Available online at
http://agrospheresmagazine.vitalbiotech.org/

ISSN (E): 2582 – 7022

Agrospheres:e- Newsletter, (2025) *6*(1), 26-28

Article ID: 744

Biofortification in Horticulture: Enhancing Nutrition through Crops

Dimple[1]*, Ashish Kumar[2] and Mohit[3]

[1]Maharana Pratap Horticultural University, Karnal-132001
[2]Subject Matter Specialist (Horticulture), KVK Rampur, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut
[3]Assistant Professor (Horticulture), IIMT University, Ganga Nagar, Meerut

Open Access

Article History
Received: 13.01.2025
Revised: 17.01.2025
Accepted: 22.01.2025

This article is published under the terms of the Creative Commons Attribution License 4.0.

INTRODUCTION

In a world facing the dual challenges of malnutrition and micronutrient deficiencies, the concept of **biofortification** has emerged as a promising and sustainable solution. Biofortification in horticulture, particularly in fruits and vegetables, offers an innovative pathway to improve the nutritional profile of commonly consumed crops and address "hidden hunger" — a form of malnutrition where individuals do not get enough essential vitamins and minerals despite consuming enough calories.

What is Biofortification?

Biofortification is the process of increasing the nutrient content of crops through agronomic practices, conventional plant breeding, or modern biotechnology. The primary focus is to enhance the levels of essential micronutrients such as iron, zinc, vitamin A and folate in the edible parts of plants.

Unlike post-harvest fortification where nutrients are added during food processing, biofortification builds nutrition directly into the plant during its growth stage. This ensures that the enhanced nutrient profile is maintained from farm to plate, even in remote areas where food processing or supplementation programs may not reach.

The Need for Biofortification in Horticulture

1. Nutritional Deficiencies Are Widespread

Micronutrient deficiencies affect over 2 billion people globally, with iron, vitamin A and zinc being the most common. These deficiencies lead to anemia, weakened immunity, impaired mental development and increased maternal and child mortality (Singh et al. 2025).

While cereals have traditionally been the focus of biofortification efforts, horticultural crops — fruits and vegetables — offer a broader spectrum of vitamins, antioxidants and phytonutrients. They can play a crucial role in improving overall diet quality, especially in developing countries where a large portion of the population relies on plant-based diets.

ISSN (E): 2582 – 7022

2. Horticultural Crops Are Diet Staples

Vegetables like carrots, spinach and sweet potatoes and fruits like bananas, mangoes and papayas are already rich in certain nutrients. Enhancing their micronutrient levels further can provide an even greater impact on public health, especially in rural and economically disadvantaged regions.

Approaches to Biofortification in Horticulture

1. Conventional Breeding

This involves selecting and crossbreeding plant varieties that naturally contain higher levels of a specific nutrient. For example:

- **Orange-fleshed sweet potatoes** rich in beta-carotene (a precursor of vitamin A)
- **Iron- and zinc-rich spinach** developed through selection from naturally nutrient-dense lines

This method is cost-effective and widely accepted by consumers and farmers alike, as it does not involve genetic modification.

2. Agronomic Biofortification

In this approach, micronutrients are added to the soil or applied through foliar sprays to improve nutrient uptake by the plant. For instance:

- Applying **zinc sulfate** to the soil for enriching leafy vegetables
- Using **iron chelates** in fertigation systems

This method is relatively quick but depends on soil type, crop species and environmental factors. It is often used as a short-term solution or supplement to breeding efforts.

3. Genetic Engineering

Where conventional breeding is limited by genetic diversity, biotechnology allows for the introduction of genes responsible for higher nutrient synthesis. A well-known example is:

- **Golden Banana**, genetically engineered to produce high levels of provitamin A (Singh et al. 2025)

This method offers precision and potential for dramatic improvement, though it is subject to regulatory scrutiny and public perception challenges.

Notable Biofortified Horticultural Crops

1. **Orange-Fleshed Sweet Potato (OFSP)**
   Developed in Africa and parts of Asia, this variety is rich in beta-carotene, significantly reducing vitamin A deficiency among children.
2. **Golden Banana**
   Bioengineered in Uganda and Australia to contain up to 25 times more vitamin A, it has shown promising results in clinical trials.
3. **High-Iron Beans and Amaranthus**
   Selection and breeding efforts have produced leafy vegetables and pulses with improved iron content, addressing anemia in women.
4. **Tomatoes Rich in Lycopene and Flavonoids**
   Lycopene, an antioxidant associated with reduced cancer risk, can be enhanced through selective breeding, improving both nutrition and shelf life (Efremov et al. 2020).

Benefits of Biofortified Horticultural Crops

- **Cost-Effective Nutrition**: Once developed, biofortified crops offer recurring benefits without requiring continued financial input from the consumer.
- **Sustainable Intervention**: It complements existing agricultural systems without the need for drastic changes in cultivation practices.
- **Improved Public Health**: Regular consumption of biofortified fruits and vegetables can significantly reduce disease burden related to micronutrient deficiencies.
- **Empowerment of Farmers**: Farmers can grow nutrient-rich crops and command better prices, especially in health-conscious urban markets.

Challenges in Implementation

Despite its potential, biofortification in horticulture faces several challenges:

1. **Limited Awareness**
   Many consumers and even farmers are unaware of biofortified varieties and their benefits.
2. **Market Acceptance**
   Without proper branding and awareness, biofortified crops may be overlooked in favor of traditional or visually appealing varieties.
3. **Seed Availability**
   The distribution of biofortified seeds is still limited in many parts of the world, including India.
4. **Policy and Regulatory Barriers**

Especially in the case of genetically modified crops, approval processes can be lengthy and controversial.

Steps Toward Wider Adoption

- **Awareness Campaigns**: Engaging farmers, consumers and policy-makers through demonstrations, nutrition education and field trials.
- **Incentivizing Farmers**: Providing subsidies, seed kits and buy-back options for growing biofortified varieties.
- **Public-Private Partnerships**: Encouraging collaboration between research institutions, seed companies and government bodies.
- **Inclusion in Government Schemes**: Biofortified crops can be incorporated into **Mid-Day Meals**, **Public Distribution Systems (PDS)** and **ICDS programs** to reach vulnerable populations.

India's Role in Biofortification

India has made significant progress in promoting biofortification. Organizations like **ICAR-**CTCRI and **IARI** have developed and released several varieties of biofortified vegetables and fruits (Yadava et. Al. 2022). For example:

- Cauliflower: Pusa Beta Kesari 1 (Country's first provitamin-A rich cauliflower)
- Potato: Kufri Manik (Rich in anthocyanin (0.68 ppm) in comparison to negligible in popular varities)
- Sweet Potato: Bhu Sona, Bhu Karishna
- Pomegranate: Solapur Lal (Rich in Iron, Zinc, Vitamin-C)
- Biofortified **tomato hybrids** with enhanced vitamin C and lycopene content

The Indian Council of Agricultural Research (ICAR) also recognizes biofortified crop varieties and is actively encouraging their adoption through Krishi Vigyan Kendras (KVKs) and extension services.

CONCLUSION

Biofortification in horticulture represents a powerful intersection of agriculture, nutrition and public health. As the world grapples with malnutrition and the demand for healthier diets rises, the importance of nutrient-rich fruits and vegetables cannot be overstated.

With continued research, supportive policies and awareness at the grassroots level, biofortification can transform horticultural crops from mere sources of calories into vehicles of nourishment and health. The journey from **"farm to fork"** thus takes on a new meaning — one where every bite contributes not just to hunger relief, but also to **better health and well-being**.

REFERENCES

Efremov G.I., Slugina M.A., Shchennikova A.V., Kochieva E.Z., Differential regulation of phytoene synthase psy1 during fruit carotenogenesis in cultivated and wild tomato species (Solanum lycopersicon), Plants 9 (2020) 1169. https://doi:10.3390/plants9091169.

Devendra Kumar Yadava, Partha Ray Choudhury, Firoz Hossain, Dinesh Kumar, Tilak Raj Sharma and Trilochan Mohapatra (2022). Biofortified Varieties: Sustainable Way to Alleviate Malnutrition (Fourth Edition). Indian Council of Agricultural Research, New Delhi. 106 p.

Unnati Singh, Deepak Lall and Aditi Sagar. A comprehensive review on bio-fortification in horticultural crops to evaluate mal-nutrition. Int. J. Adv. Biochem. Res. 2025;9(5):984-987. DOI: 10.33545/26174693.2025.v9.i5l.4454