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An Insight of Biofortification of Crops

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Humans require around 40 known nutrients in adequate amounts to live healthy and productive lives . Nutrients play crucial roles in humans and dictate our physical and mental development. Nutrients in the human diet ultimately come from plants, but all our major food crops lack certain essential micronutrients (vitamins and minerals). The mineral elements—sodium, potassium, calcium, magnesium, phosphorous, chlorine, and sulfur—are classified as essential nutrients that are required in small amounts in the body. The other class of essential nutrients required in very small amounts in the human body are termed as micronutrients—namely iron, zinc, copper, manganese, iodine, selenium, molybdenum, cobalt, nickel, and vitamins. According to the World Health Report, vitamin A, iron, zinc, and iodine deficiencies are the most prevalent deficiencies. Almost 38% of pregnant women and 43% of pre-school children are suffering from micronutrient deficiencies worldwide. More than 30% of the world's population is affected by hidden hunger. Deficiencies of micronutrients can have a devastating effect on health.

What is Biofortification

Biofortification refers to improve the nutritional quality of crop. Biofortification of crops is done using modern biotechnology techniques, conventional plant breeding, and agronomic practices. Increasing mineral content of staple food crops through Biofortification is the most feasible strategy of combating micronutrient malnutrition.

Techniques of Biofortification

Agronomic practices: This involves the application of fertilizers to increase the quantity of micronutrients in plants grown in soil conditions that are poor in such micronutrients/minerals.

Conventional plant breeding: This involves traditional breeding methods by which sufficient genetic variations are produced for the desired trait in crops such as high content of any micronutrient. It involves screening of large number of germplasm to identify donors and then crossing lines over many generations to ultimately yield a plant with high nutrient content along with other favourable traits.

Genetic engineering/modification: It is possible to raise the micronutrient content of cereals through genetic engineering This involves inserting DNA into the genome of an organism to introduce new or different characteristics such as being resistant to any disease

Benefits of Biofortification

Biofortification is promising, cost-effective, and sustainable technique of delivering micronutrients to a population that has limited access to diverse diets and other micronutrient interventions. Biofortification increase the bioavailability of essential micronutrients are deployed to consumers through traditional practices used by agriculture and food trade which therefore provides a feasible way of reaching undernourished and low income group families with limited access to diverse diets, supplements, and fortified foods. Economically biofortification is a one-time investment and offers a cost-effective, long-term, and sustainable approach in fighting hidden hunger.

Biofortified varieties developed by SAU's and ICAR institutes in India

SR. NO	CROP	VARITIES	DEVELOPED BY	IMPROVED FEATUERES
1.	Rice	CR Dhan 310	ICAR-National Rice Research Institute, Cuttack, Odisha	10.3% protein in polished grain as compared to 7.0-8.0% in popular varieties
		DRR Dhan 45	ICAR-Indian Institute of Rice Research, Hyderabad	High in zinc content (22.6 ppm) in polished grains in comparison to 12.0-16.0 ppm in popular varieties
2.	Wheat	WB 02	ICAR-Indian Institute of Wheat and Barley Research, Karnal	Rich in zinc (42.0 ppm) and iron (40.0 ppm) in comparison to 32.0 ppm zinc and 28.0-32.0 ppm iron in popular varieties
		HPBW 01	PunjabAgricultural University	high iron (40.0 ppm) and zinc (40.6 ppm) in comparison to 28.0-32.0 ppm iron and 32.0 ppm zinc in popular varieties
3.	Maize	Pusa Vivek QPM9 Improved	ICAR-Indian Agricultural Research Institute, New Delhi	Country's first provitamin-A rich maize • High provitamin-A (8.15 ppm), lysine (2.67%) and tryptophan (0.74%) as compared to 1.0-2.0 ppm provitamin-A, 1.5-2.0% lysine and 0.3-0.4% tryptophan content in popular hybrids
		Pusa HM4 Improved	ICAR-Indian Agricultural Research Institute, New Delh	Contains 0.91% tryptophan and 3.62% lysine which is significantly higher than popular hybrids (0.3- 0.4% tryptophan and 1.5-2.0% lysine)
		Pusa HM8 Improved	ICAR-Indian Agricultural Research Institute, New Delhi	Rich in tryptophan (1.06%) and lysine (4.18%) as compared to 0.3-0.4% tryptophan and 1.5-2.0% lysine in popular hybrids
		Pusa HM9 Improved	ICAR-Indian Agricultural Research Institute, New Delhi	Contains 0.68% tryptophan and 2.97% lysine compared to 0.3-0.4% tryptophan and 1.5-2.0% lysine in popular hybrids
4.	Pearl millet	HHB 299	CCS-Haryana Agricultural University, Hisar in collaboration with ICRISAT,	High iron (73.0 ppm) and zinc (41.0 ppm) as compared to 45.0-50.0 ppm iron and 30.0-35.0 ppm zinc in popular varieties/hybrids
		AHB 1200	Vasantrao Naik MarathwadaKrishi Vidyapeeth, Parbhani (MS) in collaboration with ICRISAT	Rich in iron (73.0 ppm) in comparison to 45.0-50.0 ppm in popular varieties/hybrids

5.	Lentil:	Pusa Ageti Masoor	ICAR-Indian Agricultural Research Institute, New Delhi	65.0 ppm iron as compared to 55.0 ppm iron in popular varieties
6.	Mustard	Pusa Mustard 30	ICAR-Indian Agricultural Research Institute, New Delhi	Contains low erucic acid (40% erucic acid in popular varieties
		Pusa Double Zero Mustard 31	ICAR-Indian Agricultural Research Institute, New Delhi	Country's first Canola Quality Indian mustard variety Low erucic acid (40.0% erucic acid and >120.0 ppm glucosinolates in popular varieties
7.	Cauliflower	Pusa Beta Kesari 1 (Pure line variety)	ICAR-Indian Agricultural Research Institute, New Delhi	Country's first biofortified cauliflower Contains high β-carotene (8.0-10.0 ppm) in comparison to negligible β-carotene content in popular varieties
8.	Potato	Bhu Sona	ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala	High β-carotene (14.0 mg/100 g) content as compared to 2.0-3.0 mg/100 g β- carotene in popular varieties
9.	Sweet Potato	Bhu Krishna	• Developed by ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala	High anthocyanin (90.0 mg/100g) content in comparison to popular varieties which have negligible anthocyanin content, Salinity stress tolerant
10.	Pomegranate	Solapur Lal	ICAR-National Research Centre on Pomegranate, Pune	High iron (5.6-6.1 mg/100g), zinc (0.64-0.69 mg/100g) and vitamin C (19.4 -19.8 mg/100 g) in fresh arils in comparison to 2.7-3.2 mg/ 100g, 0.50- 0.54 mg/100g and 14.2-14.6 mg/100g, respectively in popular variety.

Biofortification of crops is a challenging endeavor. Many plant breeding programs focus on improvement of productivity, resistance to biotic and abiotic stresses, and food palatability. The improvement of nutritional quality has been added as an additional breeding objective in recent years. In order to achieve these objectives, collaboration between plant breeders and nutrition scientists is essential.

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