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A Senthilkumar

Department of Soils Science and Agricultural Chemistry, The Indian Agriculture College, Radhapuram, Tamil Nadu, India

B Bhakiyathu Saliha

Department of Agronomy, Agricultural College and Research Institute, Madurai, Tamil Nadu, India

S Sheeba

Department of Soils and Environment, Agricultural College and Research Institute, Madurai, Tamil Nadu, India

R Balamurugan

Department of Agronomy, The Indian Agriculture College, Radhapuram, Tamil Nadu, India

Geethu Jacob

Department of Soils Science and Agricultural Chemistry, The Indian Agriculture College, Radhapuram, Tamil Nadu, India

J Vinoth Raj

Department of Soils Science and Agricultural Chemistry, The Indian Agriculture College, Radhapuram, Tamil Nadu, India

Corresponding Author:

A Senthilkumar

Department of Soils Science and Agricultural Chemistry, The Indian Agriculture College, Radhapuram, Tamil Nadu, India

Millets in meeting the nutrition security: A review

A Senthilkumar, B Bhakiyathu Saliha, S Sheeba, R Balamurugan, Geethu Jacob and J Vinoth Raj

Abstract

The world is experiencing an unprecedented increase in extreme weather conditions and India is not exception. In this context, millets are most useful as it is a nutritious, climate change-ready crop with enormous potential for yielding higher economic returns in marginal conditions. Also, millets are nutritionally superior to other major cereals as they are rich in dietary fibres, resistant starches, vitamins, essential amino acids, storage proteins and other bioactive compounds. Considering that there is an increasing realization of the importance of millets, the current review aims to focus on the possible role that millets could play in promoting dietary diversification and balanced diets and suggest the way forward to use millets in addressing food and nutritional security issues in India.

Keywords: Diversification, higher economic returns, millets, nutritional security

Introduction

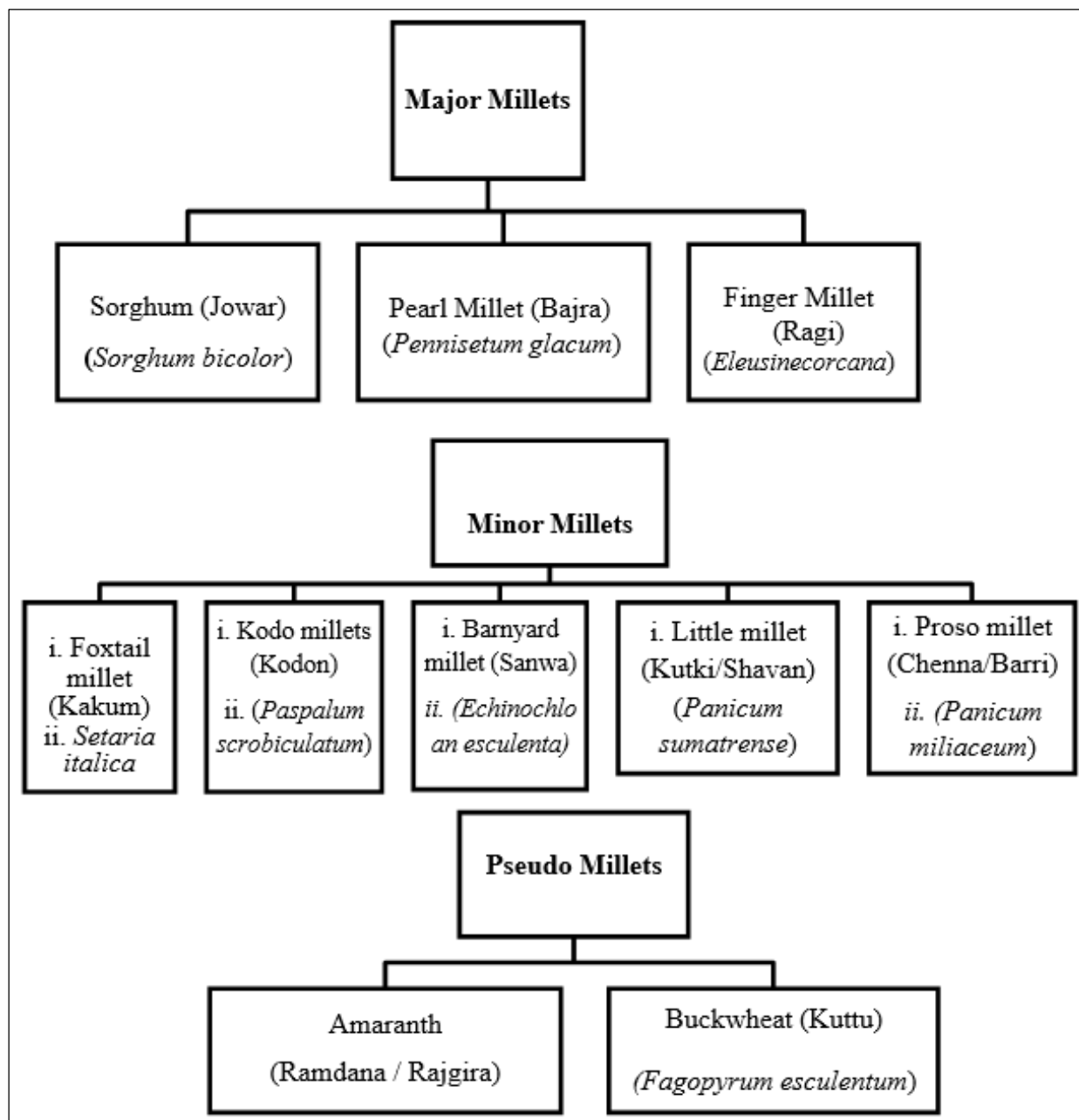
Main motto of agricultural research is to maintain food security throughout the world. Development and selection of high yielding variety, use of synthetic fertilizers and pesticides, mechanization and irrigation facilities, have resulted in sufficient availability of food. However, these shortsighted measures were partly able to increase food production but without any sustainable package of practices, we are not going to achieve food stability. Due to climate, change and global warming many countries faced considerable changes in their agroecological zones. Low fertile soils are predicted to elevate up to 50–56% in 2100 AD. According to the World Bank report, hunger is a challenge for 815 million people throughout the world. According to International crops, the research institute for the semi-arid tropics (ICRISAT) millets can play a significant role in attaining nutritional security in adverse climatic conditions. This intuition is now focusing on increasing the productivity of millets and has included finger millet (*Eleusine corcana*) as the sixth mandatory crop.

- **Types of millet:** According to the presence and absence of husk, millet can be divided into two broad categories
- **Naked grains:** Naked grains refer to the millets devoid of the tough, indigestible husk, namely, Ragi, Jowar, and Bajra.
- **Husked grains:** These types consist of an indigestible seed coat that has to be removed before consumption. Foxtail millets, little millets and Kodo millets belong to this category.

Advantages of cultivation of millet over traditional cereal crops

Less water consumption

Most of the millets are generally drought tolerant crops. They require very less amount of water for their growth as compared to the other cereals. According to the Crops Research Institute for the Semi-Arid Tropics (ICRISAT), a single rice plant requires nearly 2.5 times the amount of water required by a single millet plant of most varieties. The rainfall requirement of certain millets like pearl millet and proso millet is very low like 20 cm. Where in the case of rice the average rainfall lies between 120-140cm. Proso millet have the ability to escape the terminal drought that generally occurs during the late growing season since it matures within three months (Tadele, 2017) [9]. Though parle millet can't tolerate drought like sorghum but in that condition, it generally reduces its life cycle comes to flowering very rapidly. This interesting phenomenon is known as drought escaping mechanism.

Another classification**pH adaptability in millet**

Millet is adapted to a wide pH range. In acidic soil, wheat can easily be replaced with millet. Pearl millet shows some salinity resistance. Rice, which is very, much sensitive to salinity its yield reduced when the salinity is more than 3ds/m, but pearl millet can be cultivated up to the salinity range of 11-12 ds/m (Kumar *et al.*, 2018). The pH range of millet cultivation is 4.5 (in the case of acid soil) to 8 (in basic soil).

Physiological and morphological advantages

C-4 crop: As millets are the C-4 crops it consumes more amount of carbon dioxide and convert it into oxygen. Thus, millets can help to mitigate climatic uncertainties by reducing atmospheric carbon dioxide. For being a C-4 crop their photosynthetic rates at warm conditions and water use efficiency (WUE) and nitrogen use efficiency (NUE) is also very high, which are ~1.5 to 4-fold higher than C₃

photosynthesis (Seerat *et al.*, 2021)^[8].

Dense and deep root system: Foxtail millet produces dense and long fibrous roots with large rhinos heath, which help to penetrate deep into the soil. Depending on the availability of water pearl millet can adjust its root length from 140 cm – 3m with lateral root spreading (Seerat *et al.*, 2021)^[8].

Short life cycle: The short lifecycle of millets helps in escaping from stress, as they require 12–14 weeks to complete their life cycle (seed to seed) whereas traditional cereals like rice and wheat require a maximum of 20–24 weeks (Bandyopadhyay *et al.*, 2017)^[2].

Leaf and plant structure: Short plant structure, small leaf area thickened cell wall helps the plant become stress resistant. Bera (2020)^[3] observed an increase in leaf tensile strength in TEFF during drought.

Low carbon footprint: Among all the major cereal crops, wheat produces the highest amount of greenhouse gases around 4 tons of CO₂ eq/ha followed by rice and maize (around 3.4 tons of CO₂ eq/ha), (Bera, 2020) [3]. Millet also mitigates the effects of climate change by their low carbon footprint of 3,218- kilogram equivalent of carbon dioxide per hectare. The carbon equivalent emission (CEE) of millet has the lowest carbon emissions (878 kg C ha⁻¹), (Debangshi, 2022) [4].

Economic security: It is a low-investment crop. As it ac grows in stress conditions the cost of field preparation and fertilizer application is also very less. For being a short duration crop millet growing field can be utilized multiple numbers of times as compared to the other crops. Millets can be stored for a considerable amount of time under appropriate storage conditions, these phenomena reduce the cost of post-harvest storage and also make them 'famine reserves.

Nutritional importance of millet

According to WHO 1.9 billion adults are overweight or obese, while 462 million are underweight (WHO, 2021). As per the 2016 Global Nutrition report, 44% population of 129 countries is under very serious levels of undernutrition, adult overweight and obesity (Kumar *et al.*, 2018) [6]. These data show the worldwide nutritional imbalance in the diet of the people. As per the U.N. report (2019-2021), the number of undernourished people in India is 224.3 million and the number of children under 5 years of age having stunted growth is 36.1 million. According to the 2017 Global Hunger Index report, India ranked 100th among 119 countries (Kumari and Kumar, 2020) [7]. Achieving only food security will not solve the problem of malnutrition. For that, we need nutritional security which involves providing access to an adequate quantity of "quality food" at affordable prices to all people, at all times. For meeting nutritional stability balanced diet is important which includes different types of food in such quantities and proportions so that the need for calories, protein, fat, vitamins and minerals are adequately met. India is the largest producer and the largest consumer of millet with more than 40% of the world's millet consumption (Bandyopadhyay *et al.*, 2017) [2].

Macronutrients

The energy value, protein and macronutrient contents of millets are very high and sometimes higher than conventional cereals. Among all the millets, pearl millet has the highest content of macronutrients (Seerat *et al.*, 2021) [8]. Millet has gluten-free protein, high fibre and low glycaemic index and it is rich in different bioactive compounds.

Carbohydrates: Carbohydrates are present in the millet in different forms like soluble sugar, starch, dietary fibre, etc. Pearl millet grain contains starch around 71.82 to 81.02%, soluble sugars ranging from 1.2 to 2.6% and amylose from 21.9 to 28.8% (Hassan *et al.*, 2021) [5]. On average the carbohydrate content of millets varies from 56.88 to 72.97 g/100 g.

Proteins: It is the second major component in millet. The average protein content in I millet is ranging between 8.5% – 12.5% except in Adlay millet (6.7%) (A minor millet), (Vanga *et al.*, 2018) [10]. Proso millet contains the highest

amount of protein among the millets *i.e.*, 12.5 %. The protein content of pearl millet is believed to be about 11.6%, which is higher than the 7.2% protein found in rice, and maize (11.1%) (Hassan *et al.*, 2021) [5]. Presence of polyphenol and tannin in millet lowers the rate of in-vitro protein digestibility (IVPD), though it can be corrected by thermal processing methods like cooking in the case of Foxtail millet, Finger millet and Proso millet and through the removal of the anti-nutritional factors (Vanga *et al.*, 2018) [10].

Millet contains many essential amino acids in a wide range. Foxtail generally has the highest amounts of essential amino acids which are estimated to be almost 3g/100g with leucine alone amounting to nearly 1g/100g. Kodo millet was found to have the least amount of essential amino acids (1.8 g/100g). Finger millet is also rich in amino acid which contains methionine, valine and lysine and 44.7% of the total amino acid present in it is an essential amino acid.

Dietary fibre: On average one person should intake fibre about 28 – 35 g/day. Millets are also a rich source of both crude fibre as well as dietary fibre. Little millet (*Panicum sumatrense*) and Kodo millet (*Paspalum scrobiculatum*) contain the highest amount of dietary fibre *i.e.*, 38% and 37% respectively and Barnyard millet is the richest source of crude fibre (12.8 g/100 g), (Kumar *et al.*, 2018) [6]. This percentage of fibre is 78% higher than rice and wheat. As it is a low glycaemic food, a good choice for diabetic patients.

Lipids: Most of the millet does not contain a very high amount of fat generally it ranges between 2-6% with over 80% being unsaturated fatty acids, but this value is higher than the rice which is having 0.5g/ 100g and wheat has fat content 1.7g/100g. Among the millets, little millet has the highest fat content 5.9% and finger millet has the lowest 1.8. Though finger millet is low in lipid content but it is high in PUFA (polyunsaturated fatty acids).

Micronutrients

According to WHO (World Health Organisation), micronutrients are vitamins and minerals needed by the body in very small amounts. Though their impact on human health is critical, deficiency in any of them can cause severe and even life-threatening conditions. Millets are generally very rich sources of different minerals and B- complex vitamins. The range of minerals in millet is 1.7 to 4.3 g/100 g which is several times higher than wheat (1.5%) and rice (0.6%). The iron content of barnyard millet is nearly 17.47 mg/100 g. Foxtail millet contains the highest content of zinc among all millets *i.e.*, 4.1 mg/100 g. Apart from these millets are also a good source of β-carotene and B vitamins especially riboflavin, niacin and folic acid. Though the phosphorous content of millet is lower than wheat (355mg/100g) but higher than that of rice (160mg), (Archana *et al.*, 2014) [1]. Millet contains different types of polyphenols such as phenolic acids and tannins which are believed to act as antioxidants and play a vital role in boosting the body's immune system.

Health benefits of millets

From different epidemiological studies, we come to know that millets have the potential to protect the human body from different nutritional disorders. As millet is an alkaline forming food it is often recommended to achieve optimal health. This alkaline nature of millet helps to maintain a healthy pH

balance in the body, crucial to prevent different diseases.

Millet in Obesity: Nowadays obesity has become the biggest emerging problem not only in India but also throughout the world. Intake of high dietary fibre decreases the incidence of obesity. Millet is a rich source of dietary fibre which is comparatively higher than other cereals. Consumption of high fibre food helps in improving bowel function and reducing the prevalence of obesity by improving digestive function and absorption in the body thereby reducing the risk of chronic diseases.

Millet in Diabetes: Different studies show that the consumption of millet reduces the chance of Diabetes. Phenolic inhibits present in millet like alpha-glucosidase, pancreatic amylase reduces postprandial hyperglycemia by partially inhibiting the enzymatic hydrolysis of complex carbohydrates.

Millet in Cancer: Millets are a rich source of “antinutrients” like phenolic acids, tannins, and phytate. However, these antinutrients reduce the risk of colon and breast cancer in animals. Millet *also* has linoleic acid which contains anti-tumor activity.

Millet in Celiac Disease: Celiac disease is an immune reaction to eating gluten and it is a genetically susceptible problem that is triggered by the consumption of gluten. As the Millets are gluten-free, they are an excellent option for people suffering from celiac diseases and gluten-sensitive patients often irritated by the gluten content of the common cereal grains.

Millet in Gastrointestinal Disorders: As the fibre content in millets is very high it helps in eliminating different Gastrointestinal disorders like constipation, excess gas, bloating and cramping.

Other health benefits: Different studies show that the aqueous and ethanolic extracts of kodo millet produce a dose-dependent fall in fasting blood glucose. A good amount of antioxidant presents in finger millet prevents tissue damage and stimulates the wound healing process.

Millet-based food products

Millets are known as nutri-cereals for their high amount of nutrients. In this section let us discuss on some millet-based food products.

Bread: Report submitted by Hassan *et al.*, (2021) ^[5] shows that if wheat flour is subtracted from finger millet flour up to a concentration of 20% do not have any adverse effect on the quality of bread.

Biscuits: Anju and Sarita prepared biscuits by using foxtail and barnyard millet. There they replaced 45% refined wheat flour with millet flour. In another experiment pearl millet flour-based sweet, salty and cheese biscuits were prepared.

Alcoholic beverages: A gluten free whiskey known as Koval single barrel millet whiskey is also produced using millets.

Snack foods: Potato and barnyard millet-based oil free,

microwave puffed ready-to-eat fasting foods were developed by Debangshi (2022) ^[4].

Conclusion

According to the National Health Survey, in 2017 approximately 19 crore people in our country were compelled to sleep on an empty stomach every night and approximately 4500 children die every day under the age of five years due to hunger and malnutrition. India holds the 101st position in the Global Hunger Index (GHI) 2021 of 116 countries. From this data, it is clear that we have to emphasize agricultural production but the way should be sustainable so that farmers can fight against climate change. Millets have substantial potential to contribute toward food and nutritional security. Millets possess immense potential in our battles against climate change and poverty and provide food, nutrition, fodder and livelihood security. Cultivation of millet not only improves the economic condition of the farmers but also improves the health of the community as a whole.

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