days the products scored more than 5 points indicating that the products were good and beyond 21 days period scored less for all the observed attributes. (Fig. 14 and Appendix-XVI)

The little millet green *sev*, which was stored for 28 days was evaluated by panel of 10 judges every week. The result recorded that, (Fig. 15 and Appendix-XVII) the little millet green *sev* scored more than 8 points for all the parameters at the initial stage showing the product was extremely good over the storage period of 28 days, the scores declined. However, not much change was apparent in colour and appearance and taste. Nevertheless, the texture, aroma and over all acceptability affected very much and the mean scores were 4.2, 3.6 and 3.3 respectively. However, the product was moderately good for all

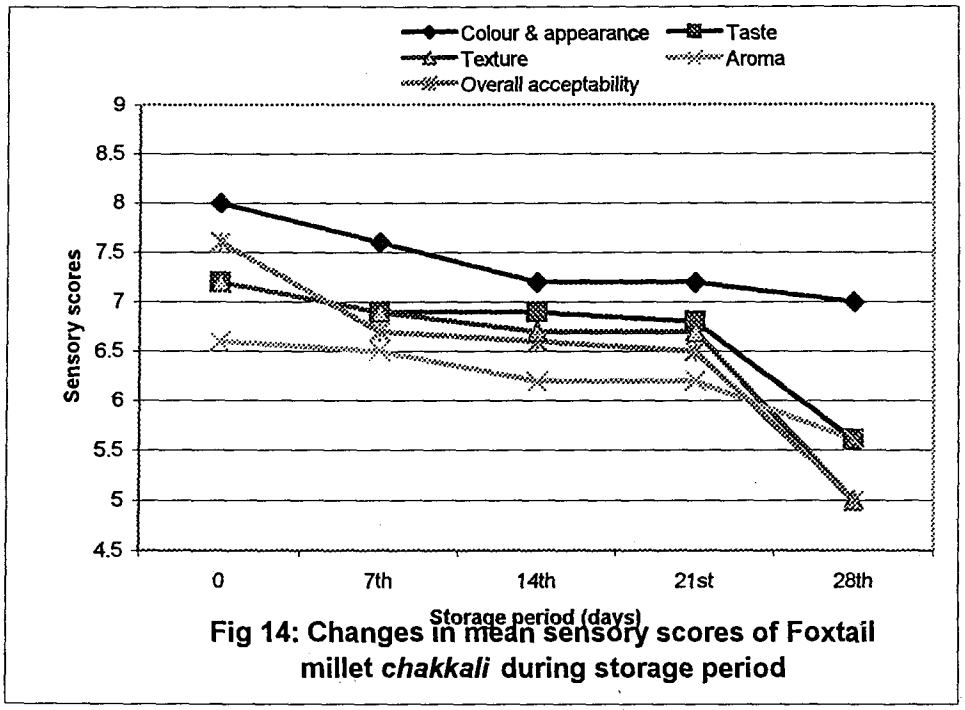


Fig 14: Changes in mean sensory scores of Foxtail millet *chakkali* during storage period

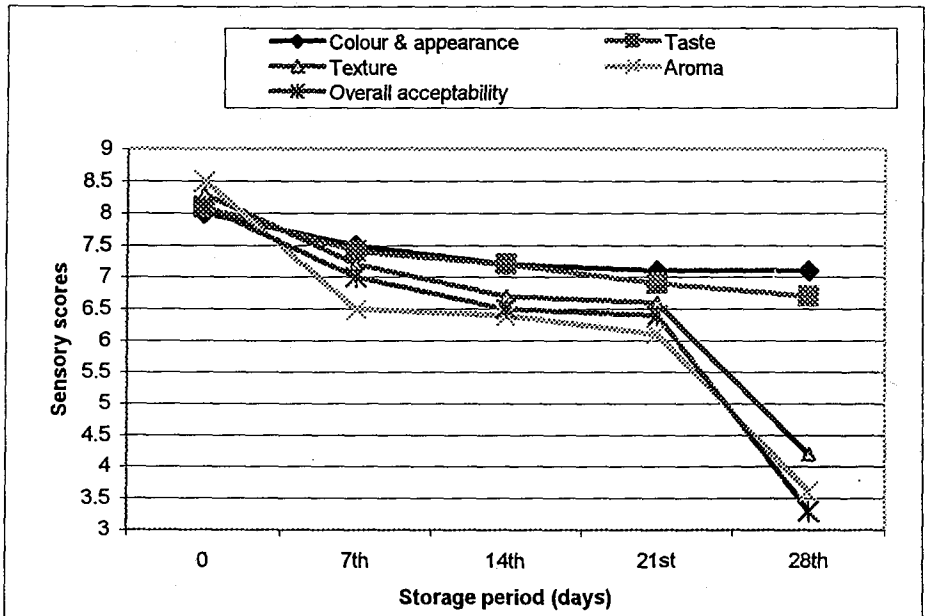


Fig. 15: Changes in mean sensory scores of Little millet green *sev* storage period

the parameters upto 21 days and further reduces drastically indicating that, the product was good upto 21 days.

The change in mean sensory scores of gardencress *laddu* is given in Fig. 16 and Appendix-XVIII. The gardencress *laddu* scored 7.5, 7.8, 7.4, 7.4 and 7.3 mean scores for colour and appearance, taste, texture, aroma and overall acceptability reported at the initial stage indicating that the product was between very good to extremely good attributes. However, not much variation in the mean scores of all the five parameters was observed during the storage period of 28 days revealing that the product was between good and moderately good. Thus the gardencress *laddu* could be stored for 28 days without much change in the quality parameters.

The changes in mean sensory evaluation scores for little millet *khara* gritters *presented* in Fig. 17 and Appendix-XIX. The little millet *khara* gritters scored more than seven score (7.4 points) for all the parameters in the initial period revealing that the product was between very good and extremely good. There was not much changes at the end of 15th day. But the product was good upto 21 days later score was very less, indicating that the product was 'fair'. Thus, the little millet *khara* gritters could be stored upto 21 days with a good sensory attributes.

The changes in the mean sensory scores for *soya hurigalu* during the storage period are presented in Fig 18 and Appendix-XX. The soya *hurigalu* scored 7.3, 7.5, 7.5, 7.1 and 7.2 representing for colour and appearance, taste, texture, aroma and over all acceptability, at the initial storage period. All the mean scores declined gradually upto 21 days and at 28 days the scores were very much less (<4.5) indicating the product was between good to fair. Thus the soya *hurigalu* could be stored upto 21 days with satisfactory organoleptic qualities.

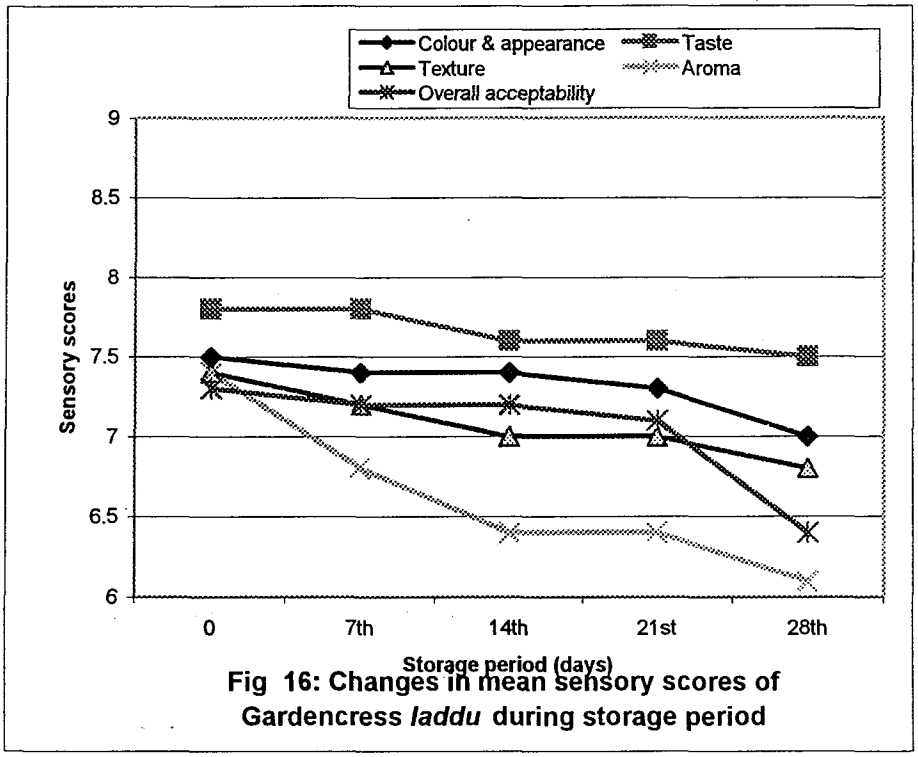


Fig 16: Changes in mean sensory scores of Gardencress *laddu* during storage period

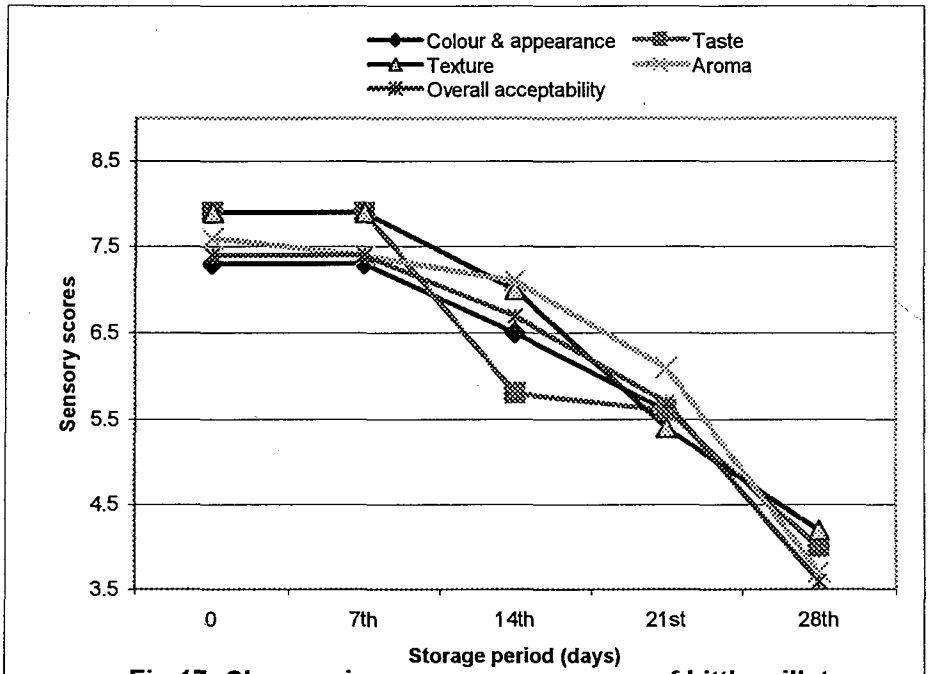


Fig 17: Changes in mean sensory scores of Little millet *khara* gritters during storage period

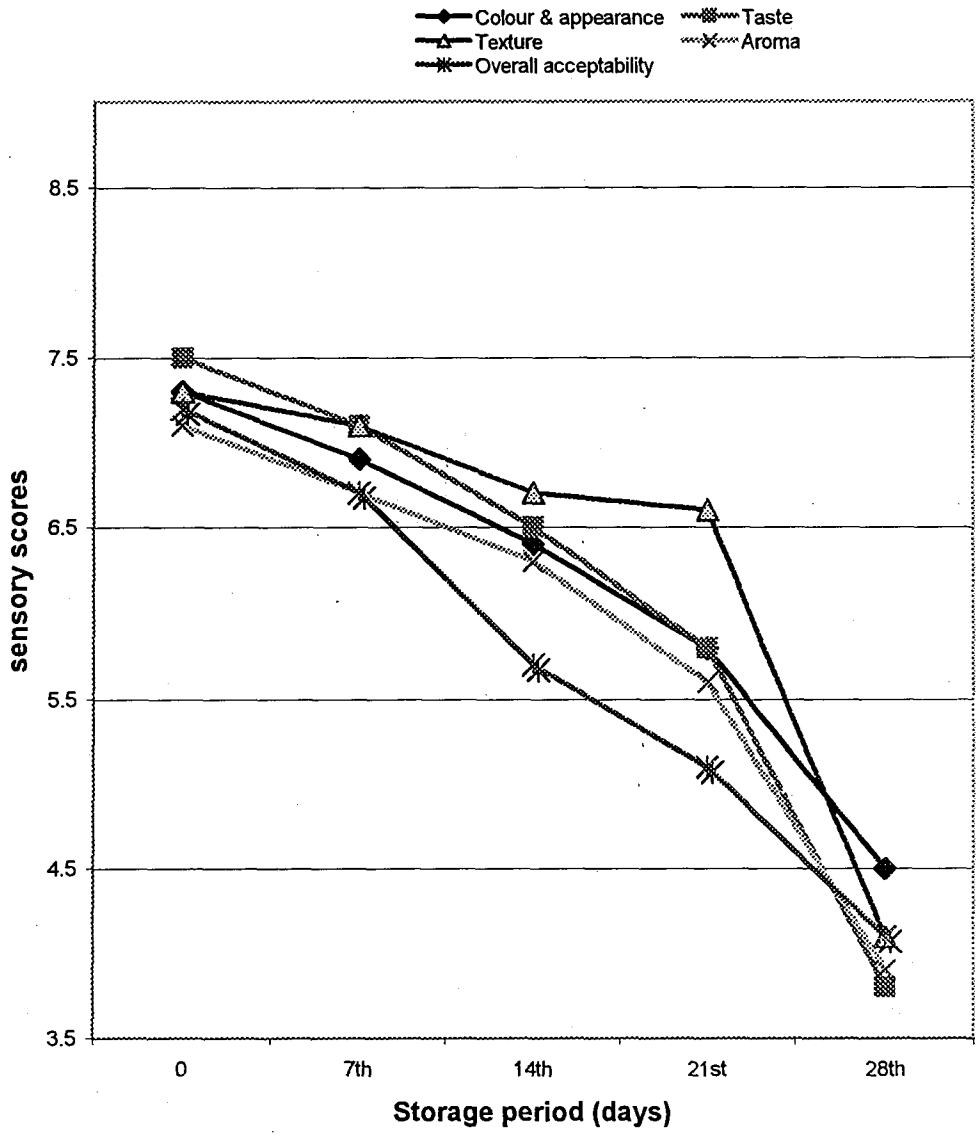


Fig 18 : Changes in mean sensory scores in Soya *hurigalu* during storage period

4.6 EFFICACY OF SUPPLEMENTATION OF VALUE ADDED TRADITIONAL PRODUCTS ON NUTRITION SECURITY

The general information of the selected subjects, nutritional status for the intervention nutrient composition of selected value added traditional recipes and impact of supplementation in terms of changes in growth, hemoglobin and serum retinol levels in children are presented in this section.

4.6.1 General profile of selected subjects

The general profile of selected subjects for the intervention study is provided in Table 16. All the 60 male children selected for experimental and control group belonged to age group 10-12 years.

Majority of the subjects from both the groups belonged to medium size family (n=23 & 18 children, respectively). In the experimental group four children were from large family and three children were from small sized family. Whereas in control groups, five children were from large family and seven were from small family and none were from very large family having >9 member in a family set up.

Equal number of children (n=23 & 7) were from nuclear and joint family in both the groups and all children from control and experimental belonged to Hindu religion. The classification according to caste revealed that, the majority of subjects were from upper and backward caste in both control and experimental (n=27 and 22, respectively) groups and equal number of children (n=3) were from schedule tribe and only five children from experimental group belonged to schedule caste.

Table 16: General information of the selected subjects

(N=60)

No.	Parameters	Experimental Group (n=30)	Control Group (n=30)
	Name of the village	Mugad	Mandihal
1	**Age (Yrs.)**	10-12	10-12
2	**Sex**	Male	Male
3	**Family Size**		
	Small (1-3 members)	3	7
	Medium (4-6 members)	23	18
	Large (7-9 members)	4	5
4	**Family Type**		
	Nuclear	23	23
	Joint	7	7
5	**Religion**		
	Hindu	30	30
6	**Caste**		
	Schedule Caste	5	-
	Schedule Tribe	3	3
	Upper & Backward	22	27

4.6.2 Dietary status of selected school children for intervention study

The mean nutrient intake and per cent adequacy of nutrients of selected school children under experimental and control group is presented in Table 17 .

The mean intake of energy in experimental and control group was 1350 and 1325 Kcal, respectively and provided only 61.64 and 60.50 per cent of Recommended Dietary Allowance (RDA), respectively. The intake of energy was significantly lower compared to RDA.

The mean intake of protein was slightly high in experimental group (33.08±5.08) providing 61.19 per cent of adequacy compared to control group with 31.08±5.08 g intake and 58.67 per cent adequacy. However, in both the groups, the intake was significantly lower than RDA.

The mean intake of fat in experimental group was 34.40±7.93 g whereas in control group it was 35.04±5.87. The per cent adequacy of fat was 156.73 and 159.27 per cent respectively which was more than RDA specified for selected age and gender group.

The mean calcium intake was 330.83 mg in experimental group and 326.13 mg in control group. It provided only 55.64 and 54.36 per cent of total requirement and was significantly less compared to RDA.

The mean intake of iron was 11.93±2.92 mg in experimental group and 11.10 mg in control group. The per cent adequacy of iron was 35.09 and 32.65 per cent, respectively and the intake was significantly lower compared to RDA.

The β-carotene intake was very less in both the group (633.40 µg ± 532.86 in experimental group and 605.33 µg ± 506.59 in control group, respectively). This intake met only 26.39 per cent adequacy in experimental

Table 17: Mean nutrient intake and per cent adequacy of selected subjects (N=60)

Nutrients	Experimental group (n=30)		Control group (n=30)	
	Mean nutrient intake	Per cent adequacy	Mean nutrient intake	Per cent adequacy
Energy (Kcal)	1350 ± 105.60	61.64	1325 ± 140.50	60.50
Protein (g)	33.04 ± 4.80	61.19	31.08 ± 5.08	58.67
Fat (g)	34.40 ± 7.93	156.73	35.04 ± 5.87	159.27
Calcium (mg)	330.83 ± 92.70	55.64	326.13 ± 103.23	54.36
Iron (mg)	11.93 ± 2.92	35.09	11.1 ± 2.70	32.65
β-carotene (µg)	633.40 ± 532.86	26.39	605.33 ± 506.59	25.22
Vit. A (µg)	160.31 ± 132.68	26.72	153.61 ± 125.00	25.60
Thiamine (mg)	0.98 ± 0.11	89.09	0.94 ± 0.13	85.45
Riboflavin (mg)	0.61 ± 0.09	46.92	0.58 ± 0.08	44.62
Niacin (mg)	9.86 ± 2.16	65.73	9.46 ± 2.86	63.07
Pyridoxine (mg)	0.23 ± 0.13	14.38	0.23 ± 0.14	14.38
Cyanocobalamine (mg)	0.09 ± 0.04	45.00	0.95 ± 1.88	75.00
Folic Acid (µg)	94.07 ± 37.63	134.39	89.91 ± 36.49	128.44
Ascorbic acid (mg)	44.61 ± 20.50	111.52	45.04 ± 19.91	112.60

group and 25.27 per cent in control group. The intake was significantly lower compared to RDA.

The intake of thiamine, riboflavin and niacin were slightly higher in experimental group compared to control group. The per cent adequacy for thiamine, riboflavin and niacin for experimental and control group were 89.09 and 85.45 per cent, 46.92 and 44.62 and 65.73 and 63.07 per cent, respectively.

The mean intake of pyridoxine was similar in both group (0.23 mg each) with per cent adequacy of 14.38 which was very low compared to RDA.

The mean intake of cyanocobalamine (B_{12}) in control group was 0.95±0.88 mg with the per cent adequacy of 75 per cent whereas in experimental group, the mean intake of cyanocobalamine was very less (0.09±0.04 mg) with per cent adequacy of only 45 per cent.

There was not much variation in the intake of folic acid among groups. The intake was 94.07±37.63 µg in experimental group whereas in control group it was 89.91±36.49 µg. The per cent adequacy was 134.39 and 128.44 per cent, respectively.

The mean ascorbic acid intake recorded in experimental group was 44.61±20.50 mg where in control group the mean intake was 45.04±19.91 mg. The per cent adequacy for ascorbic acid was more than 100 per cent in both the groups.

4.6.3 Classification of children into different degrees of malnutrition

Classification of children into different degrees of malnutrition (Waterlow's classification) by height and weight, using National Centre for Health Statistics (NCHS) 50th percentile standard is presented in Table 18.

It is evident from the table that, out of 30 children, four children (13.33%) were in the group of 'wasted' followed by 'stunted' (36.66%) and

Table 18 :Classification of subjects according to different degrees of malnutrition (Waterlow's qualitative classification)

(N=60)

Sl. No.	Waterlow's classification		Experimental group (n=30)	Control group (n=30)
1	**Normal**	Weight for height >80% Std. Height for age >90% Std.	15 (50%)	11 (36.67%)
2	**Stunted**	Weight for height >80% Std. Height for age <90% Std.	11 (36.67%)	12 (40%)
3	**Wasted**	Weight for height <80% Std. Height for age >90% Std.	4 (13.33%)	5 (16.67%)
4	**Wasted & Stunted**	Weight for height <80% Std. Height for age <90% Std.	0.00 (0.00%)	2 (6.66%)

Note: Figures in parentheses indicates percentage

'normal' (50%) in the experimental group where as in control group 6.66 per cent were 'wasted and stunted', 16.66 per cent were 'wasted', 40 per cent were 'stunted' and only 36.66 per cent were in 'normal' categories.

4.6.4 Impact of intervention on nutrition security

The selected children for intervention were fed with supplementary foods *viz.*, Foxtail millet *bisibelebath* with bengalgram leaves, little millet *upama* with bengalgram leaves and gardencress *laddu,* a value added traditional products with underutilized foods, in the form of routine dishes for the period of 90 days and the results of this trial are presented in this section.

4.6.4.1 Impact of supplementation on growth

The growth assessment was indicated by the increment in height and weight parameters. The mean height and weight of children before and after supplementation is documented in Table 19.

The supplementary food increased the height of children from 129.38 to 129.91 cm, indicating an increment of 0.53 cm after the three months of supplementation period. However, a slight increase of 0.13 cm was also observed in control group as they were in growth period.

The student 't' test indicated a significant difference between the initial and final values of experimental group for mean height of children. Such trend was also noticed among control group.

The supplementation also increased the weight of children from 23.58 to 24.03 kgs indicating an increment of 0.45 kg in three months period. This increase was significant at one per cent level. However, no such significant evidence was traceable in control group. Though a negligible increase of 0.13 g over three months period was seen.

Table 19 :Anthropometric measurements of subjects before and after the intervention

(N=60)

Parameters	Experimental group (n=30)			Control group (n=30)		
	Before	After	t value	Before	After	t value
Height (cm)	129.38 ± 5.77	129.91 ± 5.89	1.79*	132.93 ± 7.63	133.06 ± 7.65	1.71*
Weight (kg)	23.58 ± 3.20	24.03 ± 3.08	3.58**	25.20 ± 4.77	25.33 ± 4.69	1.24^{NS}

* Significant at 5% level
** Significant at 1% level
NS Not significant

4.6.4.2 Impact of supplementation on hemoglobin status

The mean hemoglobin level of selected children before and after intervention is presented in Table 20.

The mean initial level of hemoglobin in the experimental group children was 10.98 g/dl which increased to 11.64 g/dl after three months of supplementation. This increment of 0.66 g/dl was statistically significant (P>0.05). On the contrary, in the control group there was decrease in the mean hemoglobin from 10.48 g/dl to 10.14 g/dl during the experimental period.

The children were further classified according to WHO (Anon, 1986) for anaemia before and after intervention and data is presented in Fig. 19 and Appendix-XXI.

It was evident from the Fig. 19 that, 18 children (72%) were having hemoglobin between 10-11.9 g/dl and were classified under mild anemia and three children (12%) were having hemoglobin between 8-9.9 g/dl and were grouped under moderate anemia. Only four children (16%) were having normal hemoglobin level. But after the three months of supplementation, there was a shift in the children from moderate to mild to normal categories. The moderate anemia children shifted to mild and normal group. The number increased from four to nine in normal group after supplementation period of three months. On the contrary a shift was seen from normal to mild to moderate anemia in the control group. Out of twenty five, four children were in normal group, 10 in mild anemia group and 11 were in moderate group at initial group.

4.6.4.3 Impact of supplementation on serum retinol level

The mean initial serum retinol in the experimental group was 15.92 µg/100 ml. On three months of supplementation a significant (P>0.05) increase in the serum retinol was observed (19.51 mg/100g) which was statistically significant. However in control group the serum retinol increased from 16.95 to

Table 20: Mean hemoglobin levels of subjects before and after the intervention

(N=50)

Parameters	Experimental group (n = 25)			Control group (n = 25)		
	Before	After	t value	Before	After	t value
Hemoglobin level (g/dl)	10.98 ± 0.83	11.64 ± 1.25	-3.06**	10.48 ± 1.61	10.14 ± 1.16	1.24^{NS}

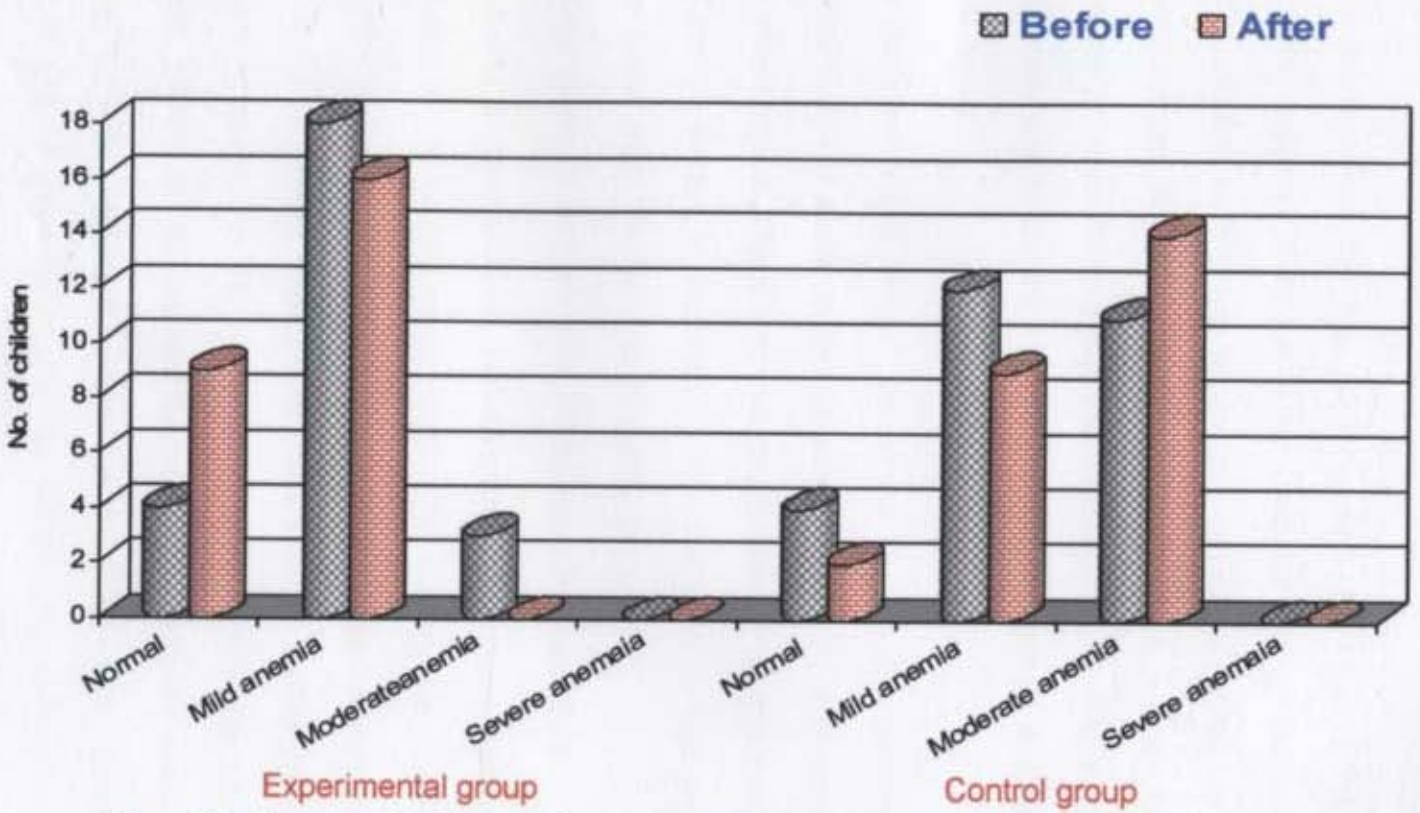


Fig 19: Impact of supplementation on anemia status of selected school children

17.57 µg/100g. The statistical test showed no significant difference after supplementation period (Table 21)

The children selected for the intervention study were classified according to serum retinol level, (Anon, 1982), before and after intervention and presented in Fig. 20 and Appendix-XXII.

It is evident from the Fig. 20 that, eight per cent of the children were 'deficient' while majority (76%) fell in the category of 'low' levels and only 16 per cent of the children were in the acceptable range before the intervention in the experimental group. But after the intervention, there was a shift in the groups. The children in 'acceptable group increased from 4 (16%) to 10 (40%) and in 'low' level there was decrease from 19 (76%) to 15 (60%) and none were found in 'deficient' group.

On the other hand, in the control group, only five children (20%) were in 'acceptable' range of serum retinol level and majority (76%) were in 'low' level before the intervention. There was not much change in the picture after three months of period, except a single shift from 'deficient' to 'low' group thus increasing in 'low' group from 19 (76%) to 20 (80%) children.

4.6.4.4 Morbidity pattern before and after supplementation

Morbidity pattern in children before and after the supplementation is presented in Table 22. In control group, initially 20, 60, 64 and 12 per cent of children were found to have suffered once from diarrhoea, cough, cold and fever, respectively. On the other hand, after three months during experimental period the per cent increased to 28, 68, 72, and 24, respectively. But, in the experimental group, initially 32, 60, 84, and 52 per cent of children were found to have suffered once from diarrhoea, cough, cold and fever, respectively. Similarly, 16, 20, 4 and 52 per cent of children suffered twice from diarrhoea, cough, cold and fever, respectively.

Table 21: Mean serum retinol levels of subjects before and after the intervention

(N=50)

Parameters	Experimental group (n = 25)			Control group (n = 25)		
	Before	After	't' value	Before	After	't' value
Serum retinol level (µg/dl)	15.92±8.02	19.51±8.06	2.37*	16.95±7.80	17.57±8.90	1.46^{NS}

* Significant at 5% level
NS- Not significant

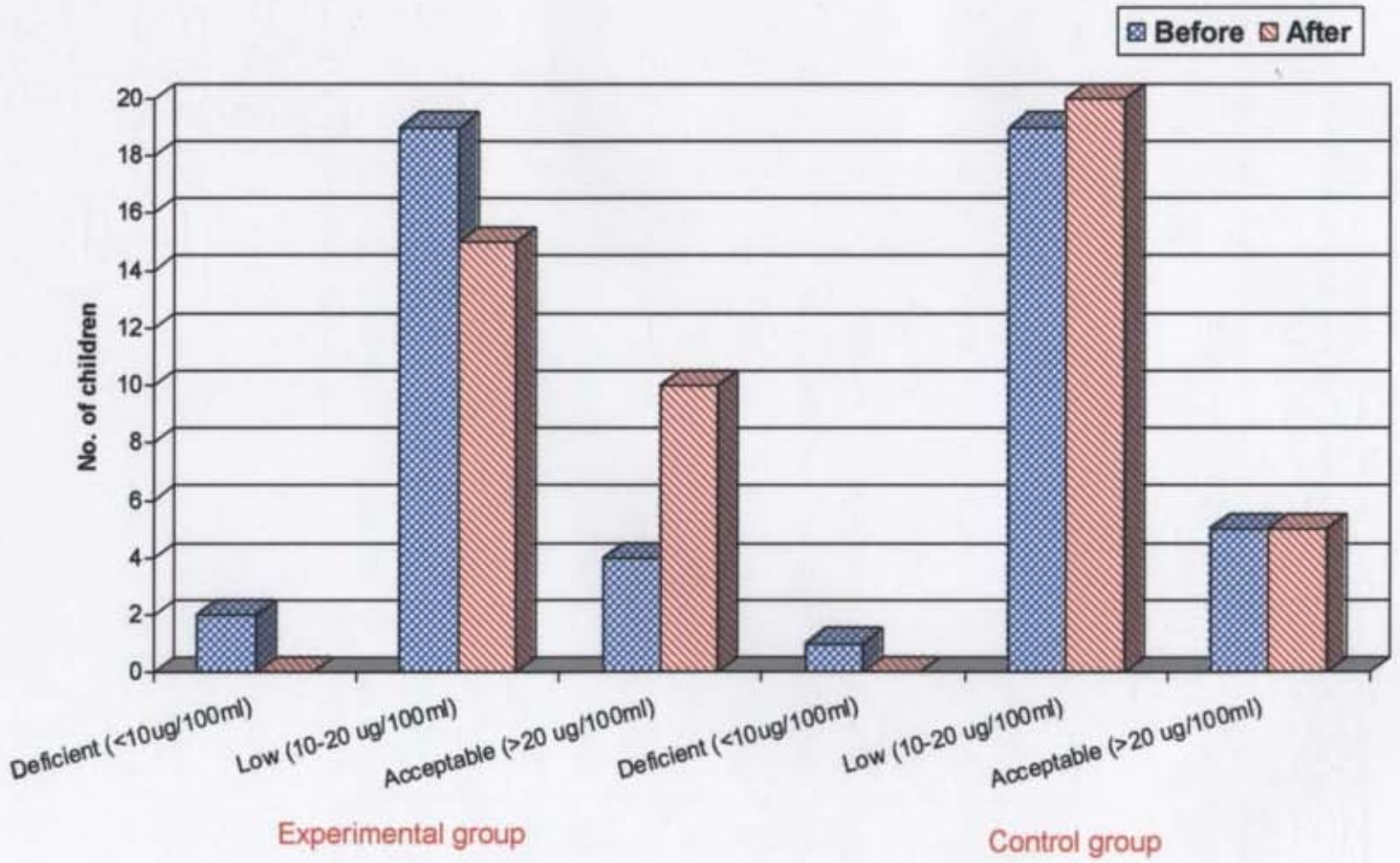


Fig. 20: Impact of supplementation on serum retinol status of selected school children

Table 22: Morbidity pattern before and after intervention

(N=50)

Illness	Frequency	Experimental group (n=25)		Control group (n=25)	
		Before	After	Before	After
Diarrhoea	0	13 (52.00)	22 (88.00)	15 (60.00)	13 (52.00)
	1	8 (32.00)	3 (12.00)	5 (20.00)	7 (28.00)
	2	4 (16.00)	0 (0.00)	4 (16.00)	4 (16.00)
	3	0 (0.00)	0 (0.00)	1 (4.00)	1 (4.00)
Cough	0	5 (20.00)	18 (22.00)	6 (24.00)	3 (12.00)
	1	15 (60.00)	7 (28.00)	15 (60.00)	17 (68.00)
	2	5 (20.00)	0 (0.00)	3 (12.00)	4 (16.00)
	3	0 (0.00)	0 (0.00)	1 (4.00)	1 (4.00)
Cold	0	3 (12.00)	21 (84.00)	6 (24.00)	1 (4.00)
	1	21 (84.00)	4 (16.00)	16 (64.00)	18 (72.00)
	2	1 (4.00)	1 (4.00)	3 (12.00)	6 (24.00)
Fever	0	10 (40.00)	23 (92.00)	20 (80.00)	15 960.00)
	1	13 (52.00)	2 (8.00)	3 (12.00)	6 (24.00)
	2	2 (8.00)	0 (0.00)	2 (8.00)	4 (16.00)

Note: Figures in the parentheses indicate percentage

After the supplementation period only 12, 28, 16 and 8 per cent of children reported that they had suffered from diarrhoea, cough, cold and fever only once respectively. Nevertheless, no children were reported to have suffered from any of the said ailments more than once except from cold.

In general, it is apparent that the percentage of children suffering with diarrhoea shifted to normal group was higher in case of supplementation compared to control children.

DISCUSSION

V DISCUSSION

Major advances have occurred in the food production during the last four decades due to large scale adoption of green revolution technology. Between 1966 and 2000, the population of densely populated low income countries grew by 90 per cent but food production more than doubled. In 1987, the average per capita food availability was 18 per cent higher than that of 1966. Development of high yielding varieties of rice, wheat and maize led to the dramatic achievements in the world food production during the last 35 years. Inspite of all the achievements of green revolution, serious food problem still exists in the world. Every 3.6 seconds somebody dies of hunger. Chronic hunger takes the lives of 24,000 people every day. Currently there are more than 80 million undernourished people in the developing countries. Every year nearly 13 million children under the age of five die because of hunger and malnutrition. Projection of food production and consumption in 2020 offer some sign of progress, but prospects of a food secure world ie., a world in which each and every individual is assessed of access at all times to food required to lead a healthy and productive life are remote. Projections of FAO on the size of food insecure population paint a bleak picture. FAO projects that 680 million of the worlds populations (12% of the developing world's population) could be food insecure in 2010. Thus, besides food security, it is equally important to address the nutritional security.

Poverty rather than food shortage is frequently the underlying cause of hunger. Nevertheless, it is an example of "poverty amidst plenty". Out of the 80,000 species of plant wealth, only 30 crops are reported to feed the world, of which 10 crops provide 75 per cent of the total plant derived energy intake and only 3 crops *viz.*, rice, wheat and maize provide 60 per cent of total food requirement. Thus to solve the worlds food problem and provide food for its

growing millions, man has not only to use all available technology in food and nutrition but also exploit various unconventional foods which are nutritious which exist but are not utilized for diverse reasons. Thus, an attempt has been made in this study to document and analyse the nutritional profile of underutilized foods from different agroclimatic zones of North Karnataka, to develop value added traditional product utilizing these underexploited foods for nutrition security and to test the efficacy of the product on growth and several biochemical parameters of school children of age group 10-12 years.

The present study for intervention claimed only to encompass male school age children to nullify the effect of growth spurt during pre adolescence and to clearly spell out the effect of nutrified underexploited foods of North Karnataka. The salient findings of the investigation are discussed in this section.

5.1 NUTRITIONAL STATUS OF FAMILIES RESIDING IN DIFFERENT AGROCLIMATIC ZONE AREAS

Totally 375 families from six agroclimatic zones were assessed for their nutritional status through the diet survey. The families from N.E. Dry Zone had significantly higher intake of nutrients compared to the rest of the zones (Table 5). These zones had better cropping pattern and irrigation facilities. The grains grown in these areas were jowar, bajra, pigeon pea and groundnut which are rich in energy, protein and fat. Impact of irrigation was seen in terms of availability of leafy vegetables, which are the treasures of micronutrients. Similarly, the Coastal Zone and N. Transitional Zone also had better nutritional status due to good rainfall in that zone, the commercial crops as well as food crops were grown adequately; in turn, population residing in these areas got varieties of fruit and vegetable, which improved their nutritional intake. On the other hand, the intake of nutrients by the families was affected in the N.E. transitional Zone because of low rainfall, which affected the cropping pattern and

also low education of families of these villages which in turn hindered the awareness of the population (Table 3).

The Table 6 projected that as the income level increased, energy consumption level also increased among the families while such trend was not evidenced for other nutrients. Only energy, calcium and ascorbic acid intake was highest in I income group and protein and folic acid were highest in II income group. On the contrary, intake of most of the nutrients was high in III group. In general, it was noticeable that the intake of most of the nutrients was very less in V group where monthly income was less than Rs. 240. Nevertheless when the adequacy of nutrients was considered, per cent adequacy of energy and protein were more than 75 per cent in all the income groups. Similarly, the adequacy of fat was more than 70 per cent in all the groups. The adequacy of micro nutrients such as iron and β-carotene was very low ie., 60.18 to 66.00 per cent and less than 30 per cent in all the groups, respectively. The inadequacies of nutrients are not uncommon in developing countries like ours, particularly among rural families, where several amenities, such as limited land, dependence on rainfall for crops, poor cultivation practices, large family size, low income, lack of health and hygiene and disparity among members are rampant. Similar observations of lower adequacy of several nutrients have been observed by Bharathi (1996) in Mundaragi taluka in Dharwad district and Usha and Naik (1992). Aujla *et al.* (1983); Busi *et al.* (1987) and Gopalan (1992) also confirmed the study and they observed the difference in food consumption pattern depended upon income level, occupation status and size of the family.

When adequacy of selected nutrients *viz.*, energy, protein, iron and β-carotene was classified as ≥100 per cent, <75-100 per cent, <50-75 per cent, and <50 per cent adequacy on per capita income basis (Fig. 8, 9, 10 & 11), higher number of families had energy adequacy >75-50 per cent in all per capita income group. More number of families of I and II income groups had protein

adequacy ≥100 per cent and this trend was not apparent for other three income groups and generally families had protein adequacy between <75-50 per cent. This observation is not surprising because all these families irrespective of income, subsists on cereal as a staple food, which has around 70 per cent starch providing 4 Kcal/g. These cereals also provide considerable quantities of protein, thus cereals were found serving to be the source of both energy and protein among the rural families. Gopalan (2003) has emphatically observed that wherever there is energy adequacy through cereals, the protein adequacy will also be taken care.

As expected the adequacy of micronutrients, iron and β-carotene pictured a very low status among the studied families. These nutrients invariably depend on the consumption of horticultural crops which are in general low among Indian population. These protective nutrients registered low adequacy among different income groups. The observation of the present investigation is in conformity with the study conducted by Usha and Naik (1992), Seema (1995) and Kasturiba (1999) among Karnataka population.

In an Indian context several non-nutritional parameters are known to influence the adequacy of nutrients among population. An attempt was made to correlate selected background variables with the nutrient intake of families (Table 23). The family size, negatively and per capita income positively but significantly correlated with protein intake. Family size alone negatively but significantly correlated with energy and β-carotene intake among the rural population studied in the present investigation. Similar results were documented by Ahmed *et al.* (1993) who found that small family size and higher family income resulted in better nutrition. Thus increase in family size increases the mouths to be fed and division of the family income with the available limited resources of the unit. Thus the trend is obvious expected evidence in the present investigation.

Table 23: Correlation coefficient between selected background variables

Nutrients	Education	Family size	Per capita income
Protein (g)	-0.004^{NS}	-0.199**	0.181**
Energy (Kcal)	-0.004 ^{NS}	-0.148*	0.120 ^{NS}
Iron (mg)	-0.007 ^{NS}	-0.104 ^{NS}	0.073 ^{NS}
β-carotene (µg)	0.032 ^{NS}	-0.0169**	0.027 ^{NS}

* Significant at 5% level

** Significant at 1% level

NS Not significant

5.2 DOCUMENTATION AND NUTRIENT ANALYSIS OF UNDERUTILIZED FOODS

The major objective of the present investigation was to utilize the underexploited nutrient dense food to achieve nutrition security among growing children. Hence, the underutilized foods in the study was defined as the food which are under cultivated, gathered and picked from the forest or field, limited availability or available but less utilized by the specific population. Based on this operational definition, a total of eight millets, seven pulses, five oilseeds, 15 vegetables, 40 each leafy vegetable and fruits, six spices and condiments, and besides these, bamboo shoot, mushroom and honey were also documented during the survey period (Table 7).

The millets being a minor crop were cultivated in a low profile only in *kharif* season (dry zone). Three of the apparently unknown millets *viz.*, proso, kodo and barnyard were not even available in the market, but few farmers grew them in their fields to a limited extent. These millets except bajra, maize and ragi were used as a substitute for rice, because they were inexpensive and could be stored for a year without processing.

These millets being small in size, require different processing technologies and house hold level processing is time consuming and laborious. These facts may also be the reason for their under utility. If processing units are made available at taluka levels, value addition and processing can be tremendously improved and diverted towards nutrition security of farm population.

Out of the seven pulses documented the pulse *lenki* was available as less cultivated only in Bidar area (N.E. Transitional Zone) and was not available in markets and available only in small quantities with the few farmers. A low percentage of low socio economic status population in Bidar consumes this pulse as dhal and *junaka*. Rests of the pulses were available in the market.

These pulses were grown in *rabi* season and were mainly used as *bhaji*, *curry*, and *dhal vada* as they were considered good for health and available cheaply compared to major pulses like greengram and redgram dhal. The consumption of horsegram had a unique concept that it is good for health and to get relief from cold by drinking a *'sangathi'* prepared out of horsegram flour. The utilization was restricted to some section of the population in the region, elsewhere horsegram is used as a cattle feed. All these pulses were stored as such for 3 – 6 months. Even though Soybean was grown in larger areas, its utilization was restricted because of beany flavour and lack of awareness of processing and consumption of the pulse and thus it is only exported to oil refineries (Kamble, 1993).

The oil seeds were grown in *kharif* season like millets except the sunflower and safflower which were grown in all season and *rabi* season, respectively. Documented oil seeds were available in nearby market, but consumed only in the form of *chutney* powder (dry) in small quantities by the people of particular region, considered good for health and can be stored for one year without processing.

India is blessed with different agroclimatic regions which enable to grow different vegetables and fruits. Thus, many vegetables available during the investigation were regional specific. Most of the vegetables were available in rainy season and in nearby market but few were gathered and/or cultivated in the fields. The documented vegetables were mainly consumed in the form of *bhaji* while *mekkikai* and *challkai* were also used for the pickle preparations. The vegetable such as *karchikai* and *sandige kumbal* (ash gourd) were dehydrated and consumed as *'sandige'* after deep fat frying. Nevertheless, the consumption of these vegetable was restricted with region specificity as they were easily available and inexpensive and good for health, good to eat atleast once in the season. Even though all these vegetables were inexpensive, *adavi hagal* which was mainly gathered from the forest was sold in the market during season at the

cost of Rs. 50/kg. In general all the vegetables were stored for 3-4 days with an exception of *mogekai* and *ash gourd* which can be for more than 6 months. Masti (2000) have also documented the utility of *karchikai* in the study.

Several of these vegetables have not been exploited either by food technologists or nutritionists; hence information regarding the utility and nutrient composition is limited and needs further exploration.

It was interesting to document nearly 40 varieties of Green Leafy Vegetables (GLV) in the different zones of North Karnataka, most of them being restricted to Uttar Kannada (dense with forest and hills) and coastal belt of the study area. The green leafy vegetables were usually either gathered from the forest and surprisingly most of them were found in home/kitchen gardens. Invariably these perishable greens were mostly available during rainy season, with few exceptions and used for *bhaji*, curry, for table purpose and consumed reasonably routinely because of availability at door step.

Similar to greens, North Karnataka was found to be the store house for varieties of fruits which were season and region specific. These fruits were usually found in the forests which were gathered by men and children and it was soothing to note that children ate lots of gathered fruits during the season. Some fruits were processed as *papad* and jam, while majority were used for table purpose as they were considered good for health. Being perishable, these fruits could be stored for only few days.

Around six unusual spice and condiments were documented during the survey period. These spices were gathered / picked from the field and two of them were also available in the local market. These spices were used mainly as accidulant and considered good for health because of their lower pH, majority of them could be stored for the period of one year with minimum processing.

Besides the above underutilized food, bamboo shoots, mushroom and honey were identified as the food gathered from the field/forest and considered in having several medicinal values. Besides, these food items were also used in certain culinary preparations.

Out of the documented underutilized foods, few selected were screened for quality and found to be the treasures of the nutrients (Table 8).

The four millets analysed had good amount of protein with a range 8.86 to 9.22 g/100g fat, ash, calcium and iron. The little millet had appreciable amount of fat (5.52 g/100g), fiber (5.2 g/100g) and iron (3.35 mg/100g) millets were fair sources of β-carotene. The analysed millets were comparable with major cereals, such as rice and wheat. The values obtained for millets were comparable with the values reported by Kulkarni and Naik (1992).

The protein content of horsegram was on par with the value recorded by Gopalan *et al.* (1996). *Lenki* and horsegram were rich sources of fat and fiber, the horsegram registered higher calcium and iron which were slightly less than the value recorded by Gopalan *et al.* (1996). Variation in agroclimatic conditions and varieties has shown to influence the nutrient composition of grains.

The vegetables such as *karchikai*, *mulangikai*, *adavi hagal*, *mogekai* and onion stalks on analysis showed wide variations in nutrient composition and were rich sources of fiber, calcium and β-carotene. Some of the vegetables such as *mulangikai* contained higher amount of iron. The β-carotene ranging from 47 to 274.30 µg/100g. The value obtained in the present study for *karchikai* is comparable to the value recorded by Masti (2000). The nutritive value of underutilized vegetables when compared with general vegetable recorded appreciable amounts of protein, fat, fiber, ash, calcium, iron and β-carotene. These vegetables are easily available and low cost can thus form potential source to enhance nutrition security.

The underutilized fruits analysed were found to have fair amounts of protein, fiber, ash and iron except the *damani hannu* which recorded good amount of fat and ash besides providing good to fair amounts calcium, iron and β-carotene. The value recorded for *Atti hannu* (figs) are comparable with the values recorded by Raghuvanshi *et al.* (2001). However, no data on *ilachi*, *damani hannu* and *kavalekai* are available for comparison. The fruits such as *damani hannu, kavalekai* and *ilachi* are season based and available in nearby forest and can provide good nutrition to the population of particular region.

5.3 VALUE ADDITION TO UNDERUTILIZED FOODS

Having realized the nutritional composition of selected underutilized foods it was thought pertinent to utilize these foods for combating malnutrition by enriching the routinely consumed traditional foods. It is obvious that each region is endowed with typical traditional food habits which are culture bound, highly acceptable to the population because these recipes are transferred from generation to generation with little modification. Hence, enriching the traditional foods by nutritious but underexploited foods could pave a way for sustainable utilization.

With this objective, around 13 traditional recipes which are commonly used in Karnataka region were selected for enrichment. The details are depicted in Table 9. There are several perennial leaves which are available through out the season such as drumstick and *chakramuni* leaves, able to be used in several recipes to the extent of 25-50 per cent. Similarly, routine foods such as *pongal*, *chapathi*, *paddu*, *dosa*, *talipattu*, *vada*, *upama* and *idli* were comfortably prepared by using millets to the extent of 50-100 per cent. Soybean was able to be utilized to the extent of 50 per cent in traditional recipes.

This value addition enriched the nutritional value of traditional recipes appreciably (Table 10, 11 and 24). There was a substantial increase in the nutritional value of *chapathi* which was enriched by soyabean with drumstick

Table 24: Nutrient change in value added traditional products with underutilized foods (Per serving)

Products	Energy (Kcal)	Protein (g)	Iron (mg)	β-carotene (µg)
1. *Chapathi*	306	5.96	2.76	21.30
a *Chapathi* with drumstick leaves	322 (5.23%)	7.08 (18.79%)	2.89 (4.71%)	1146.69 (5283.52%)
b Soya *chapathi* with drumstick leaves	324 (5.88%)	14.52 (143.62%)	4.42 (60.14%)	2338.09 (10876.95%)
2. Sweet *Pongal*	463	9.12	2.18	79.85
a. Proso millet Sweet *pongal*	462 (-0.22%)	10.32 (13.16%)	3.14 (44.04%)	79.85 (0.00%)
3. *Bisebelebath*	390	7.56	4.58	862.04
a. Foxtail millet *bisebelebath* with bengalgram leaves	397 (1.79%)	1.98 (32.01%)	11.99 (161.79%)	1569.40 (82.06%)
4. *Paddu*	225	4.65	1.25	3.80
a. Little millet *paddu* with *chakramuni* leaves	248 (10.23%)	6.41 (37.85%)	8.92 (613.60%)	969.38 (25410%)
b. Soya *paddu* with *chakramuni* leaves	237 (5.33%)	6.18 (32.90%)	3.94 (215.20%)	490.03 (13006.05%)
5. *Dosa*	315	6.96	1.25	3.80
a. Little millet *dosa* with *chakramuni* leaves	368 (16.83%)	9.32 (33.91%)	12.94 (935.20%)	723.32 (18934.74%)
b. Soya *dosa* with *chakramuni* leaves	356 (13.02%)	9.28 (33.33%)	5.93 (374.40%)	747.80 (19578.95%)
6. *Idli*	125	4.45	1.42	4.40
a. Little millet *idli* with methi leaves and carrot	310 (148%)	10.51 (136.18%)	5.46 (284.50%)	790.98 (17634.98%)
b. Soya *idli* with methi leaves and carrot	356 (184.80%)	9.28 (108.54%)	5.93 (317.60%)	934.15 (20845.07%)
7. *Upama*	385	9.66	1.66	44.10
a. Little millet *upama* with drumstick leaves	348 (-9.61%)	8.72 (-9.73%)	5.21 (213.85%)	1947.50 (4316.09%)
b. Little millet *upama* with bengalgram leaves	354 (-8.05%)	8.66 (-10.35%)	10.54 (534.94%)	957.79 (2071.86%)
c. Barnyard millet *upama* with drumstick leaves	344 (-10.65%)	8.82 (8.69%)	2.58 (55.42%)	1916.19 (4245.10%)

Contd..

Products	Energy (Kcal)	Protein (g)	Iron (mg)	β-carotene (µg)
8. Turdhal *bhaji*	205	6.22	1.62	186.04
a. Turdhal bhajoi with *chakramuni* leaves	203 (-0.98%)	9.12 (46.62%)	6.22 (283.95%)	1200.87 (545.49%)
b. Turdhal *bhaji* with *chadanabatta* leaves	203 (-0.98%)	8.78 (41.16%)	2.13 (31.48%)	517.64 (64.06%)
9. Dhal *vada*	140	6.21	1.65	43.34
a. Foxtail millet *vada* with greens	124 (-11.08%)	4.01 (-34.94%)	3.03 (83.64%)	272.05 (527.71%)
10. *Talipattu*	121	3.37	0.94	14.80
a. Foxtail millet *talipattu* with methi leaves	155 (28.16%)	5.02 (48.96%)	3.79 (303.19%)	340.06 (2197.70%)
11. Coconut *chutney*	140	1.58	0.69	386.75
a. Coconut *chutney* with sambar soppu	119 (-15.00%)	2.52 (59.49%)	1.81 (162.32%)	1107.50 (186.37%)
12 Groundnut *chutney*	52	2.31	0.28	15.41
a. Groundnut *chutney* with *chakramuni* leaves	53 (0.52%)	2.43 (5.19%)	1.40 (400.00%)	156.00 (912.98%)
13. Sprouted mothbean *usali*	199	8.81	3.87	176.89
a. Sprouted *lenki usali*	190 (-4.30%)	6.27 (-28.83%)	3.28 (-15.25%)	172.11 (-2.70%)

Note: Figures in paranthese indicates percentage change

leaves and drumstick leaves alone. The increase was substantial with respect to protein (143.62%), β-carotene (10876.95%), iron (60.14%) and energy (5.88%) in soya based *chapathi* with drumstick leaves. The substantial increase in β-carotene was achieved when drumstick leaves was added to the extent of 25 per cent in wheat and soya based *chapathi.* Iron and protein enrichment to the extent of 4.71 to 60.14 per cent and 18.79 to 143.62 per cent, respectively was noticed in wheat and soya based *chapathi* with drumstick leaves. On the other hand, when millet (proso millet) was replaced to rice in *pongal* preparation a marginal percentage of increase in iron (44.04%) and 13.16 per cent in protein was evident. *Bisebelebath* is a spicy dish prepared out of rice, turdhal and vegetable by itself considered a complete food. When this dish was enriched by bengalgram leaves (50%) and 100 per cent millet substitution to rice, a substantial increase in iron, β-carotene and protein was achieved. *Paddu*, shallow fat fried fermented product when substituted and incorporated with little millet and *chakramuni* leaves substantially increased protein, iron and β-carotene. Similarly, substituted soya (50%) and incorporated with *chakramuni* leaves had similar trend. A similar trend was observed when *dosa* was prepared with soya and little millet incorporated with *chakramuni* leaves substantially increased β-carotene and iron and fairly protein and energy value. A *masala idli* when prepared with soya and little millet substitution and incorporation of *methi* and carrot substantially increased all the four nutrients computed (13.02%, 33.33%, 374.40% and 19578.95% for energy, protein, iron and β-carotene, respectively for soya based *masala idli* and 16.83, 33.33, 935.20 and 18934.74% for energy, protein, iron and β-carotene, respectively for little millet based *idli*). Similarly, *upama* prepared with little and barnyard millet with incorporation of bengalgram leaves and drumstick leaves decreased the energy and protein content. However, when *upama* prepared with drumstick leaves increased the β-carotene content drastically because the drumstick leaves are

rich sources of β-carotene followed by bengalgram leaves, the reverse trend was observed in iron content because bengalgram leaves are rich sources of iron.

A substantial increase in iron and β-carotene was observed when turdhal *bhaji* was incorporated with *chakramuni* leaves as it was rich source of iron and β-carotene but only slight increase was observed when *chandanabatta* leaves was incorporated. The *vada,* a fried food when substituted with foxtail millet there was increase in iron and β-carotene (83.64 and 527.71%, respectively). The coconut *chutney* which incorporated with *sambar soppu,* recorded a substantial increase in β-carotene content because of substitution of β-carotene rich *sambar soppu.* Similarly, when groundnut *chutney* powder was incorporated with dried *chakramuni* leaves, there were 400 and 1200 per cent increase in iron and β-carotene, respectively. However, when *talipattu* was prepared by substituting the little millet to rice by 100 per cent the iron content increased substantially by 303.19 per cent and also in β-carotene content (2197.70%). On contrary, when *lenki* was substituted for mothbean in *usali*, both protein and iron contents decreased as the *lenki* was poor source of protein and iron compared to mothbean. (Table 24) However, the leafy vegetables when incorporated the iron and β-carotene content increased substantially which is in conformity with the study conducted by Sheela *et al.* (2003) and Bhatnagar and Sankhala (2003).

The developed products did not deviate from the original recipes from the point of sensory scores. The sensory attribute scores (Table 12) indicated that the products were highly acceptable with reasonable and affordable cost per serving.

For better utilization of unexploited foods, commercial value seems to be of paramount importance and practical approach. Hence, an attempt was made in the present investigation to develop five Ready To Eat (RTE) traditional snacks, which are convenience foods with good shelf life for commercialization.

Chakkali, *sev*, *laddu*, *khara* strips and *hurigalu* are commonly consumed snack items of Karnataka and available in local market as RTE snacks. The millet in the basic recipes blended well (Table 13) without deteriorating the sensory parameters to the extent of 50 per cent. Similarly, gardencress seeds and soyabean preparation as *laddu* and *hurigalu* respectively were scored extremely good from the point of sensory evaluation scores (Table 15). The developed snacks were highly nutritious on per serving basis and could contribute substantially for nutrition security (Table 14). All these products had good shelf-life of 21 days (Fig. 14, 15, 16, 17 and 18) and capacity to get into local market as convenience foods. These approaches not only enhance the nutritive value of traditional recipes but market can be created for underutilized foods so that cultivational practices and crop pattern can be improved and thus benefit the farming community from the financial point of view.

5.4 IMPACT OF SUPPLEMENTATION OF VALUE ADDED TRADITIONAL RECIPES FOR NUTRITION SECURITY AMONG SCHOOL CHILDREN

The children who apparently look normal, but reveal certain extent of malnutrition only when measured is the characteristics of children in developing countries. Hence, the problem of **'hidden hunger'** which has not been sufficiently expressed needs attention. A high proportion of developing world's populations particularly children suffer from deficiency of energy, minerals and vitamins. Kasturiba (1999) have identified the existence of vitamin A deficiency at sub-clinical level among rural school children of North Karnataka. These unfelt problems need to be addressed immediately; otherwise long term effect of such deficiencies may lead to nutritional crippleness, adversely affecting the socio-economic picture of our country.

Intervention programme, including supplementation, food fortification and education have been successful in reducing malnutrition in specific situation

and will be needed in the future. For example, use of iodized salt has proved to be effective in many countries being inexpensive and reach mass most at risk (Hetzel, 1990). However, such programmes in respect of the macro and micro nutrients (such as protein, iron and vitamin A) are expensive, involve ongoing annual expenditures and are unlikely to reach all of those at risk. Moreover, such intervention programmes have often been suspended for economic, political and logistical reasons (Gibson, 1994) as in the case of lifting ban on sale of iodized salt in our country.

Thus, it is pertinent to say that food based approach offers the only lasting solution to the problem of malnutrition in a country like ours. Natural foods can not only provide several of the known micronutrients, but they can also provide health giving phytochemicals.

Dietary improvement can be achieved through inclusion of conventional food items which are better endowed in vitamins for example millets, dark green leafy vegetables and other yellow fruits. Thus, an effort was made in the present investigation to test the efficacy of value added traditional products utilizing underexploited nutrient dense foods such as millets and green leafy vegetables on selected school goers, for 90 days who generally look normal, but wasted and stunted when assessed nutritionally.

The children included under the study were of homogenous group in terms of socio economic and ecological condition, sharing similar water and sanitary facilities (Table 16), which may indirectly influence their existing nutritional status. The adequacy of all the nutrients was below the RDA among both the groups except fats, folic acid and vitamin C (Table 17). The assessment of anthropometric parameters also depicted similar picture that more than 50 per cent of both groups were either stunted or wasted or both (Table 18). Similar under nutritional status has been depicted by several scientists, Suman and

Jaya (1997); Asma *et al.* (2003); Ranganath; Saran *et al.* (2003); Sheela (2003) and Singh (2003).

The intervention approach in the present study was through traditional routine diets. Traditional foods are not only tasty and indigenous, are economical and nevertheless popular for their beneficial and medicinal attributes (Devadas, 1999). The millets and green leafy vegetables substituted and/or incorporated blended well in recipes such as *bisebelebath*, *upama* and *laddu*, which are relished and desired by children of Karnataka. Karnataka housewives are familiar with the method of preparation and are at ease from the point of culinary skills.

The children who consumed the traditional value added foods *viz.*, foxtail millet *bisebelebath*, little millet *upama* and gardencress *laddu* for 90 days alternatively, during the intervention period enjoyed the sensory qualities and compliance report was excellent. No plate waste was observed, more so there was demand for more food than supplied quantities. No untoward digestible disturbances were noticed during the study period.

Foxtail millet *bisebelebath*, little millet *upama* and gardencress *laddu* (served 4 times only during the study period) were highly accepted by the children. School children being in the growth period, revealed increment in height, in both experimental and control group which was significant statistically (Table 19). In general, height expresses the effect of long term feeding while weight indicates the impact of short term feeding, which was obviously noticeable, when weight parameter was analysed. There was a significant increase in weight to extent of 0.45 kg in the experimental children while the increment in control group was 0.13 kg. The supplemented food supplied 354 to 397 Kcals of energy, 7.33 to 9.98 g protein, 10.84 to 14.72 g fat, 168.77 to 203.36 mg calcium, 10.54 to 11.94 mg iron and 957.79 to 1589 µg of β-carotene per serving each day during the study period (Table 10).

Micronutrients deficiencies *viz.*, anemia and vitamin A has been the concern of nutritionists and others who care children. The present study reported 84 per cent of children being anemic, having hemoglobin level less than 12g/dl. A little higher incidence (94%) has been documented by Kasturiba (1999) on rural school going children in Karnataka. A similar result of 85 per cent anemia was also reported in school children by Anon (1999) in Chennai. The feeding of millets and leafy vegetable based dishes increased the blood hemoglobin levels (0.66 g/dl) within 3 months of feeding period which was highly significant statistically (Table 20). On the contrary, the control children recorded no change in the status of hemoglobin level.

A very interesting picture was evident with respect to shift in anemia status of children after intervention period (Fig. 19). Number of children in normal group doubled and children who were in moderate anaemia group shifted to milder category. This picture was found reversed in control group. More number of children shifted to lower hemoglobin levels who were devoid of food supplementation. The study conducted by Sarwate *et al.* (1994) when children were fed with enriched *laddu* from jaggery, sesame seeds, bengalgram flour and dates increased the hemoglobin from 8.82 to 11.48 g/dl after 30 days of supplementation and Vijaylaxmi and Devadas (1994) also confirmed the study when the greens were added in convenience mix, the hemoglobin level increased from 11.05 to 11.73 mg/dl after 3 months supplementation. Similar report was recorded by Anon (1999d) when recipe like *shakarpara* and biscuits prepared with iron and β-carotene rich underutilized cauliflower leaves and fed for 100 days to school children.

Similar trend was depicted with respect to serum retinol level. The β-carotene rich recipes contributed significantly to improve the retinol status among experimental children to the extent of 3.59 µg/dl, while the control group registered 0.62 µg/dl increment and was not significant statistically (Table 21).

The retinol also known to exhibit erythropoitic activity. The increase in serum retinol with greens incorporated food has also been confirmed by Devadas *et al.* (1978) who recorded increase in serum retinol when fenugreek and drumstick leaves were fed for 2½ months. Similarly, Kasturiba (1999) also confirmed the present result when drumstick leaves incorporated *chapathi* was fed for 3 months. The Fig. 20 depicts the shifts of children from deficient to acceptable group of serum retinol levels. The children in the categories of acceptable group increased and such change was not evident in the control group.

Infections during childhood aggravate the growth and nutritional status of school children. Hence, decreasing the morbidity has been the aim to be achieved by food approach intervention. This concept was vividly visible in the present study. Several phytochemicals and antioxidants and micronutrients which exhibit defensive mechanism are shown to be active in intervention group compared to control, both in terms of decrease in infections and frequencies(Table 22). This trend was not noticeable in control group. A similar observation was recorded by Kasturiba (1999).

Thus the present investigation can be concluded as follows.

- There are many underutilized foods available in Northern Karnataka and needs to be popularized.
- The nutritive value of underutilized foods revealed better nutritional profile.
- The underutilized foods can be blended very well in traditional diets to improve the nutritional profile of the products in terms of protein, energy, iron and β-carotene.
- The value added traditional RTE products can be very well developed and can fetch the market value.
- The value added traditional routine diets can bring significant change in growth and biochemical parameters of school children when incorporated in routine diets and facilitate attainment of nutritional security.

FUTURE LINE OF STUDY

1. The advanced study on nutritional profile of underutilized foods is needed
2. Efficacy of many more value added products from underutilized foods needs to be tested.
3. The convenience foods can be popularized through appropriate media and commercialization.

SUMMARY

VI SUMMARY

A study on "Promotion of Underutilized Foods for Nutrition Security" was under taken during 2000-03 with the objectives of documentation of existing underutilized foods, screening the nutritive value of selected underutilized foods and to develop and test the efficacy of value added products through routine diets for nutrition security among school children.

The study was conducted in 27 villages of Northern Karnataka which were adjacent to the KVK/MRS/RRS of University of Agricultural Sciences, Dharwad. These villages were from six agroclimatic zones *viz.*, North (N.) Dry Zone, North Eastern (N.E) Dry Zone, N.E. Transitional zone, N. Transitional Zone, Hilly Zone and Coastal Zone. From each zone, 12 -16 families were randomly selected and general information, diet profile and information on available underutilized foods were documented through personal interview method. Further, selected underutilized foods were screened for proximate principles and calcium, iron, β-carotene and ascorbic acid by standard procedures. Value added products utilizing these underutilized foods were developed, standardised and subjected for organoleptic evaluation by semi trained panels. Besides, five RTE value added products were developed and impact of shelf life on physical and chemical parameters was studied. The efficiency of selected value added products for providing Nutrition Security was tested by supplementing the diet of 10 – 12 years school children for 90 days and changes in growth and selected biochemical parameters were recorded. The salient results of this investigation is summarised in this chapter.

- All the selected agroclimatic zones had different rainfall, soil and cropping pattern.
- Selected villages were within 0.5 to 25 kms from KVK/MRS/RRS with 300-1500 population with 25-8000 households.

- More than 75 per cent of villages had hospitals and education facilities upto high school and well equipped with the communication, electricity, drinking water and transport facilities. The gobar gas was found only in 12 villages. The vicinity of forest ranged from 0.5 to 20 kms from the villages.
- The major cereal crops of North and N.E. Dry Zone and Transitional Zone were jowar and rice, whereas wheat was grown as major crop only in N. Dry Zone and N. Transitional Zone and rice in Coastal and Hilly Zone villages.
- The major pulse crops grown were blackgram, greengram, bengalgram, redgram and cowpea. The redgram was grown in all zones except in N.E. transitional Zone. The major oilseeds were groundnut followed by sunflower and safflower.
- The leafy vegetables such as fenugreek, *pundi* and coriander were grown in all the zones except cabbage which was grown only in N. Transitional Zone.
- The major roots and tubers available were garlic, onion, potato and radish. The other vegetables recorded were ladies finger, green chilly, pumpkin, bottle gourd and cucumber in selected villages and cauliflower were grown in the villages of N. Transitional Zone. The common fruits *viz.*, guava, lemon, *jamun* and mango were grown in all the zonal villages.
- Out of the selected 375 families from six agroclimatic zones, majority of families (60.26%) were of medium size and 16.53, 12.82 and 10.4 per cent families were small (1-4 members), large (7-9 members) and very large (more than 9 members), respectively. About 84.2 per cent belonged to Hindus, 24.47 per cent were Muslims and only 0.26 per cent were christens.
- Most of the surveyed families were from upper caste followed by other backward caste, schedule caste and schedule tribes were least. Out of 375 families, majority (55.22%) of the head of the families were illiterate and

14.05 per cent were educated upto primary school, 12.7 per cent had high school education and only 7.84 per cent had education upto college level.

- The main occupation of majority of the families were agriculture labour (42.66%), followed by cultivators, working in private firms, government employees and least families were from business group. Maximum number of families (N=131) were having monthly per capita income of Rs. 240-464 followed by 108 families with income Rs. 465-784 and only 32 families had income Rs. <240.

- The mean intake of energy, protein, fat and niacin was less than 85 per cent of RDA and only calcium and thiamine were more than 100 per cent of RDA. The β-carotene and iron adequacy was only 26.09 and 64.36 per cent, respectively.

- The mean nutrient intake varied among families of different agroclimatic zones with higher intake in N.E. Dry Zone, Coastal Zone and N. Transitional Zone compared to other zones and non-significant difference was accounted for protein and ascorbic acid intake among the families of different agroclimatic zones.

- The mean nutrient intake and adequacy of nutrient of families according to per capita income showed that only energy consumption increased with increase in monthly income and such trend was not evident for other nutrients and intake of most of the nutrients was very less in families having monthly per capita income of less than Rs. 240.

- Majority of the families in all the income groups had energy adequacy between <75-50 per cent followed by <100-75 per cent and least families had energy adequacy less than 50 per cent.

- No remarkable trend was observed and least number of families in the entire income groups had protein adequacy less than 50 per cent.

- Majority of families in II, III, V income groups were having <50 per cent adequacy of iron, followed by <75-50 per cent adequacy. No such trend was recorded in IV and I group.

- Similarly, for β-carotene adequacy as per monthly per capita income, it was obvious that majority of families had β-carotene less than 50 per cent adequacy followed by <75-100 per cent. None were ≥100 per cent adequacy in all the group except few in III group.

- The family size negatively and per capita income positively but significantly correlated with protein intake and family size alone negatively but significantly correlated with energy and β-carotene intake among the rural population.

- Totally eight millets, seven pulses, five oilseeds, 15 vegetables, 40 each leafy vegetables and fruits, six spices and condiments and three other foods were documented as underutilized crops of northern Karnataka during the study.

- There was not much variation in moisture, protein, fiber, ash and carbohydrate content of millets analysed (N=4). The little millet recorded highest fat and iron and lowest calcium content. Whereas the foxtail millet registered high calcium content. Only proso and foxtail millet had β-carotene content in lesser amounts.

- Out of two pulses analysed for nutrients, the horsegram had higher protein, fiber, ash, calcium, iron compared to *lenki*.

- Out of the five vegetables analysed, the moisture content ranged from 69.25 to 96.19 g/100g. The vegetables were fair sources of protein, fat, ash and few were good sources of fiber. The calcium and iron content varied drastically among the vegetables. They were good sources of β-carotene and ascorbic acid.

- The analysed fruits were good sources of fat, calcium, β-carotene and ascorbic acid and fair sources of protein and ash except *damani hannu*.
- Out of the 10 leafy vegetables analysed significant variations were observed in protein and iron content. The leafy vegetables were good sources of β-carotene and calcium.
- Totally 20 value added traditional products were developed and standardised utilizing four millets, two pulses and four leafy vegetables to provide nutrition security.
- Nutrient composition of value added traditional products recorded higher energy, protein, minerals, iron, and β-carotene content.
- All the developed products (N=20) had better scores for colour and appearance, taste, texture, aroma and overall acceptability and per serving cost ranged from Rs. 1.25 to 5.35 with most of the products costing less than Rs. 2 per serving.
- Totally five Ready To Eat value added products were developed with incorporation and/or substitution of underutilized foods *viz.*, Foxtail millet *chakkali*, Little millet green *sev*, Garden cress *laddu*, Little millet *khara* strips and Soya *hurigalu*. The snacks recorded higher iron and β-carotene contents. The cost per serving ranged between Rs. 1.25 to Rs. 1.90 with sensory scores between very good to extremely good.
- During the storage period of 28 days, the moisture content of all the products increased gradually, upto 15.34 g/100g in *laddu* and 4 to 7 g/100g in rest of the products. A similar trend of increase was recorded for free fatty acid content.
- Sensory evaluation of value added RTE products revealed, that the products could be stored upto 21 days except the gardencress *laddu* which was good even at the end of storage period (28 days)
- The majority of school children (10-12 years) selected for intervention to test the efficacy of developed value added products were from the medium size

family in both experimental and control group followed by large and small size family.Majority of children were from nuclear families and all the children were from Hindu community and majority were from upper and backward castes.

- Mean intake of most of the nutrients were less than RDA in both control and experimental group except for fat, folic acid and ascorbic acid which were adequate.
- Majority of the subjects in experimental group were normal according to Waterlow's classification followed by stunted and wasted. Two children were in wasted and stunted group, followed by wasted (n=5), normal (n=11) and stunted (n=12) among control group.
- A significant increase in growth parameters *viz.*, height and weight was observed in supplemented group compared to control group after 90 days of intervention with value added products.
- A significant increase in mean hemoglobin was recorded in experimental group compared to control group after 90 days of supplementation with value added traditional recipes. A shift in anemia category was evident from moderate to mild to normal categories in experimental group.
- A significant increase in mean serum retinol level from 15.52 µg/100ml to 19.51 µg/100ml was recorded in supplementation group, which was significantly higher than control group. A shift was evident from 'low' to 'acceptable' group and 'deficient' to 'low' group in experimental group children.
- There was a reduction in percentage of children suffering with diarrhoea in case of supplemented children compared to control group.
- Thus the present investigation confirmed the nutritional benefits, utility of underutilized foods in traditional recipes and potentiality in providing protein, energy and micronutrient security to school aged children.

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VII REFERENCES

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* Original not seen

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APPENDIX

APPENDIX - I

VILLAGE PROFORMA

1. Name of the village _____

2. Taluk/Block _____ District _____

1. Vicinity to RRS / KVK _____ kms.

2. Total Population _____

5. Number of Households _____
   Number of SC _____ Number of ST _____
   Number of UC _____ Number of OBC _____

6. Number of Hospitals _____ If none, distance to the nearest health centre _____ km.

7. Schools & Colleges
   7.1 Anganwadi
   7.2 Primary
   7.3 Middle
   7.4 High School
   7.5 Intermediate College

8. Post Office - 8.1 Yes
   8.2 No

9. Telephone facilities - 9.1 Yes
   9.2 No
   Total Numbers

10. Television - 10.1 Yes
    10.2 No
    Total Numbers

11. Availability of water supply

    1. Home :
       1.1) Lake (Ponds)
       1.2) Open wells
       1.3) Bore wells
       1.4) Municipal water
       1.5) Any other

2. Farm :
   2.1) Tube wells
   2.2) Open wells
   2.3) Ponds
   2.4) Canals
   2.5) Any other

12. Electricity - 12.1 YES
    12.2 No

13. Transportation facilities - 13.1 Bus
    13.2 Train

14. Type of Road - 14.1 Asphaulted
    14.2 Mud

15. Vicinity to Forest - 15.1 Yes
    15.2 No
    If yes, Distance from the village _____ kms.

16. Sanitation
    1) Drainage - 16.1.1 Yes
    16.1.2 No

    2) Type of Drainage - 16.2.1 Open
    16.2.2. Closed

    3) Toilets in number of households _____

17. Alternate energy sources

    1. Gobar Gas in number of households _____

APPENDIX – II

HOUSEHOLD SURVEY PROFORMA

Sl. No. _____ Date of survey:_____

Name of the village _____ Taluk/Block _____ Dist _____

Name of the ARS/RRS/KUK _____

Name of the Investigator _____

Name of the Respondent _____

Location - Rural/Tribal _____

Religion - _____

Caste - UC/BC/SC/ST

Family composition

Sl. No.	Relation to head of the family	Age (years)	Sex	Education Level	Occupation Contribution of women	Source of income	Income (Rs) Annual/Month
1.	HOF (Head)						
2.	Wife						
3.	Daughter						
4.	Son						

*in income generation activities such as agriculture/animal husbandry/poultry/sericulture/ tailoring/any other, specify

Dietary survey (24 hour, Recall)

	Menu	Total Raw Ingredients used (g)	Family member partaking the meal (serial No.)
Early morning			
Breakfast			
Mid morning			
Lunch			
Snacks			
Dinner			
Any other			
Average consumption Unit			

Seasonal availability of under utilized foods*

Grains	Season (Months)	How collected	Is it available in nearby market	Form in which it is used	Reasons for using/not using	No. of days that can be stored without processing
Cereals						
Pulses						
Oilseeds/ Nuts						
Vegetables						
Green Leafy Vegetables						
Roots and Tubers						
Fruits						
Any other						

*Gathered/Weed/Under cultivated/Rarely used/Some parts not in use.

APPENDIX - III

SCORE CARD FOR EVALUATION OF VALUE ADDED TRADITIONAL PRODUCTS

Name of the product: Date:

Name of the judge:

1.	**COLOUR AND APPEARANCE**	SCORES			
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				
2.	**TEXTURE/CONSISTENCY**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				
3.	**TASTE**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				

4.	**AROMA**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				
5.	**OVERALL ACCEPTABILITY**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				

Remarks:

Signature

APPENDIX -IV

ESTIMATION OF FREE FATTY ACID

Reagents

1. Neutral alcohol
2. N/100 potassium hydroxide solution (KOH)
3. 1 per cent phenolphthalein indicator.

Procedure

Twentyfive ml of sample extract was taken in a conical flask, to which 50 ml of hot neutral alcohol and 3 to 4 drops of phenopthalene indicator were added. The content was titrated against 0.01 N KOH solution, until a pink colour developed that persisted for 15 seconds or more. Similarly, a blank was run.

FFA content was calculated as follows

$$\text{FFA (\%oleic acid} = \frac{S \times N \times 28.2}{\text{weight of fat (g)}}$$

Were,

S= ml of KOH solution

N= Normality of KOH solution

APPENDIX - V

SCORE CARD FOR EVALUATION OF VALUE ADDED READY TO EAT PRODUCTS (STORAGE STUDY)

Name of the product: Date:

Name of the judge:

1.	**COLOUR AND APPEARANCE**	SCORES			
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				
2.	**TEXTURE/CONSISTENCY**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				
3.	**TASTE**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				

4.	**AROMA**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				
5.	**OVERALL ACCEPTABILITY**				
	Excellent				
	Extremely good				
	Very good				
	Moderately good				
	Good				
	Fair				
	Very fair				
	Poor				
	Very poor				

Remarks:

Signature

APPENDIX - VI

Questionnaire to elicit information on nutritional status of rural school children (age group 10-12 years)

I. General Information :

Name of the respondent :

Address :

Age :

Sex :

Education :

Caste : Subcaste :

Type of family : Nucleus/Joint/Extended

Family consumption :

Name	Sex	Age	Relationship to respondent	Education	Occupation	Income

II. Anthropometric assessment of nutritional status of the respondent

Height (cm) :

Weight (kg) :

III. Dietary assessment of (24 hr. recall method) using standardised cups

Meal Pattern	Item prepared	Ingredients used	Ingredients consumption	
			Cooked amt	Raw Qty
1. Tea				
2. Breakfast				
3. Lunch				
4. Snacks				
5. Dinner				

IV Morbidity pattern (three months period) did the child suffered from any following ailment ?

Sl. No.	Ailment	Frequency
1.	Diarrhoea	
2.	Cough	
3.	Cold	
4.	Fever	

Appendix VII: Classification of families* according to monthly per capita income

N=375

	Income Groups (Rs)	No. of families	Percentage
I	1585 and above	23	6.13
II	785 – 1584	80	21.33
III	465 – 784	108	28.80
IV	240 – 464	131	34.93
V	<240	33	8.80

* According to Prasad (1991)

Appendix VIII: Nutrient adequacy of families[⊗] based on monthly per capita income

Nutrients	Per cent adequacy of nutrients				
	Monthly per capita income [⊗⊗]				
	I (Rs. 1585 & above)	II (Rs. 785-1584)	III (Rs. 465-784)	IV (Rs. 240-464)	V (<Rs. 240)
Energy (Kcal)	90.95	87.45	82.12	81.37	75.62
Protein (g)	81.50	84.35	83.20	82.85	79.45
Fat (g)	85.26	77.88	96.76	82.20	70.35
Carbohydrate (g)	140.57	108.64	123.67	124.55	91.68
Calcium (mg)	62.21	63.86	64.39	66.04	60.18
Iron (mg)	20.96	22.29	30.49	26.15	24.10
Thiamine (mg)	87.14	100.71	103.57	100.00	95.71
Riboflavin (mg)	50.00	51.88	53.13	53.13	45.00
Niacin (mg)	73.44	81.17	87.89	82.83	75.00
Ascorbic acid (mg)	139.83	84.07	73.83	75.68	58.03

[⊗] Based on adult consumption units.

[⊗⊗] According to Prasad (1991).

Appendix IX: Adequacy of energy as per monthly per capita income

Per capita income classification	Total No.	Adequacy of Energy			
		≥100%	<100 – 75%	<75 – 50%	<50%
I	23	4 (17.39)	8 (34.78)	8 (34.78)	3 (13.04)
II	80	16 (20.00)	19 (23.75)	29 (36.25)	16 (25.00)
III	108	15 (13.88)	29 (26.85)	46 (42.59)	18 (16.67)
IV	131	22 (16.79)	32 (24.43)	57 (43.51)	20 (15.27)
V	33	5 (15.15)	6 (18.18)	21 (63.63)	1 (3.03)

Appendix X: Adequacy of protein as per monthly per capita income

Per capita income classification	Total No.	Adequacy of protein			
		≥100%	<100 – 75%	<75 – 50%	<50%
I	23	11 (47.82)	3 (13.04)	6 (26.08)	3 (13.04)
II	80	50 (62.50)	19 (23.75)	27 (33.75)	4 (5.00)
III	108	31 (28.70)	32 (29.63)	40 (37.04)	5 (4.63)
IV	131	42 (32.06)	44 (33.59)	34 (25.95)	11 (8.42)
V	33	10 (30.32)	12 (36.36)	10 (30.32)	1 (3.03)

Figures in the parenthesis indicate percentages

Appendix XI: Adequacy of iron as per monthly per capita income

Per capita income classification	Total No.	Adequacy of Iron			
		≥100%	<100 – 75%	<75 – 50%	<50%
I	23	2 (8.70)	5 (21.74)	10 (43.48)	6 (26.09)
II	80	14 (17.50)	11 (13.75)	27 (33.75)	29 (36.25)
III	108	27 (25.00)	15 (13.88)	37 (34.22)	39 (36.11)
IV	131	18 (13.74)	30 (22.90)	47 (35.88)	36 (27.48)
V	33	4 (12.12)	5 (15.15)	11 (33.33)	13 (39.39)

Appendix XII: Adequacy of β-carotene as per monthly per capita income

Per capita income classification	Total No.	Adequacy of β-carotene			
		≥100%	<100 – 75%	<75 – 50%	<50%
I	23	0 (0.00)	0 (0.00)	3 (13.04)	20 (86.96)
II	80	0 (0.00)	9 (11.25)	10 (12.25)	51 (76.25)
III	108	3 (2.77)	3 (2.77)	8 (7.41)	24 (87.04)
IV	131	0 (0.00)	1 (0.75)	12 (9.10)	118 (90.05)
V	33	0 (0.00)	0 (0.00)	3 (9.09)	30 (90.90)

Figures in the parenthesis indicate percentages

APPENDIX - XIII
Value Added Traditional Recipes

1. Proso millet sweet *pongal*

Ingredients	Qty.
Proso millet	50g
Green gram dhal	50g
Jaggery	80g
Ghee	25g
Cashew nuts	25g
Raisins	25g
Water	550ml

Method :

- Roast proso millet and green gram dhal separaely.
- Heat ghee in a vessel and fry raisins and cashewnuts.
- Add 550ml of water and allow it to boil.
- Pour the roasted proso millet and green gram dhal to boiling water and cook till soft.
- Mix jaggery and stir well cook covering for another 5 min. on low flame.

2. Chapathi with drumstick leaves

Ingredients	Qty.
Wheat flour	80 g
Drumstick leaves	25 g
Oil	20 ml
Green Chillies	5 g
Water	25 ml

Method:

- Saute drumstick leaves in a tea spoon of oil.
- Mix the drumstick leaves, salt and chopped green chillies with wheat flour.
- Prepare the dough knead the dough thoroughly and divide into small balls
- Roll each ball into chapathies by dusting the flour.
- Bake on hot griddle applying oil on both sides.

3. Little millet *Masala Idli*

Ingredients	qty.
little millet	70 g
Rice flakes	10g
Blackgram dal	30g
Carrot	25g
Menthi leaves	25 g
Salt	To the taste

Method

- Soak Little millet and black gram dal for 4-5 hrs. and rice flakes for 15-20 min.
- Grind to a paste coarsely and keep overnight for fermentation.
- Add chopped carrot and menthi leaves to the idli batter and mix properly
- Pour batter into greased *idli* pans and steam for 10 min.

4. Little millet *Dosa* With *chakramuni* leaves

Ingredients	Qty.
Little millet	90g
Black gram dal	30g
Rice flakes	10g
chakramuni leaves	25g
Onion	25g
Oil	25ml
Green chillies	5g

Method:

- Soak little millet, black gram dal for 4-5 hrs and rice flakes for 15-20 min
- Grind to a paste and keep overight for fermentation
- Add finely chopped onion, chillies, *chakramuni* leaves and salt to *dosa* batter and mix properly.
- Prepare *dosas* on hot griddle applying oil

5. Foxtail millet *Bisebelebath* with bengalgram leaves

Ingredients	Qty.
Navane	50g
Bengalgram leaves	50g
Tur dal	25g
Onion	50g
Beans	50g
Tomato	50g
Carrot	50g
Coriander	10g
Tamarind	10g
Oil	20ml
Curry leaves	10g
Bisibele bath Masala	15g
Water	400ml

Method:

- Soak foxtail millet for 1hr.
- Wash all the vegetables and cut into big pieces. Soak tamarind.
- Pressure cook tur dal
- Heat oil in a vessel add curry leaves, onion and other vegetables and fry still it brown , add salt to the taste and leaves onion and other vegetables
- Mix foxtail millet and tur dal to the vegetables
- Add 400 ml of water and allow it to boil.
- Add *bisebelebath* masala powder and tamarind juice
- Garnish with coriander leaves

6. Little millet *Paddu with chakramuni leaves*

Ingredients	Qty.
Little millet	90g
Black gram dal	30g
Rice flakes	10g
Chakramuni soppu	50g
Onion	25g
Green chilli	25g
Oil	20g

Method:

- Soak little millet and black gram dal for 3-4 hrs and rice flakes for 15-20min.
- Grind to a paste and keep overnight for fermentation
- Mix finely chopped onion, green chillies and chakramuni soppu and salt according to the taste with *paddu* batter
- Pour batter into greased *paddu* mould and cook on both sides by applying oil

7. Foxtail millet *vada*

Ingredients	Qty
Foxtail millet	50g
Black gram dal	25g
Bengal gram dal	25g
Green chillies	10g
Chakramuni leaves	50g
Cumin seeds	10g
Oil	25g

Method:

- Soak foxtail millet, black gram dal and bengal gram dal for 3-4 hrs
- Chop chakramuni leaves finely
- Grind foxtail millet, black gram dal and bengal gram dal, green chillies, cumin seeds
- Mix chopped chakramuni leaves properly with ground paste and add salt to the taste
- Prepare *vadas* and deep fat fry till golden brown in colour.

8. Little millet *Talipattu*

Ingredients	Qty.
Little millet	50g
Wheat flour	10g
Bengal gram flour	10g
Onion	50g
Menthi leaves	25g
Green chellies	10g
Oil	25ml

Method:

- Sieve all the flour
- Mix chopped onion, *menthi* leaves,green chillies and salt with the flours
- Prepare a stiff dough
- Divide the dough into small balls and pat on wooden board applying oil
- Bake on a hot griddle to a crisp texture applying oil on both sides

9. Little millet *Upama* with drumstick leaves

Ingredients	Qty
Little millet	100g
Drumstick leaves	50g
Onion	25g
Red Chilli	10g
Bengalgram dal	10g
Blackgram dal	10g
Curry leaves	10g
Oil	25 ml
Lime	½
Water	350 ml

Method:

- Roast little millet till aroma develops.
- Chop onion and drumstick leaves finely.
- Heat oil season with mustard seeds, cumin seeds, curry leaves,chillies, blackgram dal and bengal gram dal
- Add chopped onion and drumstick leaves, fry till the onion becomes brown
- Add 350ml of water and salt to taste, when water starts boiling add little millet and cook till little millet becomes soft.
- Squeeze lime on the top and mix well.

10. Barnyard millet *Upama* with drumstick leaves

Ingredients	Qty
Barnyard millet	100g
Drumstick leaves	50g
Onion	25g
Red Chilli	10g
Bengalgram dal	10g
Blackgram dal	10g
Curry leaves	10g
Oil	25 ml
Lime	½
Water	350 ml

Method:

- Roast barnyard millet till aroma develops.
- Chop onion and drumstick leaves finely.
- Heat oil season with mustard seeds, cumin seeds, curry leaves,chillies, blackgram dal and bengal gram dal.
- Add chopped onion and drumstick leaves, fry till the onion becomes brown
- Add 350ml of water and salt to taste,when water starts boiling add barnyard millet and cook till little millet becomes soft.
- Squeeze lime on the top and mix well.

11. Sprouted *Lenki Usali*

Ingredients	Quantity
Sprouted *lenki*	150 g
Onion	100 g
Tamarind	5 g
Jaggery	5 g
Chili powder	2 tsp
Coriander leaves	5 g
Curry leaves	2 g
Fresh coconut	25 g
Mustard	1 g
Jeera	0.5 g
Turmeric powder	0.25 g
Salt	to taste
Oil	5g

Method

- Soak *lenki* for 12-14 hrs and keep it for germination for 24 hrs
- Chop onion and coriander leaves
- Heat oil in a vessel season with jeera, mustard, curry leaves and saute onion
- Add germinated moth bean, chilli powder and turmeric powder.
- Mix all the added ingredients well and cook for 10-15 minutes till moth bean becomes soft.
- Garnish with coconut and coriander leaves

12. Soya based chapathi with drumstick leaves

Ingredients	Qty.
Wheat flour	80 g
Soya flour	20g
Drumstick leaves	25 g
Oil	20 ml
Green Chillies	5 g
Water	25 ml

Method:

- Saute drumstick leaves in a tea spoon of oil.
- Mix the drumstick leaves, salt and chopped green chillies with wheat flour and soya flour.
- Prepare the dough knead the dough thoroughly and divide into small balls
- Roll each ball into chapathies by dusting the flour.
- Bake on hot griddle applying oil on both sides.

13. Soya based *Dosa* With *chakramuni* leaves

Ingredients	Qty.
Rice	90g
Black gram dal	15g
Soyabean	15g
Rice flakes	10g
chakramuni leaves	25g
Onion	25g
Oil	25ml
Green chillies	5g

Method:

- Soak rice, soyabean and black gram dal for 4-5 hrs and rice flakes for 15-20 min
- Grind to a paste and keep overight for fermentation
- Add finely chopped onion, chillies, *chakramuni* leaves and salt to *dosa* batter and mix properly.
- Prepare *dosas* on hot griddle applying oil

14. Soya based *Paddu with chakramuni leaves*

Ingredients	Qty.
Rice	90g
Black gram dal	15g
Soyabean	15g
Rice flakes	10g
Chakramuni leaves	50g
Onion	25g
Green chilli	25g
Oil	20g

Method:

- Soak rice, soyabean and black gram dal for 3-4 hrs and rice flakes for 15-20min.
- Grind to a paste and keep overnight for fermentation
- Mix finely chopped onion, green chillies and chakramuni leaves and salt according to the taste with *paddu* batter
- Pour batter into greased *paddu* mould and cook on both sides by applying oil

15. Soya based *Masala Idli*

Ingredients	qty.
Rice	70g
Rice flakes	10g
Blackgram dal	15g
Soyabean	15g
Carrot	25g
Menthi leaves	25 g
Salt	To the taste

Method

- Soak rice, soybean and black gram dal for 4-5 hrs. and rice flakes for 15-20 min.
- Grind to a paste coarsely and keep overnight for fermentation.
- Add chopped carrot and menthi leaves to the *idli* batter and mix properly
- Pour batter into greased *idli* pans and steam for 10 min.

16. Groundnut *Chutney* with *chakramuni* leaves

Ingredients	Quantity
Groundnut	100 g
Chakramuni leaves (dried)	10g
Coriander	3 g
Curry leaves	1 g
Dry coconut	5 g
Chilli powder	15 g
Garlic	5 g
salt	2.5

Method

- Roast groundnut and remove the outer skin by processing and winnowing
- Add curry leaves, coriander leaves, garlic, chilli powder, dried *chakramuni* leaves, salt and dry coconut
- Grind in a mixer to a powder

17. Turdhal *Bhaji* with *chakramuni* leaves

Ingredients	Quantity
Turdhal	100 g
chakramuni leaves	50g
Onion	100 g
Tamarind	5 g
Jaggery	5 g
Red chilli powder	3.5 g
Coriander leaves	5 g
Curry leaves	2 g
Fresh coconut	0.25 g
Turmeric powder	0.5 g
Jeera	0.5 g
Oil	20 ml
Salt	5.6 g
Water	350 ml

Method

- Soak turdhal for half an hour
- Chop onion, *chakramuni* leaves and coriander leaves
- Heat oil, season with curry leaves mustard and jeera
- Add onion, fry till slight brown in colour
- Add salt turmeric powder, tamarind extract jaggery and chilli powder
- Add soaked turdhal, cook for 30 min to soft texture
- Garnish with coconut and coriander

18. Turdhal *Bhaji* with *chandanbatta* leaves

Ingredients	Quantity
Turdhal	100 g
chandanabatta leaves	50g
Onion	100 g
Tamarind	5 g
Jaggery	5 g
Red chilli powder	3.5 g
Coriander leaves	5 g
Curry leaves	2 g
Fresh coconut	0.25 g
Turmeric powder	0.5 g
Jeera	0.5 g
Oil	20 ml
Salt	5.6 g
Water	350 ml

Method

- Soak turdhal for half an hour
- Chop onion, *chadanabatta* leaves and coriander leaves
- Heat oil, season with curry leaves mustard and jeera
- Add onion, fry till slight brown in colour
- Add salt turmeric powder, tamarind extract jaggery and chilli powder
- Add soaked turdhal, cook for 30 min to soft texture
- Garnish with coconut and coriander

19. FOXTAIL MILLET *VADA*

Ingredients	Quantity
Foxtail millet	50 g
Blackgram dhal	50 g
Bengalgram dhal	25 g
Cumin seeds	10 g
Green chillies	10 g
Chakramuni leaves	50 g
Oil	20 ml
Salt	2 g

Method

- Soak foxtail millet,blackgram dhal and bengalgarm dhal for four hours grind into coarse paste.
- Chop *chakramuni* leaves and green chillies and fry for few minutes in little oil
- Add salt,cumin seed to the mixture
- Fry in hot oil till golden yellow

20. Coconut *chutney* with sambar soppu

Ingredients	Quantity
Fresh coconut gratings	100 g
Sambar soppu	50 g
curry leaves	10 g
Green chillies	10 g
Chakramuni leaves	50 g
Oil	5 ml
Salt	0.75g

Method

- Clean the sambar soppu and sauté in 5 ml oil along with green chillies
- Add salt and grind to paste along with coconut gratings and curry leaves in a mixer.

APPENDIX – XIV

VALUE ADDED READY TO EAT FOODS

1. Foxtail millet *Chakkali*

Ingredients	Qty
Foxtail millet flour	25g
Rice flour	25g
Bangalgram dhal flour	16.66g
Black gram dhal flour	33.33g
Til	2 g
Chilli powder	20 g
Ajawan	0.25g
Oil	25 ml
Salt	1.65g

Method:

- Sieve foxtail millet flour, rice flour, bengalgram and blackgram dhal flour.
- Add chilli powder, salt, til, ajawan and hot oil 10 ml to the flour
- Prepare a dough to a slightly stiff consistency
- Put the dough into *chakkali* press
- Prepare *chakkali* by pressing and deep fat fry till golden yellow.

2. Little millet green *sev*

Ingredients	Qty
Little millet flour	50g
Bengalgram flour	50g
Ajawan	0.5g
Chakramuni leaves	50g
Turmeric powder	0.25g
Salt	2.25g
Oil	50ml

Method:

- Clean *chakramuni* leaves, blanch in boiling water for 2 minutes with little salt
- Drain the water, make into paste in the wet grinder.
- Sieve the little millet flour, bengalgram flour, ajawan powder and mix well.
- Add 20ml of hot oil to the flour mixture and mix well, add turmeric powder, salt and *chakramuni* leaves paste and knead well.
- Deep fat fry in hot oil by pressing it through Anjali press.

3. Gardencress *Laddu*

Ingredients	Qty
Gardencress seeds	50g
Fresh coconut	100g
Jaggery	150g

Method:

- Roast gardencress till they crackle
- Mix fresh coconut and jaggery with roasted gardencress and cook
- Keep on a low flame with constant stirring till it leaves the sides
- Prepare *laddus* when it cools

4. Little millet *khara* gritters

Ingredients	Qty.
Little millet flour	50 g
Maida	50 g
Oil	25 g
Salt	1.5 g
Cumin seeds	2 g

Method :

- Sieve the little millet flour and maida
- Add 5ml of hot oil to the flour and add salt, cumin seeds and knead well with water to thick consistency .
- Press through the mould and deep fat fry till golden yellow.

5. Soya *Hurigalu*

Ingredients	Qty.
Soybean	100 g
Groundnut	20 g
Roasted bengal gram dhal	20 g
Curry leaves	5 g
Chilli powder	10 g
Oil	50 ml
Salt	To the taste

Method :

- Soak soybean over night
- Drain the water and spread on cotton cloth and shade dry for 30 min
- Deep fat fry
- Season with curry leaves, groundut roasted bengal gram dhal and salt to the taste and mix well

Appendix XV: Changes in moisture content (%) and free fatty acid content of developed Ready To Eat (RTE) value added products during storage period

Products	Storage period (days)				
	0	7th	14th	21st	28th
Moisture content					
Foxtail millet *chakkali*	3.44	4.27	5.69	5.93	6.74
Little millet green *sev*	2.13	2.32	3.55	3.76	4.04
Gardencress *laddu*	14.37	13.42	16.87	16.55	15.34
Little millet *khara* gritters	5.10	5.70	5.80	5.82	5.82
Soya *hurigalu*	4.40	5.10	5.30	5.73	7.31
Free fatty acid content					
Foxtail millet *chakkali*	0.79	0.80	0.89	0.90	0.95
Little millet green *sev*	0.81	0.88	0.89	0.93	0.98
Gardencress *laddu*	0.99	1.03	1.09	1.13	1.20
Little millet *khara* gritters	1.38	1.40	1.42	1.42	1.50
Soya *hurigalu*	0.76	0.88	1.00	1.25	1.51

Appendix XVI: Changes in sensory scores of Foxtail millet *chakkali* during storage period

Sensory attributes	Storage period (days)				
	0	7th	14th	21st	28th
Colour & appearance	8.0*	7.6	7.2	7.2	7.0
Taste	7.2	6.9	6.9	6.8	5.6
Texture	7.2	6.9	6.7	6.7	5.0
Aroma	6.6	6.5	6.2	6.2	5.6
Overall acceptability	7.6	6.7	6.6	6.5	5.0

* Average scores of 10 judges on 9 point hedonic scale.

Appendix XVII: Changes in sensory scores of little millet green *sev* during storage period

Sensory attributes	Storage period (days)				
	0	7th	14th	21st	28th
Colour & appearance	8.0*	7.5	7.2	7.1	7.1
Taste	8.1	7.4	7.2	6.9	6.7
Texture	8.3	7.2	6.7	6.6	4.2
Aroma	8.5	6.5	6.4	6.1	3.6
Overall acceptability	8.1	7.0	6.5	6.4	3.3

* Average scores of 10 judges on 9 point hedonic scale.

Appendix XVIII: Changes in sensory scores of gardencress *laddu* during storage period

Sensory attributes	Storage period (days)				
	0	7th	14th	21st	28th
Colour & appearance	7.5*	7.4	7.4	7.3	7.0
Taste	7.8	7.8	7.6	7.6	7.5
Texture	7.4	7.2	7.0	7.0	6.8
Aroma	7.4	6.8	6.4	6.4	6.1
Overall acceptability	7.3	7.2	7.2	7.1	6.4

* Average scores of 10 judges on 9 point hedonic scale.

Appendix XIX: Changes in sensory scores of little millet *khara* gritters during storage period

Sensory attributes	Storage period (days)				
	0	7th	14th	21st	28th
Colour & appearance	7.3*	7.3	6.5	5.6	4.0
Taste	7.9	7.9	5.8	5.6	4.0
Texture	7.9	7.9	7.0	5.4	4.2
Aroma	7.6	7.4	7.1	6.1	3.7
Overall acceptability	7.4	7.4	6.7	5.7	3.6

* Average scores of 10 judges on 9 point hedonic scale.

Appendix XX: Changes in sensory scores of Soya *hurigalu* during storage period

Sensory attributes	Storage period (days)				
	0	7th	14th	21st	28th
Colour & appearance	7.3*	6.9	6.4	5.8	4.5
Taste	7.5	7.1	6.5	5.8	3.8
Texture	7.3	7.1	6.7	6.6	4.1
Aroma	7.1	6.7	6.3	5.6	3.9
Overall acceptability	7.2	6.7	5 7	5.1	4.1

* Average scores of 10 judges on 9 point hedonic scale.

Appendix XXI: Impact of supplementation on anemia status of selected school children

(N=50)

Classification according to WHO, 1986		Experimental group (n=25)		Control group (n=25)	
		Before	After	Before	After
Normal	Hb 12 & >12 g/dl	4 (16.00)	9 (36.00)	4 (16.00)	2 (8.00)
Mild Anemia	Hb 10 -11.9 g/dl	18 (72.00)	16 (64.00)	10 (40.00)	9 (36.00)
Moderate Anemia	Hb 8 - 9.9 g/dl	3 (12.00)	- (0.00)	11 (44.00)	14 (56.00)
Severe Anemia	Hb <8 g/dl	- (0.00)	- (0.00)	- (0.00)	- (0.00)

Appendix XXII: Classification of subjects according to serum retinol* status

Classification	Experimental Group (n=25)		Control Group (n=25)	
	Before	After	Before	After
Deficient (<10µg/100ml)	2 (8.00%)	0 (0.00%)	1 (8.00%)	0 (0.00%)
Low 10-20 µg/100ml)	19 (76.00%)	15 (60.00%)	19 (76.00%)	20 (80.00%)
Acceptable>20 µg/100ml)	4 (16.00%)	10 (40.00%)	5 (20.00%)	5 (20.00%)

Note: Figures in parentheses indicates percentage.
*According to (Anon, 1992)

DOCUMENTATION, VALUEARIZATION AND PROMOTION OF UNDERUTILIZED FOODS FOR NUTRITION SECURITY OF SCHOOL CHILDREN

2003

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ABSTRACT

A study entitled Documentation, valuearization and promotion of underutilized foods for nutrition security of school children was undertaken. Totally 375 families from 27 villages comprising 6 agroclimatic zones of Northern Karnataka were interviewed to document the underutilized foods and to assess the nutritional status of families. The underutilized foods are those which are less available, less utilized or rarely used or region specific. Millets(8), pulses, oilseeds and spices(5 each), vegetable(15),leafy vegetables and fruits(40 each) were documented as underutilized foods. The nutrient analyses of selected underutilized foods revealed better nutritional profile. Among the millets there was not much variation however in pulses, horsegram was superior compared to '*Lenki*', leafy vegetables(10) and other vegetables(5) were good sources of iron, β-caroten(e and ascorbic acid.

The valuearized 20 traditional foods with little, foxtail, barnyard and proso millets, soyabean, *lenki* and leafy vegetables *viz.*,Bengalgram leaves, *sambar soppu*, drumstick leaves and *chandanabatta* leaves had better nutritional profile over the traditional foods with respect to iron and β-carotene. The cost ranged from Rs. 0.45 to 5.35 per serving. The value added Ready To Eat products *viz.*, foxtail millet *chakali*, little millet *sev*, little millet *khara* gritters, gardencress *laddu*

and soya *hurigalu* had better nutritional and storage profile(3-4 weeks) and were highly acceptable.

The intervention with the value added traditional products viz., foxtail millet *bisebelebath* with bengalgram leaves, little millet *upama* with bengalgram leaves and gardencress *laddu* for 90 days for 10-12yrs boys showed significant increase in height, weight, hemoglobin and serum retinol levels compared to control counterparts. There was also reduction in morbidity pattern among experimental subjects. Thus, the nutritious underutilized foods if incorporated in traditional diets can provide nutrition security and ultimately improve the health status of children and found to be a sustainable strategy for combating the hidden hunger.