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Biofortification in Fruit Crops

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SUMMARY

Biofortification is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions. Low dietary diversity and major dependence on calorie rich diets are responsible for high malnutrition rates. Micronutrient malnutrition, primarily the result of diets poor in bioavailable vitamins and minerals, affects more than half of the world's population, especially women and preschool children. Highlighting the actual cause to be sole dependence on staples for food, biofortification has emerged as a new tool to combat the widely distributed menace of hidden hunger. Biofortification as being important in the accumulation for controlling micronutrient deficiencies. The challenge is to get producers and consumers to accept biofortified crops and increase their intake of the target nutrients.

INTRODUCTION

The various methods of biofortification for enrichment of food with microelements seems to be the rational method of preventive, not interventionist character. Biofortification as being important in the accumulation for controlling micronutrient deficiencies. The challenge is to get producers and consumers to accept biofortified crops and increase their intake of the target nutrients. With the advent of good seed systems, the development of markets and products, and demand creation, this can be achieved. The strategy seeks to put the micronutrient-rich trait in those varieties that already have preferred agronomic and consumption traits, such as high yield (Saltzman *et. al.*, 2013). Access to a healthy diet is a fundamental right of all human beings. Deficiencies of minerals and vitamins affect a high proportion of the world's population, particularly in the developing world (Stein 2010). Micronutrient deficiencies affect about 3 billion people, and more than 1 billion people mostly in developing countries go to bed hungry every day (FAO 2009). Collectively, over 1.5 million children die globally every year because of nutrition-related deficiencies, particularly of vitamin A, iron, and zinc, with most of those deaths occurring in South Asia and Sub-Saharan Africa (Caulfield *et. al.* 2005). Biofortification focuses on enhancing the micronutrient content of edible part of staple crops as well as their bioavailability. To develop the biofortified varieties in fruits crops like; guava, banana, pomegranate, annona spp., ber, papaya, jackfruit, pineapple, etc. are providing sufficient level of minerals and vitamins to the targeted population.

What is Biofortification?

Greek word "bios" means "life" and Latin word "fortificare" means "make strong". Biofortification is the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, or modern biotechnology. Biofortification differs from conventional fortification in that biofortification aims to increase nutrient levels in crops during plant growth rather than through manual means during processing of the crops. The ultimate goal of the biofortification strategy is to reduce mortality and morbidity rates related to micronutrient malnutrition and to increase food security, productivity, and the quality of life for poor populations of developing countries by breeding staple crops that provide, at low cost, improved levels of bioavailable micronutrients in a fashion sustainable way over time. Albeit biofortified staple foods cannot deliver as high a level of minerals and vitamins per day as supplements or industrially fortified foods, but they can increase the daily adequacy of micronutrient intakes among individuals throughout their life. The overall objective is to incorporate new traits in the highest-yielding material so that its impact in the market is assured and farmers will grow it for the yield advantage. This is especially important in an unsophisticated market that will not pay extra for better nutritional value.

Method of Biofortification

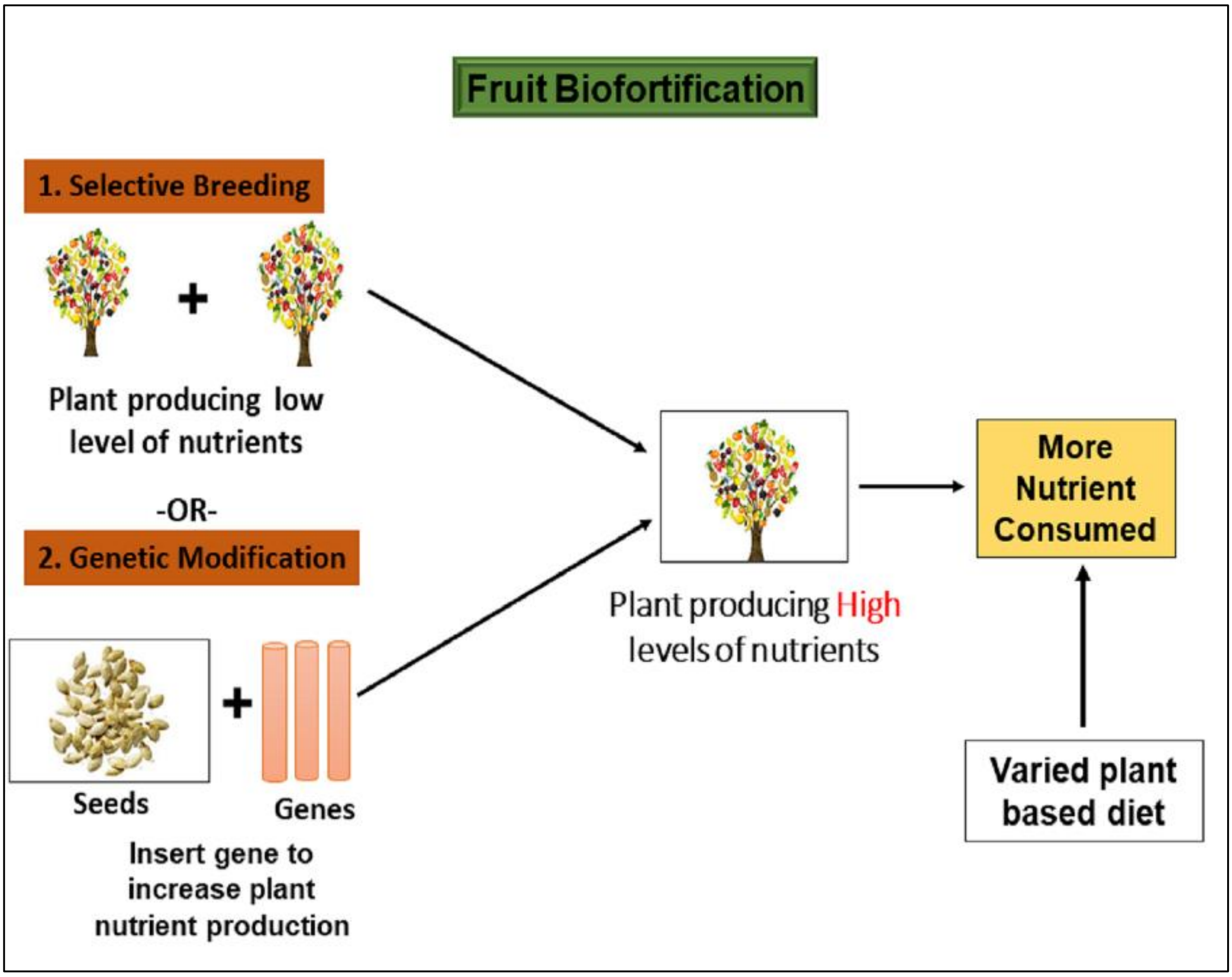
The nutritional value of crops can be enhanced by different biofortification methods, that is, agronomic biofortification, improvement of plant varieties through conventional breeding, and through genetic modification (Bouis *et. al*. 2011).

Agronomic Biofortification

The most attractive agronomic strategy of biofortification is foliar application of mineral fertilizers to the plants in readily phytoavailable state (White and Broadley 2011). Supplementation of fertilizers with nutrients (e.g., zinc, nickel, iodine, and selenium) increases their concentrations in edible plant has been proven fact by various studies (Cakmak 2008).

Conventional Breeding

An alternative approach to fortification through agricultural management is breeding of crops (Poletti *et. al*. 2004). Different varieties of the same plant showing variations in nutritional characteristics are bred conventionally to develop a new improved food crop. A group of scientists from National Research Centre for Pomegranate (NRCP), Solapur, in collaboration with Indian Institute Horticulture Research (IIHR), Bengaluru, has developed a new hybrid pomegranate variety called "NRCP H-6", which has a high content of iron and zinc. Also Solapur Lal-Hybrid Developed by ICAR-National Research Centre on Pomegranate, Solapur.



Genetic Modification

Biofortification has evolved a two-stage strategy: breeding, if possible; modifying, if necessary (White and Broadley 2011). Queensland University of Technology in Australia has developed transgenic bananas with b-carotene. Introduction of a phytoene synthase psyB73 gene from maize and a carotene desaturase crt1 gene from E. uredovora led to the establishment of a biosynthetic pathway for the production of b-carotene. The university has also developed transgenic bananas with vitamin E and iron.

Advantages of Biofortification

- After the one-time investment is made to develop seeds that fortify themselves, recurrent costs are low and germplasm may be shared internationally. It is this multiplier aspect of plant breeding across time and distance that makes it so cost-effective.
- Once in place, the biofortified crop system is highly sustainable. Nutritionally improved varieties will continue to be grown and consumed year after year, even if government attention and international funding for micronutrient issues fades.
- The biofortification strategy seeks to take advantage of the consistent daily consumption of large amounts of food staples by all family members, including women and children who are most at risk for micronutrient malnutrition. As a consequence of the predominance of food staples in the diets of the poor, this strategy implicitly targets low-income households.
- Biofortification provides a truly feasible means of reaching malnourished populations in relatively remote rural areas, delivering naturally fortified foods to people with limited access commercially-marketed fortified foods, which are more readily available in urban areas. Biofortification and commercial fortification, therefore, are highly complementary.
- Breeding for higher trace mineral density in seeds will not incur a yield penalty. In fact, Biofortification may have important spinoff effects for increasing farm productivity in developing countries in an environmentally-beneficial way.
- Mineral-packed seeds sell themselves to farmers because, as recent research has shown, these trace minerals are essential in helping plants resist disease and other environmental stresses.
- More seedlings survive and initial growth is more rapid. Ultimately, yields are higher, particularly in trace mineral "deficient" soils in arid regions.

Constraints of Biofortification

- High production cost. i.e. equipment, technology, patenting, etc.
- Potential negative interaction of biofortified crop/ non-GM crop causing loss of wild type varieties.
- Low substantial equivalence. i.e. inability to provide high micronutrient and protein content compared to supplements.
- For rural populations have limited access and resources to purchase biofortified crops.
- The genetic engineering methods used may compromise immunity in human. i.e. introduced increase risk allergecity.
- Monoculture will wipe out diversity.

Limitations of Biofortification

The biofortification must not be considered as a sole sufficient method to that can fight back huge demon of hidden hunger. To address the root cause of malnutrition a “top-down” approach is needed, that is, social equality, education, and financial security for complete eradication of hidden hunger. Second, biofortification is still in its developing stage and thus a continuous research work and huge financial investments are required. This may lead to concentration and privatization of seeds in the hands of a few transnational corporations that exacerbates the vulnerability of poor farmers. Third, the concept of biofortification poses a threat to ongoing erosion of biodiversity (Johns and Eyzaguirre 2007).

Why micronutrients are important?

The foods we eat provide our body with the raw materials it needs for growth, development and function. There are two basic groups of nutrients that must be obtained through the diet: macro-nutrients and micro-nutrients. Macro-nutrients are comprise of proteins, carbohydrates and unsaturated fats while vitamins and minerals make-up micro-nutrients. All nutrients play different but vital roles in our health and wellbeing. Micronutrients are different from macronutrients (like carbohydrates, protein and fat) because they are necessary only in very tiny amounts. Nevertheless, micronutrients are essential for good health, and micronutrient deficiencies can cause serious health problems. Micronutrients include such dietary minerals as zinc and iodine, and they are necessary for the healthy functioning of all your body's systems, from bone growth to brain function.

CONCLUSION

Biofortification is a cost effective, feasible means of reaching populations who may have limited availability and access to diverse diets, supplements, or commercially fortified foods. A one-time investment in developing for micronutrient rich varieties for farmers to grow for years to come, and the same varieties can be evaluated in other target geographies with similar agro-ecological conditions, thus multiplying the benefit of the initial investment. Biofortified crops offer a rural-based intervention that, by design, initially reaches these more remote populations, which comprise a majority of the undernourished in many countries, and then penetrates to urban populations as production surpluses are marketed. Thus, biofortification complements fortification and supplementation programs, which work best in centralized urban areas and then reach into rural areas with good infrastructure. Biofortification is one solution among many that are needed to solve the complex problem of micronutrient deficiency, and it complements existing interventions. To develop the biofortified varieties in fruits crops like; guava, banana, pomegranate, annona spp., ber, papaya, jackfruit, pineapple, etc. are providing sufficient level of minerals and vitamins to the targeted population.

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