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Biofortification in Crops with Special Reference to Pulses

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INTRODUCTION

Malnutrition is a condition that results from eating a diet in which one or more nutrients are either not enough or are too much such that the diet causes health problems. Malnutrition caused by deficiencies of vitamins and minerals - also called Hidden hunger. Hidden hunger (deficiencies in micronutrients) is emerging as a major challenge for agricultural scientists. It is caused by lack of vitamin A, zinc, iodine, folate and iron (Jawaldeh *et al.* 2019). World population is increasing, and food consumption demand is augmenting**.**

Biofortification

The term coined by Steve Beebe, a bean researcher at the international center for tropical agriculture (CIAT), in 2001.Biofortification is a method of breeding crops to increase their nutritional value. Biofortification can be defined as a process to increase the bioavailability and the concentration of nutrients in crops through both conventional plant breeding and recombinant DNA technology (genetic engineering) (White and Broadley, 2005).

Harvest Plus

Harvest Plus is the part of CGIAR Research Program on Agriculture for Nutrition and Health. Harvest Plus was formally launched in the year 2004.It coordinated by two CGIAR centers, CIAT and IFPRI.

Harvest Plus has operated in India since 2011, in close collaboration with partners in the public and private sector, to improve nutrition and public health by developing and promoting biofortified crops and building out biofortified seed and crop value chains.

CASE STUDIES

Ning *et al.* (2014) detected the genetic loci in recombinant inbreed line population of soybean for mineral concentrations, including calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn) and phosphorus (P).They detected many loci which were associated with micronutrients.

Babu and Neeraja (2017) investigated several rice varieties and land races collected from different parts of the country. Among them, about 10 varieties each with high iron and zinc content were identified and some of these lines were used in the breeding programme to develop nutritional rich genotype.

Kumar *et al.* (2019) reviewed genetic transformation of crops like rice, wheat, maize, cassava and canola for zinc, iron and vitamin A enhancement in the edible part of the crops. The researchers concluded that gene technology is a rewarding method for the development of nutrient dense crops.

Pessoa *et al.* (2021) evaluated the nutritionally potential and indicated genotypes of cowpea (*Vigna unguiculata*) for genetic improvement based on nutritional traits. The CE-0151, CE-0189, CE-0207, CE-0228, CE-0248, CE-0542, CE-0685, CE-0686, CE-0796, CE-0997, and CE 1002 genotypes are indicated for selection to continue the biofortified cowpea breeding program.

Singh *et al.* (2021) determine the potential of parents (PKG 2, ICC 19, ICC 21, ICC 22 and ICC 24) and their crosses for Zn and Fe micronutrient content through diallel cross. Heterosis was also estimated to identify superior combinations. Out of 10 crosses, a cross PKG 2 × ICC 19 showcased significant positive heterosis over mid, better and check parents for Fe content and ICC 19 × ICC 24 depicted superiority over mid and better parents for Zn content. Hence, crosses PKG 2 × ICC 19 and ICC 19 × ICC 24 could be found beneficial in biofortification programme in combating nutrient deficiency.

Shahin *et al.* (2022) identified LR-9-25 (BARI Masur-8) lentil line from RIL population created through a cross between ILLX955-135 and FLIP92-52L. BARI Masur-8 showed high yield potential (1,973 kg ha^{-1}) and high concentrations of Fe (74 mg kg^{-1}) and Zn (61 mg kg^{-1}) in seed.

Akhtar *et al.* (2023) performed line × tester analysis for the assessment of heterosis for grain yield, iron and zinc content in six lines and three testers of maize. The experiment was performed in two environmental conditions *viz.,* optimum N and low N condition for better results. Both additive and non-additive gene effects were found important for controlling iron, zinc and grain yield, while high and positive sca effect for these traits in low N condition leads to the development of promising research hybrids for low N areas.

Freitas *et al.* (2023) evaluated the potential of 100 cowpea genotypes for biofortification of iron, zinc, and proteins, and cooking quality of the grain. The superiority of genotypes for iron, zinc, proteins, and cooking quality was carried out using the nutritional quality and cooking index. The line MNC11-1023E-28 has the best profile of nutritional and cooking quality, showing potential as a food to meet consumer demands and reverse iron and zinc deficiency in the Brazilian population.

CONCLUSION

Nutrients dense crops developed through plant breeding approaches (biofortification) is now well established as cost effective and sustainable approach to minimize nutritional gaps. Limited extent of genetic variability in available breeding material and complexity in obtaining healthy, fertile recombinant restricts further nutritional gain in pulses, unlike other developed biofortified crops. The unexplored wild and related species of crops, can be incorporated in breeding programme as potential source of genetic variability to develop nutrient dense variety of a crop with competitive yield. In parallel to conventional breeding, gene technology and marker assisted breeding can also be adopted, for the development of nutrient dense crops.

FUTURE THRUST

Developing biofortified varieties that are resilient to climate change will ensure stable production even under changing environmental conditions.

Through gene stacking, combining multiple nutritional traits in a single crop variety can address multiple nutrient deficiencies simultaneously.

Development of hand-held and easy to use equipment that can quickly provide some reliable estimates of the quality parameters of the produce would be beneficial (like brix meter in sugarcane and sweet corn).

Bio-efficacy and acceptability trials of the biofortified varieties, need to be designed more often, to confirm the suitability of the variety to the end user besides developing confidence.

Assured premium remunerative price through minimum support price for biofortified produce in the market will encourage the farmers to grow more biofortified crops.

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