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Quality parameters and medicinal uses of foxtail millet (*Setaria italica* L.): A review

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Abstract

Millets are a traditional staple food of the dry land regions of the world. They are nutri-cereals which are highly nutritious and are known to have high nutrient content, including protein, essential fatty acids, dietary fibre, B-Vitamins, minerals such as calcium, iron, zinc, potassium and magnesium. Foxtail millet (*Setaria italica* L.) is one of the earliest cultivated crops, extensively grown in the arid and semi-arid regions of Asia and Africa, as well as in some other economically developed countries of the world. It has strong adaptability to abiotic stresses, especially drought, and poor soil. It also has high nutritional value. Foxtail millet is rich in essential amino acids, fatty acids and minerals, and is considered to be one of the most digestible and non-allergenic grains available and has significant importance for human health. The millet is also reported to possess hypolipidemic, and antioxidant characteristics. It is suitable for individuals suffering from diabetes mellitus due to its low glycemic index. Foxtail millet has potential to adapt in abiotic stresses associated with climate change, it is more important than ever to develop breeding strategies that facilitate the increasing demand for high quality grain that better satisfies consumers. It is a cereal suitable to address food and nutrition security due to its yielding potential in drought and poor-resource environments, and also due to its ability to produce food products with significant health-benefitting properties.

Keywords: Nutri-cereals, bio-active, glycemic index, abiotic stress, tannins

Introduction

Foxtail millet is one of the easily cultivated cereal grains crop. It belongs to the *Setaria* genus of Poaceae family and subfamily Panicoideae. It is one of the world's oldest cultivated crops. It is known by its local names in different states of India as Kangni (Hindi), Navane (Kannada), Thinai (Tamil), Kang (Gujarati) and Rala (Marathi). It is a minor but important crop in many areas of the world, particularly in northern China. Nowadays, it is mainly cultivated in China and India. In India, it is mainly cultivated in Haryana, Gujrat, Maharashtra, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, Rajasthan, Karnataka, Madhya Pradesh and Uttarakhand^[1]. In its long history of cultivation, it has been adapted to arid and semi-arid areas of Asia, North Africa, South and North America. Foxtail millet has one of the largest collections of cultivated as well as wild-type germplasm rich with phenotypic variations and hence provides prospects for association mapping and allele-mining of elite and novel variants to be incorporated in crop improvement programmes^[2].

Plant morphology

It is an annual grass with slim, vertical, leafy stems can grow to a height of 4 feet to 6.5 feet. Its glumes can be white, red, black, brown, or yellow. It is a warm season crop and can be grown in arid and semi-arid reason of the country. This crop can be harvested for green fodder or hay after 70 – 75 days of showing depending on the variety. It is self pollinated and will produce seeds in 85 - 95 days in case of grain seed production. It has strong adaptability to abiotic stresses, especially drought, and poor soil. Foxtail millet have seeds showing different colors, such as white, yellow, orange, brown, red, black and gray^[3].

Nutritional value and medicinal uses

Foxtail millet has high nutritional value. It has many amino acids present in it. Eight of the essential amino acids (isoleucine, leucine, lysine, methionine, phenylalanine, threonine, valine and tryptophan) are also present in foxtail millet, with the content of lysine varying the most, followed by methionine and valine^[4]. Fatty acids and minerals are also present in good amount. Linoleic, oleic and linolenic acids are the main unsaturated fatty acids present while palmitic and stearic acids are the main saturated fatty acids present in it. It is considered to be

one of the most digestible and non-allergenic grains available and has significant importance for human health. Foxtail grain contains 10-12% protein, 4.7-6.6% fat, 60.6–64.5% carbohydrates and 2.29 - 2.7% lysine. Carbohydrate content accounts for 75% of foxtail millet nutritional components by weight. It consists of reducing sugar, starch, cellulose and other minor components, with starch as the main form of carbohydrate. In the bran of foxtail millet, the content of linoleic acid accounts for as high as 67% of total oils [5]. The yellow pigments in millet are mainly zeaxanthin, cryptoxanthin and xanthophyl. These pigments show high thermostability and resistance to oxidoreduction, but are sensitive to light and acids. The content of yellow pigment is 5.4–19.6 mg/kg. A recent study, investigated the natural antioxidants in edible flours of small millets. Total carotenoids content varied from 78 - 366 µg/100 g in the millet varieties with an average of 199±77, 78±19, 173±25, and 366±104 µg/100 g in finger, little, foxtail, and proso millets, respectively. Higher proportion of γ - and α -tocopherols helps in reducing inflammation. However, it showed lower levels of tocotrienols in the millets. Total tocopherol content in finger and proso millet varieties were higher (3.6–4.0 mg/100 g) than in foxtail and little millet

varieties (~1.3 mg/100 g). Total antioxidant capacity in finger, little, foxtail, and proso millets were 15.3±3.5, 4.7±1.8, 5.0±0.09, and 5.1±1.0 mM TE/g, respectively. It is possible that edible flours of small millets are good sources of endogenous antioxidants. It is suitable for individuals suffering from diabetes mellitus due to its low glycemic index [6]. It is also rich in vitamins, including vitamin A, B₁, B₂ and E. It has vitamin A (1.9 mgkg⁻¹) [7] and vitamin E (43.5 mgkg⁻¹), which is higher than that of rice, wheat and maize. Foxtail millet is also rich in carotene, the precursor of vitamin A, with 1.2 mgkg⁻¹, twice as found in maize [8]. Vitamin B₁ content (5.7 mgkg⁻¹) is approximately 1.7 times as in rice and maize, Vitamin B₂ content (1.2 mgkg⁻¹) is somewhat lower than in sorghum. Recently, a survey of the folic acid content in millets of 247 cultivars and landraces from three different ecological regions have an average content of folic acid ie. 1.5 mgkg⁻¹, fluctuating between 0.37 and 2.37 mgkg⁻¹ [9].

Anti-nutrients such as phytic acid and tannin present in this millet can be reduced to negligible levels by using suitable processing methods. Table-1, given below shows a comparative analysis of nutrient value of foxtail millet with respect to other millets and major edible food sources.

Table 1: Nutrient content of different millets and cereals per 100 grams [10]

Food grain	Protein (g)	Fat (g)	Crude fiber (g)	Minerals		Sulfur containing amino acids		Unsaturated fatty acids		
				Ca(mg)	Fe(mg)	Methionine	Cysteine	Oleic	Linoleic	Linolenic
Finger millet	7.3	1.3	3.6	344	3.9	210	140	-	-	-
Kodo millet	8.3	1.4	9.0	27	0.5	-	-	-	-	-
Proso millet	12.6	1.1	2.2	14	0.8	160	-	53.80	34.90	-
Foxtail millet	12.3	4.3	8.0	31	2.8	180	100	13.0	66.50	-
Little millet	7.7	4.7	7.6	17	9.3	180	90	-	-	-
Barnyard millet	6.2	2.2	9.8	20	5.0	180	110	-	-	-
Sorghum	10.4	1.9	1.6	25	4.1	100	90	31.0	49.0	2.70
Bajra	11.6	5.0	1.2	42	8.0	150	110	25.40	46.0	4.10
Wheat (whole)	11.8	1.5	1.2	41	5.3	90	140	11.50	56.30	3.70
Rice (raw milled)	6.8	0.5	0.2	10	0.7	150	90	42.50	39.10	1.10

It helps to improve the appetite. It is a good Astringent. This is due to the high amount of tannins present in it. It is Diuretic as it helps to improve the action of the gall bladder. This is one of the best health benefits of foxtail millet. It is an emollient, it makes the skin soft [11]. It can control blood sugar level and cholesterol. It contains a good amount of resistant starch and high antioxidant level, which has the power to reduce inflammation, potentially promoting anti-cancer, anti-aging and other benefits. It is naturally gluten free hence improves the overall digestive health.

Conclusion

Foxtail millet is widely recognized for its adaptive potential and high nutritional value, the versatility and importance as a food source, which has pertinent levels of all the nutritional components required. It is a cereal suitable to address food

and nutrition security due to its yielding potential in drought and poor environments. It has ability to produce food products with significant health-benefitting properties. In recent years, the focus became on research regarding millet quality, through breeding programme of cereals. Till today, germplasm resources of good quality foxtail millet are limited, and this narrow genetic diversity strongly restricts breakthroughs in quality breeding. There are scare reports on nutrient composition of foxtail millet. However, more comprehensive analysis is required, particularly for the effects of growing conditions and agronomic methods on nutrients quality. It is required to develop new superior quality foxtail millet varieties with high yield potential, stress resistance and stable, and, so as to stabilize millet production and promote millet industry development.

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