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Finger millet a boon to food security under changing climatic condition

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Abstract

Changing climatic condition is the major threat to crop growth and productivity now a days due to different abiotic and biotic stresses. This needs the development in the management practices and varietal improvement to fight against different stress. Now a days most of the developmental works in agriculture are concentrated on the staple food crops and the millet like finger millet (*Eleusine coracana L.*) is treated as neglected crops though it is an important food crop in several semiarid and tropical regions of the world. The millets are having excellent nutraceutical values along with resilience towards adverse climatic conditions, which may help to maintain the food security and achieve the nutritional security in present era. This review is highlights on the nutraceutical importance, climate resilience and role in achieving food security under the condition of climate change.

Keywords: crop growth, productivity, nutraceutical, climate resilience, food security

Introduction

Due to the changing climatic conditions like global warming, uneven distribution of rainfall affects the agricultural production system seriously. Increasing global population combined with climate change also adversely affecting the agriculture by giving stress to produce more food from less land. The foreseen increment in temperature will influence most of the parts of the hot tropics, primarily populated by creating nations as they are probably going to endure greatest misfortune in the production of food (Cline, 2007). It has been foreseen that environmental change may seriously affect food production and food security in a many dry season inclined regions over the globe (FAO, 2005). The water scarcity is leading to reduce the dietary range and decrease in total food consumption that may lead to malnutrition and food insecurity (IPCC, 2007). Regardless of the calories consumption of a person, there may be chances of deficiency in micronutrients, vitamins and minerals leading to nutritional insecurity. Incidences of biotic stresses like diseases and pests are also expected to be greatly affected by the altering temperatures (Stireman *et al.*, 2005).

Wholesome prosperity is a maintainable power for wellbeing and improvement and augmentation of human hereditary potential. The dietary status of a community has in this manner been perceived as a significant marker of national turn of events. It can also be called as malnutrition is a main huddle in the way of development of the nation proving itself as a national problem. The solution to this problem is consideration of food security along with prevention of hidden hunger during the policy planning. It needs crop diversification with increased yield, both at individual and national level but for improving the household food security climate and area compatible traditional food crops should be grown (Singh & Raghuvanshi, 2012).

Aside from the brilliant nutraceutical estimation of finger millet, its capacity to endure different abiotic stresses and oppose pathogens make it a superb model for investigating immense hereditary and genomic capability of this harvest, which give us a wide decision to creating techniques for making atmosphere flexible staple yields (S. M. Gupta *et al.*, 2017)

Therefore, now a day the development of improved varieties with nutraceutical value and stress tolerance has been of more priority areas of research. Modern crop improvement techniques like genetic engineering and genomics-assisted breeding play important role in developing stress tolerance varieties along with different agronomic management provide measures for enhanced crop productivity. Identifying and improving native crops is very

important in present scenario because they are highly adaptive to local climate with higher nutritional value and can efficiently manage biotic and/or abiotic stresses. A single staple food crop cannot fulfill all the major criteria, the wide variety and diversity of local food crops (like minor millets) can be a choice of such climate resilient crops (Shukla *et al.*, 2015).

Finger millet:

Most world population depends upon cereals like wheat, rice and maize as their staple food, whereas millets have largely been neglected, mostly after the occurrence of green revolution. Millets represent a diverse group of small-seeded grasses grown for food, feed or forage (Lata, 2015). Millets also called as coarse cereals are a type of small edible grasses belonging to the gramineae family. These are of 10 genera and 20 species in all (Lupien, 1990). Millet is a collective term denoting to a variety of small seeded annual grasses, those are cultivated as grain crops in dry areas of tropical, subtropical and temperate regions mainly in the marginal lands (Baker, 2003). The most commonly cultivated millets are: Proso millet (*Panicum miliaceum*), Foxtail millet (*Setaria italica*), Japanese barnyard millet (*Echinochloa frumentacea*), Finger millet (*Eleusine coracana*) and Kodo millet (*Paspalum scrobiculatum*) and little millet (*Panicum sumatrense*).

Millets are very important plant genetic resources for agriculture sector that extends food security to poor farmers having arid, infertile, marginal and poor lands especially in Asia and Africa. The early maturity and multi-season growth characteristics make them suitable for more intensive cropping systems and they could be grown as a catch or relay crop in combination with other crops having late maturity. Regardless of the fact that they are used as staple food of millions of people residing in the semi-arid and arid regions of the world, millets are also called as "Orphan Crops," or even "Lost Crops." These crops are not actually lost but it indicates their cultivation by the developed countries and also their world production statistics indicate its low adaptation as compared to the other more popular food crops. However, these ignored crops are important by virtue of their role in biodiversity and the means of livelihood of the poor in various parts of the world (Belton & Taylor, 2004).

Finger millet (*Eleusine coracana*) is a grass crop grown in Africa, India, Nepal and many countries of Asia. The plant and grain is resistant to drought, pests, and pathogens. It is rich in polyphenols and particularly in calcium. The double headed trypsin, α -amylase inhibitor from this grain has been isolated and characterized extensively (Chandrashekar, 2010).

Nutraceutical importance of finger millet:

The genus *Eleusine* is derived from the name of Greek goddess of cereals, "Eleusine" while the common name finger millet comes from the "finger-like" branching of the panicle of the crop. It may be one of the oldest indigenous domesticated cereal in tropical regions of Africa. It is a highly productive crop that can tolerate many types of stressful environmental conditions, and is also organic by default. It can be cultivated on marginal and less fertile soils and is independent of the use of chemical fertilizers, hence, is a boon for the vast arid and semi-arid regions (Gull *et al.*, 2014). The different species of finger millet have genes for early maturity, vigorous growth, increased size and number of panicles and branching as well as high-density grains. Some of the species have higher water use efficiency with higher carbon dioxide fixation rates with minimal leaf area and hence could perform

excellent in semi-arid climates. It is one of the most efficient utilizer of nitrogen (S. Gupta *et al.*, 2014). Finger millet seeds are resistant to storage pests for as long as 10 years, that ensures year round food supply or even during a crop failure, that's why it is also called as 'famine crop' (Mgonja *et al.*, 2007).

Finger millet is a vital component in the diets during pregnancy and lactating stage of women, and children as well as for the economy of marginal farmers. It is relatively rich in protein, vitamins, minerals, fibre content and energy than other cereals (Vadivoo *et al.*, 1998). Few varieties of finger millet are found to contain about 450 mg of Calcium per 100g of grains (N. Gupta *et al.*, 2011). It also contains higher amount of manganese, phosphorus, iron, copper, chromium, magnesium, molybdenum, zinc and selenium (Tripathi & Platel, 2010). Therefore, it can be used as preventative drug for many diseases and also used as good quality animal fodder because of higher amount of easily digestible nutrient. Its seed coat contains higher amount of phytochemicals like dietary fibres, polyphenols and is also rich in minerals especially calcium. The seed coat is also having anti-cancerous and anti-diabetic properties, because of its higher polyphenol content, which shows the anti-oxidant activity and high fibre content results in slow digestion and stability in blood sugar level (Devi *et al.*, 2014). The finger millet grains are rich in essential amino acids like methionine and tryptophan as compared to common staple crops such as rice and wheat (Fernandez *et al.*, 2003). Finger millet is having amino acids in such a concentration that exceeds the level recommended by those of WHO/FAO. It is rich in methionine and lysine (Mbithi-Mwikya *et al.*, 2000). Supplementation of finger millet along with lysine, proteins or legumes like chick pea, green gram and soybeans improves its protein quality even further (Belton & Taylor, 2004). Finger millet is having slow digestibility, thereby providing energy throughout the day. The plant itself is found to be diaphoretic, diuretic, and vermifuge, and juice of its leaves has been given to women in childbirth (Dida & Devos, 2006). Due to its medicinal property, it has been used for treatment of various ailments including leprosy, liver disease, measles, pleurisy, pneumonia, and small pox etc. as a folk remedy (Dida & Devos, 2006). Finger millet is having higher level of fibre, which prevents diseases like constipation, high cholesterol formation, diabetes and intestinal cancer etc. (Devi *et al.*, 2014). Finger millet based diet also helps in reducing blood sugar level when compared with rice and wheat based dietary system due to the abundance of fibre, which is good for the diabetic people (Kumari & Sumathi, 2002). Due to the presence of few anti-nutritional factors in the flour of whole finger millet, it reduces the digestion and absorption of starch, that creates a lower glycemic response (Shobana *et al.*, 2007). In this way finger millet is having an excellent nutraceutical properties.

Climate resilience of finger millet:

Climate change is a major threat to global food security now a days, which has been adversely affecting the agricultural crop production system, because without conducive climatic condition there will be decrease in productivity as well as total food production. All the crop species are not susceptible to adverse climatic condition, the degree of susceptibility differs from species to species (Dida & Devos, 2006). Stress adaptability is a complex phenomenon that is managed at different levels including physiological, cellular and molecular. Describing the stress tolerance mechanisms of

plant and adaptation to adverse condition has long been the area of interest to agricultural scientists. Finger millet is given more importance for its growth under limited resources along with higher nutritional value (Gull *et al.*, 2014). Though finger millet is having many resistance and nutritional properties, it has been neglected. Due to the global concerns over food and nutritional insecurity and reduction of agricultural productivity due to climate change has increased the demand of climate resilient crops. As per the data of World Summit on Food Security at least 70% more food production is required by 2050 to feed the ever increasing population (Tester & Langridge, 2010). Because of this scenario, finger millet has got focus of scientific research for its unique quality of growing under less moisture and higher temperature condition.

Despite of finger millet is considered as an abiotic stress tolerant plant, even then there it is needed to identify newer sources of stress tolerance in this crop that can be used for the purpose of crop improvement. For the assessment of genetic diversity for both abiotic and biotic stress tolerance in finger

millet, germplasm collections is of major importance. A large number of finger millet accessions have been preserved in the national and international Gene Banks in Asian, African, and European countries as well as USA (Table-1). India is having the largest collection of finger millet germplasm followed by Ethiopia (Dwivedi *et al.*, 2012). There may be a lot of morphological and genetic diversity among different finger millet accessions or their core collections. Molecular markers is required to describe functional diversity in this crop (Kumar *et al.*, 2015). Dynamics of Calcium content (Yadav *et al.*, 2014), accumulation of tryptophan and its association mapping (Babu, Agrawal, *et al.*, 2014) and the resistance towards different diseases (Babu, Dinesh, *et al.*, 2014) have been described by the use of molecular markers (Babu, Pandey, *et al.*, 2014). Though, description of abiotic stress resistance of finger millet using molecular markers is yet very limited and offers a scope of exploring the vast collections of cultivated and wild accessions of this crop.

Table 1: Number of worldwide significant cultivated germplasm collection of finger millet preserved in national and international gene banks.

Country Reference	Institutes	No. of accessions	Reference
Asia			
India	All India Coordinated Millet Project, UAS, Bangalore	6257	(Dwivedi <i>et al.</i> , 2012)
	International Crop Research Institute for the Semiarid Tropics (ICRISAT), Patancheru	6804	(Goron & Raizada, 2015)
	National Bureau of Plant Genetic Resources (NBPGR), New Delhi	9522	(Dwivedi <i>et al.</i> , 2012)
Japan	Department of Genetic Resources I, National Institute of Agrobiological Sciences (NIAS), Tsukuba-shi	565	(Dwivedi <i>et al.</i> , 2012)
Nepal	Central Plant Breed. and Biotechnol. Division, Nepal Agric. Res. Council (CPBBD), Khumaltar, Kathmandu	869	(Dwivedi <i>et al.</i> , 2012)
Africa			
Ethiopia	Ethiopia Institute of Biodiversity Conservation, Addis Ababa	2156	(Dwivedi <i>et al.</i> , 2012)
Kenya	National Gene Bank of Kenya, Crop Plant Genetic Resources Centre, Muguga	2875	(Dwivedi <i>et al.</i> , 2012)
Uganda	Serere Agricultural and Animal Production Research Institute, Soroti	1231	(Dwivedi <i>et al.</i> , 2012)
Zambia	SADC Plant Genet. Resour. Centre, Lusaka	1037	(Dwivedi <i>et al.</i> , 2012)
America			
USA	National Center for Genetic Resources Preservation, Fort Collins, Colorado, USA	702	(Dwivedi <i>et al.</i> , 2012)
	Plant Genetic Resources Conservation Unit, USDA-ARS, Griffin, GA, USA	748	(Dwivedi <i>et al.</i> , 2012)

Source: (S.M. Gupta *et al.*, 2017)

Conclusion and future perspectives:

Now finger millet is not only a coarse cereal but also referred as a nutri-cereal or as a nutraceutical crop and regarded as a potential remedy for the food and nutritional security under the changing climatic conditions globally. Despite of excellent nutraceutical values, it is tolerant towards different biotic and abiotic stresses, which makes it an ideal crop in present situation of population explosion and climate change. Development of a super cereal in the future can be possible by incorporating various agronomically important traits into the genome of the single finger millet genotype. By developing different improved varieties of finger millet having higher nutraceutical values through different types of breeding, genetic modification, biotechnology etc. will help in solving present issues of food and nutritional security under the changing climatic conditions. The production scenario of finger millet can be improved, through modern agronomic practices and timely management of the crop in field condition.

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