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Micronutrient Deficiency: Leading Cause of Malnutrition

Aman Verma, Devendra Singh and Mahipal Choudhary
Scientist, ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan

SUMMARY

Alleviation of malnutrition has been known as one of the goal for achieving hunger-free world. It is recognized as Sustainable Development Goals-2 (SDG-2) out of 17 identified goals. The importance of nutritional and food security can be realized by the fact that out of 17 SDGs, 12 are related to nutrition signifying its value in health, education, employment and female empowerment sectors. Micronutrient deficiency remains hidden, especially in children of middle age and appears when it becomes severe. Around 155 million children of less than 5 years are stunted, whereas 52 million are wasted. Reducing anti-nutrients and promoting biofortified crops hold great promise for health and wellbeing of increasing human population and to combat micronutrient deficiency.

INTRODUCTION

Micronutrient deficiency or hidden hunger is a leading global problem. The United Nations Food and Agriculture Organization (FAO) has estimated that around eight hundred million people across the world are malnourished, out of which 90% are living in developing countries (McGuire, 2015). More to this, insufficient intake of essential micronutrients in the daily diet is causing another type of hunger known as "hidden hunger in around two billion people across the world. Annually, India is spending around six lakh crore rupees in GDP due to micronutrient deficiencies in addition to the loss of employment due to medical illness which adds to poverty index of the country as a whole. Malnutrition in its all forms could cost society up to US$3.5 trillion per year. According to Global Hunger Index, 2020, India ranked 94 among 107 nations and stands in the "serious" hunger category along with few neighbouring Asian countries. This is estimated on the basis of percentage of child mortality, undernourished population, children suffering from wasting and stunting. Indian agricultural system is seeing a paradigm shift from food sufficiency to nutritional security. The main goal of green revolution was to achieve food adequacy, but now the focus is to have nutritional food security. Though traditional Indian food habits were quite rich in terms of nutrition, but somehow due to change in priorities, lifestyle, climate change, problems like hidden hunger is rising. Rising food prices, lack of healthcare system, market accessibility and climate change are adding to this menace. Nutrient supplementation programs were not sufficient for having nutritional security. Further, anti-nutritional compounds like phytic acid, Glucosinolates etc. present in edible parts of the food exert adverse affects on human health. Now Indian agriculture is adopting and promoting production of nutrient-rich food crops in sufficient quantities, so as to fight "micronutrient malnutrition" or "hidden hunger" which under developed and developing countries should follow the same, where diets are dominated by micronutrient-poor staple food crops. Hence, biofortification of different crop varieties offers a long-term and sustainable option in providing micronutrients-rich crops to people (Verma et al 2021).

Biofortification

Human body requires nearly 40 known macro- and micronutrients to live healthy and productive lives (Table 1). These nutrients play vital roles in human's physical and mental and socio-economic development. Most of the members of vitamin B complex acts as cofactors to various catalytic enzymes and thereby regulate important functions and metabolic processes in our body (Welch and Graham, 2004).

Table 1: Essential macro- and micronutrients required for good human health.

Macronutrients			Micronutrients	
Macrominerals	**Essential Fatty acids**	**Essential Amino acids**	**Vitamins**	**Microminerals**
Potassium (K)	Linoleic acid	Histidine	Ascorbic acid)	Iron (Fe)
Calcium (Ca)	Linolenic	Leucine	Thiamin	Manganese (Mn)

	acid			
Sulphur (S)		Isoleucine	Riboflavin	Copper (Cu)
Chlorine (Cl)		Lysine	Niacin	Zinc (Zn)
Sodium (Na)		Methionine	Pantothenic acid	Iodine (I)
Magnesium (Mg)		Valine	Pyridoxine	Cobalt (Co)
Phosphorus (P)		Phenylalanine	Biotin	Nickel (Ni)
		Tryptophan	Folic acid	Molybdenum (Mo)
		Threonine	Cobalamin	Selenium (Se)
			Calciferol	
			α-Tocopherol	
			Phylloquinone	

Although India has released biofortified varieties for major crops, but its adoption among the masses is still lacking. Biofortified pearl millet varieties rich in zinc and iron have gain acceptance in Maharashtra. Recently Indian government has released 17 biofortified varieties of eight crops on World Food Day, which can increase the nutritional value of food staples. The biofortified varieties are 1.5 to 3.0 times more nutritious than the traditional varieties. List of biofortified crops is given in Table 2. Biofortification of essential micronutrients into crop plants can be achieved through three main approaches, namely transgenic, conventional, and agronomic, involving the use of biotechnology, crop breeding, and fertilization strategies, respectively (Garg et al., 2018).

Table 2: Indian Biofortified crops released on World Food Day, 2020

Crop	Variety	Trait	Developed by
Rice	CR Dhan 315	Zinc (24.9 ppm)	ICAR-National Rice Research Institute, Cuttack
Wheat	HI 1633	Rich in protein (12.4 %), iron (41.6 ppm) and zinc (41.1 ppm)	ICAR-Indian Agricultural Research Institute, Regional Station, Indore
	HD 3298	Rich in protein (12.1 %) and iron (43.1 ppm)	ICAR-Indian Agricultural Research Institute, New Delhi
	DBW 303	Rich in protein (12.1 %)	ICAR-Indian Institute of Wheat & Barley Research, Karnal
	DDW 48	Rich in protein (12.1 %)	ICAR-Indian Institute of Wheat & Barley Research, Karnal
	MACS 4058	Rich in protein (14.7 %), iron (39.5 ppm) and zinc (37.8 ppm)	Agharkar Research Institute, Pune, under ICAR-AICRP on Wheat & Barley
Maize	LQMH-1	Rich in lysine (3.03 % in protein) and tryptophan (0.73 % in protein)	ICAR-Indian Institute of Maize Research, Ludhiana
	LQMH-2	Rich in lysine (3.04 % in protein) and tryptophan (0.66 % in protein)	ICAR-Indian Institute of Maize Research, Ludhiana
	LQMH-3	Rich in lysine (3.48 % in protein) and tryptophan (0.77 % in protein)	ICAR-Indian Institute of Maize Research, Ludhiana
Finger Millet	CFMV-1	Rich in calcium (428 mg/100g), iron (58.0 ppm) and zinc (44.0 ppm)	Developed by ARS, ANGRAU, Vizianagaram under ICAR-AICRP on Small Millets

	CFMV-2	Rich in calcium (454 mg/100g), iron (39.0 ppm) and zinc (25.0 ppm)	Developed by Hill Millet Research Station, Navsari Agricultural University, Waghai under ICAR-AICRP on Small Millets
Little Millet	CLMC-1	Rich in iron (59.0 ppm) and zinc (35.0 ppm)	ICAR-Indian Institute of Millets Research, Hyderabad
Mustard	PM-32	Low in erucic acid (1.32 % in oil)	ICAR-Indian Agricultural Research Institute, New Delhi
Ground nut	Girnar-4	Rich in oleic acid (78.5 % in oil)	ICAR-Directorate of Groundnut Research, Junagadh
	Girnar-5	Rich in oleic acid (78.4 % in oil)	ICAR-Directorate of Groundnut Research, Junagadh
Yam	Da-340 & SreeNeelima	Rich in anthocyanin (50.0 mg/100g), crude protein (15.4 %) and zinc (49.8 ppm)	ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram

Reducing the Anti-nutrients:

Anti-nutrients are natural or synthetic compounds that interfere with the absorption of nutrients. Lipase inhibitors (e.g., tetrahydrolipstatin) interfere with enzymes, such as lipases, which catalyze hydrolysis of some lipids and fats. Phytic acid in the legumes, nuts, and seeds grains, has a strong binding affinity for divalent cations like calcium, magnesium, iron, copper, and zinc, preventing their absorption (Singh et al 2020). Reports are there where water soaking has reduced phytic acid content in groundnut (Verma et al 2019). Glucosinolates (e.g. mustard, although widely recognized for their medicinal value, also interfere with the uptake of iodine and flavonoids, and chelate metal ions (iron and zinc) thus reducing their absorption. Oxalic acid and oxalates, are present in many plants, particularly in spinach family, bind calcium to prevent its absorption. Many traditional preparation methods (e.g., fermentation) reduce antinutrients, such as phytic acid, increase the nutritional quality of plant foods.

Constraints

Bio-fortified crops can be directly fed into India's ambitious POSHAN Abhiyaan targeting underprivileged population with the aim to reduce malnutrition, stunting and low birth weight. Awareness building through large-scale campaigns by government organizations targeting middle-class and poor consumers is crucial. Beside developing bio-fortified varieties with higher micronutrients, there is growing concern for sufficient production of seeds for distribution among farmers. Minimum standard of nutritional trait content needs to be verified for varieties to be released into the seed production process. The farmers and stakeholders should fetch premium price for their harvest. India has a long way to go before biofortified crops make it to all our plates. But it's an important step for fight against malnutrition and hidden hunger.

CONCLUSION

For achieving nutritional and food security, sustainable food systems are required through multiple strategies with better aiming and co-ordination between different programs and policies. In India, these strategies need to focus on improving diet diversification, reducing postharvest losses, bio-fortification of main/staple crops with its inclusion in safety net programs, women's empowerment and hygiene. In future, nutritional and food security initiatives will have to be adopted in keeping with changing livelihood patterns, climate change, and health-specific generic demands.

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