

Biofortification in potato to strengthen nutritional security in Indian perspective

Potato (*Solanum tuberosum* L.) plays a major role in food security and livelihoods in India. However, micronutrient deficiencies remain a major public health concern. Biofortification provides sustainable approach to enhance the nutritional quality of potato without altering food habits. Indian efforts, led by ICAR-Central Potato Research Institute, have resulted in biofortified and coloured-flesh varieties such as Kufri Neelakanth, Kufri Manik and Kufri Jamunia, revealing shift towards nutrition-sensitive breeding. Biofortified potatoes provide nutritional, economic and agronomic benefits, contributing towards a promising pathway to strengthen nutritional security in India.

Keywords: Biofortification, Nutritional security, Potato, Potato varieties

POTATO (*Solanum tuberosum* L.) is one of the most important food crops in the world and plays a significant role in ensuring food security due to its high productivity, adaptability and affordability. In India, potato is cultivated across diverse agro-climatic regions and serves as a staple or supplementary food for millions of people. Besides being a rich source of carbohydrates, potato provides vitamins, minerals, dietary fibre and antioxidants, making it an important component of a balanced diet.

Despite considerable progress in agricultural production, micronutrient malnutrition, often referred to as hidden hunger, remains a major public health challenge in India. Deficiencies of iron, zinc, vitamin A and other essential nutrients adversely affects the health, growth and productivity of a large section of the population, particularly women and children. Improving the nutritional quality of commonly consumed food crops has therefore emerged as an important strategy for addressing nutritional deficiencies in a sustainable manner.

Biofortification, a nutritional improvement strategy aimed at increasing the levels and bioavailability of essential micronutrients in food crops through agronomic

practices, plant breeding, genetic engineering and genome editing approaches, has gained increasing attention as a cost-effective and farmer-friendly solution to combat hidden hunger. In potato, biofortification efforts have focused on increasing the levels of micronutrients such as iron, zinc, vitamin C, carotenoids and anthocyanins. The development of nutrient-rich potato varieties offers an opportunity to improve dietary quality without requiring major changes in food habits or additional expenditure by consumers.

The ICAR-Central Potato Research Institute has developed biofortified and coloured potato varieties with enhanced nutritional attributes. These varieties combine desirable agronomic performance with improved nutrient content and have the potential to contribute significantly to food and nutritional security. This article highlights the concept of potato biofortification, important biofortified potato varieties developed in India, their nutritional advantages over conventional cultivars and their potential role in strengthening nutritional security from an Indian perspective.

Biofortification efforts in potato Indian Perspectives: In India, ICAR-CPRI and its regional stations are leading biofortification research. Their efforts focus on:



Pictorial features of Kufri Neelkanth



Pictorial features of Kufri Manik

Biofortified varieties

Kufri Neelakanth: This medium-maturing potato variety produces ovoid tubers with purple skin, yellow flesh and shallow eyes with average tuber yield of 35–38 t/ha and is adapted to the north indian plains. Compared to the white-fleshed cultivars Kufri Jyoti and Kufri Pukhraj and other popular cultivars, it offers enhanced nutritional quality, with higher iron (30–50 ppm), zinc (15–25 ppm), ascorbic acid (25–35 mg/100 g FW), carotenoid (100–350 µg/100 g FW), anthocyanin contents (1–10 mg/100 g FW) and dry matter (18–20%).

Kufri Manik: This medium-maturing potato variety produces round tubers with red skin, yellow flesh and medium-deep eyes with average tuber yield of 23–25 t/ha. Adapted to the eastern plains of Uttar Pradesh, Bihar, Jharkhand, Chhattisgarh and Assam, it is moderately resistant to late blight and possesses enhanced nutritional value. The variety contains higher levels of iron (30–50 ppm), zinc (>25 ppm) and anthocyanins (1–10 mg/100 g FW) and dry matter content (18–19%) as compared to popular white-fleshed cultivars such as Kufri Jyoti and Kufri Pukhraj.

Kufri Jamunia: This medium-maturing potato variety produces oblong tubers with shallow eyes and deep purple skin and flesh with average tuber yield of 32–35 t/ha. Recommended for the north indian plains, it is moderately resistant to late blight. This variety contains iron (30–50 ppm), ascorbic acid (>35 mg/100 g FW), anthocyanins (>10 mg/100 g FW), zinc (15–25 ppm), carotenoids (100–350 µg/100 g FW) and high dry matter content (19–19.5%). It contains substantially higher levels nutrients owing to its attractive purple flesh, enhanced antioxidant content and high dry matter, the variety is suitable for table consumption as well as specialty products such as dalia, suji, ice cream and biscuits.

Red-skinned varieties

Kufri Sindhuri: This late-maturing potato variety produces round tubers with red skin, cream flesh and medium-deep eyes with average tuber yield of 30–35 t/ha. Adapted to the north indian plains, it is moderately resistant to early blight and tolerant to Potato Leaf Roll Virus (PLRV), making it suitable for low-input production systems. The variety contains iron (<30 ppm), zinc (15–25 ppm), ascorbic acid (<25 mg/100 g FW), anthocyanins (<1 mg/100 g FW) and carotenoids (<100 µg/100 g FW), with a dry matter content of 17–18%.

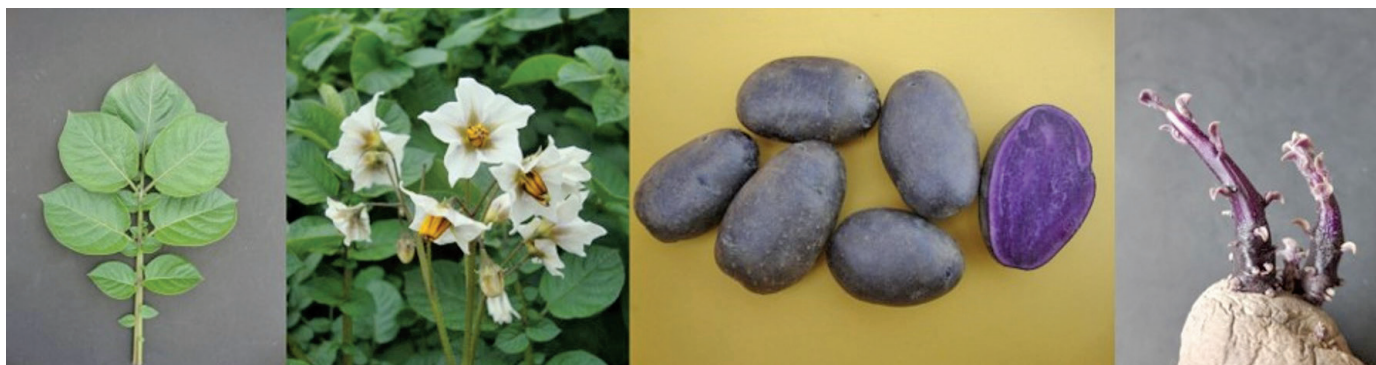
Kufri Kanchan: This medium-maturing potato variety produces ovoid-oblong tubers with red skin, cream flesh

and shallow eyes with average tuber yield of 25–30 t/ha. It is moderately resistant to late blight, immune to wart disease and characterised by a slow rate of seed degeneration, making it suitable for sustained cultivation in the North Bengal Hills and Sikkim. The variety contains iron (<30 ppm), zinc (<15 ppm), ascorbic acid (25–35 mg/100 g FW), anthocyanins (<1 mg/100 g FW) and carotenoids (100–350 µg/100 g FW), with a dry matter content of 19%. Although its micronutrient and antioxidant levels are lower than those of recently released biofortified cultivars, its disease resistance, seed longevity and adaptability make it a valuable cultivar for hill ecosystems.

Kufri Uday: This early to medium maturing potato variety produces ovoid tubers with red skin, shallow eyes, yellow flesh with a mealy texture and an average tuber yield of 36–38 t/ha. It is field-resistant to late blight and recommended for cultivation in the plains of Uttar Pradesh, Punjab, Haryana and Rajasthan. The variety possesses enhanced nutritional quality, containing iron (30–50 ppm), zinc (15–35 ppm), ascorbic acid (25–35 mg/100 g FW) and anthocyanins (1–10 mg/100 g FW), along with a dry matter content of 18–19%. In comparison to popular white-fleshed cultivars such as Kufri Jyoti and Kufri Pukhraj, it offers higher levels of micronutrients and antioxidant compounds while maintaining desirable tuber quality and processing attributes.

Kufri Lohit: This medium maturing potato variety produces medium to large-sized, attractive red-skinned tubers with shallow eyes, cream flesh and a mealy texture with an average tuber yield of 36–38 t/ha. It is field-resistant to late blight and well adapted to the central and eastern north indian plains. The variety contains higher levels of iron (30–50 ppm), zinc (15–25 ppm), anthocyanins (1–10 mg/100 g FW) and carotenoids (100–350 µg/100 g FW) than commonly cultivated white-fleshed varieties such as Kufri Jyoti, while it has dry matter content of 17–19%. These nutritional attributes, together with its attractive tuber appearance and desirable cooking quality, make it a promising cultivar for both table consumption and nutritional security.

Kufri Ratan: This medium-maturing, high-yielding potato variety produces attractive red-skinned tubers with excellent storability and broad adaptation across the north indian plains and plateau regions with average tuber yield of 36–38 t/ha. The variety contains elevated levels of iron (30–50 ppm), zinc (>25 ppm), ascorbic acid (25–35 mg/100 g FW) and anthocyanins (1–10 mg/100 g FW), exceeding those of many widely cultivated white-fleshed



Pictorial features of Kufri Jamunia

cultivars. With a dry matter content of 17–18%, it combines desirable table quality with enhanced nutritional value. Its attractive tuber appearance, good keeping quality and improved micronutrient content makes it a promising option for both farmers and consumers.

White skinned varieties

Kufri Jyoti: This medium-maturing, white-fleshed potato variety is known for its wide adaptability, early bulking ability with an average tuber yield of 25–30 t/ha and slow rate of seed degeneration. The variety contains relatively low levels of iron (<30 ppm), zinc (<15 ppm), ascorbic acid (<25 mg/100 g FW), anthocyanins (<1 mg/100 g FW), carotenoids (<100 µg/100 g FW) and dry matter content of 18–20%, making the variety suitable for general table use.

Kufri Pukhraj: This is a widely cultivated white-fleshed potato variety characterised by early bulking with an average tuber yield of 35–40 t/ha and a slow rate of seed degeneration. The variety contains iron (<30 ppm), zinc (15–25 ppm), ascorbic acid (<25 mg/100 g FW), anthocyanins (<1 mg/100 g FW) and carotenoids (100–350 µg/100 g FW), with a dry matter content of 18–20%. Although its micronutrient and antioxidant levels are lower than those of recently developed biofortified potato cultivars, Kufri Pukhraj remains popular among farmers because of its adaptability, dependable performance and suitability for diverse production environments.

Benefits to Farmers

Biofortified potato varieties provide direct economic and practical advantages to growers while aligning with changing consumer and industry preferences.

Market opportunities: Biofortified potatoes offer opportunities for value addition owing to their enhanced nutritional quality. Their unique nutritional and functional properties may help develop good markets and specialised food products. Wider adoption and market acceptance will depend on increased consumer awareness, efficient marketing and availability of quality planting material.

Greater demand from food and processing industries: Biofortified potato lines possessing high dry matter, desirable texture and attractive flesh colour are well suited for industrial use. These varieties are increasingly demanded for processing into chips, French fries, ready-to-eat foods and functional food products, offering assured markets and contract-farming opportunities to farmers.

Similar cultivation practices: Biofortified potato varieties

do not require special agronomic practices, additional inputs or new technologies. They can be cultivated using standard potato production methods, making adoption easy and risk-free for farmers while delivering added nutritional and economic benefits.

Challenges

Despite the strong potential of biofortified potatoes to improve nutrition and farm income, several challenges need to be addressed for their large-scale adoption.

Limited awareness: Many farmers and consumers are not fully aware of the nutritional advantages of biofortified potatoes over conventional varieties. The absence of clear information and labeling often limits their acceptance and market differentiation.

Need for wider adaptability: For sustained adoption, biofortified potato varieties must show stable yield, disease resistance and quality across diverse agro-climatic regions. Limited regional adaptability can restrict their spread beyond specific zones.

Market linkage: Weak linkages between producers, processors and health-conscious consumers often result in poor price realization. Organised markets, branding and assured procurement mechanisms are required to strengthen demand.

SUMMARY

Biofortification in potato offers a strategic and sustainable solution to strengthen nutritional security in India while maintaining high productivity and farmer profitability. The development of biofortified and coloured-flesh potato varieties marks a paradigm shift from yield-focused breeding to nutrition-sensitive agriculture. Indian efforts have successfully delivered varieties enriched with essential micronutrients and antioxidants without compromising agronomic performance or consumer acceptability. These varieties not only address hidden hunger but also create new opportunities for value addition, specialty markets and enhanced farm income.

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