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Nutritional benefit of small millets: Food security & sustainability in India

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Abstract

The present study was carried out for analyze the properties, nutritional profile, value added products & nutritional of small millet grains. The millet grain contains about 65% carbohydrate, a high proportion of which is in the form of non-starchy polysaccharides and dietary fibre which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to the blood stream during digestion. Lower incidence of cardiovascular diseases, duodenal ulcer and hyperglycemia (diabetes) are reported among regular millet consumers. Millet grains are also rich in important vitamins viz., Thiamine, riboflavin, folic and niacin and are comparable to rice and wheat or even rich in some of the minerals. Millets are most commonly available in the form of pearled and hulled kind. Millets are tasty grains that have a mildly sweet, nut-like flavour. Millets are rich sources of protein, dietary fiber, energy and minerals when compared to rice. These millets have diversified high food value but the consumption of these millets has declined for want of standardized processing techniques to compete with fine cereals. Hence an effort was made to increase the utilization of small millets in popular foods which would find ready acceptability with the tag of 'HEALTH FOODS'.

Keywords: Health benefits, millets, nutritional security, value added products, etc.

Introduction

Small-grained cereal grasses are collectively called as 'Millets', being one of the oldest cultivated foods known to humans. There are two main groups of millets first group consist of major millets (sorghum and pearl millet) and second group has small millets this categorization is based on the grain size, this classification is also an indication of the area under cultivation of these crops, but both (major and small millets) have traditionally been the main components of the food basket of the poor people in India, especially in dry-land farming system in India and elsewhere. Among these small millets are known by different vernacular names in different parts of the country (Table-1). The group of small millets is represented by six different species, namely finger millet (*Eleusine coracana*), little millet (*Panicum sumatrense*), kodo millet (*Paspalum scrobiculatum*), foxtail millet (*Setaria italic*), barnyard millet (*Echinochloa frumentacea*) and proso millet (*Panicum miliaceum*), representing the area grown in that order.

Geographical distribution:

Among small millets, finger millet is the most important crop grown in many states of Southern, Central, Eastern, Western and Northern India from sea level to 8000 feet altitude. The loss of area under finger millet has been less on account of improvement in productivity. On the contrary the area under other small millets has reduced by more than half with proportionate reduction in total production. The productivity remained low and stagnant around 450 kg/ha. Recent and accurate statistics regarding each of the small millets is still lacking by far it is clear that more than 60% of area under small millets is occupied by finger millet, distantly followed by little and kodo millets (just above 10%) and followed by barnyard, foxtail and proso millets.

Though small millets are grown in almost every state of the India, the distribution of individual millet is not uniform. The kodo, little and foxtail millets are grown widely in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Madhya Pradesh and Maharashtra. In Madhya Pradesh, both kodo and little millet are predominant, while foxtail millet is important

in Andhra Pradesh and Karnataka. Barnyard millet and proso millet are grown largely in hills of Uttar Pradesh, North-

Eastern region and plains of North Bihar and Western Uttar Pradesh and Maharashtra.

Table 1: Vernacular names of small millets in different parts of the country

| Language | Small millets | | | | | |
|-----------|---------------------|---------------|----------------|-------------------------|-----------------|--------------------|
| | Finger millet | Little millet | Kodo millet | Foxtail/ Italian millet | Barnyard millet | Proso millet |
| Hindi | Mandua | Kutki | Kodon | Kangni, Kakum | Sanwa, Jhangon | Barre |
| Sanskrit | Nandimukhi, Madhuli | - | Kodara | Kanguni | Shyama | Chiná |
| Kannada | Ragi | Same | Harka | Navane | Oodalu | Baragu |
| Tamil | Kelvaragu | Samai | Varagu | Tenai | Kuthiravaali | Panivaragu |
| Telugu | Ragulu | Samalu | Arikelu, Arika | Korra, Korralu | Udalu, Kodisama | Varigulu, Varagalu |
| Malayalam | Moothari | Chama | Varagu | Thina | - | Panivaragu |
| Marathi | Nachni | Sava | Kodra | Kang, Rala | Shamul | Vari |
| Gujarati | Nagli, Bavto | Gajro, Kuri | Kodra | Kang | Sama | Cheno |
| Bengali | Mandua | Kangani | Kodo | Kaon | Shamula | Cheena |
| Oriya | Mandia | Suan | Kodua | Kanghu, Kora | Khira | Chinna |
| Punjabi | Mandhuka, Mandhal | Swank | Kodra | Kangni | Swank | Cheena |
| Kashmiri | - | Ganuhaar | | Shol | - | Pingu |

Properties and nutritional profile

The small millets are small seeded grains that resemble paddy or rough rice in the morphological features of kernel. The kernel consists of distinct husk, bran and endosperm tissues. Embryo is a distinct tissue, but its proportion in the kernel is around 2%. The husk is non-edible similar to the husk in rough rice or paddy whereas bran may be part of the edible component but is separated to prepare milled millets for food uses. Normally, husk accounts to 15 to 20% of the kernel whereas the bran amount to about 5% and the endosperm to about 75% of the kernel, respectively. These grains are round to oval shaped and their 1000-kernel weight and volume range from 1.9 - 5.5 g and 1.3 - 3.8 ml, respectively. The seed coat and husk of foxtail, little and proso millet are generally of single entity with glossy appearance whereas kodo and barnyard millet contain multiple layered seed coat. Normally the seed coat of kodo millet is of brown colour, foxtail millet is yellowish whereas the other millets are greyish coloured. The husk is non-edible and unusually hard to digest similar to the husk in paddy, whereas the bran is edible. To prepare edible items out of millets, the husk is separated by milling and along with that generally, the bran is also separated similar to milled rice. Hulling does not affect the nutrient value as the germ stays intact through this process.

Small millets are more nutritious compared to fine cereals. Finger millet is the richest source of calcium (300-350 mg/100 g) and other small millets are good source of phosphorous and iron. The protein content ranges from 7 to 12% and fat content from 1 to 5.0% (Table-2). The millet protein has well balanced amino acid profile and good source of methionine, cystine and lycine (Table-3). These essential amino acids are of special benefit to those who depend on plant food for their protein nourishment. The millet grain contains about 65% carbohydrate, a high proportion of which is in the form of non-starchy polysaccharides and dietary fibre which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to the blood stream during digestion. Lower incidence of cardiovascular diseases, duodenal ulcer and hyperglycemia (diabetes) are reported among regular millet consumers. Millet grains are also rich in important vitamins viz., Thiamine, riboflavin, folic and niacin (Table-4) and are comparable to rice and wheat or even rich in some of the minerals (Table-5) as well as fatty acids (Table-6). Millets vary largely in composition of carbohydrates as proportion of amylose and amylopectin content vary from 16-28% and 72-84%, respectively (Table-7).

Table 2: Nutrient composition of millets compared to fine cereals (per 100 g)

| Food grain | Carbo-hydrates (g) | Protein (g) | Fat (g) | Energy (K Cal) | Crude fibre (g) | Mineral matter (g) | Ca (mg) | P (mg) | Fe (mg) |
|--------------------|--------------------|-------------|---------|----------------|-----------------|--------------------|---------|--------|---------|
| Finger millet | 72.0 | 7.3 | 1.3 | 328 | 3.6 | 2.7 | 344 | 283 | 3.9 |
| Kodo millet | 65.9 | 8.3 | 1.4 | 309 | 9.0 | 2.6 | 27 | 188 | 0.5 |
| Proso millet | 70.4 | 12.5 | 1.1 | 341 | 2.2 | 1.9 | 14 | 206 | 0.8 |
| Foxtail millet | 60.9 | 12.3 | 4.3 | 331 | 8.0 | 3.3 | 31 | 290 | 2.8 |
| Little millet | 67.0 | 7.7 | 4.7 | 341 | 7.6 | 1.5 | 17 | 220 | 9.3 |
| Barnyard millet | 65.5 | 6.2 | 2.2 | 307 | 9.8 | 4.4 | 20 | 280 | 5.0 |
| Sorghum | 72.6 | 10.4 | 1.9 | 349 | 1.6 | 1.6 | 25 | 222 | 4.1 |
| Bajra | 67.5 | 11.6 | 5.0 | 361 | 1.2 | 2.3 | 42 | 296 | 8.0 |
| Wheat (whole) | 71.2 | 11.8 | 1.5 | 346 | 1.2 | 1.5 | 41 | 306 | 5.3 |
| Rice (raw, milled) | 78.2 | 6.8 | 0.5 | 345 | 0.2 | 0.6 | 10 | 160 | 0.7 |

(Source: Nutritive value of Indian foods, NIN, 2007).

Table 3: Essential Amino acid profile of Millets (mg/g of N).

| Millet | Arginine | Histidine | Lysine | Tryptophan | Phenyl Alanine | Tyrosine | Methionine | Cystine | Threonine | Leucine | Isoleucine | Valine |
|----------|----------|-----------|--------|------------|----------------|----------|------------|---------|-----------|---------|------------|--------|
| Foxtail | 220 | 130 | 140 | 60 | 420 | - | 180 | 100 | 190 | 1040 | 480 | 430 |
| Proso | 290 | 110 | 190 | 50 | 310 | - | 160 | - | 150 | 760 | 410 | 410 |
| Finger | 300 | 130 | 220 | 100 | 310 | 220 | 210 | 140 | 240 | 690 | 400 | 480 |
| Little | 250 | 120 | 110 | 60 | 330 | - | 180 | 90 | 190 | 760 | 370 | 350 |
| Barnyard | 270 | 120 | 150 | 50 | 430 | - | 180 | 110 | 200 | 650 | 360 | 410 |
| Sorghum | 240 | 160 | 150 | 70 | 300 | 180 | 100 | 90 | 210 | 880 | 270 | 340 |
| Bajra | 300 | 140 | 190 | 110 | 290 | 200 | 150 | 110 | 140 | 750 | 260 | 330 |
| Rice | 480 | 130 | 230 | 80 | 280 | 290 | 150 | 90 | 230 | 500 | 300 | 380 |
| Wheat | 290 | 130 | 170 | 70 | 280 | 180 | 90 | 140 | 180 | 410 | 220 | 280 |

(Source: Nutritive value of Indian foods, NIN, 2007).

Table 4: Vitamin profile of Millets (mg/100g)

| Millet | Thiamin | Niacin | Riboflavin | Vitamin-A (carotene) | Vitamin B-6 | Folic Acid | Vitamin B-5 | Vitamin-E |
|----------|---------|--------|------------|----------------------|-------------|------------|-------------|-----------|
| Foxtail | 0.59 | 3.2 | 0.11 | 32 | - | 15.0 | 0.82 | 31.0 |
| Proso | 0.41 | 4.5 | 0.28 | 0 | - | - | 1.2 | - |
| Finger | 0.42 | 1.1 | 0.19 | 42 | - | 18.3 | - | 22.0 |
| Little | 0.3 | 3.2 | 0.09 | 0 | - | 9.0 | - | - |
| Barnyard | 0.33 | 4.2 | 0.1 | 0 | - | - | - | - |
| Kodo | 0.15 | 2.0 | 0.09 | 0 | - | 23.1 | - | - |
| Sorghum | 0.38 | 4.3 | 0.15 | 47 | 0.21 | 20.0 | 1.25 | 12.0 |
| Bajra | 0.38 | 2.8 | 0.21 | 132 | - | 45.5 | 1.09 | 19.0 |
| Rice | 0.41 | 4.3 | 0.04 | 0 | - | 8.0 | - | - |
| Wheat | 0.41 | 5.1 | 0.1 | 64 | 0.57 | 36.6 | - | - |

(Source: Nutritive value of Indian foods, NIN, 2007; MILLET in your Meals, <http://www.sahajasamrudha.org/>)

Table 5: Micronutrient Profile of Millets (mg/100g)

| Millets | Mg | Na | K | Cu | Mn | Mb | Zn | Cr | Su | Cl |
|----------|-----|------|-----|------|------|-------|-----|-------|-----|----|
| Foxtail | 81 | 4.6 | 250 | 1.40 | 0.60 | 0.070 | 2.4 | 0.030 | 171 | 37 |
| Proso | 153 | 8.2 | 113 | 1.60 | 0.60 | - | 1.4 | 0.020 | 157 | 19 |
| Finger | 137 | 11.0 | 408 | 0.47 | 5.49 | 0.102 | 2.3 | 0.028 | 160 | 44 |
| Little | 133 | 8.1 | 129 | 1.00 | 0.68 | 0.016 | 3.7 | 0.180 | 149 | 13 |
| Barnyard | 82 | - | - | 0.60 | 0.96 | - | 3 | 0.090 | - | - |
| Kodo | 147 | 4.6 | 144 | 1.60 | 1.10 | - | 0.7 | 0.020 | 136 | 11 |
| Sorghum | 171 | 7.3 | 131 | 0.46 | 0.78 | 0.039 | 1.6 | 0.008 | 54 | 44 |
| Bajra | 137 | 10.9 | 307 | 1.06 | 1.15 | 0.069 | 3.1 | 0.023 | 147 | 39 |
| Rice | 90 | - | - | 0.14 | 0.59 | 0.058 | 1.4 | 0.004 | - | - |
| Wheat | 138 | 17.1 | 284 | 0.68 | 2.29 | 0.051 | 2.7 | 0.012 | 128 | 47 |

Source: Nutritive value of Indian foods, NIN, 2007; MILLET in your Meals, <http://www.sahajasamrudha.org/>).

Table 6: Fatty acid composition of millets

| Millet | Palmitic | Palmoleic | Stearic | Oleic | Linoleic | Linolenic |
|---------|----------|-----------|---------|-------|----------|-----------|
| Foxtail | 6.40 | - | 6.30 | 13.0 | 66.50 | - |
| Proso | - | 10.80 | - | 53.80 | 34.90 | - |
| Finger | - | - | - | - | - | - |
| Little | - | - | - | - | - | - |
| Sorghum | 14.0 | - | 2.10 | 31.0 | 49.0 | 2.70 |
| Bajra | 20.85 | - | - | 25.40 | 46.0 | 4.10 |
| Rice | 15.0 | - | 1.90 | 42.50 | 39.10 | 1.10 |
| Wheat | 24.50 | 0.80 | 1.00 | 11.50 | 56.30 | 3.70 |

Source: Nutritive value of Indian foods, NIN, 2007; MILLET in your Meals, <http://www.sahajasamrudha.org/>).

Table 7: Amylose & Amylopectin content of millets.

| Cereal grain | Amylose (%) | Amylopectin (%) |
|------------------|-------------|-----------------|
| Proso millet | 28.2 | 71.8 |
| Foxtail millet | 17.5 | 82.5 |
| Kodo millet | 24.0 | 76.0 |
| Finger millet | 16.0 | 84.0 |
| Sorghum | 24.0 | 76.0 |
| Bajra | 21.1 | 78.9 |
| Short Grain Rice | 12-19 | 88-81 |
| Wheat | 25.0 | 75.0 |

(Source: MILLET in your Meals, <http://www.sahajasamrudha.org/>)

Declining small millet cultivation

Even though millets have extraordinary nutritional qualities of grains and capacities of millet farming systems, the acreage under millet production has been shrinking over the last five decades. The period between 1961 and 2009 witnessed significant decrease in cultivated area under millets, more so in case of small millets (80% for small millets other than finger millet, 46% for finger millet). The area under all small millets other than finger millet has declined drastically in all states and the total production of small millets has declined by 76% and the productivity has remained more or less stagnant in the last two decades.

Small millets and nutritional security

As it becomes clear from the data presented small millets are superior in one or more of the nutritional components compared to most widely consumed cereals, hence contribute towards balanced diet and can ensure nutritional security more easily through regular consumption along with keeping the environment safe as they are low input crops mostly adapted to marginal lands. Declining small millets cultivation has resulted in reduced availability of these nutritious grains to needy population and also the traditional consumers have gradually switched over to more easily available fine cereals due to government policies. This trend is disturbing which needs focus by the agricultural experts and policy makers. Immediate action on policy-guidelines, market support, value addition and promotional activity are necessary for checking the further decline in cultivation and also in consumption, improving productivity and enhancing demand should be the twin approaches that are to be followed simultaneously, which will ultimately help in promoting the production and consumption of millets. Developing health foods with their proper commercialization need special focus to promote the millets among the urban elite, which would lead to reduction in life-style related disorders.

Small millets consist of about a dozen distinct species of small-seeded grasses that are grown for grain, each with their own unique traits and value. The most economically significant of these at present is finger millet, but the other small millets are each in their own way important to the farmers who grow them, and are also potentially important to breeders of other cereals as sources of traits that can improve the resilience and nutritional value of those more widely grown crops. Small millets provide staple food grain for millions of poor smallholders and households in the developing world's harshest, most food insecure regions, such as the Sahel in Africa and in South Asia's semi-arid zone, with feed grain and fodder for the livestock. By default small millets are extraordinarily tolerant to drought and other abiotic stresses, which makes them "climate smart" and a good source for genetic traits that can strengthen the resilience of other crops in the face of climate change. As climate progresses to get hotter and drier, small millets and other dryland cereals will become increasingly well suited for production in areas where other crops are now grown comfortably. Millets in general provide many essential vitamins and micronutrients that can bolster nutrition for those living in dry-land areas, particularly women and children, where small millets are especially rich in iron, zinc and calcium, and have other dietary qualities that can help stave off anemia, celiac disease, and diabetes. The millets with exceptionally high nutritional value – coupled with the impressive hardiness against climate change makes them an important food security crops, for humans as well as for livestock.



Breakfast food

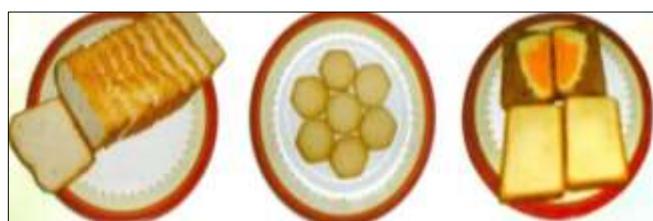
Idli, Dosa, Idiappam, Rotti, Pittu, Upma, Adai, Porridge, Khakra, Paniyaram and Chappathi.

Sweets

Halwa, sweat kolukattai, Adhirasam, Kesari, Nutritious ball and Kheer.

Snacks

Vadai, Pakoda, Ribbon pakoda, Omapodi, Murukku, Thattuvadai, Hotkolukattai and Vadagam.



Bakery products

People of all ages are affectionate of different bakery products, because of their taste, colour and easy to digest

Value added products from small millets

Millets are one of the oldest food grains known to mankind and possibly the first cereal grain used for domestic purposes. For centuries, millets have been a prized crop in India and are staple diet for nearly 1/3rd of the world's population. They can adapt themselves to marginal soils and varied environmental conditions. Small millets are more than just finger millet (*Eleusine coracana*) and include kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum sumatrense*), foxtail millet (*Setaria italica*), proso millet (*Panicum miliaceum*) and barnyard millet (*Echinochloa frumentaceae*). Millets are most commonly available in the form of pearled and hulled kind. Millets are tasty grains that have a mildly sweet, nut-like flavour. Millets are rich sources of protein, dietary fiber, energy and minerals when compared to rice. These millets have diversified high food value but the consumption of these millets has declined for want of standardized processing techniques to compete with fine cereals. Hence an effort was made to increase the utilization of small millets in popular foods which would find ready acceptability with the tag of 'HEALTH FOODS'. Small millet based value added products including traditional recipes, bakery products, pasta products, flaked and popped products instant food mixes were developed and standardized. The products which are commonly prepared by the farmers using cereals were replaced with small millets to increase their utilization.

Traditional recipe

nature. Celebrating any moment of happiness is incomplete with bakery products. Bakery products are becoming prominent day by day. Nowadays individuals have virtually no time to invest much on making breakfast it is the bread and bun or biscuits which had occurred instead of other sorts of stuff. They are good supply of snacks and therefore are broadly available. Small millets were incorporated in different variations from 10% to 50% levels to standardize bread (20%), cake (30%), cookies (50%), soup sticks (20%) and khari (40%) replacing refined wheat flour.

Pasta Products



Pasta meals like vermicelli, noodles, macaroni etc., are commonly liked by children of today's generation and by

other age groups for their taste, inexpensive and easy method of preparation. Pasta is a perfect foundation for healthy, nutritious and satisfying meals, generally eaten with nutrient-dense food partners, such as fiber-filled vegetables and beans, heart healthy fish and monounsaturated oils, antioxidant-rich tomato sauce and protein-packed cheeses, egg, poultry and lean meats. For small millets to be competitive with important cereal foods, preprocessed or alternative millet based foods are required. Vermicelli, noodles Macaroni were prepared from refined wheat flour and blending with small millets at 30% incorporation levels.



Flaked and Popped products

Popped Flaked

Cereal popped products and flakes are popular breakfast foods and at present they are mostly made from corn. By suitable processing it might be feasible to produce popped foods and flakes from millets. These Ready-To-Eat products are very popular, being crisp and friable in texture. The relatively smaller size and quick hydration of millets make them most suitable for the production of flakes and popped products. Small millets were flaked and popped and a variety of recipes were standardized.

Value added products from popped small millets

upma, bhelpoori, masala corn, cheeian.



Instant Food Mixes

In the modern days where the life is at fast pace with the time very valuable to every person, "Instant Foods" play an important role in everyone's day-to-day life. The very term 'instant food' means simple, fast and convenient food which is easy and fast to prepare besides being hygienic, free from microbial contamination and also convenient to eat. Unlike olden days where man used to have his food lavishly and slowly, the present trend changed the habits to foods which are simple and easy to digest. Hence, the existence of these foods fulfilled all the needs of modern human being. Traditional south Indian breakfast foods viz., adai, pittu, idiyapam, kali, roti, and kesari were selected. Instant mixes of these traditional products with the incorporation of small millets were standardized.

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