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National Seminar on
Recent Advances in processing, utilization and nutritional impact of small millets

Madurai Symposium, Thamukkam Grounds, Madurai

13th September, 2013

Abstracts

Under the aegis of the
Revalorising Small Millets in Rainfed Regions of South Asia - Project

Organized by

Tamil Nadu Agricultural University, Coimbatore
& DHAN Foundation, Madurai

TAMIL NADU AGRICULTURAL UNIVERSITY

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MESSAGE

Small millets are small seeded grasses that grow well in dry zones as rainfed crops, under marginal conditions of soil fertility and moisture. These crops are cultivated with less input and are unique due to their short growing season. Millet grains are nutritious with good quality protein, rich in minerals, dietary fibre, phyto-chemicals and vitamins and have the highest content of minerals in any known food grain. It is an important substitute for major cereal crops to cope with food shortage, to meet the demand of increasing population and low cost nutritive foods.

Production and consumption has declined due to urbanization, changing food preferences, supply of fine cereals at subsidized prices and social status attached to fine cereals. The lack of awareness of the health benefits of small millet consumption among general public, absence of specialized processing machineries also contribute to its under utilization.

The unique characteristics of small millets need to be exploited both in terms of its health / nutritional benefits. The present day lifestyle and changed dietary patterns (largely dependent on rice and wheat) has lead to widespread nutritional deficiency. The prevalence of micronutrient deficiency even in the affluent sections of population is a matter of concern. The presence of small millets in the food basket had been declining over the years and it is prime time to concentrate on the strategies to combat this slow fading native foods.

I am immensely pleased to learn that to address the above issues the Post Harvest Technology Centre, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore and DHAN Foundation, Madurai, are organizing a National Seminar on "Recent Advances in Processing, Utilization and Nutritional Impact of Small Millets", on 13th of September 2013. This seminar takes place against the backdrop of significant progress made under the RESMISA project supported by IDRC, Canada, to achieve an improved and food secured India.

I wish the deliberations a great success. I commend the organizers for this remarkable achievement.

(K.RAMASAMY)

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DHAN Foundation

Building Institutions for Generations

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Executive Director

MESSAGE

I am immensely happy that a National Seminar on "Recent advances in processing, utilization and nutritional impact of small millets" is being organized as part of Madurai Symposium by Tamil Nadu Agricultural University and DHAN Foundation under RESMISA project. Small millets being superior in nutritional properties when compared to commonly consumed crops like rice, their consumption need to be promoted on a large scale to address various nutritional challenges facing the country. But drudgery involved in dehulling, inadequate authentic data on the nutritional benefits and inadequate research to address issues related to food processing has been the major hindrances in this direction. I hope the deliberations in this national seminar would address these issues effectively. I also hope that the seminar would help the participants to gain insights and help them in their efforts to promote small millets. I wish the seminar much success.

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Contents

Technical Session I PROCESSING OF SMALL MILLETS

PS 01 – Lead Paper – Processing of Millets
S. Balasubramanian

PS 02 - Process Optimisation of Extruded Breakfast Cereal from Rice Mill Brokens Finger Millet – Maize Flour Blends
K.Manjula and R.Visvanathan

PS 03 – Effect of parboiling on de-hulling and cooking qualities of kodo and barnyard millet
N. Varadharaju and Ganesan,S

PS 04 - Physico- chemical and functional characteristics of processed kodo millet flour
T.Poongodi Vijayakumar, H.Shekar Shetty and Asna Urooj

PS 05 - Optimization of machine parameters of centrifugal dehuller for dehulling of foxtail and little millet
S.Ganesan[1] and N. Varadharaju[2]

PS 06 - Effect of processing on the Organoleptic qualities of barnyard millet cookies
Gurumeenakshi and Kanchana Devi

PS 07 - Effect of domestic processing on nutrient content of sorghum and green gram mix
Mrs.S.Sheela and Mr. Mohammud Ali Abdille

PS 08 - Effect of hydrothermal treatment on the milling characteristics of the tray and shade dried kodo millet (*Paspalum scrobiculatum Linn)*
Kesavan Malini, Uthira L, Jaganmohan R

Technical Session II UTILIZATION OF SMALL MILLETS

US 01 – Lead Paper - Millets for Food and Nutritional Security
Nirmala Yenagi and Mamata Mannurmath

US 02 - Acceptability study of Foxtail millet (*Setaria italica*) and Barnyard Millet (*Echinochloa frumantacea*) incorporated Bread
Guhapriya and Minu Elezabeth Mathew

US 03 - Development and Evaluation of varagu incorporated recipes
Kalpana,C.A and Koushikha,N.M

US 04 - Nutraceuticals enriched pasta products
Banumathi. P, Kanchana. S, Ilamaran. M and Thilagavathi

US 05 - Processing and evaluation of convenience foods from maize
Subbulakshmi, B, Amutha, S., Banumathi, P, Parvathi, S. and Vanniyarajan, C.

US 06 - Standardization and evaluation of small millet based instant Puttu mix
Senthamarai selvi, D.Malathi and Banumathi.P

US 07 - Formulation and acceptability of millet based value added vermicelli
DR.K.Arulmozhi , P.Sindhu

US 08 - UTILIZATION OF SMALL MILLETS
Baskar. M and Banumathi. P

US 09 - DEVELOPMENT OF MILLET MIXES AND ACCEPTABILITY OF MILLET MIX INCORPORATED FOODS
M.Anbu Malar, and Aruna Narayanan

US 10 - Nutrient Analysis and Acceptability of recipes incorporated with Bajra
Menaka.M and Sheetal Chandel

US 11 - Standardization of traditional recipes from Foxtail millet
Malathi. D.Veena. R and Malavizhi,S

US 12 - Evaluation of Little millet incorporated Cake
Padma. A,.Malathi.D and G.Sindumathi

US 13 - Standardization of Spirullina incorporated cookies

Padma. A.and R.Rajendran

US 14 - Standardization of snack recipes from Kodo millet

Malathi. D.Veena. R,.Malavizhi,S and G.Sindumathi

Technical Session III NUTRITIONAL IMPACT OF SMALL MILLETS

NS 01 Lead Paper- Promoting Small millets for improved Food security

Vijayalakshmi. D, Department of Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bangalore

NS 02 - Hypocholesterolemic Action of *Lactic acid bacillus* in Rats fed with probiotic millet based composite mix

Shilpa. Huchchannanavar, Vijayalakshmi.D, Y.B Rajeshwari, Suvarna Chavannavar

NS 03 - Formulation and analysis of nutrients, antioxidants and phytonutrients in centellaasiatica (vallarai) and panicum sumastrense (samai) incorporated extrude products

V. Krishna Prabha, Dr. N.G.P. Arts and Science College, Coimbatore

NS 04 - Sensory attributes of low glycemic millet based functional pasta

Nousheen Noorul Iyn I.,P.Banumathi.,S.Kanchana., S.M.Ibrahim., M.Ilamaranand J.Selvi

NS 05 - Pinnacles of Proso millet (*Panicum Miliaceum* L.)

Mathanghi.S.K, Dr.P.Banumathi, Dr.S.Parvathi, Dr.M.R.Premalatha, Tmt.K.Sudha

NS 06 - Effect of Supplementation of Ragi malt and its impact of nutrition education among women (20 – 50yrs) in Mallal Village

M.Manichithra, Dr.S.Kanchana

NS 07 - Health benefit of small millets

Baskar. M and Banumathi. P Kanchana. S

NS 08 - NUTRITIONAL SIGNIFICANCE AND THERAPEUTIC VALUE OF MILLETS

Reshmi.R* and Nandini P.V

NS 09 – Use of underutilized millets to reduce Calcium & Iron deficiency among adolescent girls

Dr.Punam Agarwal &Dr.P.Mishra

NS 10 - Study on the changes in the knowledge, attitude and practice of millet utilization among rural women

Senthamarai selvi, D.Malathi and Guru meenakshi

NS 11- Evaluation of physico-chemical characteristics of bread from foxtail millet

P. Karuppasamy, D.Malathi, Gurumeenakshi and Veena.R

NS 12 - Quality characteristics of porridge from foxtail millet

P. Karuppasamy, D.Malathi and Veena.R.

NS 13 - Identification of Suitable Finger millet Genotypes for Higher Productivity and Grain Nutritional Traits

V. Ulaganathan and A. Nirmalakumari

NS 14 - Augmenting Nutritional Status Of Supplementary Nutrition Programmes With Millets- Opportunities & Issues

Kiran Sakkhari, WASSAN, Andhra Pradesh

TECHNICAL SESSION I

PROCESSING OF SMALL MILLETS

PS 01 -Lead Paper

PROCESSING OF MILLETS

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It is time to analysis to have pills or shift towards forgotten (millets) traditional food grains. While the concepts of 'food' and 'nutrition' fit together for processors/dietitians, consumers often view it as a battle between 'food' and 'nutrition'. Let us rejuvenate to cook and grow millet (time capsule of life!).

ABSTRACT

The pressing need is to improve livelihoods and well-being through improved use of biodiversity. Thus, focus in India is to be on small-grain cereals, notably millets. Millets are also more reliable and produce a harvest even under adverse growing conditions. Millets can be used for traditional as well as novel foods. The richness of starch, protein and fibre, niacin, magnesium, phosphorus, manganese, iron, potassium, essential amino acids and vitamin E make millets an important nutritional bio-source. In addition, millets have therapeutic benefits such as prevention of heart diseases, diabetes, migraine and premature death. In line with the recent awareness on functional foods and neutraceuticals, millets have a great potential. The revival of millets can be achieved through concerted efforts of research, marketing testing, and entrepreneurial training and demonstration to stimulate the processing of high quality, competitive products for urban areas. Thus, in dry regions, processing facilities are particularly vital to the future of local millet farming. Thus, millets are so compelling to agree the needs and to educate consumers on health benefits and to encourage increased consumption.

Introduction

In the current era, Intellectual Property Rights (IPR) regimes - which clash with community rights - are being imposed around the world as the central instrument to open and control markets and to push new technologies. Modern technology has increased agricultural production, temporarily. However, agricultural chemicals make soil very acidic and excessive irrigation has led to salinization of land, reducing the yields from cultivated land dramatically.

The cereals belong to two main groups. These are the temperate cereals, namely wheat, barley, rye, oats and triticale, and the predominantly tropical cereals: rice, maize, sorghum, and millets. Generally, wheat and rice are grown on a wide scale. Although rice constitutes the staple diet for more people, wheat is the first in importance on a world scale of all the cereals. Millet, contrary to rice and wheat, can be grown almost anywhere; therefore growing millet should be encouraged to increase our food self-sufficiency. Millets in Indian diets are classified as coarse cereals with small grains having 2.1 – 7.1 g/1000 grain weight. Well filled grains have 1.4 – 5.1 ml/1000 grain volume. They have spherical to oval shape with colored seed coats. Millet is a rich source of carbohydrates and minerals, such as calcium, phosphorous and iron. These are good for the environment because they can thrive under marginal conditions that would be damaged by an attempt to cultivate more mainstream cereals such as wheat or rice. Millets are also more reliable and produce a harvest even under adverse growing conditions. This interest stems from the many health benefits associated with whole grain cereals and dietary fibre, such as lower plasma cholesterol (Newman et *al*., 1989; Davidsson *et al.,* 1991), reduced glycaemic index (Jenkins *et al*., 2002; Cavallero *et al*., 2002). Currently, due to reduced amount of in-home preparation time, breakfast cereal technology has evolved from the simple procedure of grain milling for cereal/coarse cereal products that requires cooking to the manufacturing of highly sophisticated ready-to-eat products. Modern children are being sufferer as well as assailant of many people, environment and geriatric diseases. While efforts are being made worldwide towards achieving self-sufficiency in food, conserving the environment, and solving health problems, millet is attracting the world's attention as a key crop to overcome population explosion and food crisis. Hence, the pressing need to improve livelihoods and well-being through improved use of biodiversity has been augmently envisaged. Thus focus in India is to be on small-grain cereals, notably millets. Eating millet will recover the diversity in staple food. There should be a systematic and holistic approach to study millet from various aspects such as environmental conservation, coping with food crisis, sustainable agriculture, traditional food culture, food and health, history, culture, cultivation, preparation, marketing, consumer acceptance, etc., are needed to bring back our traditional diet to avoid modern illness and biodiversity.

Plausible reasons for less popularity of millets

- Lack of technical-know-how among the farmers and processors about the processing methods with respect to their own old methods of processing

- Associated cultural issues in adoption and diversification of food.
- Lack of awareness among people about nutritive value of millets and a general opinion that millets are poor men crop
- Reluctance among consumers to buy and consume.

Why millet now*?*

Millets refers to a group of annual grasses mainly found in arid and semiarid regions. Millets belong to five genera: *Penissetum, Eleusine, Setaria, Panicum and Paspalum*. These grasses produce small seeded grains and are often cultivated as cereals. Millets are of paramount importance in Africa, Asia, China and Russia Federation. Millets are highly nutritious and are even superior to rice and wheat in certain constituents. They are an important source of important nutrients like niacin, magnesium, phosphorus, manganese, iron and potassium. They contain high amounts of protein, fiber, essential amino acid methionine, lecithin, and vitamin E. Recent studies have shown that due to the high content of these nutrients, millets have therapeutic benefits such as control of asthma, migraine, blood pressure, diabetic heart disease, atherosclerosis and heart attack. Fibre, in millet, prevents gallstones formation. Whole grains like millets have health promoting effects equal or even in higher amount than fruits and vegetables and have a protective effect against insulin resistance, heart disease, diabetes, ischemic stroke, obesity, breast cancer, childhood asthma and premature death. Because of these benefits millets, millets can be used in functional foods and as neutraceuticals. Hence, they are also called as ***'nutri cereals'***. Millets can be used as grain or forage. When used as grain they are categorized as cereals/coarse cereals. Millet includes pearl (bulrush) millet, finger millet, proso (golden millet) millet, fox tail millet, Japanese millet, teff millet, koda (ditch millet), brown top millet plus four other species of limited importance.

Structural features of millet grains

The basic kernel structure and anatomical components are similar in sorghum and millets. The principal anatomical components can be distinguished: the pericarp (outer covering), endosperm (starchy part), and germ (oily part). In foxtail, common and finger millets the pericarp is like a sack, loosely attached to the endosperm at only one point. In these utricle-type kernels the pericarp easily breaks away, leaving the seed-coat or testa to expose the inner endosperm. The kernels of sorghum and pearl millet are of the caryopsis type, in which the pericarp is completely fused to the endosperm and requires slightly higher amount of energy to break the pericarp. The

relative distribution of these three main components of the kernel varies. In pearl millet, the distribution of pericarp, endosperm and germ are 8.4, 75.0 and 16.5 per cent, respectively (Abdelrahman *et al.,* 1984). The ratio of endosperm to germ in pearl millet is 4.5:1, while in the sorghum kernel it is 8.4:1. In common and finger millets, the germ is very small and therefore the endosperm to germ ratio, 11:1 to 12:1, is much higher than in sorghum. Protein in millet varies from 5.6 to 14.8 per cent.

Position of millets in comparison to staple food grains in human food chain

There is a decline in consumption of millets and its products, where in it is originated and grown is due to the shift in consumer habits, rapid rate of urbanization, time and energy required to prepare millet based foods, inadequate domestic structure, poor marketing facilities, processing techniques, unstaple supplies and relative unavailability of millets and its products, including flour, compared with other foodstuffs. Though mechanical pearling or polishing is well known for wheat, rice and maize, but for millet, this primary step in the commercial processing is essentially unknown. For instance, large imports of wheat and rice and policies to subsidize production of those crops in some countries had considerable negative impact on millets production. Millets could be in great demand in the future if the technologies for specific industrial end users are developed. Thus, attention to coarse cereals/ millets for following reasons are pressing needs.

Millet foods: physiological appropriateness

Generally, food has three important functions: (i) as a source of energy to be used in the internal combustion in human body, (ii) to compose our body, and (iii) to control physiological functions. Sodium warms and strains the body while potassium cools and relaxes the body. Phosphorus and sulfur increases acidity. Magnesium, potassium and calcium increase alkalinity of blood. The foods are positioned on this figure by their functions. Blood is normally weak alkaline to neutralize the poisonous acids that are produced in the body. To keep the body temperature normal, we need to eat foods containing sodium. The muscle and processed foods have acidity. Eating too much animal products make your blood acidic. To neutralize your blood, you need to eat lot of plant food especially tropical plants. As whole grains, especially millets that are neutral foods, they are good at keeping physiological balance.

Why millets to be processed?

It is unusual, in any human society, cereals or coarse cereals to be eaten as uncooked whole seeds (Hulse *et al*., 1980). Originally, we learned millets were good for us because of their calorie and energy contributions; then we discovered millets were a good source of fibre; now we focus millets as a good source of phytochemicals. Processing involves partial separation and/or modification of three major constituents of millets-germ, starch-containing endosperm and protective pericarp. In general, primary operation in processing of cereal or coarse cereal is usually the separation of offal (portion not normally used for human consumption) from the edible portion. The offal consists of pericarp and sometimes the germ. Offal removal is frequently called decortication or dehulling. The outer tough seed coat and associated characteristic flavour (Malleshi, 1986), cultural attachments and non-availability of processed millet products similar to rice or wheat (Malleshi and Hadimani, 1993) are the main reasons for less popularity of millet foods among rice and wheat eaters. While there are many machines available for processing cereals, there is unfortunately no well-proven industrial process available for making white products from coloured minor millets. Decortication is sometimes accomplished by using rice dehullers or other abrasive dehullers. Pushpamma (1990) reported that decortication reduces total protein and lysine by 9 and 21%, respectively, but improves the remaining protein utilization. The loss of minerals was minimal. Decortication improves the biological availability of nutrients and consumer acceptability. Lorenz (1983) observed that the phytate content of common millet varieties ranged from 170 to 470 mg per 100 g whole grain, and dehulling resulted in a 27 to 53% reduction in phytate content. On dehulling, phytin phosphorus decreased 12% in common millet, 39% in little millet, 25% in kodo millet and 23% in barnyard millet (Sankara Rao *et al.,* 1983). Traditionally, dry, moistened or wet grain is normally pounded with a wooden pestle in a wooden or stone mortar. Moistening the grain by adding about 10% water facilitates not only the removal of fibrous bran, but also the separation of germ and endosperm, if desired. Although this practice produces slightly moist flour (Perten, 1983), parboiling increases the dehusking efficiency of kodo millet (Shrestha, 1972) and to eliminate the stickiness in cooked finger millet porridge (Desikachar, 1975). Millets can be used for traditional as well as novel foods. Unprocessed or processed grain can be cooked whole or decorticated and if necessary ground to flour by traditional or industrial methods. However, there is a need to look into the possibilities of alternative uses. Wheat has a unique property of forming

an extensible, elastic and cohesive mass when mixed with water. Millet flours lack these properties when used alone. Hence fortification brings lot of innovative Ready-To-Eat / Ready-To-Serve minor millet based processed products. It is possible to fortify malted finger millet (70%) weaning food with green gram (30%) having low cooked paste viscosity and high energy density (Malleshi *et al.,* 1986).

Primary processing of millets

Traditionally, dry, moistened or wet grain is normally pounded with a wooden pestle in a wooden or stone mortar. Moistening the grain by adding about 10 per cent water facilitates not only the removal of the fibrous bran, but also separation of the germ and the endosperm. This practice of tempering the grain before pounding produces slightly moist flour. Parboiling is reported to help in dehusking kodo millet and to eliminate the stickiness in cooked finger millet porridge. Parboiling is basically the process of partial cooking the grain along with husk or bran. The raw grain is briefly steamed. The resulting product is dried, dehusked and decorticated. The decortication reduced total protein and lysine by about 9 and 21%, respectively, but that it also improved the utilization of the remaining protein. The loss of minerals was minimal. Decortication improved the biological availability of nutrients and consumer acceptability. While there are many machines available for processing cereals, there is unfortunately no well-proven industrial process available to satisfy entirely for making white products from coloured minor millets. Grain, which should be fairly dry, is crushed and pulverized by the backward and forward movement of the hand-held stone on the lower stone. Generally, women do this unpleasant, laborious and inefficient hard work. It has been reported that a woman working hard with a pestle and mortar can decorticate 1.5 kg per hour, providing a non-uniform poor keeping quality products. Dry, moistened or wet grain is normally pounded with a wooden pestle in a wooden or stone mortar. Grain was moistened by adding about 10 per cent water to loosen the fibrous bran, and also to separate the germ and the endosperm, if desired. Although this practice produces slightly moist flour, many people temper the grain in this way before they pound it. Decortication is sometimes accomplished by using rice dehullers or other abrasive dehullers. Millets would probably be more widely used if processing were improved and if sufficient good-quality flour were made available to meet the demand. Technically, there are three types of pearling or decortication that can be employed to minor millets:

(a) ***abrasive decorticators***: Abrasiveness of bulk solids, *i.e.* their ability to abrade or wear surfaces with which they come into contact is considered a property closely related to the hardness of the material (Balasubramanian 2007, Fig. 2). The hardness of powders or granules is defined, in direct analogy with the definition of hardness of solid materials, as the degree of resistance of the surface of a particle to penetration by another body. It can be implied from the relative hardness of the particles and the surface with which they are in contact, using Morhs' hardness scale. Abrasive decorticators abrade away the fibrous pericarp. Obviously, the outer layers of the seed-coat are abraded away first and the innermost layers. If all parts of all grains could be abraded away at the same rate, abrasive decortication would be an efficient way of removing the pericarp. However, different parts of individual grains are abraded away at different rates, and there is some loss of endosperm (particularly from damaged grains) even when the grain is only lightly abraded. (b) ***Metal friction machines***: Attrition usually means particles getting smaller due to their corners or surface irregularities being knocked off. Attrition is a serious, yet little understood problem in handling of food materials, which may be considered responsible for economical losses in the food industry. (c) ***Roller mills***: Bassey and Schmidt (1989) described the development of these types of decorticator and its use in Africa. Munck *et al.* (1982) described a new industrial milling process developed in Denmark, which does not involve abrasive milling. Decortication is achieved by a steel rotor rotating the grain mass within a generally cylindrical chamber. When the grain is properly tempered, the pericarp is rubbed off by the movement of one seed against another. However, when the grain is too dry, abrasion of the internal components of the mill becomes severe.

(b) **CIAE- MILLET MILL (Model I & II)**

Though machines with tangential abrasive dehulling device (TADD) concepts exists for dehusking of millets, its demand for high energy and more quantity of millet grains to process restricts it operation at millet growing catchments. It requires the millets grains to its brim level of processing chamber. Also, the husk separation becomes difficult. Aiming to revival of millets in farm and table eliminating the drudgery involved during millet processing, Central Institute of Agricultural Engineering (CIAE, ICAR), Bhopal has undertaken the initiatives for mechanization of production and processing of millets to

find and develop a pathway for good profitable uses millets. In a strategy to link up pre and post harvest processing to product development, utilization, nutritional value, health and sustainability of minor millet, an eco-friendly, energy efficient continuous type CIAE-Millet mill (Model I & II) (Fig. 1) has been design and developed. It has a capacity of 100-110 kg/h of millet grains at 10-12 % moisture content. It operates with one horse power single phase electric motor. Even it can process a kilogram of millet grains with a single pass and required degree of dehusking. The separation of the husk is simultaneous with the suction arrangement and cyclone separator. It is suitable for dehusking of all minor millets viz., foxtail millet, little millet, kodo millet, proso millet and barnyard millet (Fig.2). It has provisions to adjust the clearance between the dehusking surfaces to suit the different sizes of minor millets. The dehusking efficiency of the machine is about 95%. The machine costs about Rs. 40,000. This machine is eco-friendly, because its processing zone is compact and it is attached with cyclone separator, thus it does not allow the dehusking mass to environment directly and husk is gently trapped and collected. The air and noise pollution is under control during its operation. To note, it does not require any hard labour and women friendly. Hence, it can be operated in the catchment and domestic level. Thus, CIAE-Millet mill can be installed as an enterprise in the prevailing situation of decentralized manner of millet production at rainfed conditions and trial areas, with a payback period of only three months. It is hoped that the application of this machine in millet processing will promote an effective entrepreneurship and marketing strategies in the successful commercialization of millet based health foods.

Traditional foods and potentials for novel minor millet food

A detailed classification of traditional foods from sorghum and millets has been developed and may be classified broadly into breads, porridges, steamed products, boiled products, beverages and snack foods. Millet grains, maize or sorghum can replace rice or wheat semolina in idli and dosa formulations. About 20 per cent of the wheat flour in bread making can be replaced by sorghum, millet, or maize flour. Popped or flaked millet grains have been used for the development of different types of weaning foods and supplementary foods for feeding school and pre-school children. The millet is supplemented with pulses to increase protein quality. Varieties suitable for popping have been identified in sorghum and finger millet. Finger millet varieties from Eastern Africa have varying

amounts of tannins (270–2000 mg/100 g) however both maize and finger millet are rich sources of phytic acid (Lorri and Svanberg, 1993; Mbithi-Mwikya *et al.,* 2000; Egli *et al.,* 2002). These antinutrients form complexes with micronutrients such as iron, calcium and zinc, and reduce their solubility and bioavailability. Tannins also has complex enzymes of the digestive tract adversely affecting utilization of proteins and carbohydrates, and resulting in reduced growth, feeding efficiency, metabolizable energy and bioavailability of amino acids. Traditional technologies such as decortication, soaking, germination and fermentation of cereal-based foods reduce the levels of tannins and phytates, increase bioavailability of amino acids and mineral elements and improve protein and starch digestibility (Lorri and Syanberg, 1993; Mbithi-Mwikya *et al.,* 2000; Mamiro *et al.,* 2001). Dehulling can remove 40 to 50 per cent of both phytate and total phosphorus. Bioavailability of iron in sorghum for human subjects was found to be affected more by phytin phosphorus than by tannin content of the grains (Radhakrishnan and Sivaprasad, 1980). On pearling of sorghum grain, a significant increase in ionizable iron and soluble zinc content indicated are improved bioavailability of these two micronutrients, which was attributed partially to the removal of phytate, fibre and tannin along with the bran portion during pearling (Sankara Rao and Deosthale, 1980). Inhibitors of amylases and proteases have been identified in sorghum and some millets (Pattabiraman, 1985). Chandrasekher *et al.* (1981) screened millet varieties for inhibitory activity against human salivary amylase. Japanese barnyard, common, kodo and little millet strains had no detectable activity. One pearl millet and two sorghum strains did not show any inhibitory activity against α-amylase, while other strains of sorghum, pearl foxtail and finger millets showed appreciable activity, indicating it to be a varietal and species character. Sorghum had the highest inhibitory activity against human, bovine and porcine amylases; foxtail millet did not inhibit human pancreatic amylase, while extracts from pearl and finger millets inhibited all α-amylases tested. Similar screening for protease inhibitors (Chandrasekher *et al.,* 1982) showed that kodo, common and little millet varieties had no protease inhibitory properties while pearl, foxtail and barnyard millets displayed only antitrypsin activity. Lorenz (1983) observed that the phytate content of common millet varieties ranged from 170 to 470 mg per 100 g of whole grain, and dehulling resulted in a reduction of 27 to 53 per cent in phytate content. On dehulling, phytin phosphorus decreased by 12 per cent in common millet, 39 per cent in little millet, 25 per cent in kodo millet and 23 per cent in barnyard millet (Sankara Rao *et al.,* 1983).

The nutrient composition and technological properties of minor millet grains offer a number of opportunities for processing and value addition to use as next generation to satisfy the consumers of different culture, location and society. Like many industrialised and developed countries, India, too is experiencing a nutritional transition. With more and more women joining the work force annually, fast foods and 'eating out' habits are replacing the family cook, thus leading to a rapidly developing 'fast food' industry locally. Nowadays, preparation technologies have changed mainly due to lack of time and with the advent of the fast food industry. Consumers now see eating as something to be done while you do something else.

Revival of millets!

Revival of millets can be achieved through concerted efforts of research, marketing testing, entrepreneurial training and demonstration to stimulate the processing of high quality, competitive products for urban areas. These constraints can be grouped into four broad categories: (1) inputs (grain) (2) output (processed products) (3) processing technology (4) market.

Inputs

Laboratory chemical and physical characterization of coarse cereals/ millet varieties for making the basic food products. This involves their appropriateness through threshing, dehulling and milling. Economic evaluation of millet and sorghum traits for making some preferred food products should be undertaken.

Foster the adoption of appropriate technologies (e.g. improved varieties combined with soil restoration technologies and water conservation methods) that will increase the millet supply through on-farm participatory methods.

Improve information access to technologies by extension services, Non-Governmental Organization, to food processors.

Better understanding of determinants of households' investments and consumption decisions.

Better understanding of structure, conduct and performance of national and inter-regional trade of millet/coarse cereals

Output

Surveys on processed products likely to be preferred by consumers.

Feasibility and market tests on new products.

Processing technologies

Develop or adapt proper equipment to reduce the unit processing costs for threshing, dehulling and milling compared to current traditional practices.

Conduct feasibility studies on current traditional or improved processing technologies

Markets

Examine current formal and informal contractual schemes between buyers and producers for different staple crops, in order to draw useful lessons.

Improve the information flow between processors and consumers of millets/coarse cereals.

Examine the socio-economic, institutional and policy constraints faced by current food processors.

Call for action

In a sense, it is imperative to find and develop good profitable uses of coarse cereals/millet. With increasing urbanization and rising disposable incomes, the demand for preprocessed and convenience foods is accelerating. This is one reason why commercially milled wheat and maize flour are increasingly preferred. Millet is much cheaper, but they are unprocessed and therefore less convenient to use. As a result, markets for locally grown millet are diminishing, incentives for local production are deteriorating, and foreign exchange reserves are dwindling to meet ever-rising demands for preprocessed flours. Thus, in dry regions, processing facilities are particularly vital to the future of local millet farming. Thus, millets are so compelling to agree their needs to educate consumers on the health benefits and to encourage increased consumption. To do this, a joint effort by post harvest, health, food engineers, and nutrition professionals, including industry, government, and health promotion organizations is required. As part of this effort, we need support from nutrition educators in industry, academia, and government to develop clear and consistent messages in *consumer language* to communicate the positive health benefits of millet products. Efforts to work with industry leaders to enrich their knowledge about the benefits of millets and encourage them to overcome barriers to the inclusion of more whole grains in their products, as well as continue to develop diversified and fortified products to meet consumers' needs. Thus, a commercial horizon would open up that have never before been contemplated in Indian Scenario.

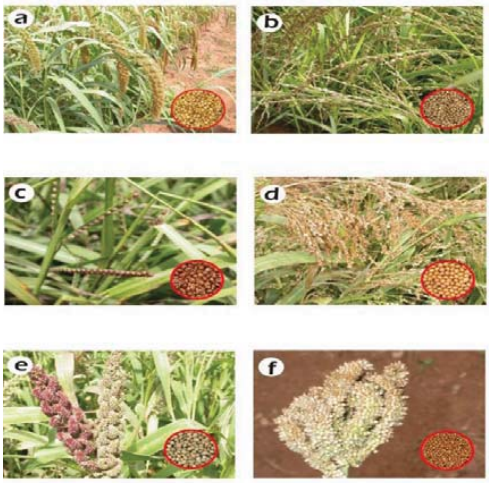
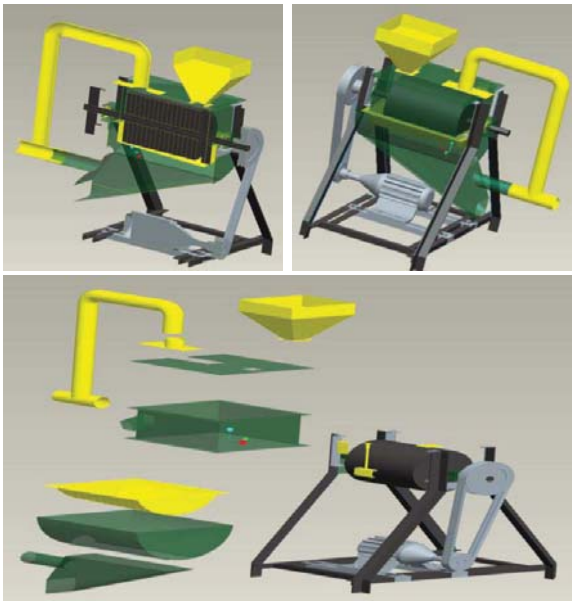
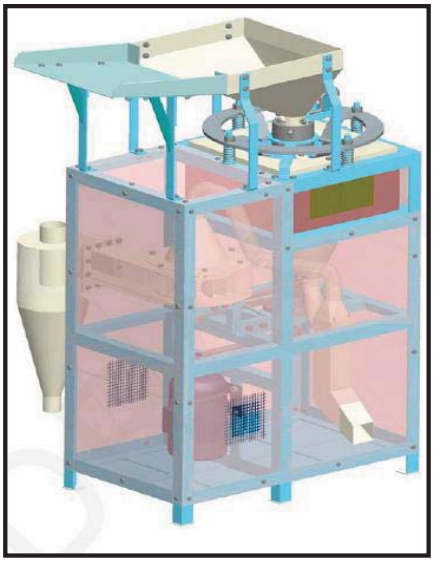


Fig.2.1 Minor Millet Crops and Grains

a.Foxtail Millet
b.Little Millet
c.Kodo Millet
d.Common Millet
e.Barnyard Millet
f.Finger Millet



Tangential Abrasive dehulling device (Balasubramanian 2007)



CIAE-MILLET MILL (Model I & II) (Balasubramanian 2013)

Millet grains along with husk and kernel

Table 1. Origins and common names of millets

Crop	Common names	Suggested origin
Pennisetum glaucum	Pearl millet, cumbu, spiked millet, bajra, bulrush millet, candle millet, dark millet	Tropical West Africa
Setaria italica	Foxtail millet, Italian millet, German millet, Hungarian millet, Siberian millet	Eastern Asia (China)
Panicum sumatrense	Little millet	Southeast Asia
Paspalum scrobiculatum	Kodo millet	India
Panicum miliaceum	Proso millet, common millet, hog millet, broom-corn millet, Russian millet, brown corn	Central and eastern Asia
Echinochloa crus-galli	Barnyard millet, sawa millet, Japanese barnyard millet	Japan
Eleusine coracana	Finger millet, African millet, koracan, ragi, wimbi, bulo, telebun	Uganda or neighbouring region

Source: FAO (1995)

Table 2. Structural features of millets

Grain	Type	Shape	Colour	1000 grain mass* (g)
Sorghum	Caryopsis	Spherical	White, yellow, red, brown	25.0 - 30.0
Pearl millet	Caryopsis	Ovoid, hexagonal, globose	Grey, white, yellow, brown, purple	2.5 – 14.0
Foxtail millet	Utricle	Elliptical	Yellow, pale yellow	1.86
Common millet	Utricle	Globose	Light Purple	4.7 - 7.2
Finger millet	Utricle	Globose	Yellow, white, red, brown, violet	2.6

Source : FAO (1995); * at 12 per cent moisture content (w.b.)

Table 3. Need for millet processing

Digestibility	Processing is required to make dried grains edible and digestible.
Food safety	Cooking inactivates natural toxins and heat prevents bacterial growth and food spoilage.
Organoleptic properties	Processing optimizes the appearance, taste and texture of foods to meet the needs of consumers.
RTE & Convenience	To meet consumer demand for quick and easy meal solutions and also nutritional supplement.
Maximise nutritional availability	Processing can make it easier for nutrients from grains to be digested. Nutrients lacking in the diet can be added to staple grain-based foods (e.g. thiamin added to flour).

Table 4. Biological value and digestible energy in dehulled millets (%)

Grain	**True digestibility**	**Biological value**	**Net protein utilization**	**Digestible energy**
Pearl millet* (low protein)	95.9	65.6	62.9	89.9
Pearl millet* (high protein)	94.6	58.8	55.7	85.3
Foxtail millet+	95.0	48.4	46.3	96.1
Little millet+	97.7	53.0	51.8	96.1
Kodo millet+	96.6	56.5	54.5	95.7
Common millet+	99.3	52.4	52.0	96.6
Barnyard millet+	95.3	54.8	52.2	95.6

Source : * Singh *et al.* (1987); + Geervani and Eggum, (1989).

Table 5. New generation RTE products from millets

Millet product	Raw material	Processing technique used
Energy bar	Dehulled grain	Flaking and binding
Breakfast cereals	Whole grains	Roasting, grinding, milling and extrusion
Puffed and expanded products	Semolina	Milling and extrusion
Multi grain biscuits, Therapeutic biscuits	Dehulled grains	Milling and baking
Health drinks (e.g. weaning foods)	Whole grains	Roasting/Malting and grinding

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PS 02 PROCESS OPTIMISATION OF EXTRUDED BREAKFAST CEREAL FROM RICE MILL BROKENS – FINGER MILLET -MAIZE FLOUR BLENDS

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Abstract

Rice mill broken (broken rice), finger millet and maize mixed flour, of various compositions were extruded into breakfast cereal in a twin-screw extruder. The extrusion parameters, *viz.,* barrel temperatures of 90°C, 100°C and 110°C; moisture of the mix, 16, 18 and 20% (w.b); screw speed, 230, 260 and 290 rpm at feeding rate of 210g/minute. The extrudates were dried in a forced air circulation oven and stored in polyethylene bags. The extrudates were evaluated for the functional and textural properties of breakfast cereal, expansion index, water absorption index, water solubility index, density, viscosity and instrumental texture. The extruded obtained showed relatively low values for water absorption index (5 g gel/g dry matter) and high values for water solubility index (8.7%). The expansion ratio of breakfast cereal was 2.46 indicating a good expansion of the final product at 16% moisture, 110°C barrel temperature and 290 rpm screw speed. For extrudate density of 0.11 g/cm^3, the hardness value of 1.35 N. it was observed. The paste viscosity is an important attribute to study the functional properties of starchy food. The maximum peak viscosity of 1836.17 cP for the formulation 20% broken rice flour, 60% finger millet flour and 20% maize flour was observed.

PS 03 EFFECT OF PARBOILING ON DE-HULLING AND COOKING QUALITIES OF KODO AND BARNYARD MILLET

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Kodo millet (*Paspalum scrobiculatum*) and barnyard millet (*Echinochloa colona*) were subjected to hydrothermal treatment at different levels of soaking temperature (60, 70, 80^{0}C), soaking time (6,7,8 h), steaming periods (10,15,20 min.) shade dried and milled in a centrifugal de-huller. The milled samples were analyzed for hulling efficiency, head rice recovery, degree of parboiling, hardness, colour, cooking time, water up take and swelling index using standard procedures.

Increase in hulling efficiency (21.8 - 27.5%) was recorded over control in kodo millet and barnyard millet (20.8 – 26.2%) and the head rice recovery enhanced by 27.3% and 25.5% in kodo millet and barnyard millet respectively over the range of experiments conducted. The increase in temperature of soaking, soaking time and steaming period increased the degree of parboiling, hardness (36.8 - 37.7 N in kodo millet and 44.7 – 47.3 N in barnyard millet) and cooking time (10.2- 10.5 min.) for both millets. Water uptake and swelling index decreased appreciably due to hydrothermal treatment. The treated samples were dark in colour compared to raw grains and the change in L*, a*, b* values were highly significant.

PS 04 PHYSICO CHEMICAL AND FUNCTIONAL CHARACTERISTICS OF PROCESSED KODO MILLET FLOUR

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Cereals and millets are subjected to milling and polishing at the commercial level, while pulses and legumes undergo dehusking. At the household level, the common methods of food processing include cooking (heat processing), soaking, and germination, roasting and puffing, and fermentation. Most of these processing methods alter the nutritive value of foods. Heat processing of foods improves the digestibility of starches, but subsequent cooling makes a small portion resistant to digestion. The nutritional significance of this effect is yet to be established. Hence the present study was done to compare various processing treatments on physicochemical characteristics of whole kodo millet flour. The kodo millet of CO3 was subjected to heat treatments such as boiling for 25 minutes at 95-100˚C, steaming at 80-90˚C for 25 minutes and pressure cooking at 9.8×10^4 Pa for 20 minutes. The treated grains were sundried, powdered and determined for its physical, functional, thermal and pasting properties; FTIR spectra, SEM micrograph, *in vitro* starch digestibility and % crystallinity. Boiling reduced the starch yield, exhibited greater porosity and water absorption capacity. Pressure cooking revealed significantly greater oil absorption capacity and swelling power; reduced the peak and final viscosity which indicates large starch damage due to greater α-amylase activity. This was further proved by SEM micrograph and high total glucose on *in vitro* starch digestion. The resistant starch content was significantly greater in pressure cooked flour which reflect significantly low starch digestibility index. FTIR spectral library search indicated a spectral match of corn flour. The steamed kodo millet flour did not show further gelatinization according to DSC thermogram. Thus pressure cooked flour was less viscous, high dense, rich in resistant starch, and found to be more suitable food in the diet for degenerative disorders.

PS 05 OPTIMIZATION OF MACHINE PARAMETERS OF CENTRIFUGAL DEHULLER FOR DEHULLING OF FOXTAIL AND LITTLE MILLET

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Dehulling is next major step to harvesting, threshing and pre-cleaning of millets. Dehulling is done to remove the outer husk and bran to obtain good quality millet grains for consumption and processing. A centrifugal dehuller was developed and studies were conducted at three moisture contents (12, 14 and 16 %), three levels of peripheral speeds (42.57, 45.04 and 47.29 m/s), three set of vanes (3,4 and 5) and three types of hitting surfaces (straight, tapered and grooved). The hulling efficiency of 87.50% and 86.75% were obtained for foxtail millet and little millet at a moisture content of 12% moisture content (db), peripheral speed of 47.29 m/s, 3 vane impeller, angular casing and two passes respectively. The broken percentage for both the grains was less than 5%.

PS 06 EFFECT OF PROCESSING ON THE QUALITY ATTRIBUTES OF BARNYARD MILLET COOKIES

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Barnyard millet is an important crop as it is a good source of slowly digestible carbohydrate, fair source of protein, excellent source of dietary fibre and minerals. Value addition of barnyard millet is an important strategy to improve its utilization and the method of processing determines the quality characteristics of the value added products. Whole barnyard millet grain was subjected to five different methods of processing to convert it into flour. The treatments included T_1- soaking, drying and pulverizing to flour, T_2- roasting, drying and pulverizing to flour, T_3- soaking, roasting, drying and pulverizing to flour, T_4- malted flour, T_0- pulverizing the whole grain to flour without any treatment. Cookies were prepared by incorporating the flour (T_0-T_4) individually at two levels of incorporation 50 and 75 per cent and evaluated for nutritional and sensory qualities. The results indicated that cookies prepared with the flour of T_3 had highly acceptable sensory and nutritional qualities at both the levels of incorporation.

PS 07 EFFECT OF DOMESTIC PROCESSING ON NUTRIENT CONTENT OF SORGHUM AND GREEN GRAM MIX

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Grain Sorghum an indigenous food to the semi-arid tropics of Africa and Asia stands fifth among the cereals in global production. Sorghum contains adequate nutritional values with 83% carbohydrate, 10% protein and 3.5% fat. Despite an impressive array of nutrients sorghum also contains anti-nutritional factors such as tannin, phytic acid, polyphenol and trypsin inhibitors which affects the human digestive system making the grain nutritionally deficient and organoleptically inferior. Traditional processing techniques namely roasting, malting and germination are found to improve the nutritional quality by reducing the content of the anti-nutrients. More over a combination of the grain with a legume is found to improve the protein quality. The study was thus undertaken with an objective to determine the effect of the domestic processing methods on the blends of sorghum and green gram flour at a ratio of 70:30. The flour mix is categorized into three variants namely, C1 (unprocessed sorghum: unprocessed green gram), V1 (roasted sorghum: roasted green gram) and V2 (malted sorghum: germinated green gram) respectively. The results of the study showed that there was a reduction in the content anti-nutrients namely phytic acid, oxalic acid and tannin on processing at 2%, 43% and 14% in the variation V1 and 3%, 51% and 22% in the variation V2 respectively. The content of nutrients namely energy, carbohydrates, iron, calcium, phosphorus, thiamine, riboflavin , niacin and vitamin C were also observed to have increased by 2.1 kcal,1.9gm, 0.60mg, 1.2mg, 15mg, 0.06mg,0.08mg,0.4mg and 0.75mg in V1 and 5.5 kcal, 2.2g, 0.11mg, 2.4mg, 33mg, 0.08mg, 0.11mg, 1.03mg, 1.25mg in V2 respectively. It could be concluded that the process of malting and germination have a positive effect in the nutritive quality and utilization of grains like sorghum which could be cultivated and used by a large sector of our people to overcome malnutrition.

PS 08 EFFECT OF HYDROTHERMAL TREATMENT ON THE MILLING CHARACTERISTICS OF THE TRAY AND SHADE DRIED KODO MILLET (*Paspalum scrobiculatum Linn)*

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Millets are highly nutritious crop that helps to prevent the increasing life style diseases. One such type of millet is the Kodo millet that contains higher amount of dietary fibre, B vitamins, proteins and antioxidant properties. Unfortunately this millet is consumed less due to its difficulty in processing from whole grain to edible portion. This study was designed to investigate the effect of hydrothermal treatment on the milling properties of tray and shade dried kodo millet. The grains of Kodo millet were pre-treated as soaking in hot water at 68 to 70^{0}C for 1-5 hours and then steamed for 20 minutes (T- I); soaking in cold water for 6 to 24 hours and then steamed for 20 minutes (T- II); steaming for 10-30 minutes (T-III). Further the grains were subjected to drying by tray drying with the help of an electric tray drier and shade drying (Modification of Poongodi, *et al.*, 2011). The dried grains were milled in Satake Laboratory Test polisher and the yields of milling fractions of millets such as husk, unpolished and dehulled grain were measured. This study shows that among the various pretreatments, steaming treatment has the maximum increase in the millet yield compared to cold water soaking and hot water soaking methods. In comparison to tray dried grains, the shade dried kodo millet grains had higher yield and lesser unpolished grains. It was also observed that hydrothermal treatment has increased the milling yield of the kodo millet grains.

TECHNICAL SESSION II

UTILIZATION OF SMALL MILLETS

US 01 - LEAD PAPER

MILLETS FOR FOOD AND NUTRITIONAL SECURITY

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Nutritional well being is a sustainable force for health and maximization of human genetic potential. The nutritional status of a community has therefore been recognized as an important indicator of national development. In the world even though there is surplus food production still endemic under nutrition is prevalent. India has the highest number of undernourished people in the world. The proportion of children in India who are underweight, stunted and wasting is the worst among the developing world. The number of adults whose BMI is lower than normal or those have over weight is very high in India. For solving the problem of deep rooted food insecurity and malnutrition, dietary quality should be taken in to consideration. Diversification of food production must be encouraged both at national and household level with increasing yields. Growing of traditional food crops suitable for the area is one of the possible successful approaches for improving household security. Millet production is mainly concentrated in South Asian regions. There has been systematic decline in the production and area of millet since 1956 and area has been diverted from millet to other crops such as wheat, rice, maize, chick pea, groundnut, mustard and cotton. According to global pattern of millet consumption, India stands at the top (42%) followed by African countries. Average household consumption of millet in different states of India is 0-200 g/CU/day. Millets are mainly single season crops grown in rainy season. In India millets are specially grown by small and marginal farmers. Millets with short biological cycle are adapted to various ecological conditions. These are consumed mainly by rural and urban poor. A traditional farming system like “Akdi” still exists. Nutritionally millets are comparable to major cereals. Protein quality of finger millet is as good as other cereals. One of the characteristic grain composition features of millet is their high ash content. Millet grain contains about 65-75 per cent carbohydrate, a high proportion in the

form of non starchy carbohydrate. Supplementation of millet based snacks and food significantly improved nutritional status of school children. Millets contain large quantities of phenolics and other compound which prevent deterioration of human health. Studies conducted on human volunteers lowered HbA1c (glycosilated haemoglobin), fasting glucose level, total cholesterol and triglyceride. Technological properties of millets like flaking, extrusion, malting, baking, and parboiling offer number of opportunities for processing and value addition. Ethnic foods made out of small millets have excellent taste and are acceptable both by rural and urban consumers. A target of 10-20 per cent of the food grains substituted with nutritious millets would ensure multifarious benefits. Decentralized Public distribution system enables locally preferred millets to the part of PDS open diversity within the PDS in the country and also open several employments locally. Production of millets declined steadily over the past few decades due to their lower economic competitiveness with other major cereals. Millets are healthy sources of carbohydrate for persons with diabetics. Deterioration of human health can be prevented by millets as a source of neutraceuticals. In spite of several health and economic benefits millets are disappearing from people's diet and farm lands. Urgent attention must be given to the production and consumption of millets to ensure food and nutrition security.

US 02 Acceptability study of Foxtail millet (*Setaria italica*) and Barnyard Millet (*Echinochloa frumantacea*) incorporated Bread

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Small millets with rich source of nutrients are widely cultivated in India and are considered as the crops of food and nutrition security owing to its sustainability in adverse agro-climatic conditions. Efforts are underway to provide it to consumers in convenient forms. Extensively available yet underutilized Foxtail millet (*Setaria italica*) and Barnyard Millet (*Echinochloa frumantacea*) were processed, incorporated in different proportions in the formulation of bread and evaluated for its acceptance. It was found that, bread could accommodate the foxtail millet and barnyard millet up to 15 and 10 per cent respectively and resulted in good overall acceptance in terms of organoleptic attributes. There was an acceptable texture with no visible changes in the microstructure of the products with that of standard. Inclusion of small millets also improved the nutrient composition considerably. Also, the millet incorporated bread had a good shelf life and was in par with the standard bread. An effective utilization of these small millets may alleviate the problem of malnutrition which is of paramount importance in India.

US 03 DEVELOPMENT AND EVALUATION OF VARAGU INCORPORATED RECIPES

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Small millets are small seeded annual cereal grains and are particularly low in phytic acid and rich in dietary fibre. Kodo millet or varagu (Paspalum scrobiculatum) is nutritionally superior to rice and wheat in terms of higher protein and dietary fiber content, lesser fat content. In the present era of higher incidence of degenerative diseases, there exists a need to use millets for nutritional benefits. Hence, the study was undertaken to incorporate varagu in commonly consumed recipes of South India and evaluate the acceptability of these recipes on the basis of organoleptic parameters and analyze their nutrient content. Fourteen recipes which included breakfast items and snacks such as idli, dosa, chappathi, pongal, puttu, idiyappam, kozhukattai, boli, biscuit, soup, adai, payasam, cutlet and laddoo were selected for incorporation. Varagu was incorporated separately in each recipe either as a whole grain or in powdered form at 30 per cent and 50 per cent levels. The overall acceptability and mean scores for each recipe were analyzed by sensory evaluation through a formulated five point scale by a panel of 30 semi trained members. The best acceptable recipes incorporated with varagu were analyzed for selected nutrients using standardized methods. The findings of the study revealed that idli, puttu, adai, payasam, kozhukattai, laddoo, cutlet were best accepted when incorporated with varagu at 30 per cent level and pongal had higher acceptability score at 50 per cent level of incorporation. Kozhukattai incorporated with varagu at 30 per cent level obtained the highest score among the recipes with a dietary fibre content of 6 g. The method of preparation of the incorporated recipes with their nutrient content was also compiled as a booklet. The study paved way to explore diversified usage and acceptability of kodo millet and a need to enlighten their importance to the community.

US 04 NUTRACEUTICALS ENRICHED PASTA PRODUCTS

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Small millets with their low carbohydrate content, low digestibility and water soluble gum content (β-glucan) have been attributed to improve glucose metabolism. These grains release sugar slowly in the blood and also diminish the glucose absorption. The dietary fibre and resistant starch of minor millets have been attributed to exhibit hypoglycemic and hypolipidemic effects. Further, the antioxidative properties of minor millets against hyperglycemia and oxidative stress, is mainly determined by their higher reserves of phytochemicals like phenolics, tannins, phytates and micro minerals. Soybean contains good source of protein and insoluble fibre showing significant amounts of amino acids (lysine and tryptophan) that improved the nutritional quality of the food products. Horse gram is a good source of linoleic acid (42.78%) which is useful for the treatment of diabetes and cardiovascular disease. Pasta has come a long way from the days when it was erroneously considered by consumers to be a "fattening food." Pasta products are normally high in starch but low in dietary fiber, minerals, vitamins, phenolic compounds, etc. With an increasing concern by the health conscious population, more nutritious pasta products rich in minerals, phenolic compounds and dietary fiber with low glycemic index have become the subject of prior significance. Today it is perceived as one of the "healthier options". Pasta is now generally acknowledged as a low glycemic food suitable for the diabetic diet because of the incorporation of small millets. This product attracts those consumers who look for low glycemic foods for various reasons. Emphasizing on this, an effort was put forth to develop nutritious enriched pasta, supplemented with millet and pulse blend which are rich in vitamins, minerals, and dietary fiber. This will improve the nutritional quality of the pasta in terms of antioxidant and hypoglycemic activity as well. Thus millet based pasta products increases the nutritive density and it is today's need to treat various dietary constraints.

US 05 PROCESSING AND EVALUATION OF CONVENIENCE FOODS FROM MAIZE

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Convenience foods or processed foods are foods which are designed to save consumer time and cost. Major cereals like rice, wheat and maize constitute about 85% of total global cereals production. Changes in climate, price of rice inducing farming community to partly diversify agriculture to sustain, augment farm income and improve the natural resources. Maize the most versatile crop with wider adaptability and highest genetic yield potential occupies an important place as a source of human food (25%), animal feed (12%), poultry feed (49%) and industrial products (12%). Since the need for nutritive foods at low cost is in demand, the use of maize in combination with other cereals for making different types of traditional and nontraditional foods is very much essential. With this background an attempt was made to develop the convenient foods viz., pittu mix and noodles from maize. Maize flour was substituted at different levels (25, 50, 75 and 100 %) for preparation of pittu and noodles and evaluated for the nutrient composition. The sensory evaluation revealed that maize flour based pittu and noodles were highly acceptable at 75 per cent and 50 per cent level respectively. Regarding the nutrient composition, pittu and noodles contained starch 64.28 %, 66.18 %; protein 10.13%, 10.58%; fat 2.36, 2.71 %; and fibre 1.52%, 1.71 % respectively. Maize contained all essential nutrients contributing food and nutritional security by meeting energy and protein needs of consumers. The feasibility of using maize in different food preparation provides health benefits and scope for small scale entrepreneurs.

US 06 STANDARDIZATION AND EVALUATION OF SMALL MILLET BASED INSTANT PITTU MIX

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In the present investigation attempts have been made to develop nutrient rich instant pittu mix by the addition standardized proportion of kodo millet and barnyard millet. Sensory attributes of instant pittu mixes were highly acceptable. The proximate composition of millet based instant pittu mix contained higher protein, fibre and minerals such as calcium, phosphorus and iron. The moisture, protein, starch, fat, crude fibre and tannin content of kodo millet (T_1) and barnyard millet (T_2) pittu mix were 10.70, 7.30, 51.80, 1.00, 3.10, 4.80 and 10.00, 6.25, 56.10, 1.80, 5.80 and 5.0 g per 100 g respectively. The minerals like calcium, phosphorus and iron were 30.00, 176.00, 4.20 and 26.00, 278.10, 6.80 mg per 100 respectively. It was found that the product was highly acceptable in Metallised Polypropylene with antioxidant for a storage period of 180 days. The cost of small millet based instant pittu mix was worked out to be Rs.4.88 (T_1) and Rs.4.38 (T_2) respectively.

US 07 FORMULATION AND ACCEPTABILITY OF MILLET BASED VALUE ADDED VERMICELLI

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Extruded products from grains are popular as it lends itself to a variety of recipes and it has many advantages like versatility, low cost, better product quality and no effluents. Vermicelli is a product prepared by using whole or refined wheat flour. Hard dough is prepared, extruded and dried in the sun. Therefore value addition of vermicelli is of prime importance to improve its nutrient content and to save its delicacy. Hence a study was undertaken to improve the quality of wheat vermicelli by incorporation of millets as they have high micronutrient content, particularly calcium and iron, high dietary fibre, higher amount of essential amino acids, low glycemic index and plays an important role in the food and nutritional security of the poor. Four variations of vermicelli were prepared using wheat flour, jowar, maize, foxtail millet and little millet. All the variations were analyzed for nutrient content and organoleptic evaluation. Results revealed that all the four variations has 300 kcal of energy , with higher protein content in variation I (12.8g). Calcium is higher in variation II (36.6mg) and Potassium is higher in variation I (215mg). The millet value added vermicelli was found to be nutritionally superior with good acceptability than control vermicelli. From the nutrient and organoleptic evaluation variation I and variation II was Subjected to further study as it received the higher score compared with other variations The highly acceptable millet value added vermicelli was incorporated in different types of recipes and stored at ambient conditions for a period of 120 days. Acceptability trials were carried out before and after the storage period. It was found that the value added vermicelli had good keeping quality. Though the cost of the millet value added vermicelli increased marginally, the nutritional benefit overrides the cost.

US 08

UTILIZATION OF SMALL MILLETS

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The small millets are gaining momentum viz. finger millet, little millet, foxtail millet, proso millet, kodo millet and barnyard millet and are so called because of their small size. Wheat and rice provide only food security. But, millets produce multiple securities like food, fodder, health, nutrition and livelihood. Millets are amazing in their nutritional content. Each of the millets is three to five times nutritionally superior to the widely promoted rice and wheat in terms of proteins, minerals and vitamins.

The nutrients that we intake during breakfast help us in starting our daily activities efficiently. Small millets are good sources of energy that is required for the proper functioning of our body. They not only contain carbohydrates but also micronutrients that stimulate the metabolic activities in the body. High fibre content of millets makes the process of digestion slow, there by prolonging the supply of energy to the body. Fermented foods are easy to digest. The growth of healthy bacteria during fermentation weakens the anti nutrients and enhances the nutrient availability. Fermented products naturally release the micronutrients required for our body. Ragi porridge, idli, dosa etc. are products prepared by fermentation which are nutritious. Fermented millet recipes will add to food diversity. In Indian diet, fried snacks are more popular and are highly enjoyed. Chakli, kodubale, nippattu, tengalu, shev etc are tasty and mouth watery fried snacks. Fried snacks are calorie dense and more suitable for growing children and people involved in physical activities. Sweet products contain high amount of calories which are needed for the body. Novel sweet items can also be prepared with these millets. Usually people are in the habit of eating papad and fryums as snack items. In market these products are in great demand and are of different size, shape and contain varieties of masala. The consumption of small millets leads to nutritional security of the community and helps prevent malnutrition.

US 09 DEVELOPMENT OF MILLET MIXES AND ACCEPTABILITY OF MILLET MIX INCORPORATED FOODS

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Iron deficiency and Iron deficiency anaemia (IDA) are the commonest forms of malnutrition occurring in the world. These affect approximately two billion people, 80% of whom live in the developing world. In India alone nearly half the world's anaemic women live. Aim: To develop nutrient rich multi-millet mixes (MMM) and to incorporate the same in to breakfast items. Pearl millet (Pennisetum glaucum), Finger millet (Eleusine coracona), Barnyard millet (Echinchloa spp) were mixed in different proportions and MM-A (40, 20, 40), MM-B (40, 15, 45), and MM-C (45, 10, 45) were developed. The formulations were incorporated in *Puri, Aappam, Maemo* and *Uthappam* at 10, 15 and 20%. Organoleptic evaluation was done on a five point scale to assess acceptability. *Puri* incorporated with 10% MM-B had good appearance (4.5±0.51), texture (4.7±0.47) and was also highly acceptable (4.1±0.71). Fifteen percent MM-C added *Puri* was tasty (4.05±0.75), had acceptable colour (4.35±0.58). "*Aappam*" with 20% MM-C scored 4.45±0.51, 4.6±0.50 and 4.6±0.50 for appearance, texture and taste respectively. Its overall acceptability was 4.45±0.51. "*Maemo*" with 20% MM-C was given 4.4±0.50 for taste. For flavour twenty percent MM-A added *Maemo* got a score of 4.45±0.68. Twenty percent MM-C added *Maemo* had good texture with a score of 4.3±0.65 and was highly acceptable with the score of 4.8±0.41. *Uthappam* incorporated with 15% MM-B had the best colour 4.5± 0.68, soft in texture(4.55±0.68), tasty (4.35±0.58) and was overall acceptable with 3.95±0.75 score. Addition of 10% MM-B or 15% MM-C was good for *Puri, Aappam and Maemo* could be incorporated with 20% MM-C without affecting the organoleptic quality. 15% MM-B addition was found to be ideal for *Uthappam*.

US 10 NUTRIENT ANALYSIS AND ACCEPTABILITY OF RECIPES INCORPORATED WITH BAJRA

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Bajra is commonly known as pearl millet. It is generally considered as a poor man's cereal. Pearl millet is nutritionally rich as it is composed of many minerals and protein. It is a gluten- free grain that retains its alkaline properties. Lysine and Methionine are the two amino acids present in pearl millet. Bajra is considered to have one of the best protein qualities. The present study aims to find the nutrient content and acceptability of recipes formulated with and without bajra among young adults. Experimental and sensory research design was used to determine the acceptability of recipes. Purposive sampling technique was used for testing the acceptability of all the selected recipes for all the three trials. The nutrients present in bajra such as carbohydrate, protein, fat, crude fibre, sodium, potassium, calcium and iron were analysed in National Agro Foundation. The nutrient analysis showed that the high fibre content of bajra makes it suitable for healthy foods to control obesity and constipation. This analysis also reveals that bajra contains high levels of iron which may help to increase the hemoglobin. The healthy nutrient composition of bajra makes it a suitable cereal to be consumed. The acceptability of standardized recipes was not much appreciated when compared to traditional recipes prepared with wheat and rice. The present study concludes that bajra is a good source of fibre, fat, iron and calcium. Bajra is a potential grain among the cereals with superior nutrient content and hence, could be a worthy to add to one's diet in an innovative form of recipe. Cultivation of bajra should be promoted considering the health benefits of bajra.

US 11 STANDARDIZATION OF TRADIONAL RECIPES FROM FOXTAIL MILLET

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Small millets are good sources of energy that is required for the proper functioning of our body. The nutrients that we intake during breakfast help us in starting our daily activities efficiently. Small millets are an excellent source of nutrients to the millions belonging to the economically challenged society in India. Foxtail millet is rich in nutrient composition including carbohydrate, protein, dietary fiber, calcium, phosphorus and has low glycemic index. Adai and payasam was standardized using foxtail millet as per the standard procedures. The standardized adai and payasam was evaluated for their organoleptic and nutritional quality. The standardized foxtail millet adai and payasam was evaluated for sensory attributes using a nine point hedonic scale by a panel of members. The products were highly acceptable at 100 percent incorporation level and the scores obtained for overall acceptability for adai mix was 8.6 and that of Payasam mix was 9. The protein, carbohydrate, fat, fibre, calcium and iron content of the foxtail millet adai was 19.38g , 53.11g 4.86g,10.21g, 75.5mg and 3.5mg and 6.98g,61.58g, 5.19g, 8.71g, 63.9mg and 1.74mg respectively.

US 12 EVALUATION OF LITTLE MILLET INCORPORATED CAKE

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Millets are recognized as important substitutes for major cereal crops to cope with worldwide food shortage, to meet the demands of increasing population both developing and developed countries and to develop low cost nutritious foods to combat malnutrition. Little millet being rich in soluble and insoluble dietary fibre, is cultivated under rain fed regions. Little millet flour can be supplemented in bakery products to improve its protein quality and fibre content. The standard recipe for preparation of cakes was used with little millet incorporated at 10, 20, 30, 40 and 50 per cent respectively. The organoleptic evaluation of the cakes showed that cake with 30 per cent little millet was highly acceptable, with the score for the overall acceptability being 8. Protein, fibre and iron content of the standardized cake were found to be 6.33g/100g, 5.99g/100g and 4.68 mg/100g respectively than the control cake. The shelf life of the product was better in poly propylene bags than the other packing materials upto 20 days. The microbial population was within the safer limit during the storage period.

US 13 STANDARDIZATION OF SPIRULINA AND KODO MILLET INCORPORATED COOKIES

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Kodo millet popularly known as "nutritious millet" is rich in minerals and fibre content. Spirulina, the blue green algae, is rich in protein content and has several therapeutic properties. The present study focuses on standardizing cookies incorporated with kodo millet and spirulina at different levels. In this work an attempt is made to use both kodo millet and spirulina in preparation of cookies. Along with the ingredients in the standard receipe, spirulina was incorporated at 5, 10, 15 per cent and kodo millet was incorporated at 25, 50, 75 per cent respectively. Results of Organoleptic evaluation showed that 10 per cent spirulina with 50 per cent kodo millet was highly acceptable, with score for overall acceptability being 8.5 than the control cookies. Protein, fibre and iron content of the standardized cookies were found to be 14.6g/100g, 6.92g/100g and 4.28 mg/100g respectively than the control cookies. The shelf life of the product was better in plastic containers (600guage-P_2) than propylene bags (200guage-P_1) upto 15 days and the microbial population was within the safe limit during the storage period.

US 14 STANDARDIZATION OF SNACK RECIPES FROM KODO MILLET

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After decades of neglect, small millets are figuring in the National Agricultural Development Agenda. India is one of the diversity centers of millet crops and is primary or secondary centre of diversity for several millet crops. Kodo millet is found across the world in humid habitats of tropic and subtropic. Kodo millets are highly nutritious, non glutinous and non acid forming foods. Hence they are soothing and easy to digest. Pakoda and Murkku were standardized by incorporating kodo millet at various levels of incorporation. The standardized pakoda and murukku was evaluated for their organoleptic and nutritional quality. The standardized kodo millet pakoda and murukku was highly acceptable at 100 percent incorporation level. The scores for the sensory attributes ranged from 8.7 to 9. The protein, carbohydrate, fat, fibre, calcium and iron content of the Kodo millet pakoda was 7.33g, 52.98g, 1.57g, 7.67g, 76.75mg and 1.15mg and 8.12g, 56.5g, 6.98g, 8.52g, 105mg and 1.77mg respectively.

TECHNICAL SESSION III

NUTRITIONAL IMPACT OF SMALL MILLETS

NS 01 Lead Paper

Promoting Small millets for improved Food security

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The term millet includes number of small grained cereal grasses. Based on the grain size, millets have been classified as major millets which include sorghum and pearl millet and several small grain millets which include finger millet (ragi), foxtail millet (kangni), kodo millet (kodo), proso millet (cheena), barnyard millet (sawan) and little millet (kutki).

The advantages of growing these crops include drought tolerance, crop sturdiness, short to medium duration, low labour requirement, minimal purchased inputs, resistance to pests and diseases. Millets have been called nutri-grains since they are rich in micronutrients like minerals and B-complex vitamins. Additionally millets are also rich in health promoting phytochemicals, and can be used as functional foods.

FALL IN MILLET AREA AND PRODUCTION

Though India is the largest producer of millets in the world, between 1961 and 2012, there has been drastic reduction in the area under cultivation of millets. (Table 1). Unfortunately the National food security mission launched in 2007, during the 11th five year plan, addresses the issue of cereals and pulses, but not millets

Table 1. Fifty years of cultivation of millets vis-à-vis other crops in India *(Area in Million ha)

Crop / Year	1955-56	1965-66	1975-76	1985-86	1995-96	2005-06	2008-09	2011-12
Jower	17.36	17.68	16.09	16.10	11.33	8.68	7.53	
Bajra	11.34	11.97	11.57	10.65	9.32	9.58	8.75	
Ragi	2.30	2.70	2.63	2.41	1.77	1.53	1.38	
Small.Millets	5.34	4.56	4.67	3.16	1.66	1.06	0..91	
Total Millets	36.34	36.91	34.96	32.30	24.08	22.08	18.57	18.6
Rice	31.52	35.47	39.48	41.14	42.84	43.66	44.553	
Wheat	12.37	12.57	20.45	23.03	25.01	26.48	27.71	
Maize	37.00	48.00	60.30	58.00	59.80	75.88	81.74	
Total cereals	51.08	55.48	68.76	71.305	74.658	78.36	82.16	99.15
Share of millets (%)	42	40	34	31	24	21	18	14.6

Source: Directorate of Millets Developmnet, DAC, Ministry of Agriculure, GoI, Jaipur Agricultural statistics at a glance, Economics and Statistics, Ministry of Agriculture, GoI, New Delhi.

Reasons for Decline in Millets Area in India:

Both demand and supply side factors have contributed to reduced interest in millets

Demand side factors

1. Rapid urbanization, 2. Changing consumer tastes and preferences due to rising per capita incomes, 3. Government policies favouring other crops such as output price incentives and input subsidies, 4. Supply of PDS rice and wheat at cheaper price introduced in non-traditional areas of fine cereals:, 5. Low shelf-life of grain and flour.

Supply side factors

1. Increasing marginalized cultivation, 2, Low profitability-low remuneration for millets vis-à-vis competing crops , 3. More remunerative crop alternatives in kharif competing with millets .4. Lack of incentive for millets production, 6. Development of better irrigation infrastructure /options as in small millets

Demand for millets can be increased by creating awareness regarding their nutritional and other health benefits making them available through PDS, value addition, inclusion under feeding programmes like the mid day meal, ICDS feeding, and adolescent girls nutrition scheme (now under consideration of ministry of women and child welfare).

The future priorities for research on millets may be considered in order to sustain the production and productivity of millets.

BIO FORTIFICATION

Bio-fortification means enrichment/value addition in crop through genetic manipulations. This seed- based approach is farmer empowering and can go along way in reducing deficiency of micronutrients, particularly iron, zinc and vitamin A (Beta carotene) in Indian diets.

Priority is needed for research in bio fortification, preferably using conventional breeding and molecular breeding methodologies since genetic engineering have become controversial.

SEED PRODUCTION:

In order to promote cultivation of millets, we also need to strengthen seed delivery system, community-based services including post-harvest, input-supply and marketing support. Besides all these, creation of awareness among people on health benefits of millet foods will help promote millets as industrial crop.

NUTRITIONAL AND HEALTH VALUE OF MILLETS: Nutrient content of cereals and millets is given in table 4.(Gopalan et al 2004) . Millets in general are rich source of fibre, minerals and B-complex vitamins. Some varieties of pearl millet also contain beta carotene (pro vitamin A).

Table 2. Nutrient content of cereals and millets

Grain/ nutrient	Bajra	Jowar	Ragi	Fox tail millet	Proso millet	Barnyard millet	Kodo millet	Rice-milled	Maize	Wheat-flour
Energy kcal	361	349	328	331	341	397	309	345	342	346
Protein g	11.6	10.4	7.3	12.3	7.7	6.2	8.3	6.8	11.1	12.1
Fat g	5.0	1.9	1.3	4.3	4.7	2.2	1.4	0.4	3.6	1.7
Calcium mg	42.0	25	344	31.0	17.0	20.0	27.0	10	10	48
Iron mg	8.0	4.1	3.9	2.8	9.3	5.0	0.5	3.2	2.3	4.9
Zinc mg	3.1	1.6	2.3	2.4	3.7	3.0	0.7	1.4	2.8	2.2

Thiamin (Vit. B1) mg)	0.33	0.37	0.42	0.59	0.21`	0.33	0.33	0.06	0.42	0.49
Riboflavin Vit. B2 mg	0.25	0.13	0.19	0.11	0.01	0.10	0.09	0.06	0.10	0.17
Folic acid mg	45.5	20	18.3	15.0	9.0	-	23.1	8.0	20	36.6
Fibre g	1.2	1.6	3.6	8.0	7.6	9.8	9.0	0.2	2.7	1.2

Effect of Processing

Milling, roasting, soaking and malting

Milling, roasting, soaking, malting, germination and fermentation have been found to reduce phytic acid and tannin contents of millets.The nutrient content of millet grain is relatively poor after milling but the bioavailability of certain nutrients, such as iron improves considerably.

Milling: Milling to separate the seed coat or decortication reduces protein, dietary fibre, vitamins and mineral contents of the grains to some extent but this is compensated by better consumer acceptability, improved bioavailability of the nutrients and enhanced product making qualities. The bran fraction from pearl millet and some of the small millets is very good source of dietary fibre and edible oil. Hence, it can serve as an extender to the rice bran for oil extraction. The deoiled millet bran may be used as source of dietary fibre in formulating high- fibre foods as it contains negligible or less of silica compared to de-oiled rice bran.

Popping: Popping is one of the traditional and popular dry-heat (high temperature short time – HTST) processing methods followed to prepare ready-to-eat products. Popped grains serve as snacks after seasoning and can be used for preparation sweet meats such as *laddu* or *sattu* and *chikki etc.* Popped grains can be blended with toasted or puffed legumes, oilseeds and jaggery or sugar to prepare delicious and nutritionally balanced convenience supplementary foods. The snacks and supplementary foods from them will be nutritionally superior over similar products from rice and wheat.

Expanded grains: Expanded products which resemble rice *poori* or *murmura* are the new generation snacks from millets. Expanded grains are novel and high value products and can find application as ingredients for snacks and crispy in confectioneries as well as thickener in soup mixes.

Flaking: Cereal flakes are of three kinds in India and their methods of preparation include use of edge runner, roller flaker and extrusion cooker and flaker. The process of flaking gelatinizes the starch and also inactivates the lipase. Hence, the flakes are RTE products. They normally have better shelf-life.

Malting and Brewing: Malting is one of the very early biotechnological processes adopted for cereal processing for food and brewing. Although, barley has the place of pride for malting, sorghum and finger millet malting is also practiced extensively. Finger millet malting is mostly followed in India for specialty food product formulations. Pearl millet has very limited scope for malting as the malt will have poor keeping quality; likewise, other minor millets are at disadvantage because of the low level hydrolytic enzymes in their malts. Malted finger millet being a good source of amylases and micro-nutrients is termed as "Amylase Rich Food" (ARF).

Pasta/Vermicelli/Noodles: Pasta and vermicelli/noodles are generally prepared from wheat because of the beneficial properties of gluten. Hence, the flours or the fine semolina from millets need special pre-treatment to partially gelatinize the starch to extrude into strands. Very often some kinds of functional ingredients such as gums are also used to facilitate binding. However, efforts to prepare noodles from these grains have not been fruitful till date and the composite flour consisting of wheat and millets are used for the purpose. Such products are marketed in Karnataka and Tamil Nadu.

Bakery products: Composite flours consisting of wheat blended with 20 - 30% millets could be used for preparation of such products without affecting the texture and taste. In fact, the products from the composite flour would be nutritionally superior to wheat- based products due to the phytochemical content of millets.

Papad and Such Other Meal Adjuncts: *Papad, sandige*, *murukku, chakkuli* and such other products prepared normally at home or cottage industry level are important adjuncts in the Indian diets. *Papads* from finger millet are popular. Millets flours suitably blended with legumes (moong bean or horse gram) can be sheeted and cut into products of required shape and size, and can be toasted or deep oil fried or blistered in hot air to prepare ready-to-eat multi-grain snack products.

Extrusion Cooking: Extrusion -cooked products being of RTE nature will have greater scope for use as weaning and supplementary foods . With these technologies, it is possible to prepare multigrain snacks or supplementary foods or health bars. Extrusion cooking has very high potential for production of pet foods, the demand for which is expanding in the country.

MILLETS AS FUNCTIONAL FOODS

Millets which are a treasure trove of health-promotive phytochemicals, have invited lot of attention for their potential role as functional foods. Being non-glutinous, millets are safe for people suffering from gluten allergy and celiac disease. They are non-acid forming, and hence easy to digest. They are also non-allergenic. Processing methods like soaking, malting, decortication, and cooking affect anti-oxidant content and activity.

Millet and Diabetes: Millets have been reported to have beneficial effect on diabetes mellitus. The diabetes preventing effect of millets is primarily attributed to high fibre content. The beneficial effect of soluble dietary fibre may be mediated through slower absorption and digestion of carbohydrates. This leads to reduced demand for insulin. Insoluble dietary fibre tends to shorten intestinal transit time, which in turn permits lesser time for carbohydrates to be absorbed. The complex carbohydrates present in millets break down to simple sugars at a slow rate, and get absorbed at a slower rate, allowing slow rise in blood glucose. Some antioxidant phenols in millets also tend to have anti-diabetic effect.

Among minor millets, fox tail and barnyard millet have low glycaemic index -40-50. However systematic studies to examine their glycemic index are needed to establish them as functional foods. Though many consume ragi thinking it is anti-diabetic, evidence is controversial. Depending on the type of preparation the glycaemic index of ragi has varied from 60-65 for ragi roti, idli and dosa to over 90 for ragi dumplings.Gelatinisation increases glycaemic index.(Naik et al, 2013). Malting increases glycaemic index due to break down of starch into sugar and hence ragi malt should not be recommended for diabetics.

Millets and Other Degenerative Diseases: Diets high in fibre and antioxidants have been shown to have beneficial effect on serum lipid profile besides blood sugar. Some forms of cancer are also prevented by high fibre diets. Millets being high in fibre, antioxidants and complex carbohydrates

are potential candidates for having beneficial effects on diseases like CVD, cancer and ageing in general. Few in vitro and animal studies support this view but well controlled studies in human are needed.

In conclusion millets have potential for protection against age- onset degenerative diseases. This is an area where more work is needed since these diseases are increasing in India. As the largest producer of millets, India can capture world market with appropriate, well-tested foods.

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NS 02 HYPOCHOLESTEROLEMIC ACTION OF *LACTIC ACID BACILLUS* IN RATS FED WITH PROBIOTIC MILLET BASED COMPOSITE MIX

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Cholesterol is known to be a major risk factor for coronary heart disease. Current treatments for elevated blood cholesterol include dietary management, regular exercise, drug therapy and bile acid sequestrants. Such therapies, however, are often suboptimal and carry a risk for serious side effects. Lactic acid bacteria with active bile salt hydrolase (BSH) or products containing them are suggested to lower cholesterol levels. This experiment was undertaken to study the hypocholesterolemic effect of a developed probiotic millet based composite mix. The cultures were standardized and dehydrated using lyophilizer. The viable count of the probiotic was 10^8 CFU. Composite food mix had the combination of foxtail millet, cereal, pulse and oil seed. Rats were used as experimental animals, Albino rats of 120 days old were selected for the 6 week study. The control group was provided composite mix without probiotic treatment. Experimental groups contained composite mix and single culture or mixed cultures. The study showed that the effect of *Lactic acid bacillus* used single or mixed with other strains of bacteria in the diet significantly lowered total serum cholesterol, LDL cholesterol, VLDL cholesterol and triglycerides where as HDL cholesterol levels increased. The developed food mix proved to have commercial viability, nutritious and wholesome and has therapeutic application too.

NS 03 FORMULATION AND ANALYSIS OF NUTRIENTS, ANTIOXIDANTS AND PHYTONUTRIENTS IN CENTELLAASIATICA (VALLARAI) AND PANICUM SUMASTRENSE (SAMAI) INCORPORATED EXTRUDED PRODUCTS

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Centellaasiatica, (vallarai) is a small herbaceous annual plant of the family Apiaceae and it is used in ayurvedic medicine for increasing memory power, to treat skin diseases, heal wounds, improve mental clarity and promote longevity and control hypertension. The plant is reported to contain numerous phyto constituents (terpenes, glycosides, saponins, flavanoids, alkaloids, saponins and flavonoids) which are also main constituent of *Centellaasiatica*. The study aimed in the incorporation of *Centella* leaves for the standardization of extruded products because the pasta, noodles, and macaroni are considered to have stimulating effect in our taste buds. The test samples were prepared in the proportion of 60% wheat, 40% samai and 10% *Centellaasiatica* for T1 and 60%wheat, 35% and 15% *Centellaasiatica* for T2. In comparison of flavonoid, T2 contain higher value of flavonoid namely quercetin (20.2+-3.28) than T1 (19.4+_3.25) and control. For antioxidant T2 (4.85+_1.2) was higher than T1 (4.29+-0.87) and control. Four recipes namely vegetable macroni and pasta Payasam were standardized. The organoleptic evaluation of the prepared extruded products T1 got maximum acceptability than T2 in all recipes. The nutrients analysis of *Centellaasiatica* T2 showed that the values for protein was 2g, vitamin C was 11.5 mg, iron was 3.62mg, phosphorus (294.7+_10.6), betacarotene (18.4+-1.72) were higher than T1 and control. The microbial load of macaroni and pasta was minimum at the end of the storage (30 days) in the room temperature.

NS 04 SENSORY ATTRIBUTES OF LOW GLYCEMIC MILLET BASED FUNCTIONAL PASTA

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Pasta is the generic term for any variety of flour based noodles. Extrusion technology, a multi-step, multi-functional and thermal process, is implied in the innovation of functional pasta. The objective of this study was to optimize the formulation process for the millet based functional pasta. The kodo millet (*Paspalum scrobiculatum)* and barnyard millet grains (*Echinochloa frumentacaea)* were utilized for the development of pasta (Noodle, spaghetti and macaroni) and to improve the therapeutic value of pasta, the cassava modified / resistant starch was incorporated as a functional food ingredient. The various formulations of functional flour blend as, refined wheat flour (50%) only and refined wheat flour (50%) + whole wheat flour (10%) and also by replacing the refined wheat flour with whole wheat flour (upto 50%) with combinations of kodo millet / barnyard millet flour and green gram dhal flour at different levels incorporated with cassava modified/resistant starch (from 5% up to 25%) for pasta production were experimented. The pasta products were evaluated for the influence of millet flour on cooking and sensory attributes. Results suggest that, the cooking time for pasta products were found to be 12- 15 minutes. The 25 per cent level of kodo millet / barnyard millet flour and cassava modified / resistant starch incorporation to formulate functional pasta products were found to be acceptable. The overall organoleptic score of developed pasta products without affecting its sensory attributes negatively were for the proportions, whole wheat flour + kodo millet flour/ barnyard millet flour (50:50), whole wheat flour + kodo millet flour/ barnyard millet flour + Cassava modified/resistant Starch (50: 25: 25) and whole wheat flour + kodo millet flour/ barnyard millet flour + cassava modified/resistant Starch +green gram flour (50: 25: 15:10) respectively.

NS 05 **PINNACLES OF PROSO MILLET (*Panicum miliaceum* L.)**

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Proso millet is considered as self-pollinated crop and true millet of history which is well adapted to many soil and climatic conditions. It contains high carotenoid content (366 mcg/100g) when compared to finger, foxtail and little millet. It stands second in the total tocopherol content (3.6mg/100g) next to finger millet. Alpha & gamma isomer of tocotrieonol is high in proso millet. D-galactosomine induced elevation of serum activities of aspartate aminotransferase, alanine aminotransferase and lactate dehydrogenase can be suppressed by proteins of proso millet and acts as a preventive food for liver injury. The grain contains a comparatively high percentage of indigestible fibre because the seeds are enclosed in the hulls which act as a resistant starch. This proso millet when ingested helps in inhibiting the liver microsomal 3-hydroxy-3-methylglutaryl CoA (HMG-CoA) reductase and aids in increasing good cholesterol in our body. Also proso-millet protein concentrate helps in elevating plasma high-density lipoprotein cholesterol (HDL cholesterol) and adiponectin levels and can bring about effective reduction in the levels of glucose and insulin with up-regulated expression of adiponectin and down regulating effect of tumor necrosis factor-α (TNF-α) and abetting type 2 diabetes, obesity, and cardiovascular diseases.

NS 06 EFFECT OF SUPPLEMENTATION OF RAGI MALT AND ITS IMPACT OF NUTRITION EDUCATION AMONG WOMEN (20 – 50YRS) IN MALLAL VILLAGE

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Nutrition education has been one of the effective strategies to alleviate the ignorance and malnutrition in the Society. Low cost supplementary ragi malt was formulated. It contained ragi, milk, groundnut and jaggery. The ragi malt was supplemented to the experimental group for a period of one month. The increments were seen in biochemical parameters before and after supplementation. The mean hemoglobin level of control group reduced to 12.1g/dl from 12.6 g/dl (not signification) while that of the experimental group showed a slight increase from 11.3 g/dl to 11.8 g/dl (not significant). The results showed that the consumption of ragi Malt had beneficial effects on the women and if the same is prolonged, there will be an improvement in their dietary intake. This study was conducted with the objective of creating awareness in women about the existing socio-economic health status and nutrition knowledge. The sets of selected questions were administered to experimental group before and after the exposure to the treatments. The results revealed that the pre-exposure and post exposure knowledge levels of the women respondents for nutrition education programmes were assessed in order to find at the knowledge gain. The data predicts that there was a consequent increase in ragi malt consumption as a result of education. However it had been found that the intake of energy, protein, calcium, vitamin and iron were higher after supplementation. The knowledge had increased 45 percentage after the nutrition education.

NS 07

HEALTH BENEFIT OF SMALL MILLETS

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Small millets are also known as miracle grains because of their high nutritive value. Small millets like finger millet, little millet, proso millet, foxtail millet, kodomillet, barnyard millet etc are cultivated in different parts of India, depending upon the climatic conditions. Around 70 to 80% of energy supplied to the body is from cereals and millets. Since these cereals form a major portion of our daily food, 30% of the protein required for the body is supplied by these cereals. Millets contain more dietary fiber compared to rice and wheat. This enhances slow release of energy, thereby increasing physical efficiency. Millets also contain fat in a considerable quantity which is needed for body. They are a source of 'B' Vitamin and minerals. Compared to rice and wheat, mineral content in millets is higher. While finger millet contains 30 times more calcium than rice and wheat, other millets posses at least 2 time more calcium than rice and wheat. Little millet and foxtail millet have a higher degree of iron.

Millets are also characterized by therapeutic qualities. Millets being non glutaneous so used for people with gluten allergy. The fat content in minor millets not only provides energy but also aids in controlling the cholesterol synthesis in the body. Millet protein contains aminoacids in balanced proportions and is rich in methionine, cysteine and lysine. These are especially beneficial to vegetarians who depend on plant food for their protein nourishment. The grain contains a high proportion of carbohydrates and dietary fiber which help in prevention of constipation, lowering cholesterol and slow release of glucose to the blood stream during digestion. Important vitamins namely thiamine, riboflavin and niacin are present in high quantities. It is reported that cardiovascular diseases, duodenal ulcers and hyperglycemia occur rarely in millet eaters. Awareness created on nutritional importance of small millets leads to the prevention of malnutrition.

NS 08 NUTRITIONAL SIGNIFICANCE AND THERAPEUTIC VALUE OF MILLETS

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Millets are a group of small-seeded species of cereal crops or grains, widely grown around the world for food and fodder in tropical and temperate regions. Millets are important crops in the semi-arid tropics of Asia and Africa (especially in India, Nigeria, and Niger), with 97 per cent of millet production in developing countries. The crop is favored due to its productivity and short growing season under dry, high temperature conditions. Millets, like are predominantly starchy and the protein content is comparable to that of wheat and maize. The protein content in millet is very close to that of wheat; both provide about 11 per cent protein by weight, on a dry matter basis. Pearl and little millet are high in fat, while finger millet contains low fat. Barnyard millet has low carbohydrate content and energy value. Millets are also relatively rich in iron and phosphorus. The bran layers of millets are good sources of B-complex vitamins. However, millets also feature high fiber content and poor digestibility of nutrients, which severely limit their value in nutrition and influence their consumer acceptability. Finger millet has the highest calcium content among all the food grain. Millets are rich in B vitamins (especially niacin, B_6 and folic acid), calcium, iron, potassium, magnesium, and zinc. Millets contain no gluten. Millets have high therapeutic value. They can be used in the management of many life style diseases like diabetes mellitus, cancer and heart diseases. Some millet are also found useful in growth and development, celiac diseases, even some of them have antithyroid and antioxidant properties. Millets have high nutritional value with varied health benefits. Bringing forward these plant foods can be one of the solutions to the problem of food security and malnutrition in the country because they can substitute cereals to a great extent. So along with cereals, millets must also be given importance and appropriate steps should be taken to popularize the growth and use of these plant foods.

NS 09

Use of underutilized millets to reduce Calcium & Iron deficiency among adolescent girls

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The underutilized millets such as Ramdana and Ragi can overcome the problem of food insecurity as well as the deficiency of major minerals in poor sections of the community/ India's population. The objective of this research study is to assess the calcium & iron status among rural girls between the age of 10 to 12 years & 13 to 15 years and suggest ways to improve them with cost optimization. The total 80 subjects were randomly selected and details of their food consumption were collected and analyzed to find out their health condition. The results showed 52.5% deficiency in calcium among girls of 10 to 12 years whereas 67.5% deficiency among girls of 13 to 15 years which was reduced to 45.5% and 59.4% respectively after supplementation of Ramdana and Ragi. At the same time the iron deficiency symptoms were reduced to 10% which is the maximum. The mean body height and weight were increased by 0.83cm and 1.1kg respectively. As Ramdana and Ragi are rich in both calcium and iron, hence the changes were observed in anthropometric and clinical signs together. Thus supplementation of these low cost small millets is found to be most effective in increasing the calcium and iron status of rural adolescent girls of Orissa.

NS 10 STUDY ON CHANGES IN KNOWLEDGE, ATTITUDE AND PRACTICE (KAP) OF THE RURAL WOMEN IN MILLET CONSUMPTION THROUGH NUTRITION EDUCATION

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The study is to assess the knowledge, Attitude and Practice (KAP) of rural women of Peraiyur Taluk, Madurai, Tamil Nadu with respect to small millet. Nutrition education programme specially aimed to improve the knowledge regarding the nutritional significance of the millets, nutrient composition of barnyard millet and kodo millet, health benefits of small millets, product diversification of small millets, general hygiene and sanitation and usage of small millet products as a dietary component was conducted. The feasibility of using millet based products in daily diet and use of millet based instant mixes was also included as a major theme in the nutrition education programme. Hands on training was given on the method of preparation of instant mixes for a period six months. This brought about considerable positive changes in knowledge, attitude and practice of adopting healthy dietary food practice, utilization of millets and improved the food and personal hygiene among the rural women.

NS 11 EVALUATION OF PHYSICO-CHEMICAL CHARACTERISTICS OF BREAD FROM FOXTAIL MILLET

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Small millets are recognized as important substitutes for major cereal crops to cope with worldwide food shortage, to meet the demands of increasing population of both developing and developed countries and to develop low cost nutritious foods to combat malnutrition. Breads were standardized by incorporating foxtail millet flour at 10, 20, 30, 40, 50, 60 and 70 per cent levels. The prepared bread was evaluated for their sensory attributes by a panel members using a hundred point scale. Bread developed from foxtail millet was highly acceptable at 20 per cent level. The bread was analyzed for their physico-chemical properties using standard procedures. Effect of incorporation level of foxtail millet flour in bread characteristics such as height, weight, specific volume, bulk density, water absorption were increased and dough extensibility decreased. As the level of substitution increases, the whiteness index (L*) increased (65.00-66.72) and the yellowness index decreased for the foxtail millet bread. The staleness of bread crumb increased (497.77-1005.15gf) on storage. The texture profiles like springiness, cohesiveness and resilience decreased. The crude fibre content of the foxtail millet bread was 1.53g and it was higher than the control (0.36g) bread. The calcium and iron content of the foxtail millet bread was 22.21 and 2.28mg respectively. The shelf life of the bread was 7 days under ambient condition in different packaging materials (70 gauge polypropylene pack and 100 gauge polypropylene pack) and the microbial population was within the safer limit during the storage period.

NS 12 QUALITY CHARACTERISTICS OF PORRIDGE FROM FOXTAIL MILLET

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Small millets are recognized as important substitutes for major cereal and porridge as a low cost traditional food to meet the various health aspects. Small millet based porridge was standardized by incorporating foxtail millet flour at 50, 75 and 100 per cent levels. The optimized porridge was evaluated for its sensory attributes and was highly acceptable at 100per cent level. The optimized foxtail millet porridge was analyzed for its physico-chemical properties, rheological and cooking characteristics using standard procedures. The water activity of foxtail millet flour was lower (0.44a_w) and sedimentation value (25.50ml) was higher than the control (0.61a_w and 0.21ml). The final viscosity and pasting temperature of foxtail millet porridge was 2024.00cP and 77.30^oC respectively. The gelatinization temperature for foxtail millet was 78^oC and the time taken was 5mins. The protein, fibre, iron and calcium content of foxtail millet was 9.00g, 7.70g, 2.30mg and 28.36mg and per 100g respectively. The microbial load was found to be within the safer limit.

NS 13 Identification of Suitable Finger millet Genotypes for Higher Productivity and Grain Nutritional Traits

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The present study aims to reveal the importance of some quantitative traits and genetic variability existing in the thirty finger millet genotypes constituted of twenty five germplasm accessions and five standard varieties. Highly significant mean sum of squares due to genotypes and wide range of variability were noticed among the genotypes for all the thirteen characters studied. Phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the characters studied. High values for phenotypic and genotypic coefficients were recorded for single plant grain yield and flag leaf blade length, indicating that more variability is present in the genotypes for this characters. All the thirteen characters recorded high heritability in the present study indicated that these characters were relatively less influenced by environmental conditions and phenotypic selection would be effective for the improvement of these characters. High genetic advance as per cent of mean was observed for all characters which indicated that these characters were governed by additive gene action and selection would be effective for improvement of such characters. Grain nutritional quality traits like iron, calcium and zinc content and genetic differences assessed by the breeders were also used as selection tools. Among the thirty genotypes, eight genotypes were selected based on the desirable productivity and quality traits. Generally, the result revealed the existence of variability for the characters studied in finger millet genotypes. Hence, this is a potential character of interest which could be used in the genetic improvement of finger millet through hybridization and/or selection.

NS 14 AUGMENTING NUTRITIONAL STATUS OF SUPPLEMENTARY NUTRITION PROGRAMMES WITH MILLETS- OPPORTUNITIES & ISSUES

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The millets are highly nutritious grains that contains large doze of fiber, vitamins and minerals; the grains have low cholesterol; they are non-acid forming soothing food which are easy to digest. Despite their agronomic and nutritional benefits, the area under millets has drastically come down and some of the traditional millet areas, they were reduced to a few pockets or paved way for the commercial crops. It is an acknowledged fact that the critical developments of the child take place during period of 3 to 6 years of age. The schemes of supplementary feeding and early childhood centers are implemented to enable both physical and intellectual faculties of the children. The nutritive value of the diet provided in the supplementary feeding contributes to nourishment for the healthy growth. Integrated Child Nutrition Services is centrally sponsored scheme which was initiated in 1975 with just 33 blocks is poised for universalization of this programme across India reaching approximately 28.85 million children. This is the world's largest outreach programme. Despite this being implemented for the last 30 years, the child malnutrition in India is more than many of the sub-Saharan African countries.

Currently, rice and wheat based menu are supplied to the children in these centres. In order to ameliorate the nutritional status of the menu served in these centres to tackle the malnutrition, a small pilot has been initiated in Srikakulam district of Andhra Pradesh, where nutritious millets *viz.,* Ragi and foxtail millet, Bajra and Korra are proposed to be served in the diet served in the ICDS centers. Out of the total 26 days of the feeding, 17 days children are served millet based menu and the rest of the 9 days, they are fed with rice & wheat based menu. There is a quantum jump in the nutritional status of the foods served to the children by including millets in their viz., proteins (29%), fibre (169%) calcium (383%), Iron (77%), Magnesium (18%) and Zinc (28%). However there are many operational issues for including the millets in Supplementary Nutrition Programmes such as cost of the millets, processing of millets, shelf life of the millets etc. Locally acceptable recipes also need to be standardized so that children show interest in consuming the millets. Nutritionists need to focus their attention to improve the shelf life of the processed millets, developing locally adaptable recipes, whereas the policy makers need to be sensitive to the local procurement of the millets to reduce the costs of the procurement as well as to encourage the local production. Besides processing is also a grey area which requires focus.

NS 15 EFFECTS OF INCORPORATING MILLET ON THE COOKING CHARACTERISTICS OF NOODLES

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Noodles are one of the convenience foods consumed not only in India but also in many other countries. Millets are rich in certain vitamins and minerals especially calcium, phosphorous and iron. In spite of being nutritionally superior to rice and wheat in many aspects millets such as kodo millet, little millet and foxtail millet remains underutilized and unpopular. In order to exploit commercial uses of these millets, noodles were prepared by incorporating millet flour with refined wheat flour and whole wheat flour (10:90, 20:80, 30:70, 40:60) at different proportions. The cooking characteristics such as optimum cooking time, cooked weight, water absorption, and volume after cooking decreased whereas the total solid losses tend to increases with the increased millet incorporation. Cooking characteristics of noodles indicated that noodles prepared by addition of millet flour up to 30% were as good as those prepared from refined wheat flour and whole wheat flour. Especially in the sensory characteristics the usage of 30% incorporated millet flour noodles give satisfactory results in terms of acceptability.