

## Biotechnological Intervention for Biofortification



Biotechnology

KEYWORDS :

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### ABSTRACT

*Malnutrition affects more than half of the world population, particularly in developing countries. Progress has been made to control micronutrient deficiencies through supplementation and food fortification, but new approaches are needed, especially to reach the rural poor. Biofortification is the process of increasing the bioavailable concentrations of an element in edible portions of crop plants through traditional breeding practices or modern biotechnology. The delivery of micronutrients via micronutrient-dense crops through biofortification, offers a cost-effective and sustainable approach, complementing these efforts by reaching rural populations. Improving the nutritional status by developing micronutrient dense staple crops using the modern biotechnology is a highly effective way to increase economic productivity in agriculture and other sectors. Successful biofortification efforts could contribute by focusing on local crops and local varieties rather than global staples. The application of biofortified crops would benefit farmers by increasing their income in the long run.*

### INTRODUCTION

Food security is defined as “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life” (FAO, 1996). A sufficient and balanced diet is possibly the most important contribution to human health and prophylaxis. The most recent estimates from FAO indicate that 945 million people do not receive enough energy from their diets to meet their needs. The majority of these people live in developing countries (FAO, 2010). Micronutrient deficiencies can exist in populations even where the food supply is adequate in terms of meeting energy requirements. In this situations, people are not considered as ‘hungry’, but their diets may be grossly deficient in one or more micronutrients, referred as “hidden hunger” (Mason et al., 2001).

Micronutrient malnutrition affects more than one-half of the world’s population, especially women and preschool children (SCN, 2004). Since gaining independence in 1947, India’s main thrust in agricultural research has been on food security. With a matching progress in the manufacture and consumption of fertilizers, increase in the area under irrigation and development of rural infrastructure, such as, roads, schools, etc., it has been possible to achieve food security in the country. Nevertheless it is high time that along with food security due attention is also paid to adequate micronutrient nutrition in India (Rajendra Prasad, 2010).

#### Major micronutrient deficiencies in humans

Globally three major micronutrient deficiencies have been recognized in humans (Latham, 1986), these are:

##### (i) vitamin A deficiency

Vitamin A deficiency leading to blindness, about 57% of preschool children in India have subclinical vitamin A deficiency (Krishnaswamy, 2009).

##### (ii) iron deficiency

Iron deficiency leading to anaemia; about 79% of the kids between 6 and 35 months of age and 56% of women between 15 and 49 years of age are anaemic in India (Krishnaswamy, 2009).

##### (iii) iodine deficiency

Iodine deficiency leading to goitre and cretinism is endemic in 85% districts in India (Krishnaswamy, 2009).

Micronutrient deficiency of Zn has recently received global attention (Hotz and Brown, 2004).

#### Strategies to address micronutrient deficiencies

The main strategies for addressing micronutrient deficiencies are

##### 1. Dietary diversification

Dietary diversity can be augmented by expanding the produc-

tion processing, marketing and consumption of wide variety of foods.

##### 2. Supplementation

Supplementation is a technical approach in which nutrients are delivered directly by means of syrup or pills.

##### 3. Biofortification

Biofortification is the process of increasing the bioavailable concentrations of an element in edible portions of crop plants through traditional breeding practices or modern biotechnology (White, 2005).

#### Biofortification – A New Approach

The biofortification word comes from Greek word “bios” means “life” and Latin word “fortificare” means “make strong”. Biofortification is the process of increasing the bioavailable concentrations of an element in edible portions of crop plants through traditional breeding practices or modern biotechnology (White, 2005). Biofortification has been defined as the process of increasing the bioavailable concentrations of essential elements in edible portions of crop plants through agronomic intervention or genetic selection. Traditional interventions to address mineral malnutrition have focused on supplementation, food fortification and dietary diversification. For various reasons, none of these have been universally successful. They require safe delivery systems, stable political policies, appropriate social infrastructures and continued investment. Recently, a complementary solution to mineral malnutrition termed ‘biofortification’ has been proposed. Biofortification for enhancing the nutritional properties of crop varieties, reflects the new application of an old technique.

Biofortification may have important spinoff effects for increasing farm productivity in developing countries in an environmentally beneficial way. Exploitation of genes for essential nutrients, through biotechnology and conventional plant breeding, offers a promising route for improving the quality of crop foods. This strategy has received considerable scientific attention and is the focus of a program on biofortification (Bouis et al., 2003). Biofortification differs from ordinary fortification because it focuses on making plant foods more nutritious as the plants are growing, rather than having nutrients added to the foods when they are being processed. This is an improvement on ordinary fortification when it comes to providing nutrients for the rural poor, who rarely have access to commercially fortified foods (Yassir, 2007).

Biofortification of the major food staple crops consumed has considerable potential to increase the micronutrient status of vulnerable populations if the challenges of seed distribution can be overcome. These new biofortified crops have the properties like higher yield, drought resistance, and insect resistance that

farmers look for in a successful crop. Based on the experience with current strategies of food fortification, it is shown that the political environment for biofortified crops developed through conventional breeding is highly favorable. Analyzing the current state of biosafety legislation and the political debates regarding genetically modified (GM) crops in the region, where the current focus is on Bt cotton, it is concluded that the political environment for introducing GM biofortified food crops is at present not conducive.

### Methodology

Biofortification is a method of breeding crops to increase their nutritional value. This can be done either through conventional selective breeding, or through genetic engineering. Plants are bred using one of two main methods.

#### 1. Selective breeding

Using this method, plant breeders search seed or germplasm banks for existing varieties of crops which are naturally high in nutrients. They then crossbreed these high-nutrient varieties with high-yielding varieties of crops, to provide a seed with high yields and increased nutritional value (*HarvestPlus*, 2008). Crops must be bred with sufficient amounts of nutrients to have a measurable positive impact on human health. As such, they must be developed with the involvement of nutritionists who study whether the consumers of the improved crop can absorb the extra nutrients, and the extent to which storage, processing, and cooking of the crops affect their available nutrient levels (Wolfgang, 2007). This method is prevalent at present, as it is quicker, cheaper, and less controversial than genetically engineering crops.

#### 2. Genetic modification (Genetic Engineering)

By using the methods of genetic engineering, a gene which contains the nutrients is inserted in the seed. This seed is when bred with the high yield quality crop; the result will be production of crops rich in micronutrients (*Adnan, 2010*).

Golden rice was produced using this method. Golden rice is an example of a GM crop developed for its nutritional value. This rice is rich in beta-carotene which is the most essential nutrient for the children. It provides vitamin A to the children. Children who are partially blind, they can use this type of rice to fulfill the need of Vitamin A. Golden rice contains genes from the soil bacterium *Erwinia* and either maize or daffodil plants, and contains increased levels of beta-carotene which can be converted by the body into vitamin A. This can help alleviate symptoms of vitamin A deficiency (Paine et al., 2005).

#### Biofortification through biotechnology

Much is known about the molecular mechanisms effecting the accumulation of Fe, Zn, Ca, Mg and Se in plants (Cakmak, 2002). This knowledge will be useful for developing functional (DNA-sequence) markers for conventional breeding and molecular targets for genetic engineering to aid the development of crops with increased mineral concentrations (Vreugdenhil et al., 2005). Transgenic approaches to biofortification rely on improving mobilization from the soil, uptake from the rhizosphere, translocation to the shoot and accumulation of mineral elements in bioavailable forms in edible tissues. The capacity of genetic modification to produce plants with useful traits such as pest resistance, reduced post-harvest losses, increased yield, reduced labour requirements, or enhanced content of particular desirable constituents is readily apparent (Tripp, 2001). Biotechnology is already used to introduce, isolate, and enhance specific nutritional and functional properties in food, motivated by both consumer demand or entrepreneurial innovation (Bouis et al., 2003).

A less ambitious use of biotechnology is marker-assisted selection for quality trait identification (Naylor et al., 2004). While accessions screened for markers of nutrient or phytochemical quality could be used in traditional breeding or biotechnology efforts, they can also be promoted directly to consumers as nutritionally valuable crop varieties. The use of biotechnology to create genetically modified organisms (GMOs) has the potential

to design foods with specific attributes.

Biofortification is a promising new approach to reduce micronutrient malnutrition that could be a game changer in how we deliver micronutrients to impoverished people. Breeding crops to be naturally higher in nutrients through a process called biofortification, is a promising new strategy to reduce hidden hunger that has several advantages. As such, biofortification is seen as an upcoming strategy for dealing with deficiencies of micronutrients in the developing world. Providing staple food fortified with essential amino acids, vitamins and trace elements at no additional cost to the consumer is a provisional solution to the most pressing problem of vitamin and trace element deficiency for the poor in the population. In short, biofortification may well prove to be a sustainable long-term approach for providing millions of poor people in developing countries with at least a part of their micronutrient requirements. As a component of a strategy that includes dietary diversification, supplementation and commercial fortification significant progress could be made in reducing hidden hunger globally.

#### Advantages

Food fortification that involves adding of micronutrients to the food has played an important role in tackling malnutrition to a great extent. Biofortification, on the other hand, improves the genetic potential of the crop plants to produce micronutrient-rich grains and thus offers self-sustaining solution. Biofortification simply adds nutrients to other traits being developed for farmers. In this way, biofortification is integrated into existing farming practices, and does not "require more water or land". Usually when plants are produced through traditional breeding, they have the nutrients which are present in them naturally but the crops produced through biofortification method are always rich in nutrients like iron, zinc and Vitamin A (*Adnan, 2010*).

Biofortification could be the most cost-effective strategy. Biofortification requires a one-time investment to produce a new crop that farmers can grow for years to come. It's a very sustainable intervention. Reduce hidden hunger by providing micronutrients through biofortified staple foods. Used to breed nutrient-rich varieties of common staple crops, such as rice, maize. Biofortified crops have higher yield, drought resistance, and insect resistance. Most biofortified seeds can be saved and shared year after year. Biofortification will play in feeding the future.

#### The possible limitations

Narrow focus – increasing any single micronutrient in the diet is unlikely to address the whole problem. Allergenicity and toxicity – increasing the amount or incidence of certain plant products in the diet could have a negative impact on some peoples health.

#### CONCLUSION

Biofortification is seen as an upcoming strategy for dealing with deficiencies of micronutrients in the developing world. Biofortification offers another tool to cost-effectively provide crucial micronutrients to millions of poor people in rural areas, through the foods that they already grow and eat every day.

Based on micronutrient deficiency rates, there is compelling evidence that biofortification can be a key objective for plant breeders, in addition to the traditional objectives of disease resistance, yield, drought tolerance, etc. Scientific evidence shows that biofortification is technically feasible. Predictive cost-benefit analyses have shown biofortification to be important in the armamentarium for controlling micronutrient deficiencies. The challenge is to get consumer acceptance for biofortified crops, thereby increasing the intake of the target nutrients. With the advent of good seed systems, the development of markets and products, and demand creation, this can become a reality.

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