Nutritional attributes of the millets: A source for alleviating nutritional hunger

Akansha Pandey, Pratibha Rathore and Pritesh Vyas*

School of Applied and Life Sciences, Uttaranchal University, Dehradun-2480087, Uttarakhand INDIA

*Corresponding Author Email: *priteshvyas@uumail.in*

ABSTRACT

Green revolution led to food security in our country with high levels of crop production. With course of time food security got stronger and the need of nutritional security was felt. The new cultivars developed during that duration provided food to the increasing population of the country but the nutritional hunger became a grim issue. Millets are the diverse crops which are having biotic and abiotic resistance and along with that it has got a high nutritional value. This nutritional value is so diverse that it almost overcomes the deficiency caused due to the consumption of other staple crops. This review gives a glimpse of the nutritional attributes of the millets and provides a comprehensive idea for their consumption in the human diet.

Introduction

Millet, a member of the Poaceae family, is regarded as one of the world's oldest cereal crops. Its production has increased over the past ten years to keep up with the growing global population (Gari, 2002). Millet grain possess abundant amount of nutrients, and high quality proteins used as a food and feed (Table 1). Millets come in a variety of forms, including pearl millet (*Pennisetum glacum*), finger millet (*Eleusine coracana*), small millet *(Panicum sumatrense*), and large millet (sorghum). Pearl millet is commonly known as Bajra which is the most consumed crop and originated from Sub – Sahara Africa (Dayakar et al., 2017). In contrast to finger millet, also known as ragi, which evolved in sub-humid regions of East Africa, pearl millet has a higher calcium, iron, and phosphorus content than cereal crops (Adeola et al., 1995). Additionally, it contains a lot of calcium, iron, and manganese. Among all the cereal crops pearl millet is known to be the sixth highest producing crop in world because it provides good nutrition and income scale to the farmers (Gari, 2002). It can be well grown in soil with high salinity, pH and can be tolerate harsh climatic conditions where all cereal crops would not survive in that condition (Dube et al., 2018).

One of the staple foods in the world, particularly among rural East and Central African cultures, is finger millet. It is crucial to the agriculture of the steep regions of Uttarakhand

(Patel et al., 2015). It is used for the manufacture of beer and liquor. It also provides fodder for cattle which reduces the pressure on forests and help in balancing ecosystem of the Himalayas.

Millets are nutritionally rich in various sources like minerals, proteins, fatty acids, dietary- fibres, micronutrients, and other phytonutrients (National Research Council, 1996). Millets are an excellent source of energy, calcium, zinc, lipids, potassium, magnesium, and high-quality proteins for both human and animal diets (Hassan et al., 2021).

Table 1 Different types of nutrients found in Millets

Name of Millet	**Scientific name**	**Common name**	**Location**	**Macronutrients**	**Health benefits**	**References**
Pearl millet	*Pennisetum typhoideum*	Bajra	U.P, Rajasthan, Haryana	Unsaturated fatty acid	Promote bone health Beneficial in treating stomach ulcers	Chauhan et al., 2023
Finger millet	*Eleusine coracana*	Ragi	Karnataka, Tamil Nadu	Protein, dietary fibres	Reduce blood glucose level Repair injured muscle tissue	Trisha, 2023
Foxtail millet	*Setaria italica*	Kangni	Andhra Pradesh, Tamil Nadu	Protein, dietary fibres	Improve immunity Proper functioning of nervous system	Dayakar et al., 2017
Proso millet	*Panicum miliaceum*	Chena	Maharastra,Madhya Pradesh	High protein content with high calcium	Help in bone growth and maintainance Help in smooth functioning of nervous system	Chauhan et al., 2023

Little millet	*Panicum miliare*	Gajrao	Tamil Nadu, Andhra Pradesh ,West Bengal	High dietary fibre with high iron content	Rich in anti-oxidants Help in decreasing blood cholesterol level	Anandhara makrishana n et al., 2022

Carbohydrates

The three types of carbohydrates found in pearl millet are soluble sugars, starch, and dietary fibre. In pearl millet, most of the endosperm is composed of starch (Hassan et al., 2021). It contains amylose and amylopectin, which are forms of glucose. Starch is utilised to improve the textural properties of food by thickening, gelling, and bulking it. 65-75 %carbs, 7-12%protein,15-20%deitary fibre, and 2-5%lipids are included in millets (Dayakar et al., 2017).

Starch

Starch accounts for half to three-fourths of the grain weight. It is a significant source of energy, and its unique structure—which is abundant in amylose—contributes to its low glycaemic index and delayed digestion. Pearl millet contains a lot of starch (Dayakar et al., 2017). Many millets have a high amylose content, which helps control blood sugar levels by causing glucose to enter the bloodstream gradually. Because of this, millets are a healthy dietary option for diabetics and those trying to control their weight.

Protein

Protein is millet's second main ingredient. According to estimates, pearl millet has a protein level of about 11.6%, which is higher than that of sorghum (10.4%), rice (7.2%), barley (11.5%), and maize (11.1%) (Anitha et al., 2019). However, the protein content of finger millet ranges from 5-8% (Martinez-Ballesta et al., 2010). Additionally, it was noted that the proteins of sorghum and maize have lower levels of lysine, threonine, methionine, and cysteine than those of pearl millet. Finger millet contains a higher concentration of lysine, threonine, and valine than other types of millet, which results in a more balanced composition of essential amino acids (Dayakar et al., 2010).

Dietary Fibre

It's believed that fibre is essential for gut health, and eating foods high in fibre in moderation may support gut health (Nambiar et al., 2011). Additionally, fibre is essential for avoiding heart disease, diabetes, and colon cancer (Taylor et al., 2004). Pearl millet's high dietary fibre content (8% to 9%) improves bowl movement (Jha et al., 2013). Additionally, millet's fibre may raise

good cholesterol while lowering bad cholesterol. Furthermore, it prevents the body from secreting bile acids, which leads to gallstones (Hrideek & Nampoothiri, 2017). Furthermore, pearl millet's high fibre content slows down the movement of food from the stomach into the intestines. This leads to longer feeding intervals, which prevent obesity.

Lipids

It is believed that pearl millet contains 5–7% fat (Trisha, 2023). Pearl millet possesses a considerable amount of fatty acids, such as palmitic, stearic, and linoleic acids , however oleic acid is found to be a low percentage when compared to maize (Dube et al., 2018) Compared to other millet varieties, pearl millet grain has a higher total lipid content, ranging from 1.5% to 6.8% (Chethan & Malleshi, 2007). Nonetheless, it was found that the primary fatty acids found in finger millet were oleic, palmitic, and linoleic acids. The fatty acid content of finger millet is composed of 74.4% unsaturated fatty acids and 25.6% saturated fatty acids.

Macronutrients

Each type of millet grain has a varied mineral composition. Environmental stressors that affect foods mineral content include excessive salt levels, scarce water supplies, and intense heat (Anitha et al., 2019). Pearl millet's total mineral and trace element content varies depending on the kind of soil. The high oil content of pearl millet makes it a good source of both vitamin A and fat-soluble vitamin E (Nambiar et al., 2011). The mineral phosphorus, which is essential for the mineral matrix of bones, and adenosine triphosphate, or ATP, the body's energy source, are also abundant in pearl millet (Martinez et al., 2010). Moreover, it promotes bone growth, development, and repair.

Vitamins

Vitamin E and B-complex vitamins are rich in millets. Millets are particularly rich in certain B vitamins, which are necessary for neurological function, energy metabolism, and red blood cell synthesis (McIntosh, 2003). Finger millet (Ragi) is one of the best sources of vitamin B6, which is essential for metabolism, neurotransmitter synthesis, and brain health. On the other hand, millets contain vitamin E, which has antioxidant properties that protect cells from oxidative damage, support skin health, and support immunological function

Phytochemical

Millets are rich in a variety of phytochemicals, including tannins, phenolic acids, anthocyanins, phytosterols, and pinacosanols. Human health may benefit from these substances. One of the primary phytochemicals is phenolic compounds (Dayakar et al., 2017). Millets are a great source of phenolic compounds since they contain condensed tannins, flavonoids, and phenolic

acids in a variety of genetically dependent forms and quantities. While phenolic acids are found in all types of sorghum, most lack condensed tannins.

Phenolic compounds

Millets are mostly composed of insoluble-bound hydroxycinnamic acids, which are the most prevalent phenolics. Millets include phenolic components that, among other health benefits, reduce inflammation, protect against oxidative stress, and enhance metabolic and cardiovascular health (McIntosh, 2003). Ferulic acid is one of the phenolic acids that is most commonly found in finger millet grains. It is abundant in the cell walls of many grains' aleurone, pericarp, and embryo, but it is present in trace levels in the starchy endosperm.

Flavonoids

A class of polyphenolic chemicals called flavonoids is well-known for its anti-inflammatory, antioxidant, and possibly health-promoting qualities. A wide range of plant foods, such as fruits, vegetables, grains, and seeds, frequently include them (McIntosh, 2003). From sorghum grains, flavonoids have been separated and identified. Tannin, quercetin, anthocyanin, and catechin are examples of health-promoting flavonoids.

Tannins

Millets contain tannins, especially in their outer layers and in pigmented types like pearl millet and finger millet. The majority of sorghum lacks tannins (Eshak et al., 2010). However, the bioavailability of minerals and proteins may be negatively impacted by an excess of condensed tannins.

Future prospects of Millets

Millets show a large deal of variation in grain quality characteristics, which promises to be breed for particular end products (Chauhan et al., 2023). Millets are considered a climate-adaptable crop because they use less water and are more resilient to environmental stresses like drought. In low-input agricultural settings and on marginal soils, where primary cereal crops typically yield little, millet crops are planted (Anandharamakrishnan, 2022). The development of creative value chains that link farmers with customers and markets is necessary, as is the promotion of millets as a competitive substitute for other cereal crops. Further research on the nutrigenomics of millets is necessary to understand how its nutritional components impact people's health. Food items made from millet for specific diets are a growing market with tonnes of potential for entrepreneurship.

Conclusions

Millets present a viable answer to several worldwide nutritional and agricultural issues. Their nutritional worth, historical significance, and ability to withstand hard conditions make them

desirable for more sustainable food production and increased food security. Furthermore, the inclusion of nutraceuticals in millets adds significance to their health advantages, particularly for humans. Millets are beneficial for the diet because they improve nutrition, particularly by supplementing with vitamins and minerals that keep people healthy and prevent many diseases.

Acknowledgement

The authors acknowledge School of Applied and Life Sciences, Uttaranchal University for providing support and basic infrastructure facilities for carrying out this work.

Conflict of Interest

The authors declare that they have no conflict of interest for this work.

References

Adeola O, Orban JI (1995) Chemical composition and nutrient digestibility of pearl millet (*Pennisetum glaucum*) fed to growing pigs. J Cereal Sci, 22: 177-184.

Anandharamakrishnan, C., Rawson, A., & Sunil, C. (2022). Handbook of Millets - Processing, Quality, and Nutrition Status.

Anitha S, Govindaraj M, Kane-Potaka J. (2019) Balanced amino acid and higher micronutrients in millets complements legumes for improved human dietary nutrition. Cereal Chem, 97: 74-84.

Chethan, S., & Malleshi, N. G. (2007). Finger millet polyphenols: Optimization of extraction and the effect of pH on their stability. Food Chem, 105: 862-870.

Chauhan , D., Sethi , L., Tyagi , M., & Sharma, S. (2023). Millets: The sustainable ancient superfood of the modern world, J Drug Res Ayurv Sci, 8 (Suppl 1), S34-S41.

Dayakar Rao, B., Bhaskarachary, K., Arlene Christina, G., Sudha Devi, G., & Tonapi, V. A. (2017). Nutri Health Benefits Millets. Hyderabad: ICAR ,Hyderabad, 2.

Dube T, Mlilo C, Moyo P, Ncube C, Phiri K. (2018) Will adaptation carry the future? Questioning the long-term capacity of smallholder farmers' adaptation strategies against climate change in Gwanda District.

Eshak ES, Iso H, Date C, Kikuchi S, Watanabe Y, Wada Y, Wakai K, Tamakoshi A (2010) Dietary fiber intake is associated with reduced risk of mortality from cardiovascular disease among Japanese men and women. J Nutr, 140: 1145-1453.

Gari J A. (2020) Review of the African millet diversity Paper for the International workshop on Fonio, food security and livelihood among the rural poor in West Africa, 2002.

Hrideek, T. K., & Nampoothiri, K. U. K. (2017). Millets as an integral Part of Nutritional Diet in India. In Examining the Development, Regulation, and Consumption of Functional Foods (pp. 83-108). IGI Global.

Hassan, Z., Sebola, N., & Mabelebele, M. (2021). The nutritional use of millet grain for food and feed, Agric Food Secur, 10: 1-14.

Jha A, Tripathi AD, Alam T, Yadav R. (2013) Process optimization for manufacture of pearl millet-based dairy dessert by using response surface methodology (RSM). J Food Sci Technol, 50: 367-373.

Manna, T., Saha, S., & Chattopadhyay, R. (2021) Millets: Climate Smart Nutritional Reservoir for Next Generations.

Martínez-Ballesta, M. C., R. Dominguez-Perles, D. A. Moreno, B. Muries, C. Alcaraz-López, E. Bastías, C. García-Viguera, and M. Carvajal. (2010). Minerals in plant food: effect of agricultural practices and role in human health. Sust Agric 2: 111-128.

McIntosh GM, Noakes M, Royle PJ, Foster PR. (2003) Whole-grain rye and wheat foods and markers of bowel health in overweight middle-aged men. Am J Clin Nutr, 77; 967-974.

Nambiar VS, Dhaduk JJ, Sareen N, Shahu T, Desai R. (2011) Potential functional implications of pearl millet (*Pennisetum glaucum*) in health and disease. J Appl Pharm Sci, 62-67.

National Research Council, Policy, Global Affairs, Office of International Affairs, Board on Science, & Technology for International Development. (1996). *Lost crops of Africa: volume I: grains* (Vol. 1). national academies press.

Patel K, Gartaula H, Johnson D, et al. (2015) The interplay between household food security and wellbeing among small-scale farmers in the context of rapid agrarian change in India. Agric Food Secur, 4: 1-16.

Taylor JRN (2004). In: Wrigley C, Corke H, Walker CE, editors. Millet: in encyclopaedia in Grain Science, Vol. 2. London: Elsevier.