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Bio-fortification an innovation approach to eradicate hidden hunger: A review

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Abstract
Malnutrition is a major problem in world; more than 2 billion people suffer from 'hidden hunger' in which they are unable to meet the recommended nutrients or micronutrients from their daily dietary intake. Bio-fortification refers to developing micronutrient-rich diet foods using traditional breeding methods and modern biotechnology, a promising approach to nutrition enrichment as part of an integrated strategy for food systems. Bio-fortification varies from conventional fortress since it centres on making plant food varieties more nutritious as the plants are developing; instead of having supplements added to the food varieties when they are being prepared. This is a significant enhancement for common fortress with regards to giving supplements to the country poor, who once in a while approach financially invigorated food source. In that capacity, bio-fortification is viewed as an impending system for managing insufficiencies of micronutrients in low and centre pay nations. On account of iron, WHO assessed that bio-fortification could help restoring the 2 billion individuals experiencing iron inadequacy instigated weakness. Here we examine about some of atomic and reproducing approaches improve the healthful quality in the yields.

Keywords: Malnutrition, hidden hunger, bio-fortification

Introduction
Bio-fortification is the idea of breeding crops to increase their nutritional value. This can be done either conventional breeding or through genetic engineering. The micronutrients currently being targeted by bio-fortification program are iron, zinc and pro vitamin A. Why we need bio-fortification implies one of the reasons for healthiness in India is monetarily imbalance. Supplements save a lot of lives, but bio-fortification is a way to address the underlying cause by breeding plants with higher nutrients, there by substantially reducing the need for more short-term measures. We don't want to claim that bio-fortification is a silver bullet or will eliminate all nutrition problems. Iron (Fe) is an essential micronutrient for most organisms, including all plants and animals. Fe deficiency is one of the most prevalent micronutrient deficiencies globally, affecting an estimated two billion people (Stoltzfus *et al.* 1998) and causing 0.8 million deaths annually worldwide. Iron deficiency is ranked sixth among the risk factors for death and disability in developing countries with high mortality rates.

Review
Bio-fortification is a promising strategy for sustainable long-term approach in combating micronutrient deficiency but successful bio-fortification at the cost of the environmental damage is not acceptable. In agronomic practice, leaching is one of the main concerns in application of fertilizer as it will damage the environment, but most micronutrients are not susceptible to leaching as they are able to form a strong bond with the soil (Valenca *et al.* 2017). However, continuous application of micronutrient fertilizer may cause accumulation of these minerals which result in toxicity. Excessive intake of iron may cause Fe^{2+} and Fe^{3+} to act as a catalyst to form noxious reactive oxygen species (ROS). ROS are strong oxidizing agents, which are able to cause detrimental effect on DNA, proteins, and lipids in plants. Therefore, fertilization strategies should be devised and optimized to ensure adequate supply of iron for proper growth of agronomic plants while minimizing accumulation of iron (Wang *et al.* 1988). For instance, the 4R Nutrient Stewardship principle (application of fertilizer at the right place, right rate, right time and right source) could be implemented with fertilizer application (IPNI Issues 4R Plant Nutrition Maunal).

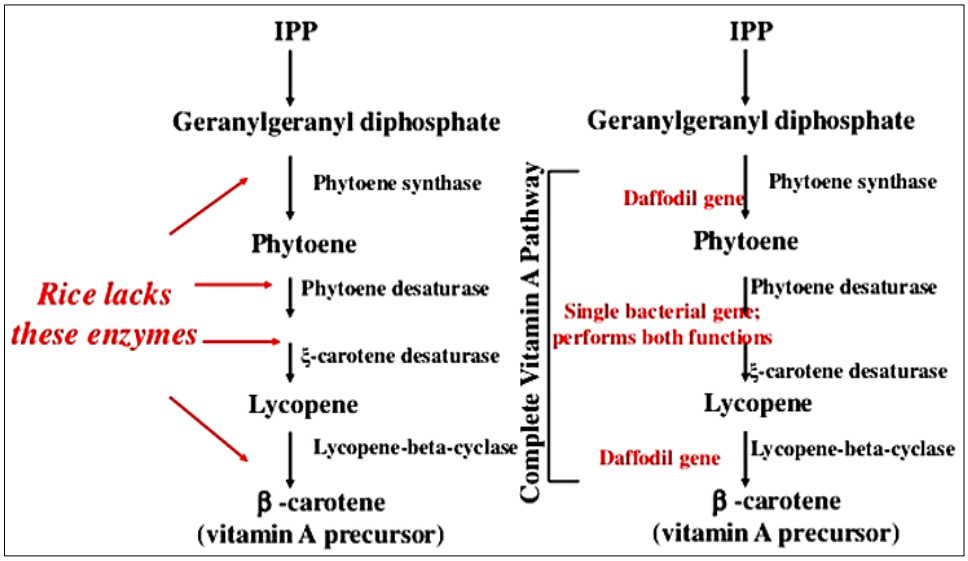
Based on Harvest Plus breeding programs, the iron bio-fortified rice are to meet a recommended target iron level which is approximate 30% of the estimated average requirement (EAR) or 15 µg/g (dry weight) in polished grain. The recommended 30% EAR could be achieved via genetic engineering approaches, however, the iron concentration in rice grain decreases when evaluated under field conditions as compared to iron concentration achieved in rice grown in greenhouse. This demonstrates that interactions between genetic and environment play an important role in Iron concentration in rice.

While iron bio-fortification in rice is a promising approach in combating iron deficiency, the success of bio-fortification is dependent on various factors and it requires the collaboration between different parties ranging from consumer, plant breeder, multilateral organizations, national governments, and researchers from various disciplines. Without the help and adoption from plant breeders, bio-fortified crops are unable to be produced despite the crop has the potential to alleviate micronutrient deficiency. Hence to gain plant breeder acceptance, bio-fortified crops should contain visible and favourable traits such as increased in yield, higher stress tolerant, disease resistance, and other important agronomic traits (Sperotto *et al.* 2012) [7]. Plant breeders may be reluctant to produce the bio-fortified crops with the potential income risk if the consumer does not adopt with the new crop variety especially with bio-fortified crops having their sensory characteristics altered such as the colour and taste (Welch *et al.* 2005) [9]. Some bio-fortified crops have been introduced for production and accepted by the public in some countries despite the change in sensory characteristics (Saltzman *et al.* 2017) [6]. These bio-fortified crops are orange flesh sweet potato, orange maize, yellow cassava, iron pearl millet, and iron beans. Consumer acceptance on bio-fortified crops is not easy and achievable in a short duration of time but it can be accomplished through thoroughly planned strategies such as spreading knowledge among the people, raising awareness of micronutrient deficiency, creating new market opportunities, and creating a demand on bio-fortified variety. On the contrary, the success of iron bio-fortification would results in improved nutritional value of micronutrient-deficient affected areas in developing countries and as a first step toward improving nutritional status worldwide (Beyer *et al.* 1991) [1]. Partially, this includes the utilization of various underlying qualities and the utilization of various selectable marker qualities. With the revelation that the lycopene-cyclase is not important to accomplish pro-vitamin A union, it might even be feasible to eliminate the selectable marker from co-transformants by reproducing strategies. The perception that an administrative pathway might be included calls for top to bottom biochemical and atomic organic examinations, at present being embraced. Studies on the bioavailability of the pro-vitamin A, move of the attribute into agronomically significant assortments, and hazard evaluations will be done in a joint effort with other research organizations (Wieczorek *et al.* 2012) [10]. While the debate on the safety of GM foods will continue with no definite conclusion in the near future, there is much more benefit to this technology than depicted by the mass. There are definitely GM plants that should be adopted immediately such as Golden Rice. Other crops may require further testing before being deemed completely safe for human and the surrounding ecological systems.

Development of golden rice

Golden rice 1

The rates at which T-DNA effectively coordinates into the plant genome and genome and becomes appropriately expressed are low. Frequently, just a single cell in at least 1000 will be effectively changed. Prior to developing refined plant cells into develop plants to test their aggregates; it is essential to wipe out the foundation of non-trans framed cells. This should be possible utilizing either certain or negative choice procedures. An illustration of negative determination includes utilization of a marker quality, for example, the hygromycin-obstruction quality. This quality, alongside a fitting sponsor, can be brought into plant cells close by the nature of interest. The cells are then brooded in culture medium containing hygromycin-an anti-microbial that additionally hinders the development of eukaryotic cells. Just cells that express the hygromycin obstruction quality will endure. It is then important to check that the safe cells likewise express the changed quality. This is frequently done by methods, for example, PCR enhancement utilizing quality explicit preliminaries. Plants that express the quality of interest are then tried for different attributes, including the aggregate gave by the presented quality of interest. An example of positive selection involves the use of a selectable marker gene such as that encoding phosphomannose isomerase (PMI). This enzyme is common in animals but is not found in most plants. It catalyses the inter-conversion of mannose 6-phosphate as well as fructose 6-phosphate. Plant cells that express the pmi gene can make due on engineered culture medium that contains just mannose as a carbon source. Cells that are changed with the pmi gene levelled out of a proper advertiser and the gene of interest can be emphatically chosen by developing the plant cells on a mannose-containing medium. This kind of sure determination was utilized to make Golden Rice 2. Studies have shown that cleaned PMI protein is easily handled, non-allergenic, and nontoxic in mouse oral destructiveness tests. Assortments insure decision incorporates use of a marker quality whose enunciation achieves an obvious total, similar to sworn statement of shaded shading. The accompanying portrayals outline the strategies used to design two GM crops: Roundup-Ready soybeans and Golden Rice 2. Gathering Ready Soybeans, the Roundup-Ready soybean GM assortment got market endorsement in the United States in 1996. It is a GM plant with protection from the herbicide glyphosate, the dynamic fixing in Roundup, an industrially accessible expansive range herbicide. Glyphosate interferes with the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), which is present in all plants and is necessary for plant synthesis of the aromatic amino acids' phenylalanine, tyrosine, and tryptophan. EPSPS is not present in mammals, which obtain aromatic amino acids from their diets. To produce a glyphosate-resistant soybean plant, researchers cloned an epsps gene from the Agrobacterium strain CP4. This gene encodes an EPSPS enzyme that is resistant to glyphosate. They then cloned the CP4 epsps gene downstream of a constitutively expressed promoter from the cytomegalovirus to allow gene expression in all plant tissues. In addition, a short peptide known as a chloroplast transit peptide (in this case from petunias) was cloned onto the 5 end of the epsps gene-coding sequence. This allowed newly synthesized EPSPS protein to be inserted into the soybean chloroplast (ST Figure 1). The final plasmid contained two CP4 epsps genes and, for the initial experiments, a beta-glucuronidase (GUS) gene from *E. coli*.



https://www.google.com/search?q=golden+rice+path+way&tbm

Fig 1: ß-Carotene pathway problem in plants

Golden rice 2

To create Golden Rice 2, scientists cloned three genes into the T-DNA region of a Ti plasmid. The Ti plasmid, called pSYN12424, is shown in ST Figure 1. The first gene was the carotene desaturase (crtI) gene from Erwinia uredovora, fused between the rice glutelin gene promoter (Glu) and the nos gene terminator region (nos). The Glu promoter directs transcription of the fusion gene specifically in the rice endosperm. The nos terminator was cloned from the Agrobacterium tumefaciens nopaline synthase gene and supplies the transcription termination and polyadenylation sequences required at the 3 end of plant genes. The second gene was the phytoene synthase (psy) gene cloned from maize. The maize psy gene has approximately 90 percent sequence similarity to the rice psy gene and is involved in carotenoid synthesis in maize endosperm. This gene was also fused to the Glu promoter and the nos terminator sequences in order to obtain proper transcription initiation and termination in rice endosperm. The third gene was the selectable marker gene, phosphomannose isomerise (pmi), cloned from E. coli. In the Golden Rice 2 Ti plasmid, the pmi gene was fused to the maize polyubiquitin gene promoter (Ubi1) and the nos terminator sequences. The Ubi1 promoter is a constitutive promoter, directing transcription of the pmi gene in all plant tissues. To introduce the pSYN12424 plasmid into rice cells, researchers established embryonic rice cell cultures and infected them with *Agrobacterium tumefaciens* that contained pSYN12424. The cells were then placed under selection, using culture medium containing only mannose as a carbon source. Surviving cells expressing the pmi gene were then stimulated to form calluses that were grown into plants. To confirm that all three genes were present in the transformed rice plants, samples were taken and analysed by the polymerase chain reaction (PCR) using gene-specific primers. Plants that contained one integrated copy of the transgenic construct and synthesized beta-carotene in their seeds were selected for further testing.

Conclusion

Therefore, fertilization strategies should be devised and optimized to ensure adequate supply of iron for proper growth of agronomic plants while minimizing accumulation of iron. Without the help and adoption from plant breeders, bio-fortified crops are unable to be produced despite the crop has the potential to alleviate micronutrient deficiency. Hence to gain plant breeder acceptance, bio-fortified crops should contain visible and favourable traits such as increased in yield, higher stress tolerant, disease resistance, and other important agronomic traits. In molecular aspects Cells that are changed with the pmi gene levelled out of a proper advertiser and the gene of interest can be emphatically chosen by developing the plant cells on a mannose-containing medium. This kind of sure determination was utilized to make Golden Rice 2. Hence forth it might be concluded that the wider adaptation as well as consumption of the Golden Rice 1 and Golden Rice 2 may leads to eradicate the hidden hunger of the growing population.

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