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Pearl millet (*Pennisetum glaucum*) production in the 21st century

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Abstract

Pearl millet, commonly known as bulrush millet is one of the most significant millet crops grown in arid and semi-arid regions of the world. Pearl millet belongs to the family *Poaceae*, subfamily *Panicoideae*. Pearl millet is critically important for food and nutritional security as it possesses several advantages such as early maturing, and drought tolerance, requiring the minimum purchase of inputs, and being mostly free from biotic and abiotic stresses. Its grains have high protein content, a balanced amino acid profile, and high levels of iron, zinc, and insoluble dietary fiber. It has special health-benefiting properties for people suffering from lifestyle diseases like diabetes, obesity, etc. as it has high proportions of slowly digestible starch (SDS) and resistant starch (RS) that contribute to the low glycemic index (GI). Pearl millet is gluten-free and retains its alkaline properties even after being cooked which is ideal for people suffering from gluten allergy and acidity.

Keywords: Pearl millet, review, health, SDS, GI, birdseed, ICRISAT gene bank, forage crop

Introduction

Pearl millet (*Pennisetum glaucum* (L.) R. Br.] is the sixth most important cereal crop after rice, wheat, maize, barley, and sorghum. It is widely grown on 30 million ha in the arid and semi-arid tropical regions of Asia and Africa, accounting for almost half of the global millet production. It is also consumed as feed and fodder for livestock. It is the sixth most important cereal crop in the world next to maize, rice, wheat, barley, and sorghum. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat, and maize. It is one of the oldest food crops known to man and possibly the first cereal grains to be used for domestic purposes (Railey, 2006) [2]. Especially in locations under significant environmental stress due to drought, it has been predicted that pearl millet symbolizes a tremendous yield potential. In relatively short order, pearl millet offers staple food for the underprivileged in the country's dry regions. Is a good source of protein (11%) has higher digestibility (12.1%), fats (5%), carbohydrates (69.4%), and minerals (2.3%)., & it is nutritionally superior to many kinds of cereal (Shweta, 2015) [3]. It is a short-day crop that flowers, or flowers earlier, when day lengths are short (Billiard and Pernes, 1985; Clerget *et al.*, 2007) [16, 17] and long photoperiod delays floral initiation (Uzoma *et al.*, 2010). A significant warm-season coarse grain cereal, pearl millet is farmed on 26 million ha in some of the dry, semi-tropical regions of Asia and Africa. India, along with sorghum, has the largest area (9–10 million acres) dedicated to this crop. It is grown in the driest, least fertile where no other grain crop can thrive, such as dry Rajasthan soils and drought-prone areas. Even in these circumstances, pearl millet produces 300–400 kg of grain per hectare.

Distribution

Pearl millet accounts for about 50 % of the total area under all millets in the world. Pearl millet is cultivated on about 32 m ha in more than 30 countries of four continents, viz., Asia Africa, North America, and Australia. Pearl millet is cultivated on about 14 m ha in Africa and on about 12 m ha in Asia. Among all pearl millet growing countries, India has the largest area (>8 million ha) with 8.5 million tons of production. The developing countries in Asia and Africa contribute about 93 % of total millet production in the world. Asia alone contributes 43 % of world millet production. Recently pearl millet cultivation has expanded to a 4–5 m ha area in Brazil. The states growing pearl millet in India are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, Haryana, Tamil Nadu, Andhra Pradesh, and Karnataka, though the first four states

account for >90 % of pearl millet acreage in the country. Most of the pearl millet in India is grown during the rainy (Kharif) season (June–September) but is also cultivated during summer (February–May) in Gujarat, Rajasthan, and Uttar Pradesh and during post-rainy (*rabi*) season (November– February) at a small scale in Maharashtra and Gujarat (Mula *et al.* 2009)^[14]. During the *Kharif* season, pearl millet is largely grown as a rainfed crop except in some areas in Eastern Rajasthan, Southern Haryana, and Western Uttar Pradesh where supplemental irrigation is provided in case of a shortage of rainfall during the crop season. Summer season pearl millet is cultivated as an irrigated crop under high levels of agronomic management. Yields of more than 50 q/ha have been experienced in FLDs and 70 and 80 q/ha were achieved in national demonstrations with good management practices.

Pearl Millet Production

The area and production of pearl millet in the world are combined with other millet crops like finger millet, foxtail millet, etc. So, data are not available for the pearl millet crops alone. However, pearl millet accounts for almost half of global millet production.

60% of the world's millet area is in Africa. Asian countries occupy 35% of the world's millet area. European countries cover 4% of the millet area and 1% is in North America.

The developing countries in Asia and Africa contribute around 93% of total millet production in the world. Asia alone contributes 43% of world millet production. European countries produce 6% and 1% is in North America (Bisht, 2021)^[13].

India is the largest producer of this crop, both in terms of area (9.1 m ha) and production (7.3 m t), with an average productivity of 780 kg/ha during the last five years. As compared to the early 1980s, the pearl millet area in India declined by 26% during the last five years, but production increased by 19% owing to a 44% increase in productivity. Pearl millet cultivation is dispersed mainly during Kharif (Rainy) season across the country. It is also grown to a lesser extent during Rabi (Post-rainy) season in Andhra Pradesh, Karnataka, Tamil Nadu, and Pond cherry States. Summer pearl millet is popular in Gujarat State with a very high yield exceeding 1.88 tons per ha with excellent grain quality. It is also grown during the summer season in Punjab, Rajasthan, and obtain India, the yield of pearl millet varies from state to state with varying rainfall and soil type, and also between seasons. The productivity imbalance in pearl millet is due to no rain/erratic rains/shifting of Pearl millet cultivation to marginal soils due to the diversification of traditional areas to high-value crops across the country. Only about 8% of the pearl millet area is irrigated.

Pearl millet is a descendant of the wild West African grass and was domesticated over 4,000 years ago in the West African Sahel, spreading later to East Africa and India (Sharma *et al.*, 2020)^[5]. Now it is being cultivated over 30 million ha worldwide, with the majority of the crop grown in Africa (>18 million ha) and Asia (>10 million ha) (Raheem *et al.*, 2021)^[6]. Pearl millet grain is a staple diet for about 90 million people in the Sahelian region of Africa and northwest India (Srivastava *et al.*, 2020)^[5]. According to (Jukanti *et al.*, 2016)^[7], pearl millet's genesis and evolutionary history have been evaluated. It is grown on 30 million ha in the arid and semi-arid tropical regions of Asia and Africa, accounting for about half of the world's millet production, with 60% of the

cultivation area in Africa and 35% in Asian nations. It is the sixth-largest cereal crop in the world, after maize, rice, wheat, barley, and sorghum. India is the biggest producer of pearl millet in terms of both area and output. India produced 17.96 million tonnes of pearl millet on average between 2019 and 2020, with an average area of 8.5 million ha. It occupies 6.93 million ha, producing an average of 8.61 million tonnes per year at a productivity of 1,243 kg/ha (Directorate of Millets Development, 2020)^[8].

Marketing and Economics

The main commercial market to date for grain-type pearl millet has been the broiler market. Lack of familiarity with the crop has limited its use in other livestock feed markets. However, as feed formulators and buyers become more familiar with the crop, its potential markets will expand. In the meantime, pearl millet grain can certainly be used on-farm as feed for cows, hogs, or poultry (Khairwal, 2007)^[12]. A one-to-one substitution of pearl millet for corn in a feed formulation is usually appropriate. Given its comparable feed value to corn, pearl millet has been priced based on corn prices, or sometimes at a slight discount relative to corn. In situations where pearl millet delivers superior feed value to corn, it should in the long run receive a premium, but it will take time for such market value to be realized. However, yields of current pearl millet are not competitive with corn or even sorghum on good, fertile soils. Pearl millet has a competitive advantage over corn and sometimes sorghum on sandier soils in moisture-limited situations. Yields of grain-type pearl millet are expected to rapidly improve with the release of new hybrids over the next several years. At this time, 4000 to 4500 pounds per acre would be a reasonable yield on good soils, with 3000 pounds typical on more marginal soils. Thus, gross income based on these yields will be well under \$200 per acre if corn is priced below \$2.50/bushel (Delate, 2013)^[11]. Even though production costs on pearl millet are low (comparable to corn and sorghum), grain yields need to be increased by breeders to help make the crop competitive on larger acreage.

Another potential market for pearl millet is as part of wild birdseed mixes. Although no research has been done on its use as birdseed, it has been repeatedly noted that a number of songbirds, including goldfinches and juncos, enjoy feeding on the seed. Sorghum is often used in birdseed mixes, but pearl millet may be more attractive to certain songbirds. The birdseed market could potentially absorb tens of thousands of acres of pearl millet grain production. In the mid-1990s, a few thousand acres of pearl millet were sold into the commercial birdseed market. The birdseed market could generate higher prices for pearl millet than the feed market, provided the demand is strong enough. Price initially would depend on whether the pearl millet was substituted for sorghum (low value) or proso millet (moderate value) in birdseed mixes.

Pearl millet consumption

Pearl millet is consumed primarily as food in most developing countries. Pearl millet grain is also used as bird feed, but this use is largely restricted to developed countries. But its utilization pattern is changing even in developing countries where its use is growing in feed, alcohol, beer making, and food processing industry. Pearl millet fodder is an important feed resource in the crop–livestock systems where the crop is grown. In India, pearl millet is usually pounded into flour and

then used to make a range of dishes for consumption. It is consumed mainly in the rural areas of western and central India. However, with the introduction of cheaper rice and wheat through the Public Distribution System (PDS), consumers of pearl millet in rural areas have shifted away from pearl millet to the consumption of wheat and rice.

Conclusion

Pearl millet being a climate-resilient crop along with high nutritional value can be exploited for improving nutritional quality and combating malnutrition. It is almost free from major diseases and insect attacks and could be cultivated with a good harvest. Hence, the focus should be laid on the development of food products from pearl millet to make it acceptable as an alternative crop of the future. 100 grams of bajra has the following nutritional values: energy 360 calories, moisture 12 g, protein 12 g, fat 5 g, mineral 2 g, fiber 1 g, carbohydrate 67 g, Calcium 42 mg, phosphorus 242 mg, and iron 8mg. By any nutritional parameter, millets are miles ahead of rice and wheat. In terms of their mineral content, compared to rice and wheat. Each one of the millets has more fiber than rice and wheat. Some as much as fifty times that of rice. Finger millet has thirty times more Calcium than rice while every other millet has at least twice the amount of Calcium compared to rice. In their Iron content, foxtail and little millet are so rich that rice is nowhere in the race. While most of us seek a micronutrient such as Beta Carotene in pharmaceutical pills and capsules, millets offer it in abundant quantities.

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