Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 7 Issue 10 October 2023

Review Article

Millet: The Superfood

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Received: September 01, 2023

Published: September 29, 2023

Abstract

Millets are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. Millets are the world's sixth largest grain producer in Asia and Africa, these are rarely used cereals play a major role in the food security of millions of people. Millets are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. Millets have a good nutritional profile along with good nutraceutical potential and thus can be considered a great crop for combating food nutritional security globally. A wide variety contains the phenolic content and antioxidant capacity of millet grains. In addition, millet grain phenolics, available, has biological properties that are resistant to several pathophysiological conditions and can act as natural sources of antioxidants in food and biological systems. They are considered underutilized crops and can sustain in harsh environments with limited water resources where other crops grow or yield poorly. Millets being adaptable can grow in dry regions, on clay soils, in wet lowlands, or alluvial lands. Their root systems are very powerful, able to descend very quickly to a great depth of the soil to extract water and minerals. They are drought resistant crops. Millets have a good nutritional profile along with good nutraceutical potential and thus can be considered a great crop for combating food nutritional security globally. The nutritional composition of the millets is compared with that of rice and wheat. The protein content of foxtail millet, proso millet and pearl millet are comparatively higher than the protein content in wheat and rice. The fibre content of kodo, little, foxtail and barnyard millet is higher. Finger millet has a remarkable amount of calcium. The food products of millets has become increasingly popular due to nutritional and economic advantages. Value added products from millet have the potential to add value to business and has a large potential for growth as consumers believe that millets and millet based foods contribute directly to their health.

Keywords: Millets; Antioxidants; Finger Millet; Foods; Nutritional Profile; Pearl Millet; Domestic Purposes

Introduction

Millets, which are small-seeded grains, thrive in arid regions across temperate, tropical, and subtropical zones. They are cultivated as essential grain crops on marginal lands due to their ability to yield well even under adverse conditions [23,46]. Ranking sixth among the most significant cereal crops in global agricultural production, millets play a crucial role in ensuring food security and contributing significantly to the economies of many less developed countries [8,56]. These versatile grains are grown over an area of 31.24 million hectares, with India being a major producer, yielding 11.56 million tons over 9.1 million hectares in 2017 [41]. Various types of millets are cultivated, including Pearl millet, which accounts for 40% of the world's production, Foxtail millet, Proso millet, and Finger Millet. Among them, Pearl millet stands out with the largest seeds [6,30,38].

Figure 1: Type of Millets.

Millets boast high levels of fiber and polyphenols, making them beneficial in reducing the rate of fat absorption and potentially mitigating non-communicable diseases such as cardiovascular disease, diabetes, and hypertension [33,46]. As essential cereal grains, millets play a paramount role in the global food supply and hold significant importance in the diets of people worldwide [4]. Millet is primarily grown as a subsistence crop for local consumption in many regions worldwide. However, engaging in commercial millet

production can be risky, especially in Africa, due to the lack of significant market outlets. Fluctuations in millet output lead to substantial price variations, particularly in areas where millet serves as the main food crop. Beyond grain production, millet is also cultivated for other purposes like grazing, green fodder, or silage. Livestock plays a crucial role in most millet production systems, and millet crop residues make a substantial contribution to fodder supplies. In regions like India, certain popular landrace varieties of millet can grow over 3 meters tall, providing valuable fodder despite relatively lower grain yields.

Millet cropping systems are typically extensive and often lack the widespread adoption of improved agricultural technologies. However, in some commercially advanced farming regions of India, there is a partial exception to this trend. Millet crops are commonly cultivated without irrigation or the use of chemical fertilizers. They thrive on light and well-drained soils with low organic matter content. When farmers have access to supplementary or full irrigation, they often prefer to grow more profitable crops, except in specific regions like Gujarat in India. In such areas, there is a seasonal demand for pearl millet crop residues as fodder for milch (milk-producing) animals, leading to their continued cultivation even with irrigation options available.

Millets have historically served as the primary staple food in the country. However, the prevalence of polished rice, processed sugar, and other refined food products, produced using chemical fertilizers, has become pervasive in our daily lives. Unfortunately, without viable alternatives, people have adapted to consuming these refined foods, leading to various health issues such as diabetes, high blood pressure, and obesity.

History of millets

Millets have a long history as one of the oldest food crops, dating back to early human civilizations. Archeobotanical studies indicate that common millet became a staple in North China around 10,000 years ago [36]. Noodles made from proso and foxtail millets were found in Northern China around 4000 years ago [35]. Finger millet, another ancient crop, was known as "nrtta-kondaka" in ancient Indian Sanskrit literature, meaning "Dance Dance." It was also called "rajika" or "markataka"[3]. The origin of finger millet is debated, with speculation that it might have arrived in India through sea routes from Arabia or South Africa or across the Indian Ocean from both sides [3,21]. Archaeological studies, including the work of Fuller (2002, 2003) [19,20] provide evidence of finger millet's African origins and its presence in India. The grain, known as "ragi," has been cultivated in India for a long time and has become an integral part of the Indian diet [3].

Millet Cultivation

Various varieties of millets are grown in different regions of the world, and their cultivation requirements vary accordingly. While millions of people rely on rice, wheat, and maize as their primary sources of nourishment, millets are also consumed, albeit to a lesser extent. The growth patterns of these crops are influenced by temperature and water availability. Sorghum and millets are resilient to limited water supplies, making them suitable for cultivation in semi-arid and arid regions. These millets have high yields even in low-quality soils with minimal additional inputs, making them valuable crops for such challenging environments [9,43].

Millets generally prefer higher temperatures and can reproduce with limited water inputs, making them xerophilic. However, different millet species have varying soil requirements to thrive healthily. Finger millet, scientifically known as Eleusine coracana L., is cultivated in various regions of Africa and India. In India, it ranks sixth among the country's principal cereal grains, following wheat, rice, maize, sorghum, and bajra [16]. Compared to other cereal crops, finger millet can grow at higher temperatures and on more salinized soils. It thrives in temperatures ranging from 11 to 27 °C, with a soil pH between 5 and 8, and moderate rainfall [55]. Proso millet is grown in China, India, and Russia, and it is believed to have originated in Central and Eastern Asia before spreading to Russia, India, the Middle East, and Europe [10]. It is a vital crop in various Middle Eastern countries like Iran, Iraq, Syria, and Turkey, as well as in Afghanistan, Kazakhstan, Northwest China, Australia, Central and Southern India, Russia, and the USA.

Foxtail millet seeds have been discovered in archaeological sites across Europe, the Middle East, Eastern and Central Asia, and are currently grown in various regions such as the Korean peninsula, China, India, Indonesia, Europe, and the former USSR. Foxtail millet is considered an ideal catch crop due to its quick ripening mechanism and strong photosynthetic efficiency (Leder, 2004). It is nutrient-dense and has high resilience to pests and diseases [57]. Foxtail millet has proven to be more water-efficient than sorghum and maize, despite receiving only one pre-sowing precipitation. Barnyard millet is known for its drought tolerance, quick maturity, and excellent nutritional properties [59].

Kodo millet is believed to have been domesticated around 3000 years ago in India. It thrives in tropical and subtropical climates, and when grown for 80 to 135 days, it is considered the most drought-resistant among minor millets, yielding a respectable harvest [7,28,29]. The ideal conditions for cultivating Kodo millet include temperatures between 11 and 27°C, soil pH ranging from 5 to 8, and moderate rainfall.

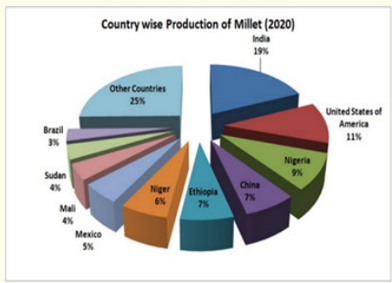

Figure 2: Country wise millet production.

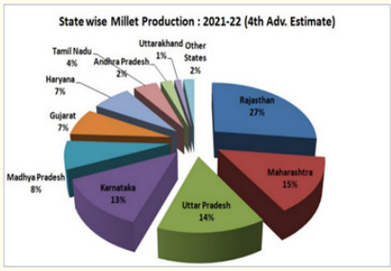

Figure 3: State wise millet production.

Importance of millets

India is currently discussing the Food Security Bill, which will significantly impact the poor and marginalized in their struggle to access food and nutrition for a dignified and healthy life. The Millet Network of India advocates that the nation should aim for food sovereignty, not just food security. This means empowering people with control over the production, distribution, and consumption of food. One crucial step in achieving this is to bring millets back into the food security debate, as millions of households in dryland and hilly regions rely on these crops for their food needs.

During this period, the area under millet cultivation declined by nearly 50%, from about 18 million hectares to about 9 million hectares. Millet production also decreased from about 8.8 million tons to about 7.2 million tons, marking an 18% decline. These statistics indicate that many households can no longer access affordable and nutritious food. Promoting millets and integrating them into food programs can help address this issue and work towards achieving food sovereignty, where people have greater control over their food sources and nutrition.

Storehouse of nutrients

The millet, now referred to as Nutri-cereal instead of coarse grain, boasts a higher proportion of complex carbohydrates, resistant starch, and slow-releasing sugars. It is rich in fiber, with soluble fiber content ranging from 3.4% to 6.5%. Additionally, millets are low in fat, ranging from 1.1% to 5.0%. They are also abundant in B vitamins, especially niacin, pyridoxine, and folic acid, while providing a good amount of calcium, iron, potassium, magnesium, and zinc. Overall, millets exhibit better nutrient content than rice or wheat. Millets contain approximately 8.0% protein and 4.0% fat and are a rich source of vitamins and minerals. The dietary carbohydrate content in millets is relatively high. The major portion of their proteins comprises prolamines and glutelins. The fats from millets contain a higher portion of unsaturated fatty acids, supplying essential fatty acids that are beneficial for health. Millets are particularly rich in unavailable carbohydrates, resulting in a slow release of sugar. The protein in millets contains amino acids in balanced proportions and is especially abundant in methionine, cysteine, and lysine. Millets also provide significant quantities of important vitamins, namely thiamine, riboflavin, and niacin. Being a rich source of dietary fiber, millets offer a wide range of nutrients and phytochemicals, including dietary fiber, vitamin E, magnesium, and folate, which optimize health [50].

Finger millet, also known as ragi, is particularly noteworthy for its high protein, iron, calcium, phosphorus, fiber, and vitamin content. It contains higher calcium content than all other cereals and has the highest iodine content among all food grains. Ragi stands out for its quality protein, essential amino acids, Vitamin A, Vitamin B, and phosphorus [24]. Due to its richness in antioxidants and phytochemicals, ragi is easily and slowly digestible, making it beneficial in controlling blood glucose levels in diabetic patients. It is a valuable dietary source for various groups, including growing children, expectant women, elderly individuals, and patients [32].

Nutritional composition of millets

Millets are distinguished from other cereals by their rich content of calcium, dietary fiber, polyphenols, and protein [17]. These grains are particularly abundant in essential amino acids, including sulfur-containing amino acids like methionine and cysteine. They also have higher fat content compared to maize, rice, and sorghum [42]. Cereal grains, including millets, are essential sources of dietary nutrients globally and are extensively used in the food industry [5,31]. The total dietary fiber content in finger millet is reported to be higher (22.0%) than in many other cereal grains like wheat, rice, maize, and sorghum, which range from 4.6% to 12.8%. However, pearl millet contains dietary fiber ranging between 8% to 9% [49]. Millets are also known for their polyphenol content, particularly phenolic acids and tannins, which act as antioxidants and contribute to the immune system's defense [13,19]. The dietary fiber content in millet-based foods can vary significantly depending on the extent of milling, with whole grains offering higher fiber content.These grains are a valuable source of carbohydrates, providing energy, and are rich in magnesium and phosphorus. Magnesium aids in reducing the effects of migraines and heart attacks, while phosphorus is crucial for energy production in the body [16]. Millets' carbohydrate content mainly consists of starch and non-starchy polysaccharides, making them beneficial for health [17].

Nutritional Composition of Millets as compared with major cereal crops (Per 100 g)

Commodity	Protein (g)	Carbohydrates (g)	Fat (g)	Crude fibre (g)	Mineral matter (g)	Calcium (mg)	Phosphorus (mg)
Sorghum	10.4	72.6	1.9	1.6	1.6	25	222
Pearl millet	11.6	67.5	5.0	1.2	2.3	42	296
Fingermillet	7.3	72.0	1.3	3.6	2.7	344	283
Proso millet	12.5	70.4	1.1	2.2	1.9	14	206
Foxtail millet	12.3	60.9	4.3	8.0	3.3	31	290
Kodo millet	8.3	65.9	1.4	9.0	2.6	27	188
Little millet	8.7	75.7	5.3	8.6	1.7	17	220
Barnyard millet	11.6	74.3	5.8	14.7	4.7	14	121
Barley	11.5	69.6	1.3	3.9	1.2	26	215
Maize	11.5	66.2	3.6	2.7	1.5	20	348
Wheat	11.8	71.2	1.5	1.2	1.5	41	306
Rice	6.8	78.2	0.5	0.2	0.6	10	160

Figure 4: Nutritional composition of millets.

Effect of processing on nutritional quality of millets

Various processing technologies are employed in the manufacturing of food products to enhance their nutritional characteristics, sensory properties, and convenience. Additionally, traditional household food processing and preparation methods can be utilized to improve the availability of micronutrients in plant-based diets. These methods encompass thermal processing, mechanical processing, soaking, fermentation, and germination/malting. The primary objectives of these procedures are to increase the physicochemical accessibility of micronutrients, reduce the levels of antinutrients like phytates, and boost the presence of compounds that enhance nutrient absorption [27].

Consumption of millets in India

According to reports from the National Nutrition Monitoring Bureau (NNMB, 2006), sorghum consumption is high in Gujarat (maize, pearl millet), Maharashtra (sorghum), and Karnataka (sorghum), but it is almost negligible in Kerala, West Bengal, Orissa, and Tamil Nadu, where rice is the dominant staple. In Gujarat and Maharashtra, grain consumption was higher (200 g/CU and 132 g/CU, respectively) compared to Karnataka (75 g/CU/day), Madhya Pradesh (32 g/CU/day), and Andhra Pradesh (16 g/CU/day). Pearl millet stover serves as a crucial fodder for livestock in various parts of India and Africa. The limited demand and unreliable availability of pearl millet grains in international markets have led to minimal exports and imports [11].

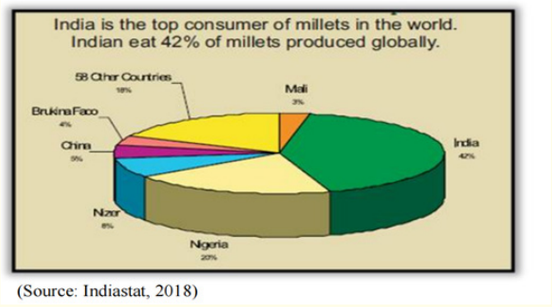

Figure 5: Consumption of millets.

Factors responsible for lower consumption of millets

The limited preference for millets has resulted in irregular supply, while cheap and more preferred millets are not readily available due to underdeveloped marketing channels between production areas and consumers. Additionally, food aid systems like the public distribution system primarily supply cereals like rice and wheat, further contributing to the lack of regular millet consumption. Another challenge is that millets have been categorized as "Orphan crops" because of the lack of global trade. However, the government is making efforts to encourage millet cultivation through various schemes and by introducing new-generation nutrient-rich millets, such as teff millet, chia, brown top millet, and quinoa. These endeavors aim to break the social stigma associated with millets being perceived as "food for the poor" and to combat malnutrition in the community.

While millet cultivation offers significant advantages, research on improving age-old cultivation practices is still in its early stages and requires attention to popularize these nutritious foods. Recently introduced millets command higher market value than major cereals, contributing to uplifting the socio-economic status of marginal farmers in dryland regions.

Potential health benefits

Millets are known for their abundance of nutraceutical components, including antioxidants, polyphenols, and crude fibers, making them valuable for enriching processed products with health benefits. Consumption of finger-millet-based diets has been associated with lower plasma glucose levels compared to rice and wheat due to the higher fiber content in finger millet. The lower glycemic response of whole finger-millet-based diets may be attributed to the presence of anti-nutritional factors in whole finger millet flour, which can reduce starch digestibility and absorption [34]. Dehulled and heat-treated barnyard millet has been reported to have a low glycemic index, making it potentially beneficial for individuals with type 2 diabetes [54].

Millets are considered rich sources of magnesium and phytochemicals, such as phytic acid, which can lower cholesterol levels and reduce the risk of migraine and heart attack [14]. The presence of phenolic acids, tannins, and phytate in millets act as "antinutrients" and have been associated with reducing the risk of colon and breast cancer in animals [25,52]. Since millet is gluten-free, it serves as an excellent alternative for people with celiac disease or those allergic to gluten found in wheat and other cereal grains.

Therapeutic advantages of millets

Millets offer several therapeutic advantages, particularly for individuals with Diabetes Mellitus, the most common metabolic disorder affecting humans and leading to various health complications. Including millets in the diet can be beneficial due to their composition. They are rich in complex carbohydrates, low in fat, and abundant in fiber. The consumption of millets has been associated with hypocholesterolemic and hypoglycemic effects on humans. They also act as effective binders with toxins, promoting their elimination through stools in the colon. Regular consumption of millets has been linked to a lower occurrence of cardiovascular diseases, duodenal ulcers, and hyperglycemia in individuals who include them in their diet [58].

International trade

Most of the millet grains are consumed in the countries where they are produced, with approximately 97% of millets being cultivated by developing nations, particularly by resource-poor and marginal farmers. However, there has been a gradual increase in both import and export of millets from the 1960s to 2017, with import growing by 25.4% and export by 25.9%. During the last decade, the import and export of millet grains reached 374.5 and 376.4 thousand tons, respectively. The surge in importation was

particularly prominent in the 1970s, mainly due to a high demand for millets in Europe. The global import and export values of millets reached their peak during 2011-2017, with the highest recorded values being $155.26 million and $127.60 million, respectively. Analysis of average data from 2010 to 2017 indicates that Asia is the largest importer of millet grains, accounting for more than 65% of the global import., America holds the position of the largest exporter of millets, with over 83% of the global millet export attributed to it. Among different countries, India, the United States, Argentina, and China together contribute to more than 33% of millets export (FAOSTAT 2018) [18]. India is a major player in pearl millet export, while the United States dominates in proso millet exports. Similarly, China stands as the largest exporter of foxtail millet.

The global trade of sorghum is primarily driven by the demand for animal feed and price differences between sorghum and maize (Hariprasanna and Rakshit 2016). The highest global values for sorghum import ($2290.29 million) and export ($1926.80 million) were recorded during 2010-2017. Around 90% of the global sorghum export is contributed by Argentina, Australia, China, and the United States [26].

Production constraints

Millet farming is predominantly concentrated in developing nations, where the average productivity remains below the global average [47]. Moreover, the availability of improved millet seeds in most developing nations relies on informal seed chains, resulting in the cultivation of less productive and heterogeneous landraces or local cultivars [44]. The challenges are mainly due to inherent problems such as high seed shattering and unsynchronized maturity. Biotic constraints, such as diseases, insect-pests, parasitic nematodes, birds, parasitic plants, and weeds, also pose significant challenges to millet cultivation. Several diseases, including downy mildew, blast, grain mold, smut, rust, ergot, and charcoal rot, affect different millet species [15,48]. Weed infestation is a major constraint in global millet production, leading to a significant reduction in grain yield [12]. Manual weed management and bird scaring further increase the cost of producing quality seeds in minor millets.

Abiotic constraints related to environmental and soil factors, such as moisture stress, nutrient stress, salinity, alkalinity, acidity, and heat stress, also impact millet production. Moisture stress, especially in dryland areas where millets are primarily grown by resource-poor farmers, is considered the most critical constraint. Drought can occur at various growth stages of millets, leading to significant yield reductions. In African countries, drought is one of the most significant stress factors for millet production [22,37]. In India, millets (sorghum and finger millet) are cultivated in two seasons, during the rainy and post-rainy seasons. Soil salinity and poor drainage particularly affect the crop during the seedling emergence stage [37]. Changes in food habits and consumer preferences have resulted in the conversion of millet-cultivated land to other high-value cereal grains, leading to a reduction in millet production. In India, the millet cropping area decreased from 8 million hectares during the late 1940s to 2.3 million hectares during 2011-2012, primarily due to a shift towards cultivating other cereal grains [45].

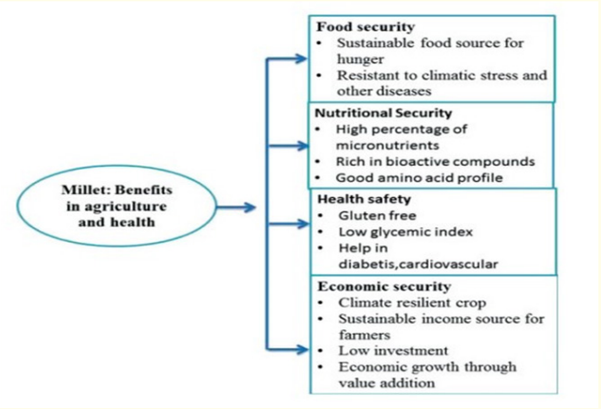

Figure 6: Millet: Benefits in agriculture and health.

Millet for food and water security

Food security is achieved when all individuals have physical, social, and economic access to safe, sufficient, and nutritious food that meets their dietary needs and preferences, enabling them to lead active and healthy lives. The four pillars of millet food security encompass the availability, access, utilization, and stability of food [52]. Millets are exceptionally well-suited to adapt to changing dietary patterns and climatic conditions due to their short growth cycle, high photosynthetic efficiency, nutritional richness, and moderate resistance to pests and diseases [57]. In India, a quantitative analysis of shifting monsoon cereal production highlighted millets as a potential solution to ensure food security and environmental resilience. These grains are abundant in proteins, niacin, fiber, thiamine, riboflavin, methionine, lecithin, and contain essential minerals such as iron, magnesium, calcium, and potassium. Their consumption is associated with various health benefits, including cancer prevention, reduced risk of heart disease, and improved gastrointestinal health, among others [9].

Moreover, millets serve as an excellent source of phytochemicals, including polyphenols, lignans, phytosterols, phytoestrogens, and phytocyanins, which contribute to immune regulation, detoxification, and antioxidative properties, guarding against age-related degenerative illnesses like cancer, diabetes, and cardiovascular diseases (CVD). Millets are suitable for those with celiac disease and gluten allergies, as they are gluten-free and easy to digest. Additionally, they offer defense against age-related degenerative illnesses, metabolic syndrome, Parkinson's disease, and other degenerative conditions, while also boosting the respiratory system's immunity, increasing energy levels, and improving muscular and neural functions. These health benefits can be attributed to their content of resistant starch, oligosaccharides, lipids, antioxidants, phenolic acids, avenanthramides, flavonoids, lignans, and phytosterols [53]. Compared to other cereal crops like rice and wheat, millets offer higher nutritional content and drought resistance, making them a sustainable choice. Moreover, millets provide sig-

nificant benefits to millions of people, particularly small/marginal farmers in rain-fed regions, by providing food security and a stable source of income.

Threats on millet cultivation

Millets face a significant threat in India due to the unnatural promotion of maize, resulting in maize invasion in various parts of the country [40]. It plays a vital role in ensuring food and nutritional security for the nation. The urgency to prioritize millets is heightened by the challenges posed by climate change in the coming decades. Rising global warming, increasing water scarcity, and the projected malnutrition affecting 70% of the Indian population, particularly the poor and vulnerable, necessitate resilient and adaptable crops like millets. With their hardiness and ability to withstand harsh climatic conditions, millets present an ideal solution to tackle climate change.

Dr. Rama Naik emphasizes that millets are among the most nutritious food grains available in India, and regular consumption of millets leads to better health, even in old age. These crops can aid in managing and preventing lifestyle diseases such as diabetes and obesity. One of the constraints faced in promoting millets is the lack of processing facilities at the community level.

Figure 7: Millets.

Market potential

The Millet Market is projected to witness substantial growth during the forecast period (2023-2028), with its size expected to increase from USD 11.02 billion in 2023 to USD 13.80 billion by 2028, representing a Compound Annual Growth Rate (CAGR) of 4.60%.

Millet is a group of small-seeded cereals, including sorghum, finger millet, pearl millet, barnyard millet, proso millet, and little millet. These hardy crops are cultivated across more than 32 million hectares worldwide, thriving in diverse and challenging climates, such as dry, semi-arid, and sub-humid agricultural regions. Among the leading millet-producing nations, India, Niger, and China account for over 55.0% of the global production, with India being the largest producer.

In recent years, Africa has witnessed a significant surge in millet production as many countries in the region promote dryland agriculture due to water scarcity and favorable sub-tropical climatic conditions for millet cultivation.

Millets offer high protein content, making them particularly appealing to the vegetarian and vegan populations in regions like the United States, Europe, and the Asia-Pacific. The ongoing pandemic has positively impacted the millet market as people increasingly incorporate millets and their derivatives into their diets, favoring nutrient-rich foods over junk foods to enhance immunity and overall health. As a result, the demand for millet-based products is experiencing rapid growth in these regions, driving the expansion of the millet market.

Government Initiatives

- The government has taken several measures to promote millets, aiming to boost both domestic and international demand while providing nutritious sustenance to the people. In 2018, India celebrated the "National Year of Millets," and subsequently, the UN General Assembly endorsed India's proposal to designate 2023 as the "International Year of Millets."
- In April 2018, the Union Agriculture Ministry recognized millets as "Nutri-Cereals" due to their exceptional nutritive value and beneficial properties in managing diabetes.

The National Food Security Mission (NFSM), initiated in October 2007, includes the Government of India's Millet Mission. This dedicated mission focuses on enhancing farm-gate processing, empowering farmers through collective efforts, and giving priority to value addition and increased aggregate production of millets.

Figure 8: Government initiatives of millets.

Advantages

All millets can be cooked in a manner similar to rice once they are dehulled. Italian millet, for instance, is consumed as stiff porridge known as "sargatic" or as leavened bread called "roti" after milling the dehulled grain into flour. Proso millet flour serves as a substitute for rice flour in various snack foods. However, millet protein lacks gluten, making it unsuitable as the sole material for bakery products. Millets and black gram are mixed in a ratio of 3:1, wet ground, and fermented overnight. The resulting batter can be used to make idli, dosa, or wet pan cakes. Moreover, millets can be utilized in the preparation of non-conventional foods such as flakes, extruded products, or by parboiling, popping, and malting. Flakes are made by soaking pearled millets, steaming them under

pressure to fully gelatinize the starch, drying them to about 18% moisture, and then pressing them between heavy-duty rollers before drying further.

Strategies to increase millet production

As millets and small millets are predominantly grown in marginal and sub-marginal drylands by poor farmers, fluctuations in their production not only bring hardships to farmers but also create instability in the total coarse cereal production. To address this, developmental efforts should focus on minikit demonstrations and State Level Training Programmes. It will help popularize newly released varieties among farmers, replacing low-yielding local varieties Furthermore, non-monetary inputs such as line sowing, optimum row spacing, seeding depth, and timely cultural practices for higher productivity should be explained and demonstrated to farmers right in the field. Agronomic research should focus on developing efficient, low-cost technologies that are easily adoptable by farmers.

Millets should be integrated into the existing Public Distribution System (PDS) and introduced in meals twice a week in schemes like the Integrated Child Development Services (ICDS), school mid-day meals, welfare hostels, and others. The government should be determined in converting cultivable fallows into millet farms. With focused efforts and support for millet cultivation on these lands, the country has the potential to produce a minimum of 25 million tonnes of millets, 5 million tonnes of pulses, and fodder to feed an astounding 50 million heads of cattle.

Figure 8: Harvested millet.

Millet products by nutrelis

Nutrelis Agro Foods has launched varieties of millet products which not only delightful but also provides important nutrients to the body.

Millet Cookies

Millet cookies are delicious and nutritious baked treats made with the inclusion of millet grains in the dough. These cookies offer a unique texture and flavor, with the millet grains providing a delightful crunch. Packed with essential nutrients like protein, fiber, vitamins, and minerals, millet cookies offer a healthier alternative to traditional cookies, appealing to health-conscious individuals, vegetarians, and vegans alike. The combination of millet's nutritional benefits and the delectable taste of cookies makes them a popular choice for the consumer.

Figure 9: Different types of millet cookies.

Figure 10: Varieties of middles noodles.

Millet noodles

Millet noodles are a made from millet flour, offering a nutritious and gluten-free alternative to traditional wheat-based noodles. Millet, a group of small-seeded cereals, is ground into flour and used to create these noodles. Millet noodles are known for their light and delicate texture, making them a versatile option for various dishes. They are particularly popular among individuals with gluten sensitivities or those seeking healthier carbohydrate options. These noodles can be prepared in a similar way to regular noodles, boiled until tender, and then used in soups, stir-fries, salads, or any dish that calls for noodles. Millet noodles not only add a unique taste and texture to meals but also provide the nutritional benefits of millet, including essential nutrients like protein, fiber, and various vitamins and minerals.

Millet pasta

Millet pasta is a type of pasta made from millet flour, which is a gluten-free and nutritious alternative to traditional wheat-based pasta. It is well-suited for individuals with gluten sensitivities or those looking for healthier grain options. It has a mild and slightly nutty flavor and can be cooked in boiling water until tender, similar to regular pasta. Millet pasta can be used in various pasta dishes, such as spaghetti, penne, or macaroni, offering a delicious and nutritious way to enjoy pasta while benefiting from the nutritional qualities of millet, including protein, fiber, vitamins, and minerals.

Figure 11: Millet pasta.

Millet puff

Millet chips are savory snacks made from millet grains, offering a wholesome and tasty alternative to traditional potato or corn-based chips. These chips are typically seasoned with various flavors, such as salt, herbs, spices, or cheese, to enhance their taste. Millet chips are gaining popularity as a healthier snack option due to their nutritional benefits. They are often gluten-free, making them suitable for individuals with gluten sensitivities. Millet is a good source of protein, fiber, vitamins, and minerals, adding to the appeal of these chips as a nutrient-rich snack. These crunchy and flavorful millet chips can be enjoyed on their own as a satisfying snack or paired with dips, salsas, or other condiments for added taste.

Conclusion

The implementation of new field demonstration methods has shown significant potential for increasing yields through recommended technologies. Farmers adopting these practices have experienced substantial improvements in yield levels and income. For instance, the adoption of recommended technology led to an increase of around 82% in finger millet, 95% in little millet, 83% in kodo millet, 43% in foxtail millet, 76% in proso millet, and 82% in barnyard millet. Despite their low genetic potential, small millets are still cultivated due to the socio-economic conditions of farmers and the assured income they provide under low-input conditions.It ensures nutritional security for the family and improving soil productivity and health. Similarly, the use of new high-yielding varieties and fertilizers has significantly influenced crop yields. Despite the health-promoting components present in millets, there is still a lack of awareness, research, and processing techniques leading to their underutilization as cereals. Novel processing and preparation methods are needed to improve the bioavailability of micronutrients and enhance the quality of millet-based diets. Developing millet-based nutraceutical products at an economical cost is essential to ensure proper utilization and improve the nutritional status of society.

Acknowledgement

We sincerely acknowledge the valuable contributions of all the researchers and experts whose work has been reviewed and cited in this paper. Their significant research efforts have laid the foundation for our study and enriched its content. A very thanks to Nutrelis Agro Foods for providing a full fledged R&D Lab for doing the research. The lab consists of modern euipments which provided me with precise accurate results. It helped me a lot in conducting the research work. We also extend our gratitude to the peer reviewers for their insightful feedback and suggestions, which have greatly improved the quality of this review.

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