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Biofortification: A way to combat hidden hunger

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Introduction

Food is a basic necessity of all living creatures and is the source of vital energy. Food has a great impact on the health of individuals and thereby building a healthy society. Availability of quality food is equally important along with quantity. The food crop has undergone significant improvements in productivity and production over the last few decades, under the moniker "Green Revolution". As a result, we are in a reasonably secure position to satisfy the demand for food. However, the major focus was emphasized on production and productivity to hasten the food supply rather than giving importance to its nutritional status. The micronutrient content of staple food crops is not at its optimal level, and processing further decreases this concentration. Regular consumption of calorie-rich food with low nutrient status will cause an invisible deficiency of nutrients in the body called hidden hunger. There are various methods to combat this problem. In this chapter, an overview of strategies to overcome hidden hunger is explained with a major emphasis on biofortification.

Balanced diet

One of the natural, healthy, and sustainable ways to overcome nutrition deficiency is a balanced diet. A balanced diet contains an adequate amount of all the nutrients required by the body to grow, remain healthy and be disease-free. In addition, a healthy, balanced diet provides the necessary energy requirement, protects against vitamin, mineral, and other nutritional deficiencies, and builds up immunity. Even though it is one of the best methods of a healthy diet, the availability of various kinds of food sources is seasonal and location-specific. People living in the poverty-stricken area cannot afford healthy food and often depends on a few staple foods crop available in the locality. Hence, enhancing the nutrient content of staple food crops has become the need of the day.

Food supplements

Food supplements are concentrated sources of nutrients or other substances with a nutritional or physiological effect that are marketed in the form of pills, capsules, syrups, etc. They are mainly intended to correct some deficiencies in individuals for quick resort. Supplementation of iron, calcium, and vitamin supplements is commonly recommended for people whose daily diet has an inadequate quantity of these vitamins and minerals. Governments are running such supplementation programs for children and women for enhancing their health. However, this is purely an artificial method and requires government and institutional effort to supply doses to the people. Implementation and acceptance of this program are scanty in reality.

Food fortification

Fortification is the practice of deliberately increasing the content of one or more micronutrients (i.e., vitamins and minerals) in food or condiment to improve the nutritional quality of the food supply and provide a public health benefit. Food fortification is done to prevention, reduction, and control of micronutrient deficiencies. It can be used to correct a demonstrated micronutrient deficiency in the general population (mass or large-scale fortification) or in specific population groups (targeted fortification) such as children, and pregnant women. Some of the compulsory fortification programs are done by the government such as table salt fortification with iodine, flour fortification in industrial mills, etc. even though it is a successful program but fortified elements will not be an integral part of the food. Hence, biofortification came as an alternative, sustainable, easy, and natural way of enhancing food quality by biological means.

Biofortification

The term 'biofortification' was coined in the year 2001 by Steve Beebe. Enhancing the nutrition status of crop plants following biological or natural ways is called biofortification. It can be considered as a subclass of food fortification utilizing biological processes. Biofortification has the advantage of sustainable increment in the food's nutritional status and nutrients will be an integral part of tissues enhancing the bioavailability. Bio-fortification is the process of increasing vitamin and mineral density in a crop through conventional plant breeding, transgenic approach, or agronomic practices. The regular consumption of staple bio-fortified crops produces measurable improvement in human nutrition and health. Among the different micronutrients main targets of biofortification are iron, zinc, selenium, vitamins, and some important amino acids like thymine. Biofortification can be done through agronomic, genetic, or transgenic means.

Agronomic biofortification

sustainable agriculture, natural or organic farming with low-yielding landraces can maintain soil health. However, to meet food demand, large-scale cultivation of high-yielding varieties and monoculture lead to the exploitation of the available nutrient status of the soil. It has become necessary to feed crops before they feed us. The application of nutrients in the form of fertilizer or foliar spray to enhance the nutrient content of food grains is called agronomic bio-fortification. For example, enhanced zinc and iron content in wheat or rice can be achieved by either foliar spray or soil application of zinc and iron fertilizers. Agronomic biofortification (fertilizers) for selenium has been made mandatory in Finland to ensure sufficient selenium content in crops. Even though it is an easy method of biofortification, educating farmers and mandatory application of fertilizer with micronutrients is taken care of.

Genetic biofortification

Using different breeding methods, the nutrient levels of staple crops can be increased to the target level without altering the agronomic traits and compromising yield levels. Available variations for nutrient content in the germplasm lines, pre-breeding lines, wild relatives, and landraces can be used for enhancing the nutrient status of food crops. Breeding targets for each micronutrient are based on the consumption pattern of the target population, nutrient bioavailability, and losses during processing and storage. Conventional breeding approaches following hybridization, segregation, and screening are one of the most commonly followed approaches to develop lines with higher nutrient content. However, the influence of the environment is very high in the expression of micronutrient content in plants, especially, soil nutrition status, irrigation, and abiotic stress. Advanced breeding tools such as marker-assisted selection, QTL mapping, and genome-wide association study were followed.

Some examples of, varieties with enhanced Zn, Fe, and selenium are available in staple crops like wheat, rice, maize, pearl millet, etc. WB2 and BHU1 in wheat, HHB229 and AHB 1200 in maize, Jalmagna in rice, Dhanshakti in pearl millet, Parbhani Shakti in sorghum, IPL220 in lentils are some examples of biofortified varieties for micronutrient released in India. Other important components of food such as vitamins and anti-oxidant contents were also enhanced by breeding approaches. β Carotene and anthocyanin-rich varieties in wheat, sweet potato, and cauliflower were developed. Quality protein maize (QPM) with high lysine, tryptophan, and pro-vitamin A content are also targets of breeders to tackle deficiency of these amino acids in corn. The presence of anti-nutritional factors in the food crop decreases the bioavailability of nutrition and has a major impact on health. Hence, reduced erucic acid and glucosinolate in the mustered lead to the development of single zero and double zero varieties. Genetic bio-fortification is one of the safe and economical ways of enhancing the food value of crop plants.

Transgenic biofortification

Along with the genetic approaches the transgenic approach has also been used to increase the mineral accumulation ability of crops mainly of iron and zinc through increased uptake from the soil, and reduction in the anti-nutritional factors content like phytic acid. Increased provitamin A or β Carotene was achieved by transgenic technology in rice by inserting the genes phytoene synthase (PSY), phytoene desaturase (CrtI), and lycopene β-cyclase (β-lcy) to produce yellow-colored rice called Golden Rice. This technology was also extended to wheat, maize, canola, and cassava to enhance their provitamin content. Transgenic for biofortified Zn in rice has been developed using HvNAS1, phytase, and OsNAS1 genes. The transgenic soybean varieties rich in oleic acid and linoleic acid were developed through transgenic approaches. Transgenic technology can be efficiently utilized to develop biofortified varieties of crop crossing reproductive barriers. However, government regulation and social acceptance is the real question for transgenics.

Conclusion

The consistent effort of governments and other international institutes brought down micronutrient deficiency compared to earlier decades. Food fortification, food supplementation, and biofortification played a crucial role in making this happen. However, micronutrient deficiencies are still a key public health concern, especially in underdeveloped and developing countries. In the coming future biofortification should be more intensively tried for meeting the global sustainable development of human health. Different biofortification strategies need to be implemented in a need-based manner to achieve a nutritious food supply. Biofortified crops are aimed to complement the existing micronutrient deficits and in turn, they should have a visible impact on the health of millions of people suffering from hidden hunger. The use of the biofortification strategy for the improvement of micronutrient contents of staple crops across the world needs strong support and consistent efforts.

References

Gupta, P. K., Balyan, H. S., Sharma, S., & Kumar, R. (2021). Biofortification and bioavailability of Zn, Fe and Se in wheat: present status and future prospects. *Theoretical and Applied Genetics*, *134*, 1-35.

Kumar, S., Dikshit, H. K., Mishra, G. P., & Singh, A. (Eds.). (2022). *Biofortification of Staple Crops*. Singapore: Springer.