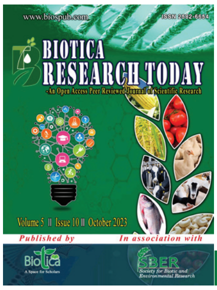

Bio. Res. Today 2023, 5(10):738-740

Biotica Research Today

e-ISSN: 2582-6654

October, 2023

Article ID: RT1474 Popular Article

Enhancing Nutritional Value through Biofortification in Indian Crops: A Comprehensive Overview

Ranjani M.[*], Sindhu P.M., Rajan Mahendra and Ajay Narola

Division of Food Science and Postharvest Technology, Indian Agricultural Research Institute, New Delhi (110 012), India

Open Access

Corresponding Author

Ranjani M.

✉: ranjani99mr@gmail.com

Conflict of interests: The author has declared that no conflict of interest exists.

How to cite this article?

Ranjani *et al*., 2023. Enhancing Nutritional Value through Biofortification in Indian Crops: A Comprehensive Overview. *Biotica Research Today* 5(10), 738-740.

Abstract

Biofortification, employing selective breeding, genetic modification and enriched fertilizers, stands as a cost-effective solution to address micronutrient deficiencies in populations with limited dietary diversity. This innovative process enhances essential vitamins (A, B_1, B_2, B_3, B_6, B_9, B_{12}, C and E) and minerals in staple crops, ensuring significant health and nutritional improvements upon regular consumption. Biofortification employs a range of diverse methodologies, encompassing agronomic practises, conventional breeding, and advanced biotechnology techniques. In India, significant advancements have been made in several initiatives, particularly in the area of rice fortification. These efforts have primarily targeted isolated populations, with the support of government programmes such as the Mid-Day Meal and Integrated Child Development schemes. The Food Safety and Standards Authority of India (FSSAI) has developed criteria for fortified rice, with a particular focus on incorporating novel methods such as continuous blending. Despite encountering various obstacles, biofortification holds the potential to contribute to a more salubrious future by providing fair and equal access to vital nutrients, particularly in rural regions.

Keywords: Agriculture, Biofortification, Micronutrients, Nutrition

Introduction

Biofortification, involving the enhancement of micronutrients in crops, emerges as an economically viable strategy to combat malnutrition. Fortifying staple crops with vital vitamins and minerals addresses deficiencies in populations with limited dietary access. Biofortification methods encompass selective breeding, genetic modification and innovative agricultural practices. Notable progress has been made in India, especially in rice fortification, benefiting marginalized communities through government programs. The Food Safety and Standards Authority of India (FSSAI) has played a pivotal role in formulating fortified rice standards. Despite challenges such as production costs and biodiversity risks, Biofortification promises to enhance the health and resilience of communities, bridging nutritional gaps, particularly in rural regions.

Diverse Approaches

Biofortification can be accomplished by employing agronomic techniques, traditional breeding methods, genetic engineering, and contemporary biotechnology approaches (Garg *et al.*, 2018).

Biofortification: A Nutritional Revolution

Biofortification, a process enhancing crop nutritional values, has revolutionized Indian agriculture. Through selective breeding and genetic modification, staple crops like rice, beans, maize, sweet potato and cassava are fortified with essential micronutrients. This approach particularly benefits remote communities, effectively addressing vitamin and mineral deficiencies (Thakur *et al.*, 2023).

Biofortification Advancements in India

Biofortification initiatives in India have resulted in notable advancements, particularly in the fortification of rice. The National Nutrition Mission implemented rice fortification initiatives, such as the Mid-Day Meal scheme, Integrated Child Development Scheme, and Public Distribution System, in response to the prevalent nutritional deficits observed throughout several states. The Food Safety and Standards Authority of India (FSSAI) has developed requirements

Article History

RECEIVED on 06th October 2023 RECEIVED in revised form 16th October 2023 ACCEPTED in final form 17th October 2023

for fortified rice and has successfully applied innovative procedures, such as continuous blending, on a widespread basis. This represents a notable advancement in the efforts to address the issue of malnutrition (Thakur *et al.*, 2023).

Potato: Kufri Neelkanth

Kufri Neelkanth is a remarkable antioxidant-rich potato variety, featuring dark purple-black tubers with a medium-depth eye, cream flesh and excellent flavor. Developed in CPRI, Shimla, this hybrid is ideal for the North Indian plains. It boasts good storability, medium dry matter (18%) and medium dormancy.

Brinjal: Pusa Safed Baigan 1

Released by IARI in 2018, Pusa Safed Baigan 1 is an oval-shaped white brinjal variety rich in total phenol content and antioxidants.

Cauliflower: Pusa Beta Kesari 1

Pusa Beta Kesari 1, which was produced by the Indian Agricultural Research Institute (IARI), New Delhi, is recognised as the first Biofortified cauliflower in India. This variety has a significantly higher concentration of β-carotene, ranging from 8.0 to 10.0 ppm, in comparison to ordinary cauliflower cultivars (Yadava *et al.*, 2018).

Carrot Varieties

Pusa Rudhira: High carotenoid (7.14 mg per 100 g) and phenol (45.15 mg per 100 g) content found in Pusa Rudhira Self-Core red-colored roots.

Pusa Asita: Featuring self-black colored roots and rich anthocyanin content, Pusa Asita is a late-bolting carrot variety.

Sweet Potato Varieties

Bhu Sona: Adapted to Odisha, Bhu Sona offers high β-carotene content (14.0 mg per 100 g) and resilience to salinity stress (Yadava *et al.*, 2018).

Bhu Krishna: This variety stands out with its high anthocyanin content (90 mg per 100 g) and adaptability to Odisha's conditions (Yadava *et al.*, 2018).

Radish Varieties

Pusa Gulabi: Known for its pink flesh, high carotenoids, anthocyanin and ascorbic acid content, Pusa Gulabi thrives in summer heat.

Pusa Jamuni: A purple-fleshed variety rich in anthocyanin and ascorbic acid, Pusa Jamuni is a nutritionally dense radish.

Transgenic Vegetables

Potatoes have been engineered for higher provitamin A, vitamin C and essential amino acids. Carrots with enhanced calcium content have been developed. Lettuce, cauliflower and sweet potato varieties with increased nutritional content and antioxidants have been created. Cassava has been biofortified for provitamin A, iron and zinc, while mustard has been enhanced for unsaturated fatty acids (Garg *et al.*, 2018).

Transgenic Fruits

Tomatoes have been bioengineered to boost carotenoids, vitamins and antioxidants. Apples have been modified for increased antioxidant capacity and bananas have been enriched with beta-carotene (Garg *et al.*, 2018).

Advantages of Biofortification (Bouis and Saltzman, 2017)

1. *Enhanced Nutritional Values*: Biofortification increases the levels of bioavailable nutrients like Vitamin A, B_6, Iron, Protein and Zinc.

2. *Reduced Mortality*: It reduces adult and child mortality caused by micronutrient deficiencies.

3. *Decreased Nutritional Deficit Illnesses*: Biofortification lowers the occurrence of illnesses like blindness in children, diarrhea and anemia.

4. *Cost-Effectiveness*: Plant breeding for Biofortification proves cost-effective over time due to its multiplier impact.

5. *Accessibility in Rural Areas*: Biofortification is a realistic approach to reach malnourished individuals in isolated rural locations.

6. *Higher Yields*: Biofortified crops often yield more.

7. *Eco-Friendly*: They require fewer herbicides and pesticides due to their natural resistance to parasites, weeds and diseases.

Limitations of Biofortification (Kiran *et al.*, 2022)

1. *High Production Costs*: Biofortification faces high production costs related to equipment, technology and patenting.

2. *Risk of Extinction*: Interactions between Biofortified and wild-type crops might lead to the extinction of natural varieties.

3. *Low Nutrient Equivalency*: Biofortified crops may not deliver nutrients and protein at levels comparable to supplements.

4. *Limited Access in Rural Areas*: Rural populations often lack access and resources to purchase Biofortified crops.

5. *Monoculture Threat*: Widespread cultivation of Biofortified crops might lead to the eradication of biological diversity.

6. *Genetic Engineering Risks*: Genetic engineering methods could potentially harm human immunity, raising concerns about their application.

Conclusion

Biofortification offers an affordable avenue to alleviate malnutrition, particularly among communities with limited dietary options. Notably, India's initiatives, notably in rice fortification, signify a significant stride toward improving public health through essential government programs. Despite hurdles, the commitment to addressing nutritional deficiencies through innovative methods like continuous blending showcases a promising future. While challenges exist, Biofortification represents a beacon of hope, promising a healthier and more resilient society, especially in regions grappling with micronutrient deficiencies. The ongoing efforts underscore a collective commitment toward ensuring equitable access to essential nutrients and enhancing the overall well-being of vulnerable populations.

References

Bouis, H.E., Saltzman, A., 2017. Improving nutrition through biofortification: A review of evidence from HarvestPlus, 2003 through 2016. *Global Food Security* 12, 49-58. DOI: https://doi.org/10.1016/j.gfs.2017.01.009.

Garg, M., Sharma, N., Sharma, S., Kapoor, P., Kumar, A., Chunduri, V., Arora, P., 2018. Biofortified crops generated by breeding, agronomy, and transgenic approaches are improving lives of millions of people around the world. *Frontiers in Nutrition* 5(5), 12. DOI: https://doi.org/10.3389/fnut.2018.00012.

Kiran, A., Wakeel, A., Mahmood, K., Mubaraka, R., Hafsa, Haefele, S.M., 2022. Biofortification of staple crops to alleviate human malnutrition: Contributions and potential in developing countries. *Agronomy* 12(2), 452. DOI: https://doi.org/10.3390/agronomy12020452.

Thakur, S., Singh, A., Insa, B., Sharma, S., 2023. Food fortification in India as malnutrition concern: A global approach. *Sustainable Food Technology* 1(5), 681-695. DOI: https://doi.org/10.1039/D3FB00079F.

Yadava, D.K., Hossain, F., Mohapatra, T., 2018. Nutritional security through crop biofortification in India: Status & future prospects. *Indian Journal of Medical Research* 148(5), 621-631. DOI: https://doi.org/10.4103/ijmr.IJMR_1893_18.