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POPULAR ARTICLE

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Global Strategies for Prevention of Malnutrition in India

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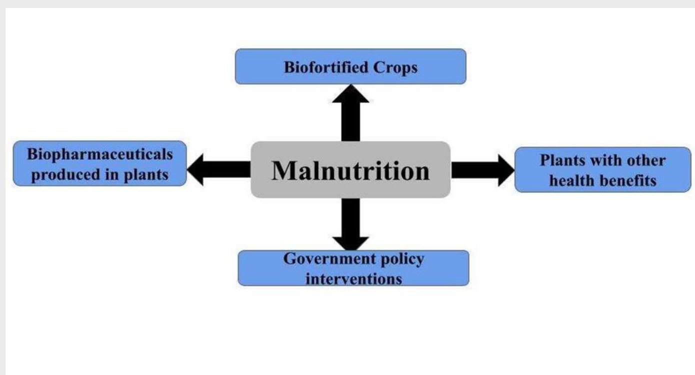
The authors assert that the manuscript was developed without any commercial or financial associations that could be interpreted as a potential conflict of interest.

Authors Contribution

All listed authors have contributed significantly, directly, and intellectually to the work and have endorsed it for publication.

Abstract

Any excess, imbalance, or deficit in a person's energy and nutrient consumption is called malnutrition. It may be the result of either an excessive or insufficient calorie intake. Undernourished children are a major public health issue in India. India has one of the highest rates of underweight children worldwide, about twice as high as Sub-Saharan Africa, which is indicative of this. With one-third of the world's malnourished children living in India, the country has one of the highest rates of child malnutrition. The National Family Health Survey 5 (NFHS 5) conducted by the Government of India reveals that 36% of children under five have stunted growth, 19% are wasted, 32% are underweight, and 3% are overweight. Biotechnology has produced food crops with increased nutritional value within 20 years. The world's impoverished have a lot to gain economically and health-wise from biofortified sorghum, cassava, maize, rice, and other staple crops enhanced with vital micronutrients. This article examines the reasons behind under-five child malnutrition in India in this regard. It analyzes the global approaches with the help of upcoming biotechnological processes to prevent or cure malnutrition in India.



KEYWORDS

Malnutrition, Diseases, Biotechnological strategies for prevention.

INTRODUCTION

A major issue that affects people all around the world at different stages of life is malnutrition. Malnutrition is a significant worldwide problem. Currently, it impacts everyone regardless of location, socioeconomic position, gender, and sex, as well as overlapping homes, communities, and nations. Anyone can be affected by malnutrition, but the most susceptible are those with poor immune systems, the poor, and children and teenagers. In India, undernourished children represent a serious health risk. India has one of the highest numbers of malnutrited children in the world [1]. A recent study conducted in 130 districts using Demographic and Health Surveys in 53 countries between 1986 and 2006 found that among children aged three months to three years, the variance in mild underweight has a larger and more robust correlation with child mortality than the variance in severe underweight. These days, one of the biggest issues facing the world is considered to be hidden hunger or micronutrient deficiencies. Achieving sufficient food production, in addition to the creation of crops rich in nutrients, is one of the primary challenges in satisfying the demands of an increasingly populous globe. Enhancing the quantity and quality of agricultural output is essential to achieving the goal of increased crop yield. The assessment attempts to concentrate on the reasons behind India's micronutrient deficiency. This study will cover advanced biotechnology tools and global biotechnology techniques to reduce malnutrition [2].

CLASSIFICATION OF MALNUTRITION

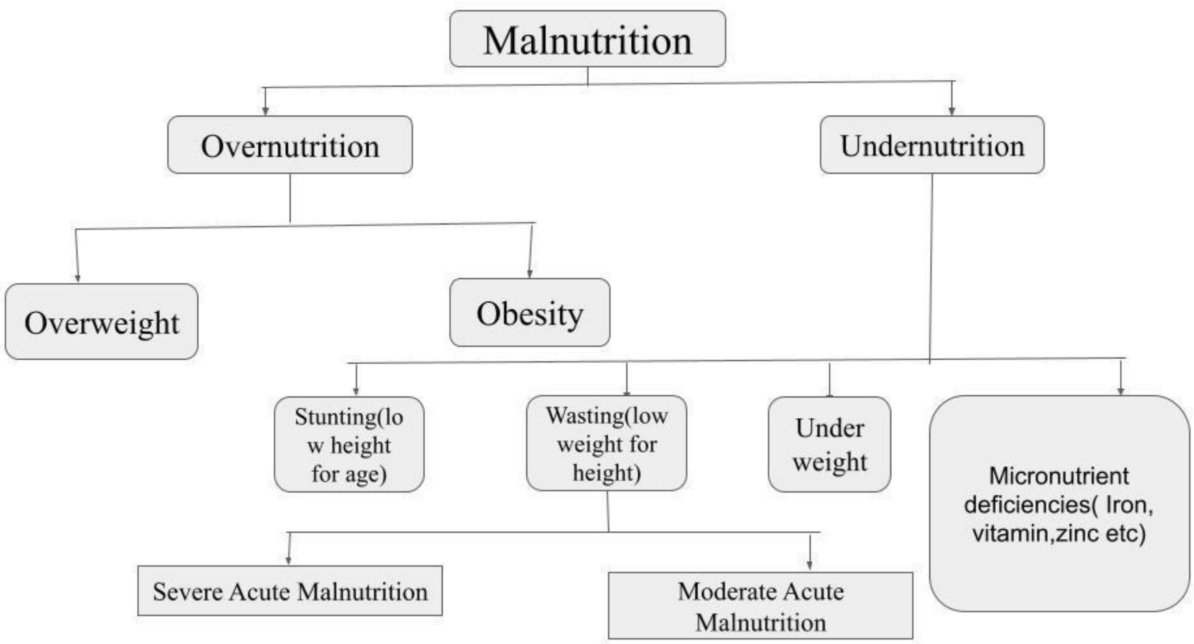


Fig 1: Classification of malnutririon

MICRONUTRIENT DEFECIENCY AND ADVANCE GENOME EDITING TOOLS

Plant susceptibility to different environmental stressors is impacted directly or indirectly by micronutrient deciencies. According to Ahmad and Prasad (2011), plants that are grown in environments lacking micronutrients are more vulnerable to a range of abiotic and biotic stressors. Thus, other issues include helping crops become more stress-tolerant and applying chemical fertilizers sparingly, in addition to increasing the nutritional value of the crop and seeds. Notable developments in biotechnological techniques in recent years, such as mutation, transgenic technologies and hybridization, have opened the different way for the development of different kinds of crops (genetically modified). In the late 1990s, mutagenesis and transgenic breeding methods allowed for genome manipulation of many crops, leading to the development of some high-yielding cultivars. [3]. A solid understanding of gene sequences, regulatory mechanisms, cell signaling, enzyme kinetics, and the phenotypic effects of genetic change are necessary for advanced biotechnological technologies. Many metabolic pathways can be altered or modified to increase the quantity of desired chemicals or minerals using modern biotechnology techniques. Since the development of techniques for genome editing, plant sciences have experienced a dramatic transformation. Genome editing technologies have significantly contributed to the clarification of gene function and the development of crop plants through the use of site-specific endonucleases for targeted mutagenesis. Meganucleases which alter the targeted region of any genome, have demonstrated signicant promise for improving crops. Following the successful application of ZFNs in animal and plant systems following their discovery in 1985, TALENs were introduced to modify specic genes in plants. Subsequent studies have located a region in the promoter of the barley phytase gene, HvPAPhy, that has a series of regulatory motifs. To alter the phytase gene, TALENS specifically targeted these regulatory regions. Soybean cultivars with high oleic acid content were produced by specifically mutating fatty acid desaturase genes, such as FAD2-1 A and FAD2-1 B, using TALENs. In order to improve the desired quality required for processing potatoes, TALENs were employed to knock out the vacuolar invertase gene (VInv) in potatoes. Among the potential genes linked to Fe and Zn homeostasis that have been identified and shown to be essential for iron uptake from soil are OsIRT2, OsDMAS1, OsYSL15, OsNAS2 and OsYSL2, and thus these transporters are among the potential targets for genome editing. Recent studies have shown that CRISPR/Cas9 may be used to target four yield-related genes in rice in order to boost yield properties [4]. Furthermore, base editing hybrids offer an efficient means of rapidly improving desirable traits and have the ability to increase crop yield and grain nutrient value several times over. With time, this technology is anticipated to contribute to addressing the worldwide challenge of food security. The CRISPR-Cas9 system has emerged as a new generation breeding tool for the development of climate-resilient crops, induction of self-compatibility, and increase of nutritional content in agricultural plants. [5].

RECENT INSILICO APPROCHES TO PREVENT MICRONUTRIENT DEFICIENCY

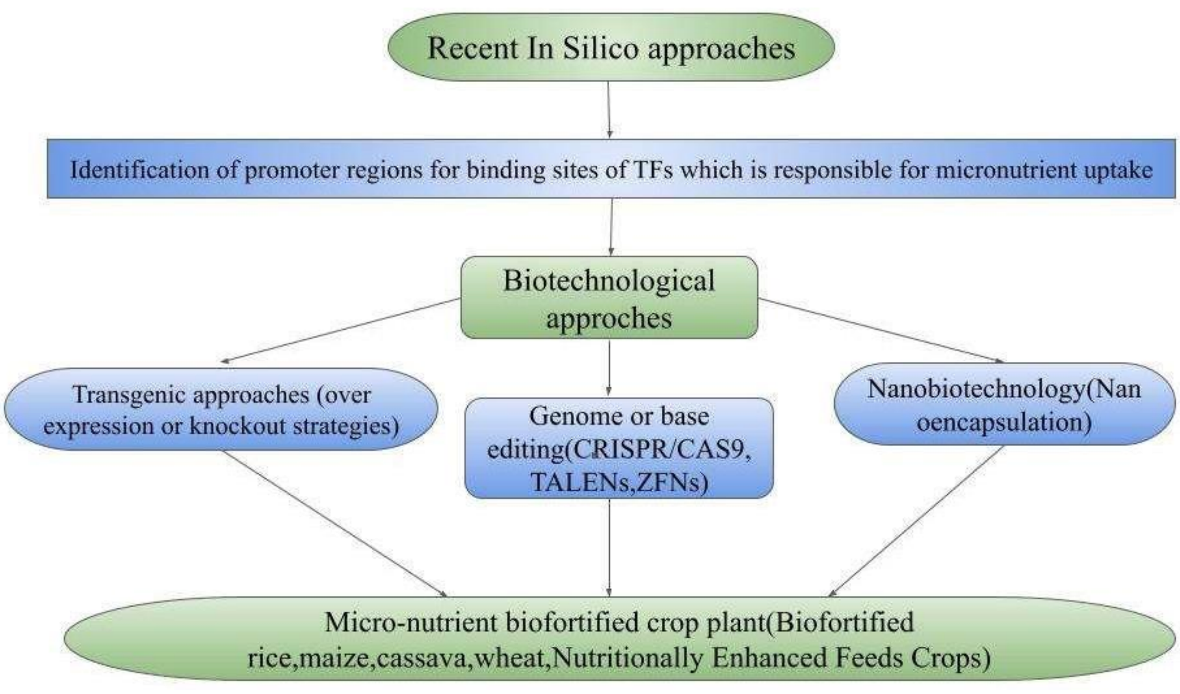


Fig 2: Recent In sicilo approaches to prevent micronutrient defeciency

Numerous investigations have exhibited the significance of transcription factors in controlling an extensive array of genes that are responsive to stress. Additionally, a range of TFs modify the expression of several transporter genes in plants, which has a direct or indirect impact on the control of micronutrient absorption and accumulation. Surprisingly, when OsNAC5 was overexpressed in the ag leaves during grain lling, rice seeds accumulated more Fe [6]. The fastest reaction to Fe deciency genes and the distribution of Fe are controlled by the OsYSL2 gene. Iron deciency response element binding factor-1 and 2, respectively, belong to the ABI3/VP and NAC/CUP families. [7].

THE ROLE OF MICRORNAS IN THE ABSORPTION OF MICRONUTRIENTS

Regulatory RNA molecules, or microRNAs, are small non-coding RNA molecules that have a length of approximately 22 nucleotides. These RNA molecules are essential to almost every plant function, including development, cell wall synthesis, response to different stresses, and growth regulation. It is known that a number of miRNAs have a significant role in regulating the uptake and transport of minerals by plants. Recent studies in rice, wheat, and arabidopsis have shown that miRNAs control the expression of genes linked to phosphate and sulfate. [8]. Arabidopsis showed increased expression of miR159a and miR394a in the roots and miR159a and miR169b in the shoots when there was a Fe deficit. Cu is necessary for plants to respond to oxidative stress because it is a cofactor of Copper/Zinc Superoxide Dismutase (CSD). Moreover, it has been shown that the expression of numerous miRNAs, is elevated in Cu deficient situations. In the end, this results in the suppression of specific laccase genes, in addition to genes for plastocyanin. The target specificity of miRNAs and their functional network in the regulation of several genes offer fresh perspectives on the molecular processes underlying the metabolism of micronutrients. Therefore, it seems that miRNAs are crucial genetic targets for identifying new features that increase crops' capacity to use micronutrients efficiently.

NANOTECHNOLOGY

Nanotechnology has become one of the most promising tools with prospective uses in agriculture to address the inadequacies of current agricultural techniques. Interest in nano-biotechnology for agriculture has grown as a result of the growing advancements in nanotechnology within the realm of medicine. Various nanotechnology-based approaches, including nanoparticles, nanodevices, and nanoencapsulation, have been used to increase the efciency of plants' uptake of micronutrients. It also increases the solubility of the less soluble molecule. Interestingly, there may be some advantages to encapsulating micronutrients in nanoparticles and microcapsules as opposed to conventional fertilizers. Studies have shown that rice's absorption of zinc is enhanced by Zn-containing nanostructures with a Mn-carbonate coating in the middle (Yuvaraj and Subramanian 2014). These results suggest that Mn nanoparticles may increase photosynthetic activity in plants, hence stimulating growth and development [9].

FINAL THOUGHTS AND PROSPECTIVE DIRECTIONS

Because they control cellular metabolism and protein synthesis and are the primary structural elements of numerous coenzymes and macromolecules, including amino acids, micronutrients are critical for sustaining plant growth and development. In the meantime, several studies concentrating on genetic engineering and biotechnology methods to improve the nutritional (Fe and Zn) content of rice endosperm and other crop plants started to appear. Research has revealed that zinc and nickel are important for the growth of plant defense mechanisms. Most research and review articles released in the recent several years (2020–2022) have addressed the function of transporters and how the molecular regulation of these proteins influences plants' capacity to utilize micronutrients more effectively. The potential use of agricultural biotechnologies as biofortication tools in combination with combinatorial strategies of dietary diversification and mineral supplementation to reduce micronutrient deficiency and enhance human health worldwide has been made clear by recent study. Agricultural biotechnology-based biofortication also depends on genetically modifying regulatory elements like microRNAs and precision genome editing methods like CRISPR-Cas9 and other genome editing techniques [10]. Apart from genome editing, several other biotechnological methods have been the focus of study lately. Examples of this include how microRNA affects metabolic enzymes and nutrient transporters in cereal crops during nutritional stress. A significant tool to address the issue of global micronutrient malnutrition will eventually be provided by biofortication of crops through agricultural biotechnology employing less expensive, quicker, and more promising genome editing strategies in addition to conventional and marker-assisted plant breeding techniques. However, experts from all over the world also play a crucial role in convincing regulatory bodies and society of the advantages and disadvantages of the crops produced utilizing biotechnology technologies by sharing knowledge from the lab and field.The recent global problem caused by COVID-19 and the clear indications and effects of climate change have made knowledge transfer increasingly important when it comes to future approaches to biotechnology-mediated crop difculties.

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