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Biofortification: Enhancing Nutrition for a Healthier Tomorrow

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ABSTRACT

Nutritious diets are crucial for overall human health and growth. Cereals and pulses are commonly consumed in developing nations to meet daily nutritional needs and provide essential micronutrients. However, hidden hunger and malnutrition continue to pose significant challenges worldwide. In addition to having a significant impact on growth, development, cognitive function, and physical working capacity, hidden hunger has been linked to multiple newborn and maternal fatalities. Therefore, addressing this issue is of utmost importance. Currently employed methods in food crops to combat malnutrition and hidden hunger include transgenic techniques, plant breeding, and agronomic biofortification. These methods can be effectively utilized to biofortify crops and mitigate malnutrition.

INTRODUCTION

Healthy eating is vital for human growth and well-being. cereals and pulses are staple foods that are consumed to meet daily nutritional needs and as a source of micronutrients. However, they fail to provide balanced nutrition due to deficits in various necessary components, macronutrients, and micronutrients. For example, grains are low in iron, zinc, some essential amino acids, and high-quality proteins, meanwhile, pulses contain anti-nutrient molecules, which limit micronutrient bioavailability. As a result, the population suffers from malnutrition, which leads to various ailments. Therefore, it is important to biofortify cereals and pulses in order to reduce malnutrition and provide the general public with balanced diets.

Biofortification is the process to enhance the important mineral and vitamin content and their bioavailability in the edible portions of staple food crops. It ensures optimal mineral absorption, transfer to edible portions, and bioavailability. Biofortification of cereals and pulses for essential micronutrients is very important to resolve the issue of malnutrition, so that it can cure hidden hunger while providing everyone access to a balanced diet.

Malnutrition and Hidden hunger

Malnutrition is the state in which the body has either excessive amounts of nutrients from food (overnutrition) or not enough (undernutrition), which can have a negative impact on health. Consuming foods high in calories but low in minerals and vitamins can result in hidden hunger, sometimes referred to as micronutrient deficiency, a symptom of undernutrition. Malnutrition is a growing concern in a world population that is constantly growing. It is expected that that the current global population of 7.8 billion would increase to 8.3 billion by 2030 and UNFAO estimates that 792.5 million people worldwide suffer from malnutrition, with the developing world accounting for a larger share of cases (Shahzad *et al*., 2021)

The important micro- or macronutrients, such as zinc, iron, selenium, iodine, folic acid, lysine, vitamin A, vitamin B12, vitamin C, vitamin D, and others are either absent from their diets or present in insufficient amounts. These nutrients and vitamins are required for the human body to grow, develop and function properly. Short-term deficiencies in these micronutrients do not pose much of a threat, but long-term deficiencies can lead to a number of illnesses, including rickets (vitamin D deficiency), scurvy (vitamin C deficiency), pellagra (niacin deficiency), beriberi (vitamin B deficiency), and anemia (Fe deficiency).

Biofortification provides numerous advantages over other methods for addressing malnutrition and hidden hunger. It can be implemented at lower cost after the early stages of development, and meets the nutritional demands of both urban and rural populations. Foods can be biofortified with several kinds of nutrients without affecting their cost. The primary drawback of biofortification is that it is unable to rapidly enhance the overall health of populations with severe dietary deficiencies.

Biofortification methods

Biofortification can be accomplished through improved agronomic practices, conventional breeding and modern biotechnological interventions.

Agronomic biofortification involves the practice of applying mineral fertilizers to soil or crops in order to increase the concentration and bio accessibility of specific nutrients. It aims at increasing mineral solubilization and mobilization. The composition of the soil, the mobility and solubility of minerals, the capacity of crops to absorb minerals, and the accumulation of bioavailable minerals at non-toxic concentrations in the edible portions of the crops all affect the effectiveness of agronomic interventions (Ofori *et al.* 2022). Agronomic biofortification mainly focuses on minerals rather than vitamins as the vitamins are produced in the crops. (Ofori *et al.* 2022). Agronomic biofortification is easy to implement and provides immediate outcomes. However, the high cost of mineral fertilizers utilized in agronomic biofortification increases the cost of biofortified crops, making them unaffordable for poor populations.

Plant breeding-based biofortification tries to improve the concentration and bio-accessibility of minerals in crops by exploiting genetic variations between crops of similar species. To increase the effectiveness of biofortification, plant breeding methods should concentrate on introducing genotypes that would improve the intake, transport and redistribution of minerals. Conventional, molecular, and mutant breeding methods can be used for biofortification of crops. Among these, the most popular and widely recognized method of breeding plants for biofortification is conventional breeding.

Conventional breeding improves crop nutritional attributes while maintaining other agronomic aspects. It involves crossing crops with traits for high nutrient density and agronomic features to create new variety with desirable nutrient and agronomic properties. In mutation breeding, differences in genetic traits among crops are created by induced mutations by using chemical treatment or physical methods. These created variations are utilized further for biofortification. Biofortification with molecular breeding involves locating the position of a gene responsible for increasing nutritional quality and markers that are closely associated with that gene. (Ofori *et al.* 2022). Conventional breeding can then be used to incorporate the desired trait into the crop with the help of the marker.

New Breeding Techniques such as transgenic breeding, RNA interference etc. are improving crop biofortification by creating novel genetic variation that is not already present in the gene pool. Transgenic breeding can improve biofortification by introducing genes that reduce anti-nutrient compounds or enhance micronutrient accumulation and bioavailability. RNA Interference is a sequence-specific gene regulatory process that inhibits a gene's transcription or translation. It is initiated by a double-stranded RNA (dsRNA) molecule. Through biofortification and bio-elimination, RNAi offers a platform for high-quality food. It is frequently used to improve the nutritional value of crops and get elimination of contaminants and food allergens (Shahzad *et al.*, 2021).

Examples of biofortification:

A successful example of biofortification is the Golden rice where the beta-carotene content present in rice was improved genetically. Beta-carotene is a protein that the body converts into vitamin A. Many crops such as wheat, rice, beans, sweet potato and maize have been biofortified with zinc. Similarly, some iron biofortified crops are rice, beans sweet potato etc.

DRR Dhan 45 and DRR Dhan 48 are varieties rich in zinc content, developed by Indian Institute of Rice Research, Hyderabad. WB 02 is a biofortified wheat variety rich in iron and zinc content and it was developed by Indian Institute of Whear and Barley Research, Karnal. HD 3171 is also a wheat variety biofortified with higher zinc content, developed by Indian Agricultural Research Institute, New Delhi. Pusa Ageti Masoor is a biofortified lentil variety rich in iron content, developed by Indian Agricultural Research Institute, New Delhi

CONCLUSION:

Micronutrient deficiencies or hidden hunger are still a problem, especially in underdeveloped areas. Biofortification is a sustainable and affordable way to improve the health and well-being of people with limited resources. Micronutrient deficiency can be addressed by plant breeding, transgenics and mineral fertilizer applications. Therefore, biofortification could enhance nutritional health worldwide and bring us one step closer to reducing hunger and malnutrition.

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