An International Multidisciplinary e-Magazine
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An International Multidisciplinary e-Magazine

Volume 1| Issue 4 | July, 2021

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BIOFORTIFICATION -A NEW APPROACH TO FIGHT AGAINST HIDDEN HUNGER AND MALNUTRITION

[Article ID: SIMM0082]

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ABSTRACT

So far, our agricultural system has not been designed to promote human health; instead, it only focuses on increasing grain yield and crop productivity. Biofortification is the idea of breeding crops to increase their nutritional value. This can be done either through conventional selective breeding, or through genetic engineering. It is an upcoming, promising, cost-effective, and sustainable technique of delivering micronutrients to a population that has limited access to diverse diets and other micronutrient interventions. Unfortunately, major food crops are poor sources of micronutrients required for normal human growth. The manuscript deals in all aspects of crop biofortification which includes—breeding, agronomy, and genetic modification. It tries to summarize all the biofortification research that has been conducted on different crops. Success stories of biofortification include lysine and tryptophan rich quality protein maize, Vitamin A rich orange sweet potato, generated by crop breeding, oleic acid, and stearidonic acid soybean enrichment, through genetic transformation and selenium, iodine, and zinc supplementation. The biofortified food crops, especially cereals, legumes, vegetables, and fruits, are providing sufficient levels of micronutrients to targeted populations. Although a greater emphasis is being laid on transgenic research, the success rate and acceptability of breeding is much higher. Besides the challenges biofortified crops hold a bright future to address the malnutrition challenge.

Keywords: biofortification, transgenic, malnutrition.

INTRODUCTION

"Biofortification" or "biological fortification" refers to nutritionally enhanced food crops with increased bioavailability to the human population that are developed and grown using modern biotechnology techniques, conventional plant breeding, and agronomic practices. Despite increased food crop production, around two billion people across the world suffer from another type of hunger known as "hidden hunger," which is caused by an inadequate intake of essential micronutrients in the daily diet. Besides this overnutrition is growing matter of concern. Now agriculture is undergoing a shift from producing more quantity of food crops to producing nutrient-rich food crops in sufficient quantities. This will help in fighting "hidden hunger" or "micronutrient malnutrition" especially in poor and developing countries, where diets are dominated by micronutrient-poor staple food crops.

Traditionally, vitamins and minerals have been provided to the masses through nutrient supplementation programs, but it falls short of the goals set by the international health organizations as the supplementation programs rely on external funding that is not guaranteed to be available from year to year. Other limitations are purchasing power of poor people, their access to markets and health-care systems, and lack of awareness regarding the long-term health benefits of these nutrient supplements. Hence, biofortification of different crop varieties offers a sustainable and long-term solution in providing micronutrients-rich crops to people. Furthermore, biofortified crops with increased bioavailable concentrations of essential micronutrients are deployed to consumers through traditional practices used by agriculture and food trade which therefore provides a feasible way of reaching undernourished and low income group families with limited access to diverse diets, supplements, and fortified foods. From an economic point, biofortification is a one-time investment and offers a cost-effective, long-term, and sustainable approach in fighting hidden hunger because once the biofortified crops are developed; there are no costs of buying the fortificants and adding them to the food supply during processing.

Plant-based foods offer an array of nutrients that are essential for human nutrition and promote good health. However, the major staple crops of the world are often deficient in some of these nutrients. Traditional agricultural approaches can marginally enhance the nutritional value of some foods, but the advances in molecular biology are rapidly being exploited to crops with enhanced key nutrients. Nutritional targets include elevated mineral content, improved fatty acid composition, increased amino acid levels, and heightened antioxidant levels.

Hidden hunger is insidious. It strikes people who, on the outside, may appear to be consuming an adequate amount of food—mainly staple crops grown on small family farms. Yet, the calories of many staple crops disguise an invisible hunger that affects the health and wellbeing of people living on the margins. Hidden hunger describes a condition of undernutrition where the body lacks essential vitamins and minerals that keep people healthy. Deficiencies in micronutrients such as zinc, iron and vitamin A can cause profound and irreparable damage to the body—blindness, growth stunting, mental retardation, learning disabilities, low work capacity, and even premature death. The effects of hidden hunger are acute during the first 1,000 days of a child's life—from conception to the age of two years. Micronutrient deficiencies are especially damaging to women. This condition reduces their productivity, decreases their economic potential, and affects their reproductive health outcomes.

MAIN CAUSE OF MALNUTRITION IS POVERTY

Poverty drives people to consume single staple crops to satisfy their basic hunger but these cannot provide the essential vitamins and minerals needed for a healthy body. This problem is exacerbated during periods of rising food prices when consuming a more varied diet a problem even in the absence of economic shocks is economically prohibitive. Poverty, then, becomes both a cause and effect of hidden hunger. Consuming poor diets of primarily staple foods lacking in essential vitamins and minerals has a negative effect on health. Poor health not only decreases the productivity of the people, but can drain the limited resources of the household, the community and, ultimately, the nation.

BREEDING APPROACHES OF BIOFORTIFICATION

Conventional plant breeding is not new, it began hundreds of years ago. Farmers have been altering the genetic makeup of the crops they grow for the past eight to ten thousand years, since the dawn of agriculture. Early farmers chose the best looking plants and seeds and saved them for next year's planting. As the science of genetics became better understood, plant breeders were able to select certain desirable traits in a plant to create improved varieties of plants through genetic engineering. Biofortification was principally developed as a food-based strategy to address widespread deficiencies of vitamin A, iron, and zinc that remain prevalent to the greatest extent in low-income countries. Strategies most widely implemented for the prevention of micronutrient deficiencies are the distribution of micronutrient supplements in pharmacological preparations, and food fortification, with far less investment thus far in dietary diversification strategies. In this context, there are several potential advantages and limitations to biofortification as a micronutrient intervention. Biofortification is targeted primarily to the rural poor who rely heavily on locally produced staple foods as their primary source of nutrition, and who often have restricted financial or market access to commercially processed fortified foods. The biofortification strategy has potential for sustainability as, once planting material is obtained, it can often be saved, recycled, and further disseminated to other farmers. Once initial development and dissemination are completed, recurring costs of maintaining production of biofortified crops are estimated to be low. However, the additional amount of micronutrient achievable through biofortification will be modest compared to amounts supplied in supplements, and in some cases fortified food. The time required to develop a viable crop with a stable, minimum level of additional nutrient content can extend up to 6–8 years or more. As such, there is less flexibility to adjust the content and combination of nutrients according to specific needs.

CONCLUSION

Humans require more than 22 mineral elements, which can all be supplied by an appropriate diet. However, the diets of populations subsisting on cereals, or inhabiting regions where soil mineral imbalances occur, often lack Fe, Zn, Ca, Mg, Cu, I or Se. Traditional strategies to deliver these minerals to susceptible populations have relied on supplementation or food fortification programs. Unfortunately, these interventions have not always been successful. An alternative solution is to increase mineral concentrations in edible crops. This is termed 'biofortification'. It can be achieved by mineral fertilization or plant breeding. There is considerable genetic variation in crop species that can be harnessed for sustainable biofortification strategies. Furthermore, in the next few decades, a major population increase might take place in the developing world and with the changing climatic conditions; achieving food security will pose a greater challenge.