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Biofortification in *Pennisetum Glaucum* L. Progress and Prospects

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Abstract

The process of producing crops into highly nutritious food crops, to supply an unceasing, long-term technique for delivering micronutrients to rural populations in developing countries is known as biofortification. . Biofortification is a cost-effective practice of nutrient fortification using modern breeding, enhanced agronomic practices, transgenic approaches and microbiological interventions. It is an attainable and economical means of bringing micronutrients to populations that may have determinate access to diverse diets and other micronutrient interventions. It is required to enhance mineral absorption in vivo from cereal-based diets. Genetic engineering as well as traditional and modern breeding approaches are being used for the biofortification of crops. It is a good pathway to remove hidden hunger from many suffering poor people.

Keywords:-Biofortification, Conventional breeding, Genetic engineering, Hidden hunger, Micronutrients.

Introduction

Pearl millet [Pennisetum glaucum L.] is the major staple food grown on more than 26 mha in the arid and semiarid tropical regions of Asia, Africa, and Latin America. In India, it is the fourth most widely cultivated crop with an average production of 9.73 mt. It has high nutritional value and is rightly termed as nutritional as it is rich in protein, essential fatty acids, dietary fiber, vitamins, and minerals such as calcium, iron, zinc, potassium, and magnesium. It helps in rendering several health benefits, but its direct consumption of food has significantly declined over the past three decades for various reasons.

It is a highly nutritious cereal and established as a “nutritional” due to the presence of good quality protein, vitamins, unsaturated fatty acids, carbohydrates, insoluble dietary fiber, and minerals such as iron, zinc, magnesium, calcium, and potassium and the year 2023 was

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declared as the "Year of Millets". The major health problems among the poor in India Pearl millet [Pennisetum glaucum L.] is the main staple food grown on more than 26 mha in the arid and semiarid tropical regions of Asia, Africa, and Latin America. The major health problems among the poor in India are due to micronutrient deficiencies and to meet the challenge of hidden hunger. biofortification can prove to be an effective approach. It is cost-effective because it involves only a one-time investment in plant breeding. In addition, biotechnological tools and genomic studies using high throughput genomic tools are also promising approaches as they have huge potential to accelerate genetic gains and improve breeding efficiency in the changing climatic scenario.

Biofortification

Biofortification is a method of breeding crops to increase their micronutrient content. Micronutrient deficiencies lead to poor health and considerable efforts are being made in this direction to improve the health of poor people by breeding staple food crops enriched with essential micronutrients using strategies like biofortification on global and national fronts. Biofortification is the approach to enhancing the content and bioavailability of essential vitamins/minerals in crops using modern breeding, transgenic approaches, improved agronomic practices, and microbiological interventions. It helps in changing genetic architecture, increasing micronutrient uptake and properly distributing them in edible tissues to safe levels, reduction in antinutrients in food staples ultimately leading to crop improvement (Bouis et al., 2011). It is an upcoming, cost-effective, sustainable, and effective strategy to deliver essential micronutrients to a larger population that has limited access to diverse diets. Further, the efficiency of the biofortification approach mainly depends on the farmer's and consumer's acceptance and future policy interventions.

Biofortification in pearl millet

Biofortification research in pearl millet has shown large variability for Fe (31-125 ppm) and Zn (35-82 ppm) content with good prospects of developing cultivars with higher contents of these micronutrients. Biofortification Priority Index (BPI) indicates pearl millet is a major target crop for iron and zinc biofortification. Pearl millet has a relatively higher content of Fe & Zn but commercially available cultivars have lower Fe and Zn content. Thus, pearl millet biofortification research focuses on the development of high-yielding and high-Fe/Zn hybrids in India. The gene banks of pearl millet contain varieties with high levels of iron and zinc which may be used to produce new pearl millet varieties with elevated iron levels bred with the high yielding varieties.

Conventional approaches are good but time-consuming and need the support of genomics, genetic transformation, and various modern biotechnological tools to accelerate millet development programs. Molecular tools and genomic studies are gaining a lot of momentum these days as they are playing a major role in crop improvement programs. The advanced next generation sequencing (NGS) and molecular profiling tools are more efficient in detecting DNA sequence variations over several loci and identifying and tagging genes underlying a trait. Enormous development in the area of genomics during the past years has rendered various novel tools for precise and faster breeding programs. Recently, the whole genome sequencing of pearl millet has been carried out and the draft genome and resequencing data will help researchers better understand the trait variation while advancing the genetic improvement of the crop. Genetic maps, NGS, GBS, GWAS, transgenic approaches, molecular tools, genomic studies,--synteny studies, expression profiling, fine QTL mapping, candidate gene identification and genetic engineering technology, transcriptomics, proteomics, and metabolomics are some of the useful platforms which can be used for the advancement of nutrient-rich pearl millet.

Conclusion

Biofortification is very useful for addressing the issue of malnutrition and will be more accessible in the long term because it eliminates hurdles and is independent of any infrastructure or procurement. Also, the normal taste and texture of grains remain, such as plants absorbing minerals in organic forms and which absorb obviously bioavailable. The bio-fortification is quite long and is being discussed in several forums, but yet more efforts are required to take it into the mainstream, including a focus on its bioavailability. In conclusion, biofortification strategies and multidisciplinary research are required to move forward and raise the importance of nutritional pearl millet more effectively, so that the products can be made reliable and available to consumers, are due to micronutrient deficiencies and to meet the challenge of hidden hunger, biofortification can prove to be an effective approach. It is the cost[effective because it involves only a one-time investment in plant breeding. In addition, biotechnological tools and genomic studies using high throughput genomic tools are also promising approaches as they have huge potential to accelerate genetic gains and improve breeding efficiency in the changing climatic scenario.

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