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Nutri-cereals: The wonder crops

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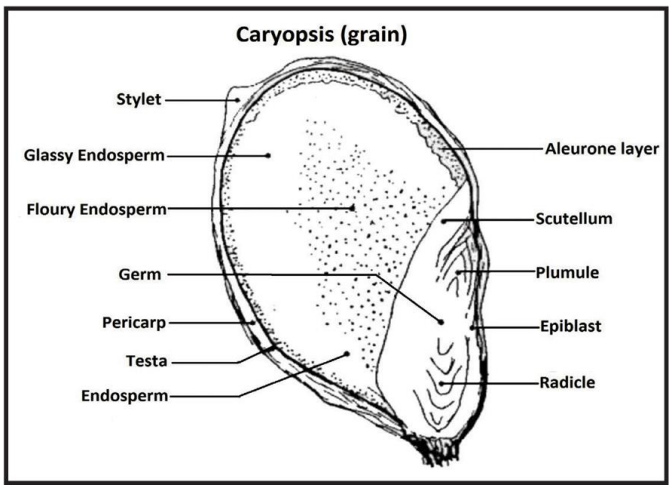
Abstract
India is the leading country in the production of millets which are often referred to as coarse cereals. Important millets grown in India are finger millet, pearl millet, sorghum, barnyard millet, foxtail millet, kodo millet, proso millet and little millet. After realizing the nutritional composition and their beneficial effects on the human health, these millets are popularly known as Nutri-cereals or Nutrition rich grains. These millets are highly nutritious and composed of vital minerals and vitamins, like vitamin B, potassium, calcium, zinc, iron and magnesium. Millets are also gluten-free and have a low Glycemic index (GI), which are best suitable for diabetic patients. These nutri-cereals are an excellent source of starch, protein and fibre.

Keywords: Nutri-cereals, wonder crops, millets

Introduction
Minor millet crops are called nutricereal which are small seeded annual grass includes like finger millet (*Eleusine coracana* (L.) Gaertn), Barnyard millet (*Echinochloa frumentaceae* L.), Little millet (*Panicum sumatrense*), Foxtail millet (*Setaria italika* L. P. Beauvois), Proso millet (*Panicum miliaceum* L.) and Kodo millet (*Paspalum scrobiculatum*). Some other crops are Pearl millet (*Pennisetum glaucum* (L. R.Br.), Bahiagrass (*Paspalum notatum* Flugge), Guinea grass (*Panicum maximum* Jacq.) and Elephant grass (*Pennisetum purpurium* Schumach). In the different part of world the millets known by different names as finger millet (Mandua, Ragi), barnyard millet (Sanwa, Jhangora), foxtail millet (Koni, kakum), proso millet (Cheena), little millet (samai, gindi, mutaki, kutki), kodo millet (khoddi, arugu, varagu, Kodon), pearl millet (Bajra) amd sorghum (Jowar).

However, in spite of a rich inter/intra-species diversity and wider climatic adaptability cultivation of diverse millet species/varieties is gradually narrowing in the recent past. In a way, a lack of institutional support for millet crops in contrast to the institutional promotion of rice and wheat continue to shrink the millet-growing region. In spite of this, several communities in the dry/rain fed regions having known the food qualities of millets over generations continue to include a range of millets in the traditional cropping patterns, which recognize millet as an essential part of the millet diet.



Caryopsis (Grain)

Vernacular Names of Millets

English	Sorghum	Pearl Millet	Finger millet	Little millet	Kodo millet	Foxtail/ Italian millet	Barnyard millet	Proso millet
Hindi	Jowar	Bajra	Mandua	Kutki	Kodon	Kangni, Kakum	Sanwa, Jhangon	Barre
Sanskrit	-	-	Nandimukhi, Madhuli	-	Kodara	Kanguni	Shyama	Chiná
Kannada	Jola	Sajjai	Ragi	Same	Harka	Navane	Oodalu	Baragu
Tamil	Cholam	Kamboo	Kelvaragu	Samai	Varagu	Tenai	Kuthiravaali	Panivaragu
Telugu	Jonna	Sajjalu	Ragulu	Samalu	Arikelu, Arika	Korra, Korralu	Udalu, Kodisama	Varigulu, Varagalu
Malayalam	Cholam	Kamboo	Moothari	Chama	Varagu	Thina	-	Panivaragu
Marathi	Jcwari	Bajri	Nachni	Sava	Kodra	Kang, Rala	Shamul	Vari
Gujarati	Juar	Bajri	Nagli, Bavto	Gajro, Kuri	Kodra	Kang	Sama	Cheno
Bengali	Juar	Bajra	Mandua	Kangani	Kodo	Kaon	Shamula	Cheena
Punjabi	-	Bajra	Mandhuka, Mandhal	Swank	Kodra	Kangni	Swank	Cheena

Nutritional Characteristics

Carbohydrates

The carbohydrate content in sorghum is composed of starch, soluble sugar and fiber (pentasons, cellulose and hemicellulose). Millet carbohydrates classified into non-structural (sugars, starch and fructosans) and structural (cellulose, hemicelluloses and pectin substances) carbohydrates The chief non-structural carbohydrate (NSC) is starch. In normal sorghum it is mainly composed of amylopectin. The most common mutants contain waxy (only amylopectin) and high amylose starch (Boyer *et al*., 1983) [1]. Colour of sorghum starches is related to intensity of the pigments in the pericarp and in the leaves of the sorghum plant (Freeman & Watson, 1971; Subramanian *et al*., 1994) [4, 11]. Starch is the most abundant component while soluble sugars are low.

Starch

From one half to three-fourths of the grain weight is starch. Starches exist in a highly organized manner in which amylase and amylopectin molecules are held together by hydrogen bonds and arranged radically in spherical granules. Starch is the main source of energy utilized during germination. It is composed of linear chains of glucose joined by α-1, 4-glycosidic bonds called amylopectin. Amylopectin is a much larger, branched polymer. The pigments of millet grain pericarp sometimes discolour the starch, yielding a light pink colour, green and yellow colours.

Soluble Sugars

The soluble sugar content of caryopses changes during development and is maximum, 5.2% (Murthy *et al*., 1985) [12]. At maturity the average soluble sugar content was 1.3% (0.8-4.2%), with sucrose being 75% of the sugars (Jambunathan *et al*., 1984) [7]. Mature caryopses contain 2.2 to 3.8% soluble sugars, 0.9 to 2.5% free reducing sugars and 1.3 to 1.4% non reducing sugars. Glucose and fructose ranged from 0.6 to 1.8% and 0.3 to 0.7% respectively. High lysine and sugary cultivars of millets contain more soluble sugars.

Carbohydrate Digestibility

For nutritional purposes, starch is generally classified into rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS), depending on the rate and extent of digestion. Nutritional properties of SDS are very important for the treatment and prevention of various diseases. Elevated plasma glucose and insulin levels after a glucose load are associated with noninsulin dependent diabetes and cardiovascular diseases. Prolonged digestion and absorption of carbohydrates are favourable not only for the dietary management of metabolic disorders such as diabetes and hyperlipidemia but for healthy subjects due to positive effects on a number of physiological factors. Therefore, much attention is being given to SDS as a new functional material.

Dietary Fiber

The dietary fibre contents of several Indian foods have been determined. Dietary fibre components exert their beneficial effects mostly by way of their swelling properties, and by increasing transit time in the small intestine

Health Benefits

Research evidence suggests that whole grains and cereal fiber consumption are inversely associated with waist circumference, total cholesterol, metabolic syndrome, mortality from cardiovascular diseases, insulin resistance, and incidence of type 2 diabetes. Besides nutrients, millet grains have an abundance of phytochemicals, particularly phenolic compounds. Several potential health benefits of millets have been reported like preventing cancer and cardiovascular diseases, lowering blood pressure have been attributed to these phenolics. Phenolic compounds are one of the most important groups of secondary metabolites in millets having antinutrient properties. However, these compounds act as antioxidants, reducing agents, singlet oxygen quenchers, metal chelators and inhibitors of digestive and regulatory enzymes, thus promoting human health through a variety of different mechanisms. In addition to antioxidant properties, polyphenols of millets, particularly finger millet, possess some other important health benefits such as antimicrobial, anti-inflammatory, antiviral anticancer, antiplatelet aggregation and inhibitory activities on cataract formation. Millets Acceptability There are limited areas to grow the millets in India. Most of the farmers do not want to grow the millets particularly in hilly areas because of the loss of the produce by the different wild animals like wild boars, rabbits, monkeys etc. Farmers can rescue the crops at day time from the birds but at night the crop completely devastated by the wild animals. Further, farmers are facing difficulty in marketing of the produce. Yield of these nutria-cereals is very low as compared to other cereals like rice and wheat. Therefore, farmers should have some improved varieties or hybrids for higher yield as well as quality. There are some improved varieties or hybrids have been developed and used by farmers in different parts of India.

Some of the points need to be addressed for higher production and increasing the area of millets are as follows:

- Development of improved varieties or hybrids

- Value addition of the millets products
- Marketing facility improvement
- Awareness regarding to millet crops to the farmers Quality improvement of the millets
- Biotechnological intervention in millets improvement

Table 1: Some of the improved varieties or hybrids of millets

Crop	Varieties name
Finger millet	VL 379, VL Mandua 376 (VL 376),VL Mandua 352 (VL 352), VL 348,VL 324, VL 315, VL 149, VL 146,PES 400, PRM 1, PRM 2, CO 13,CO 12, CO 9, VR 847, PR 202, VR 708, VR 762, VR 900, VR 936, Vakula (PPR2700), OEB 10, OUAT 2, BM 9-1, OEB 526, OEB532,Chhattisgarh Ragi-2 (BR-36), Phule Nachani 1 (KOPN 235), KOPLM83, Dapoli 1, Dapoli 2, GNN7,GNN 6, GN 5, GN 4, GPU 28, PR 202 *etc*.
Barnyard millet	VL 172, VL 207, PRJ 1, VL 29, PRS 1, DHBM93-3, Anurag, DHBM 93-3, Kanchan, MDU-1, DHBM93-3, DHBM23-3, CO 1, CO 2, VL 181, VL 29, DHB 93-2, DHBM23-3, Gujarat Banti1, VL Madira 181
Foxtail millet	PRK 1, PS 4, SiA 3088, Sreelaxmi, Narasimharaya, SiA 326, S-114, PRK 1, Sreelaxmi, SiA 326, SiA 3156, SiA 3085, RAU-2, SiA 3088,SiA 3156, SiA 3085, Prathap Kangani-1 (SR 51), SR 11, SR 16(Meera), Lepakshi, Narasimharaya, Krishnadevaraya *etc.*
Kodo millet	JK 439, JK 137, JK 106, JK98, JK 65, JK 48, JK 13, RBK 155, RK 390-25, GPUK 3, DSP9-1, TNAU86, KMV 20 (Bamban), CO 3, TNAU 86, GPUK 3, RK 390-25,GK 2, GK 1, GPUK 3, Chhattisgarh Kodo-2, Jawahar Kodo137 RBK 155,Indira Kodo 48, Indira Kodo1, JK 439, JK98, JK 65, Chhattisgarh-2, RK 390-25 *etc*.
Little millet	Chhattisgarh Kutki 1 (BL-6), OLM 203, OLM 208, OLM217, DHLM36-3, DHLM14-1, Jawahar Kutki 4 (JK 4), JK 8, JK 36, JK137,Paiyur 2, TNAU 63, CO 3, CO4,K1, GV 2, GV 1 Phule Ekadashi (KOPLM 83) *etc*.
Proso millet	PRC 1, TNAU 145, TNAU 164,TNAU 151, ATL 1 (TNPm 230),Co5, TNAU 145, TNAU 202, CO 4,K2, CO 3,CO 2, GPUP 21, GPUP 8,ATL 1 (TNPm 230), DHPM-2769,GPUP8,GPUP 21,Sagar, Nagarjuna, CO 4, CO 3, TNPm230, Bhawna *etc*.
Pearl millet	MP 535 (Pusa Composite 701) MP7872, MP 7792, KBH 108, GHB905, 86M89, MPMH 17, Kaveri Super Boss, Bio 448, 86M86, 86M66, RHB-173, HHB 299 (MH2076), AHB 1200, CO 10, Co 9,HHB 234, Bio 70, HHB-226, RHB-177, RHB 223 (MH 1998), HHB 299 (MH 2076), AHB 1200, MP 535 (Pusa Composite 701) MP 7872, MP 7792, HHB 272 (MH1837), HHB 67, MPMH21, MPMH 17, KBH 108, GHB 905, 86M89 *etc*.
Sorghum (*Kharif*)	**Hybrids:** CSH 27, CSH 25, CSH23, CSH 18, CSH 16, CSH 14, CSH41, CSH 35, SPH 1635, SPH 1641*etc.*
	Varieties: CSV39, CSV36, Palamuru jonna (CSV31), CSV 23, CSV 20, CSV 17, CSV 15, PDKV Kalyani (AKSV -181), GJ42 (SR-666-1), Raj Vijay Jowar 1862 (RVJ 1862) *etc.*
Sorghum (*Rabi*)	**Hybrids:** CSH 39R, CSH 19R, CSH15R *etc.*
	Varieties: Phule Rohini (RPASV3), Phule Suchitra (RSV 1098), CSV 216R, CSV 29R, CSV 22R, CSV18R, Parbhani Super Moti, PKV Kranti, Phule Vasudha, CSV 26R, Phule Anuradha, Phule Chitra, CSV 29R, CSV 26R, CSV 22R, CSV18R, BJV 44 (SPV 2034), SPV-2217, CSV 29R, CSV 22R, DSV5*etc.*
Forage sorghum	**Single cut varieties:** HC 308, PCH 106, Pant Chari 5, CSV 30F, CSV21F, JJ 20, JS 263, JS 29-1, HJ 513, HJ 541, Pant Chari 7, K1, K7, CSV 32F, Pratap Chari 1080, Ruchira, CSV 32F, GFSH 1, GFS 5 *etc.*
	Multi-cut varieties: CSV 33MF, SSG 59-3, Pusa Chari 6, Pusa Chari 23, SL 44, CoFS 29, CSV 33MF,Pant Chari 6 Pant Chari 8, CSV 33MF
	Multi-cut hybrids: CSH 20MF, CSH 24MF, Punjab Sudex Chari 1, Punjab Sudex Chari 4 *etc.*
Sweet sorghum	SSV 84, CSV 19SS, CSH 22SS, CSV 24SS *etc.*

Source: Chapke *et al.*, 2020 [3]

Conclusion

Nutri-cereals have tremendous potential to eradicate the malnutrition from India. It is the need of the hour to promote and popularize the importance of these nutrient rich millets. Further, create awareness among people to adopt and consume these nutri-cereals for the better health benefits. Increase in production and consumption of these nutri-cereals or wonder crops help India free from malnutrition.

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