NEW ERA AGRICULTURE MAGAZINE

Techniques of biofortification and their importance in vegetable crops

Ramesh Rajbhar[1], Dr. Budhesh Pratap Singh[2], Priyanka Rajbhar[3], Rathish Gowda B R[4]

Introduction

Population growth, malnutrition, hunger, and lack of vitamins and minerals are some of the biggest problems that most countries in the world are currently facing. Vitamin A deficiency is prevalent in developing countries among children and women, causing more than 600,000 deaths worldwide each year in children under 5 years of age. Greek word "bios" means "life" Latin word "fortificare" means "make strong." In a single word Biofortification means make life strong. Biofortification is the process of adding nutritional value to the crop. It refers to nutrient enrichment of crops to address them negative economic and health consequences of vitamin and mineral deficiencies in humans (Prasad *et al*. 2015). Bio-fortification refers to increasing genetically the bioavailable mineral content of food crops (Brinch *et al*. 2007). Developing biofortified crops also improves their efficiency of growth in soils with depleted or unavailable mineral composition (Borg *et al*. 2009).

Main deficiencies affect about 30% of the population, including 60% of Zinc, 60% of Iron, 15% of Selenium, and 30% of Iodine. Micronutrients play an important role in human nutrition, in the prevention and treatment of various diseases, as well as promoting mental and physical health. According to UNICEF, one in three malnourished children in the world is Indian. It is estimated that reducing malnutrition could add some 3% to India‟s GDP. (Singh, 2019).

Objectives of biofortification

1. To develop vegetable crops containing highly available micronutrients such as iron, zinc vitamin A for preventing global deficiency of these nutrients.
2. To screen for biofortification of vegetable crops from existing germplasm.
3. To study the efficacy of mineral nutrients.

Importance of biofortification

Ramesh Rajbhar[1], Dr. Budhesh Pratap Singh[2], Priyanka Rajbhar[3], Rathish Gowda B R[4]

[1]Ph.D. Research Scholar, Department of vegetable science, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, U.P.

[2]Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, U.P.

[3]Cane supervisor, Cane Development Council, Puranpur, Pilibhit, U.P.

[4]M.Sc. Vegetable Science, Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner Jaipur, Rajasthan.

Biofortification provides a comparatively cost-effective, sustainable, and long-term means of delivering more micronutrients in relatively remote rural areas. Biofortified staple foods help by increasing the daily adequacy of micronutrient intakes among individuals throughout the lifecycle. Biofortification is not expected to treat micronutrient deficiencies or eliminate them in all population groups. No single intervention will solve the problem of micronutrient malnutrition, but biofortification complements existing interventions to sustainably provide micronutrients to the most vulnerable people in a comparatively inexpensive and cost-effective way.

- Biofortification is the different types of fortification and can be significantly increasing the level of vitamins and nutrients in the living product.
- It is especially important for poor rural community with finite access to a varied diet, fortified foods or supplements.
- It can help the people by improving the daily amount of micronutrient intake throughout their lifecycle.
- It is important for woman and children since they face greater risk of micronutrient malnutrition.
- To also promote food security.
- To alleviate poverty.

Techniques of Biofortification:

Biofortification can be achieved through three strategies.

i) Agronomic Biofortification

ii) Conventional plant breeding

iii) Genetic engineering

1. Agronomic Biofortification:-

Agronomical Biofortification refers to the technique of use fertilizer or fertifortification by using seed treatment, foliar application and using organic manure for increasing the neutraceutical values since these are very cheap and rapid method for evaluating the mineral content of various vegetables.

Example:

Amaranthus: A microbial inoculants "Spirulina platensis", used as a biofortifying agent to enhance the iron level of crop. The sample with two hours of soaking recorded a high content (18.35± 0.03 mg g-1) of iron (Kalpana et al., 2014)

Lettuce: Iodine application as Iodate in biofortification programs (at doses of 80<µM), has been confirmed to improve the foliar biomass, antioxidant response, and accumulation of phenol compounds in lettuce plants but also supplements the human diet with phenolic compounds and the trace element iodine.

Carrot:

1. **Pusa Asita:** self-black coloured roots Late bolter. Rich source of anthocyanin.

2. **Pusa Rudhira**: Has higher level of Carotenoid (7.14mg) & Phenol (45.15mg)/ 100g Possess antioxidant property.
3. **Pusa Meghali:** Highest beta carotene content–11,571 IU/100g.

Radish:

1. **Pusa Gulabi:** First Pink fleshed variety High in total carotenoids, anthocyanin and ascorbic acid content.
2. **Pusa Jamuni**: It is first purple fleshed nutritionally rich variety, high in anthocyanin and ascorbic acid content.

Cassava: It is rich in carotene content i.e. 466IU/100g. Starch content in fresh tubers is 25–27%.

Cowpea: Two early-maturing high-iron and zinc fortified varieties, Pant Lobia-1 (82 ppm Fe and 40 ppm Zn) and Pant Lobia-2 (100ppm Fe and 37 ppm Zn), have been developed by conventional plant breeding and released in 2008 and 2010 respectively.

Amaranthus (Pusa Kiran): It is developed through natural crossing between Amaranthus tricolour and Amaranthus tristis, rich in iron content. Glossy green leaves and stem, average yield is 55 t/ha.

2. Conventional plant breeding method: Conventional breeding practices help in increase the concentration of minerals like β-carotene, carotenoids, amino acids, amylase, carbohydrates etc, through making proper selection of breeding material to increase nutritional efficiency.

Example:

Potato (Kufri Neelkanth) : This is a table purpose Antioxidant(anthocyanins >100µg/100g fresh wt. & Carotenoids – 200 µg/100g fresh wt.).

Brinjal (Pusa Safed Baigan 1): White coloured oval fruit rich in total phenol content (31.21 mg 100 g-1) and high antioxidant activity (3.48 mg 100 g-1).

Cauliflower (Pusa Beta Kesari 1): These variety high β-carotene (8.0-10.0 ppm).

Sweet potato:

1. **Bhu Sona:** It is a pure line variety and contains high β-carotene (14.0 mg/ 100 g).
2. **Bhu Krishna:** It is a pure line variety and contains high Anthocyanin (90.0 mg/100g).
2. **Sree Kanaka**: Cylindrical tubers with dark orange flesh colour. It has High beta carotene content (9-10 mg /100g FW).

3. Genetic Engineering: Genetic engineering techniques use an illimitable gene pool to produce new cultivars through transfer of desirable characters from one organism to another organism to develop elite cultivars and improve its value.

Example: Tomato:

Carotenoids -rich tomato: Lycopene is a powerful antioxidant that has been shown to reduce the risk of epithelial cancer and improve human health. Dhanshree recorded the highest beta carotene content (1.30 mg/100g) followed by variety Pusa Ruby (0.90 mg/100g).

Anthocyanin-rich tomato: Arka Vikas was developed to increase the anthocyanin content in the fruit of a profitable tomato cultivar by Agrobacterium-mediated transformation of two transcription factors Del and Ros1.

Potato:(Protein-rich potato): The genetically modified potato 60% increase in total protein content developed by introducing AmA1 gene (Amaranth Albumin 1) from edible amaranth plant into seven commercial varieties of potatoes.

Cabbage: High antioxidant properties and anthocyanin content (>10g/kg DM) in red cabbage can reduce the risk of cancer, cardiovascular disease, and brain disorders. (Draghici et al., 2013).

Cassava: Staple food deficient in Pro-Vit A, Iron and Zinc. Plants over-expressing a PSY transgenic produced yellow-fleshed and high-carotenoid roots. Cyanogen-free cassava was produced by encoding the genes (CYP79D1 and CYP79D2).

Conclusion:

Malnutrition cannot be solved by biofortified crops, whether they are produced using Conventional breeding techniques or by modern biotechnological equipment. A sufficient and varied diet for the entire world's population still stands as the ultimate goal of global nutrition. Biofortified crops, on the other hand, can support current micronutrient initiatives and significantly improve the lives and health of millions of people, particularly those who are most in need. Biofortification provides naturally fortified meals to those who don't have access to commercially fortified foods, which are more easily accessible in towns, making it an easy option to target undernourished people in rural areas. As a result, there is a direct connection between industrial and biofortification. In the end, a sufficient intake of a variety of nutrients and other chemicals in quantities and combinations that are still unknown is necessary for optimal nutrition. Therefore, boosting consumption of a wide variety of non-staple foods in developing nations is a successful strategy for eliminating under nutrition as a public health issue.

References

1. Sil. D.Bhattacharjee, T. and Saha. S, (2023). Biofortification of Vegetable Crops. Vigyan Varta 4(2): 137140.
2. Pedersen. H.B, Borg. S, Tauris B, Holm P.B,.(2007) Molecular genetics approaches to increasing mineral availability and vitamin content of cereals. J. of Cereal Sci., 46:308-326.

3. Pedersen. H.B, Borg. S, Tauris B, Holm P.B,. (2009) Iron transport, deposition and bioavailability in the wheat and barley grain. Plant and Soil, 325: 15-24.
4. Kalpana P, SAI B.G, L and Anitha (2014) Biofortification of Amaranthus gangeticus using Spirulina platensis as microbial inoculant to enhance iron levels. Internat. J. Res. Appl. Nat. Social Sci., 2(3): 103-110.
5. Prasad B.V.G., Mohanta S., Rahaman S., Bareily.P, (2015) Bio-fortification in horticulture crops Journal of Agricultural Engineering and Food Tech, 2350-0263: 95-99.
6. Singh A. (2019) Childhood Malnutrition in India.