Vol. 3 Issue-9, May 2023 (e-ISSN: 2582-8223)

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Biofortification of Fruits Crops

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ARTICLE ID: 06

Article

"Biofortification" or "biological fortification" refers to nutritionally enhanced food crops with greater bioavailability that are designed and cultivated utilizing modern biotechnology techniques, conventional plant breeding, and agronomic approaches. Currently employed solutions for food crops include agronomic biofortification, plant breeding, and transgenic methods. Cereals, legumes, oilseeds, vegetables, and fruits have been biofortified utilizing all three of these techniques. The transgenic technique is sustainable, efficient, and quick, which makes it appropriate for biofortification operations. Moreover, omics technology has been implemented to enhance the efficacy of the transgenic method.

Strategies for Biofortification

1. Agronomic biofortification

Agronomic biofortification is the process of applying mineral fertilizers to soil or crops in order to increase the concentration and bioavailability of specific nutrients in the crops. Because vitamins are generated in crops, agronomic biofortification is mostly focused on minerals and not vitamins. And therefore, agronomic biofortification can't be employed alone to eliminate micronutrient deficiencies and should be combined with other biofortification strategies to be effective.

2. Plant breeding

Plant breeding entails creating genetically distinct or novel crop varieties with enhanced micronutrient content. Biofortification through plant breeding tries to increase the mineral content and bioavailability of crops through the utilization of genetic differences between closely related species. The most prevalent and well acknowledged method of plant

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breeding for biofortification is conventional breeding. Combining crops with genotypic traits such as elevated nutrient density and other agronomic qualities to develop new variety with desirable nutrient and agronomic attributes constitutes conventional biofortification.

Mango Breeding

Mango is a natural source of beta-carotene, vitamin C, and beneficial antioxidants, however the quantities of these nutrients vary by type. It has been noted that the majority of mango types exceed the daily value recommendations for vitamin C and beta-carotene. Mango also contains phenolic compounds such as ellagic acid, gallotannin, and mangiferin. The Ataulfo variety from Mexico had the highest levels of vitamin C (ascorbic acid) and beta-carotene, according to the USDA's Agricultural Research Service. The Indian Agricultural Research Institute (IARI) introduced numerous varieties to India that had improved nutritional qualities and agronomically essential traits.

Grape Breeding

Grapes have a high mineral content, as well as high levels of vitamins C and K, are a natural source of antioxidants and other polyphenols, and provide numerous additional health advantages. The phenolic components and antioxidant capabilities of many Chinese grape varieties have been evaluated. The Indian Agricultural Institute has introduced a new cultivar, PusaNavrang, which is richer in total soluble solids (carbohydrates, organic acids, proteins, lipids, and minerals) and antioxidants.

3. Genetic engineering/transgenic

Genetic engineering is different from plant breeding in that it is not limited to crops from the same species. Genetic engineering has been shown to be a good way to solve this problem. It has also been demonstrated to be an effective method for improving crops such as bananas and apples that cannot be enhanced through conventional plant breeding. Using plant breeding and biotechnology concepts, genetic engineering enables the addition of novel nutritional or agronomic features to specific crop kinds. When genetic engineering is applied for biofortification, it identifies and describes the genes that could be inserted into crops to give them nutritional benefits. It uses genes from bacteria, fungus, and numerous other creatures.

Apple (*Malusdomestica*)

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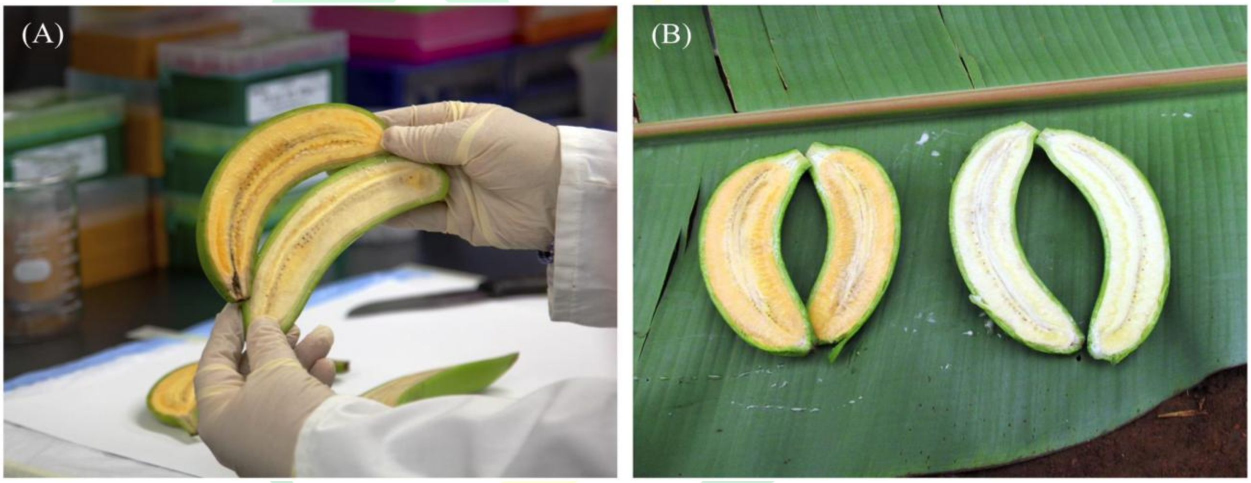
Apples have been known for a very long time to be an excellent source of antioxidants. The apple has been genetically modified to contain a stilbene synthase gene that originally came from the grapevine (*Vitisvinifera* L.). This has resulted in the production of resveratrol in the transgenic apple, which has increased its ability to fight free radicals.

Banana (*Musa acuminata*)

The beta-carotene content of bananas, which ranks as the fourth most significant crop for food production in developing nations, has been the primary focus of research. In order to accomplish this goal, a transgenic banana known as the Super Banana was developed by expressing the PSY gene (PSY2a) from an Asupina banana. This particular banana is naturally rich in beta-carotene.



(A) PVA-biofortified "Cavendish" banana in Australia and (B) PVA-biofortified (left) and wild-type control (right) "Nakitembe" EAHB in Uganda. (Source: Paul *et al*, 2018)

Advantages of Biofortification

- Enhancement in nutritional values i.e. bioavailable Vitamin A and B6; Fe; Protein; Zinc etc.
- Reduction in adult and child mortality exacerbated by micronutrient deficiency.
- Decreased nutritional deficit illnesses. For instance blindness in children, diarrhoea, anaemia etc.
- The cost-effectiveness of plant breeding across time and space is due to its multiplier impact.
- After it has been implemented, the biofortified crop system has a very high level of sustainability.

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- A population that is healthier and better able to respond quickly and effectively to infectious diseases.
- Biofortification offers a method that is not only workable but also realistic for reaching malnourished persons in rural locations that are relatively isolated.
- Higher yields.
- Because of their innate resistance to parasites, weeds, and diseases, these plants are more eco-friendly than others because they require fewer herbicides and pesticides.

Limitations of Biofortification

- A high cost of production, in regard to factors like equipment, technology, patenting, and so on.
- The possibility of a negative interaction between biofortified crops and wild-type varieties leading to their extinction.
- Low substatial equivalency, often known as the inability to deliver a high level of micronutrients and protein content in comparison to supplements.
- People living in rural areas have limited access to, and resources for, purchasing biofortified crops.
- The spread of monoculture will eradicate biological variety.
- The methods of genetic engineering that were applied could potentially damage human immunity.

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