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Significance of Biofortification in Horticultural Crops

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Micronutrient malnutrition is known to affect more than half of the world's population and considered to be among the most serious global challenges to humankind. Modern plant breeding has been historically oriented toward achieving high agronomic yields rather than nutritional quality, and other efforts related to alleviating the problem have been primarily through industrial fortification or pharmaceutical supplementation. Micronutrient malnutrition or the hidden hunger is very common among women and preschool children caused mainly by low dietary intake of micronutrients, especially Zn and Fe. Increasing population, inadequate food and nutrition, hunger, malnourishment of vitamins and micronutrients etc. are the biggest challenges to address most of the nations across the world. Vitamin A deficiency (VAD) predominant in developing countries among children and women which leads to >600,000 deaths each year globally among children <5 year of age. Among the micronutrient malnourishment of population about 60% of iron, 30% of zinc, 30% of iodine and 15% of selenium are predominant. Inadequate availability of these important vitamins and micronutrients resulted in many health and physical disorders in human beings. Traditional agricultural practices can partly enhance the nutritional content in plant foods but biofortification is a practice of nutrient fortification into food crops using agronomic, conventional and transgenic breeding methods to provide a sustainable and long term strategy to address negative impacts of vitamin&nutrient deficiencies. Biofortification works have been practiced in most of the horticultural crops like Banana, Cassava, Beans, Potato, Orange sweet potato (OSP), Cowpea, Pumpkin etc. several conventional and transgenic varieties have been released.

What is Biofortification?

Biofortification is the process of adding nutritional value to the crop.It refers to nutrient enrichment of crops to address the negative economic and health consequences of vitamin and mineral deficiencies in humans.

Need for Biofortification

Vitamin A deficiency (VAD) is an important health concern in developing countries among children and women of childbearing age[**1**] and is estimated to account for >600,000 deaths each year globally among children <5 years of age.According to Government of India statistics provided to the World Health Organization (WHO) 62% [1] of all preschool-age children are VAD. Iron (Fe), zinc (Zn), and selenium (Se) deficiencies are serious public health issues and important soil constraints to crop production, particularly in the developing countries.

Methods of Biofortification

1. Agronomic bio fortification
2. Conventional plant breeding
3. Genetic engineering

Agronomic Biofortification

Application of fertilizers to increase the micronutrients in edible parts. The degree of success in agronomic biofortification is proportional to the mobility of mineral element in the soil as well as in the plant[**2**].Most suitable micronutrients for agronomic bio fortification Zinc, (foliar applications of Znso4),Iodine(Soil application of iodide or iodate), Selenium(as selenate).The application of inorganic Se fertilizers resulted in over 10-fold increase in Se concentrations. Synthetic metal chelators (e.g. EDTA-Fe- and Zn-chelates which were effective in increasing mineral concentration in edible vegetable and fruit tissues) [**3**].Foliar application is the quick and easy method of nutrient application to fortification of micro nutrients (Fe,Zn,cu etc.) in plants. Several studies have found that the mycorrhizal associations increase Fe, Se, Zn and Cu concentrations in crop plants **[4].**AM-fungi increases the uptake and efficiency of micronutrients like Zn, Cu, Fe etc.

Conventional Plant Breeding

Traditional breeding mainly focused on yield attributes and resistance breeding from last four decades and lack of priority on nutritional aspects lead's to decreased amount of nutrient status in the existed varieties. Examples of minerals that their mean concentration in the dry matter has declined in several plant-based foods are Fe, Zn, Cu and Mg **[5]**. Recent progress in conventional plant breeding has given emphasis on fortification of important vitamins, antioxidants and micronutrients.

Genetic Engineering

Lack of sufficient variation among the genotypes for the desired character/trait within the species,or when the crop itself is not suitable for conventional plant breeding (due to lack of sexuality; e.g. banana) then genetic engineering offers a valid alternative for increasing the concentration and bioavailability of micro nutrients in the edible crop tissues.One of the main concerns is these-called 'gene flow' environmental problem, i.e. the concern of transfer of foreign genes to non-target species **[8]**.Targets for transgenes include, redistributing micronutrients between tissues, increasing the efficiency of biochemical pathways in edible tissues, or even the reconstruction of selected pathways. Some strategies involved in the removal of 'antinutrients'.Since then, there have been similar successes with other crops, giving us a variety of carotenoid-enriched foods **[9]**

Targeted Horticultural Crops Present

Biofortification works have been practiced in most of the horticultural crops like Banana, Cassava, Beans, Potato, Orange sweet potato (OSP), Cowpea, Pumpkin etc. several conventional and transgenic varieties have been released.

Minerals and Vitamins

Minerals, in the context of the human diet, are inorganic chemical elements (or more properly their dissociated ions) that are required for biological or biochemical processes including

the accumulation of electrolytes. Carbon, hydrogen, nitrogen, and oxygen are excluded from the list as these are found in common organic molecules. There are 16 essential minerals, but

11 of them are required in such small amounts and/or are so abundant in food and drinking water that deficiency arises only in very unusual circumstances. The remaining five are present in limiting amounts in many foods, so a monotonous diet can easily result in deficiency. These minerals are iodine (I), iron (Fe), zinc (Zn), calcium (Ca), and selenium (Se).

Alleviating Hidden Hunger Interventions

The term "hidden hunger" has been used to describe the micronutrient malnutrition inherent

in human diets that are adequate in calories but lack vitamins and/or mineral elements. The diets of a large proportion of the world's population are deficient in Fe, Zn, Ca, Mg, Cu, Se, or I, which affects human health and longevity and therefore national economies. Mineral malnutrition can be addressed by increasing the amount of fish and animal products in diets, mineral supplementation, and food fortification and/or increasing the bioavailability of mineral elements in edible crops.

Promotion of Dietary Diversification

Education is an important element in ensuring that improvements in income result in better

maternal and child health. However, dietary diversification is constrained by resource availability for poor households and seasonal availability of fruits and vegetables. Promotion of home gardens is often touted, but the poor have a high opportunity cost for their labour and often limited land. Increased production of fruits and vegetables for household use reduces resources available for other income-earning or food production activities. This type of effort is also relatively expensive and difficult to sustain on any large scale.

Biofortification: Strategic Advantages

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.

Future Challenges

- Promote initiatives supporting large-scale prospective studies on the effects of iron biofortified crops on effectiveness of the adopted biofortification strategy in relieving
- iron deficiency anemia and in improving general health.

- Improve the efficiency with which minerals are mobilized in the soil.
- Improve the efficiency with which minerals are taken up from the soil into the roots of the plant.
- Improve the transport of minerals from the roots to storage tissues, such as grain.
- Increase the capacity of storage tissues to accumulate minerals in a form that does not
- impair plant vegetative growth and development, but remains bioavailable for humans.
- Reduce the level of antinutritional compounds such as phytic acid, which inhibit the absorption of minerals in the gut.

Conclusion

Biofortification in horticultural crops is a transformative approach to enhance the nutritional quality of our food supply. By fortifying essential nutrients in fruits and vegetables, we not only combat malnutrition but also contribute to a healthier, more resilient global population. As we move forward, prioritizing research, investment, and public awareness will be crucial in realizing the full potential of biofortification to create a world where everyone has access to nutritious and wholesome food.

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