International Journal of Environment and Climate Change

Volume 13, Issue 11, Page 2546-2559, 2023; Article no.IJECC.109177
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Unveiling the Nutritional Spectrum of Millet: An In-depth Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i113423

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/109177

Review Article

Received: 27/08/2023
Accepted: 04/11/2023
Published: 09/11/2023

ABSTRACT

A comprehensive analysis of millets, small-seeded Poaceae family grains that have been traditionally cultivated in semi-arid regions of Africa and Asia. The primary objective is to elucidate the multi-faceted advantages of millets, encompassing nutritional, metabolic, and immunological benefits, in addition to their significance in sustainable agriculture and ethical trade. Millets are rich in essential macronutrients and micronutrients, including but not limited to, carbohydrates, proteins, fats, vitamins, and minerals. They also contain bioactive compounds such as phenolic acids, flavonoids, and antioxidants. The ethical dimensions of millet cultivation are emphasized, focusing on fair trade protocols that could significantly elevate the socio-economic status of marginalized farmers. Millets also hold distinct cultural and traditional relevance in various indigenous

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communities, thus positing a loss in millet agriculture as a loss of cultural heritage. A critical gap in current literature is identified in the domains of farming practices, climate adaptability, and socio-economic implications of millet cultivation. Although millets have been evaluated for their nutritional profile, research is scant in areas like optimal agronomic practices, the potential impact of climatic variations, and social-economic ramifications of millet-based agriculture. Future research paradigms could profitably focus on the utility of millets in managing chronic lifestyle disorders and their integrative role in sustainable agricultural frameworks.

Keywords: Millets; nutrition; sustainability; metabolism; immunology.

1. INTRODUCTION

Millets are small-seeded grasses that have long been an essential part of the human diet and agriculture. This importance is deeply entrenched in various cultures across Africa, Asia, and the Americas where millets serve as a staple food [1]. Nutritionally, millets offer a range of essential nutrients including proteins, fiber, and vitamins and minerals like magnesium, phosphorus, and iron [2]. They are gluten-free and have a low glycemic index, making them particularly beneficial for people with dietary restrictions such as diabetics [3]. Not just a nutritional goldmine, millets are also incredibly versatile in the kitchen, finding their way into a variety of dishes from porridges to breads [4]. Beyond their dietary importance, millets hold considerable promise for sustainable agriculture. They require minimal water and are well-adapted to nutrient-poor soils, qualities that make them particularly suited for arid and semi-arid regions [5]. In an era of climate uncertainty where water scarcity and soil degradation are very real threats, the drought-resilient nature of millets presents a compelling case for their increased cultivation [6]. The socio-economic impact of millets is another facet that cannot be ignored. They are often grown on small plots by marginal farmers, thereby serving as a source of livelihood for many rural communities [7]. The genetic diversity inherent in millets also serves as a crucial resource for crop improvement programs, offering insights into stress tolerance and nutrient efficiency that can be applied to other crops as well [8]. Given this backdrop, the purpose of this review is to provide an in-depth look at the nutritional spectrum of millets. The study aims to dissect the nutritional composition of various types of millets and discuss their health benefits. Additionally, this review will explore the role of millets in sustainable agriculture, touching upon their minimal water and soil nutrient requirements, and their potential to improve rural livelihoods. The scope of this review will encompass multiple types of millets, including but not limited to Pearl millet, Finger millet, and Foxtail millet. It will offer a detailed breakdown of the macronutrients and micronutrients found in these grains, as well as any bioactive compounds of note.

2. HISTORY

The history of millets traces back several millennia, covering vast geographical landscapes and numerous cultures. These small-seeded grains have made an indelible mark not only on agriculture but also on the culinary and cultural heritage of various societies.

3. ORIGIN AND DOMESTICATION OF MILLETS

The journey of millets from wild grasses to cultivated crops is both fascinating and instructive. It is widely acknowledged that different types of millets were simultaneously domesticated in various parts of the world. For instance, Pearl millet is believed to have been domesticated in Africa around 4000 to 5000 years ago, while Finger millet, native to the highlands of East Africa, was brought under cultivation nearly 3000 years ago [9]. In Asia, particularly in China and India, other varieties like Foxtail millet and Little millet were domesticated. Archaeological evidence suggests that these grains were grown in China around 6000 years ago [10]. This simultaneous domestication across multiple continents underscores the adaptability and resilience of millets, traits that have only grown in importance as the world grapples with climate change and food security issues [11]. Noteworthy is the remarkable adaptability of millets that allowed early farmers to cultivate these crops in regions with diverse climatic conditions. Whether it was the arid plains of Africa or the temperate zones of Asia, millets thrived, leading to their widespread adoption [12]. Additionally, they served as crucial secondary or fallback crops, safeguarding against potential failures of primary staples like maize or rice [13].

Table 1. Domestication timeline and characteristics of various millets [9,10]

Millet Type	Domestication Region	Estimated Domestication Period	Notable Characteristics
Pearl Millet	West Africa	2500-2000 BCE	Heat tolerant, high drought resistance
Foxtail Millet	East Asia	6000-5000 BCE	Short growing season, adaptable to various soils
Finger Millet	East Africa	3000 BCE	High calcium content, good shelf life
Proso Millet	East Asia/Northern China	5000-4000 BCE	Short growing season, minimal water requirement
Sorghum	Northeastern Africa	3000-2500 BCE	Diverse uses, including fodder, grain, and brewing
Teff	Ethiopia/ Eritrea	1000-4000 BCE	Gluten-free, high in fiber and protein
Barnyard Millet	East Asia	2000 BCE	Fast growing, high iron content
Little Millet	South Asia	Unknown	High in phosphorus, quick cooking

Table 2. Regional culinary traditions and uses of millets [16]

Millet Type	Region of Popularity	Traditional Dishes	Usage
Pearl Millet	India, Africa	Bajra Roti, Tô, Sadza	Staple grain, used in flatbreads and porridge
Foxtail Millet	China, India	Xiao Mi Zhou, Kangni Roti	Porridges, rice substitute, brewing
Finger Millet	East Africa, Nepal, India	Ugali, Ragi Dosa, Ragi Mudde	Porridges, cakes, breads
Proso Millet	Eastern Europe, Russia, China, India	Kasha, Millet Upma	Grain bowls, porridges, pilafs
Sorghum	Africa, India, USA	Jowar Roti, Sorghum Syrup, Jollof	Flatbreads, syrups, beverages
Teff	Ethiopia, Eritrea	Injera, Teff Porridge	Flatbreads, cakes, porridge
Barnyard Millet	India, Nepal, Japan	Sama ke Chawal, Hie	Fasting foods, risottos, congees
Little Millet	India, Sri Lanka	Samai Rice, Kutki Khichdi	Alternative to rice, porridges, salads

4. REGIONAL POPULARITY AND USAGE IN TRADITIONAL CUISINES

Millets' role as a staple food in traditional diets is an ode to their adaptability and nutritional content. In Africa, millets have been a cornerstone of local cuisines for centuries. They are often consumed as porridges, flatbreads, or fermented products like beer [14]. Pearl millet, in particular, is commonly used in the preparation of a variety of dishes such as 'sadza' in Zimbabwe and 'tuwo masara' in Nigeria [15].

In Asia, especially in regions like India, millets hold cultural and culinary significance. They are an integral part of several traditional recipes ranging from 'ragi mudde,' a type of ball made from Finger millet in Southern India, to 'kangni ki kheer,' a Foxtail millet-based dessert in Northern India [16]. The use of millets is not just limited to everyday meals but extends to festive and religious occasions, symbolizing their cultural prominence [17]. The culinary versatility of millets also lends itself well to traditional food preparations in other parts of the world. For instance, in the Americas, millets have been used by indigenous communities for making bread and as an ingredient in other native dishes [18].

4.1 Classification of Millets

Millets are classified into various types, each with its unique set of characteristics, growing conditions, and nutritional profiles. Understanding this classification is pivotal for an in-depth review of their nutritional spectrum, as it directly impacts the variety and extent of nutrients found in different types of millets.

4.2 Various Types of Millets

Pearl Millet (*Pennisetum glaucum*): Pearl millet is one of the most widely grown types of millet and has its origins in Africa [19]. It is highly adaptable to arid conditions, making it the preferred millet type in regions suffering from drought and poor soil fertility [20]. Nutritionally, Pearl millet is rich in carbohydrates, fiber, and is a good source of essential amino acids [21].

Finger Millet (*Eleusine coracana*): Finger millet, native to the highlands of East Africa, is another important type of millet [22]. Known for its higher calcium content compared to other cereals, Finger millet is particularly important for bone health [23]. It also contains various phytochemicals with antioxidant properties, offering additional health benefits [24].

Foxtail Millet (*Setaria italica*): Originating from China, Foxtail millet has spread to various parts of the world, including Europe and North America [25]. It's recognized for its low glycemic index, making it a suitable choice for managing diabetes [26]. Additionally, it is rich in iron and folic acid, nutrients often deficient in standard diets [27].

4.3 Other Types

Besides these main types, there are other less common but significant millets like Proso millet (*Panicum miliaceum*), Barnyard millet (*Echinochloa* spp.), and Little millet (*Panicum sumatrense*), each with unique attributes and regional importance [28].

4.4 Geographical Distribution

Africa: Pearl millet and Finger millet are predominantly grown in Africa. Countries like Niger, Burkina Faso, and Nigeria have large Pearl millet plantations, contributing significantly to their food security [29]. Finger millet, on the other hand, is more popular in East African countries like Kenya and Uganda [30].

Asia: In Asia, especially India and China, the cultivation of millets like Finger millet, Foxtail millet, and Little millet is widespread. These grains are integral to the regional diets and have historical and cultural significance [31].

Americas: In the Americas, especially the United States, Proso millet is the most commonly grown type, mainly for birdseed and fodder [32]. The potential for millets as a human food source is increasingly being recognized, given their nutritional benefits and resilience as a crop [33].

Europe and Other Regions: In Europe, millets like Foxtail and Proso are grown, albeit in limited quantities, mainly as a niche health food or for specific culinary applications [34].

4.5 Nutritional Composition

Understanding the nutritional composition of millets is crucial for appreciating their potential as a source of vital nutrients in the human diet. Millets are abundant in both macronutrients—such as carbohydrates, proteins, and fats—and micronutrients, including various vitamins and minerals.

Table 3. Classification and Characteristics of Different Millet Types [20,21]

Classification	Millet Types	Botanical Name	Features
Major Millets	Pearl Millet	Pennisetum glaucum	Largest kernels, widely cultivated
	Foxtail Millet	Setaria italica	Second most produced millet
	Sorghum	Sorghum bicolor	Versatile uses, from grain to syrup
	Finger Millet	Eleusine coracana	Rich in calcium and amino acids
Minor Millets	Proso Millet	Panicum miliaceum	Short growing season, high productivity
	Barnyard Millet	Echinochloa spp.	Good source of fiber and iron
	Little Millet	Panicum sumatrense	Small seeds, rich in phytochemicals
	Kodo Millet	Paspalum scrobiculatum	Drought-tolerant, nutritious
	Teff	Eragrostis tef	Tiny seeds, gluten-free, high in protein

Table 4. Global Geographical Distribution of Millet Cultivation [29,31]

Millet Type	Primary Regions of Cultivation	Secondary Regions of Interest
Pearl Millet	India, Nigeria, Niger	Pakistan, Sudan, Namibia
Foxtail Millet	China, India	Russia, United States
Finger Millet	Uganda, India, Nepal	Rwanda, Malawi, Zimbabwe
Proso Millet	Northern China, Russia	United States, India
Sorghum	Nigeria, United States	Mexico, Sudan, Ethiopia
Teff	Ethiopia, Eritrea	United States, Australia
Barnyard Millet	India, Nepal	Japan, Sri Lanka
Little Millet	India	Nepal, Sri Lanka
Kodo Millet	India, West Africa	Vietnam, Philippines

4.6 Macronutrients

Carbohydrates: Millets are predominantly carbohydrate-rich grains, with most varieties containing around 60-70% carbohydrates [35]. These are mostly complex carbohydrates, including significant amounts of dietary fiber. For instance, Pearl millet contains approximately 67% carbohydrates, much of which is in the form of starch, and around 2.3% fiber [36]. This high fiber content is crucial for maintaining digestive health and has implications for weight management and the control of blood sugar levels [37].

Proteins: Proteins are another important macronutrient found in millets. They typically constitute about 8-12% of the dry weight of the grain [38]. Finger millet is particularly high in protein, with levels reaching up to 14% in some varieties [39]. The amino acid profile of millets is also noteworthy; they contain essential amino acids like lysine, methionine, and cysteine, although the levels may vary between different types [40]. These amino acids are crucial for various physiological functions, including tissue repair and immune system support [41].

Fats: Although millets are generally low in fats, ranging from 1-5% of the total composition, the fats they do contain are largely unsaturated [42]. Unsaturated fats are essential for heart health, reducing bad cholesterol levels and increasing good cholesterol (HDL) levels [43].

4.7 Micronutrients

Vitamins: Millets are a good source of various essential vitamins, including B-vitamins like niacin, folic acid, and thiamine, and Vitamin E [44]. B-vitamins are vital for metabolic processes, while Vitamin E acts as an antioxidant, helping to protect cells from damage [45].

Minerals: Millets are rich in important minerals like iron, zinc, magnesium, and phosphorus [46]. Finger millet, for example, contains up to 344 mg of calcium per 100g, making it one of the best plant sources of this essential mineral [47]. Iron and zinc are crucial for oxygen transport and immune function, while magnesium and phosphorus are important for bone health and energy production [48].

In essence, millets are nutritional powerhouses that offer an array of essential macronutrients and micronutrients. Their high carbohydrate content, much of which is fiber, makes them an excellent source of energy that is also beneficial for digestive health. The protein content is not only substantial but also includes essential amino acids, making millets a valuable part of a balanced diet. Although they are low in fats, the fats present are mostly unsaturated, contributing positively to heart health. When it comes to micronutrients, millets offer a range of important vitamins and minerals, further emphasizing their role as a highly nutritious food source. The wide geographical distribution of different millet types only enhances their potential as a globally relevant nutritional resource. Whether it is the calcium-rich Finger millet from East Africa or the protein-rich Pearl millet from arid regions, each type brings with it unique nutritional benefits. As such, millets hold the promise of contributing to a balanced diet, thereby playing a significant role in addressing malnutrition and promoting overall well-being.

4.8 Other Bioactive Compounds

Millets are not merely a source of essential macronutrients and micronutrients but also a treasure trove of bioactive compounds. These secondary metabolites, including phenolic acids, flavonoids, and antioxidants, have been shown to have significant health benefits, making millets even more valuable as a food source.

Phenolic Acids: Phenolic acids are ubiquitous in plant-based foods, and millets are no exception. These organic compounds have been extensively studied for their antioxidant properties [49]. Specifically, ferulic acid, one of the most prevalent phenolic acids in millets like Finger millet, has been shown to have anticancer, anti-inflammatory, and antidiabetic properties [50]. The high content of phenolic acids in millets is also thought to contribute to their longer shelf life compared to other cereals, making them particularly valuable in regions where food preservation is a challenge [51].

Flavonoids: Another class of bioactive compounds found in millets is flavonoids. These compounds are well-known for their antioxidant capabilities but also have potential anti-inflammatory, antiviral, and anticancer properties [52]. Catechin and quercetin are examples of flavonoids found in millets like Foxtail millet, which have been studied for their ability to neutralize free radicals and reduce oxidative stress [53].

Table 5. Comparative nutritional composition of various millets (Per 100g Raw) [35,38]

Nutrient (per 100g)	Pearl Millet	Foxtail Millet	Finger Millet	Proso Millet	Sorghum	Teff	Barnyard Millet	Little Millet	Kodo Millet
Energy (kcal)	361	331	328	346	329	367	307	329	309
Protein (g)	11.6	12.3	7.3	12.5	10.4	13.3	10.1	7.7	8.3
Fat (g)	5.0	4.0	1.3	2.0	3.3	2.4	2.2	5.2	3.6
Carbohydrates (g)	67.5	63.2	72.6	70.4	74.6	73.1	60.9	60.9	65.9
Fiber (g)	1.2	8.0	3.6	1.9	6.3	4.0	10.1	7.6	9.0
Minerals (g)	2.3	3.3	2.7	1.9	-	2.1	1.6	1.5	2.6
Calcium (mg)	42	31	344	14	28	180	20	17	27
Iron (mg)	8.0	2.8	3.9	0.8	4.4	7.6	18.6	9.3	0.5

Antioxidants: Beyond phenolic acids and flavonoids, millets contain other antioxidants, such as tocopherols and phytosterols [54]. These compounds can inhibit lipid peroxidation, thereby potentially reducing the risk of cardiovascular diseases [55]. They are also thought to have neuroprotective effects, making them an area of interest for research into neurodegenerative diseases [56].

4.9 Health Benefits

4.9.1 Digestive health: fiber content and impact on gut health

One of the most compelling health benefits of millets, particularly in the context of digestive health, is their high fiber content [57]. Dietary fiber, especially soluble fiber, serves as a substrate for gut microbiota, helping to maintain a balanced gut ecosystem [58]. This has broader implications for digestive health, including improved stool regularity, and potential prevention of gastrointestinal diseases such as diverticular disease and colon cancer [59]. Fiber also acts as a bulking agent, which not only aids in digestion but also contributes to a feeling of fullness, potentially helping in weight management [60]. Further, high fiber content slows down the rate of carbohydrate digestion, leading to more gradual increases in blood sugar levels, making millets a suitable dietary option for managing diabetes [61]. The unique blend of bioactive compounds in millets enhances their nutritional profile and positions them as a significant health resource. Phenolic acids like ferulic acid not only add to the antioxidant capacity of millets but also have multiple health benefits, including anti-inflammatory and anticancer properties. Flavonoids further augment the antioxidant profile, with additional health-promoting properties. It's important to remember that these bioactive compounds are not isolated nutrients but part of a complex food matrix that includes carbohydrates, proteins, fats, vitamins, and minerals. This complexity adds a layer of synergy where the health benefits of individual components may be amplified when consumed as part of the whole grain [62].

4.9.2 Metabolic implications of millets

Millets have been hailed as a boon for metabolic health, offering multiple benefits across a range of parameters, from blood sugar control to immunological health and weight management. These ancient grains are more than just a source of essential nutrients; they can be viewed as a holistic food that offers multiple metabolic advantages.

4.9.3 Role in managing diabetes and cholesterol levels

One of the standout features of millets is their ability to help regulate blood glucose levels. The low glycemic index (GI) of millets makes them an ideal choice for diabetes management [63]. Low-GI foods are digested and absorbed more slowly, resulting in a slower rise in blood sugar levels. This can be particularly beneficial for type 2 diabetics who need to manage postprandial (after-meal) blood sugar spikes. Pearl millet, for example, has a GI value of around 50-55, which is significantly lower than the GI value of other staple grains like rice [64]. Millets are rich in dietary fiber, which also contributes to slower carbohydrate digestion and absorption, making them beneficial for both type 1 and type 2 diabetes patients [65]. Several studies have also shown that millets can help in the regulation of lipid profiles. For instance, consumption of Finger millet has been found to reduce LDL (low-density lipoprotein) cholesterol levels and increase HDL (high-density lipoprotein) cholesterol levels [66].

4.9.4 Immunological benefits: role in immune function

The immune system is the body's first line of defense against external pathogens, and millets offer a range of nutrients that can enhance immune function. For example, millets are a good source of zinc, which is known to play a pivotal role in the immune response [67]. Zinc deficiency has been linked to an impaired immune system, making it a crucial nutrient for maintaining health [68]. The bioactive compounds such as antioxidants and phenolic acids in millets can provide anti-inflammatory benefits [69]. Chronic inflammation is often linked to a weakened immune system, and by reducing inflammation, these compounds can indirectly boost immune function [70].

4.9.5 Potential in weight management: low glycemic index and its implications

Weight management is a complex issue that involves multiple factors, including diet, physical activity, and metabolic rate. Millets can play a significant role in this regard due to their low glycemic index and high fiber content [71]. Foods with a low glycemic index are often recommended for weight management as they promote satiety and reduce overall calorie intake [72]. The high fiber content in millets not only helps in digestion but also contributes to a feeling of fullness, thus potentially helping in weight management [73]. Moreover, millets like Pearl millet and Finger millet have been shown to have higher protein content compared to other grains, and protein is known to induce satiety to a greater extent than carbohydrates or fats [74]. In a society grappling with lifestyle diseases such as obesity, diabetes, and cardiovascular diseases, the inclusion of millets in the diet offers a multi-faceted solution. They are not merely a substitute for other grains but offer distinct metabolic advantages. The low glycemic index makes them ideal for diabetes management, helping to control blood sugar levels effectively. Their role in cholesterol management further extends their benefits to cardiovascular health. The fiber content in millets aids digestion and contributes to gut health, which has ripple effects on metabolic health, including enhanced immune function. The array of bioactive compounds adds another layer of metabolic benefits, particularly in terms of immune health. In the context of an increasing global health burden of metabolic diseases, millets offer a dietary strategy to manage and possibly mitigate some of these challenges. Their versatility and adaptability make them suitable for various culinary applications, from traditional dishes to modern health foods, thus making it easier to incorporate them into different diets. Given the growing body of evidence on their health benefits, millets could very well be the key to tackling the dual challenges of malnutrition and lifestyle diseases, underscoring the need for further research and greater inclusion in dietary guidelines.

5. COMPARISON WITH OTHER GRAINS

5.1 Nutritional Differences

Millets, often considered the 'poor man's grain,' have risen in nutritional esteem when compared to more commonly consumed grains like wheat, rice, and maize [75]. In terms of protein content, millets like finger millet and pearl millet offer a higher protein density compared to white rice and maize [76]. In addition, the amino acid profile in millets is more balanced, providing essential amino acids that are often lacking in other grains [77]. The fiber content in millets is notably higher than that in rice and wheat, contributing to various health benefits like better digestion, lower blood sugar levels, and potentially reduced risk of certain types of cancer [78]. Millets also surpass other grains in micronutrients such as magnesium, phosphorus, and iron [79].

5.2 Culinary Uses

Traditional Recipes: Millets have been an integral part of traditional cuisines in various parts of the world, from Asia to Africa. In India, for instance, 'Ragi Mudde,' a ball made of finger millet, is a staple food in some regions [80]. Similarly, in Africa, pearl millet is commonly used to make 'Tô,' a kind of dough often consumed with soup or stew [81].

Contemporary Culinary Innovations: The increasing awareness of millets' nutritional benefits has inspired a new wave of culinary innovations. Modern interpretations include millet-based salads, millet flour in baked goods, and even millet-based beverages [82].

5.3 Sustainability Aspect

Water Usage: One of the most compelling advantages of millets over other grains is their low water requirement. Millets can grow under drought-like conditions, making them an ideal crop in regions facing water scarcity [83].

Soil Fertility Implications: Millets are also beneficial for the soil as they require minimal fertilization. They are often grown in rotation with other crops to improve soil fertility [84].

Pest Resistance: Additionally, millets exhibit a higher resistance to pests compared to other grains, reducing the need for chemical pesticides [85].

5.4 Ethical and Social Considerations

Fair trade and farmer welfare: Millets have been traditionally grown in marginal environments where modern, intensive agriculture is often not sustainable [86]. This puts millet farmers, often subsistence farmers in developing countries, in a precarious position. Fair trade can play an instrumental role in improving the welfare of these farmers. Fair trade practices can help farmers get a better price for their produce, thus increasing their income levels [87]. Additionally, it can promote sustainable farming practices, which in turn can make the occupation more sustainable in the long run [88].

Cultural Significance: Millets hold significant cultural importance in various parts of the world. In many African and Asian countries, millets are part of traditional festivals and ceremonies [89]. They are also integral to traditional medical practices in some cultures [90]. The loss of millet cultivation, therefore, represents not just an economic loss but also a loss of cultural heritage [91].

5.5 Gaps in Current Research and Future Prospects

Areas Needing More Scientific Investigation: While millets have been studied for their nutritional and health benefits, there is a gap in research when it comes to understanding the best farming practices for different types of millets [92]. The impact of climate change on millet farming is another area that requires urgent attention [93]. Studies that delve into the socio-economic aspects of millet farming can also provide valuable insights [94].

Potential for Upcoming Research: The rising incidence of lifestyle-related diseases globally makes millets an attractive subject for future research, particularly their role in managing conditions like diabetes, obesity, and cardiovascular diseases [95]. Additionally, given the increasing importance of sustainable agriculture, research into how millets can fit into sustainable farming systems is another promising avenue [96].

6. CONCLUSION

Millets present a multifaceted opportunity not just in terms of nutrition and health, but also concerning ethical and social considerations. Practices like fair trade can offer long-lasting benefits to farmers, while the cultural significance of millets cannot be underestimated. Moreover, there is a pressing need for further research in areas like farming practices, climate change implications, and millets' role in managing lifestyle-related diseases. Bridging these research gaps could pave the way for millets to be more widely recognized and adopted, not just as a 'fallback' crop but as a significant contributor to both human health and sustainable agriculture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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