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Fortification: A remedy against hidden hunger in India

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Introduction

Globally, an estimated two billion people suffer from a chronic deficiency of essential vitamins and minerals (micronutrients), a condition known as hidden hunger. The Hidden Hunger Index provides the global health and development community with evidence to inform where to focus national strategies and programs, and on which micronutrients. The options to fulfil these requirements are through medicine (expensive, problem of monitoring for quality of medicine), diet diversification (expensive and unaffordable for many) and fortification. Fortification is the addition of key nutrients to staple foods either preharvest operations (Biofortification) and postharvest operations (food fortification). Fortification is a globally proven intervention to address the much prevalent micronutrient deficiencies in the population. Fortification is required because; out of 129 countries, 57 countries have severe levels of under- nutrition and adult overweight (Anonymous, 2018); out of world population of 7 billion, 2 billion suffer from micronutrient deficiencies; South Asia is home to more than 35% of the world's poor and 21.9% of the population of India lives in poverty; India is home to world's highest under-nourished people (194.6 million), where 38.4% of the children (<5 years) are stunted and 35.7% are underweight; annually India losses over US$12 billion in Gross Domestic Product to vitamin and mineral deficiencies (FAO, 2017); considerable loss of nutrients during the processing of food.

The various benefits of fortification of foods (Anonymous, 2020); nutrients are added to staple foods since they are widely consumed. Thus, this is an excellent method to improve the health of a large section of the population, all at once; It is a safe method of improving nutrition among people. The quantity added is small and well under the Recommended Daily Allowances and are well regulated as per prescribed standards for safe consumption; it is a cost-effective intervention and does not require any changes in eating patterns or food habits of people; it is a socio-culturally acceptable way to deliver nutrients to people; it does not alter the characteristics of the food like the taste, aroma or the texture of the food.

Types of fortification

***Market driven fortification*:** In the accessing of promoting public health by adding essential nutrients to foods the market driven fortification lowering the onset of micronutrient insufficiency as per regulations set by the government. These type of fortification interventions on public health are performed in most developing countries in a limited way.

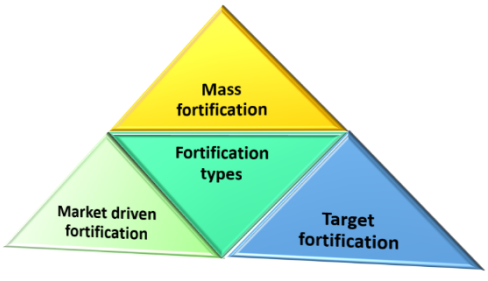

Figure 1: Fortification and its types

***Mass fortification*:** An unacceptable public health risk is quite common and this can be mainly required adequate micronutrients in definite quantity (Dary and Hurrell, 2006). These types of fortifications are also known as free market fortification as the population may not actually be

deficient, but it may benefit from strengthening and mainly depend on normal biochemical or dietary standards.

***Target fortification*:** These fortification interventions focusing on a particular food for a defined population and thus, increases the intake for that selected group not by following mass groups of people. Daily micronutrient requirements framed and according to this foodstuff has to be supplied to the target group.

Methods of fortification

Biofortification

Biofortification, the process of maximizing the bioavailability of essential micronutrients in consumable part of the plants using various agronomic interventions methods in order to eradicate the mitigations of hidden hunger (Singh *et al.,* 2016). Howarth E. "Howdy" Bouis in 1990 developed a process called biofortification which reduces micronutrient malnutrition, also known as hidden hunger. The selection of target crops is divided into two phases; phase-I includes the staple crops to the particular zones such as wheat, rice, maize, sweet potato, beans and pearl millet and phase-II are potato, sorghum, banana, lentils and groundnut which has special attention in the diet other than staple foods. The main aim of the biofortification is to enhance the quality of micronutrients of crops at edible portion. Singh *et al.,* 2016 notify several methods through which biofortification has been carried out such as; plant breeding, conventional plant breeding, mutation breeding, molecular breeding, genetic engineering and tissue cultures. Some of the biofortified crops in grown in India are shown in Table 1.

Food fortification

Food fortification is a postharvest process which includes the adding of micronutrients (essential trace elements and vitamins) to food. It can be carried out by food manufacturers, or by governments as a public health policy which aims to scale down dietary deficiencies of the people within the population. Globally, these are the cheapest practices to rectify the micronutrients malnutrition issues now a days. As we are familiar with the iodization of salt in which iodine part is added which decline the cases of goitre (Gomez-Galera *et al.,* 2010).

Food Safety and Standard Authority of India (FSSAI) has established Food Fortification Resource Centre (FFRC) on October 16, 2016 in collaboration with Tata Trusts and various International NGOs working in the field of nutrition as a resource centre to promote large-scale fortification of food (Anonymous, 2020). The FFRC is a Resource and Support Centre to promote large-scale fortification of food across India. It is a resource hub which provides information and inputs on standards and food safety, technology and processes, premix and equipment procurement and manufacture, quality assurance and quality control for fortification of foods. On August 22, 2017 India FSSAI announced that the fortification logo (+F logo) is now a mandatory labelling requirement on all fortified food products.

Table 1: Some of the biofortified crops in India (Yadava et al., 2017)

Crop variety	Developed by, year of release	Specifications	Adaptations
Rice: CR Dhan 310	ICAR-NRRI, Cuttak, 2016	Protein (10.3%) in polished grain as compared to 7.0-8.0% in popular varieties	Odisha, Madhya Pradesh and Uttar Pradesh
Rice: DRR Dhan 45	ICAR- IIRR, Hydrabad, 2016	High in zinc content (22.6 ppm) in polished grains in comparison to 12.0-16.0 ppm in popular varieties	Karnataka, Tamil Nadu, Andhra Pradesh and Telangana
Wheat: WB 02	ICAR- IIWBR, Karnal, 2017	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	Punjab, Haryana, Delhi, Rajasthan, Jammu and Kashmir, Himachal Pradesh and Uttarakhand
Pearl millet: HHB 299	CCS, HAU, Hisar-ICRISAT, 2017	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	*Kharif* season in Haryana, Rajasthan, Gujarat, Punjab, Delhi, Maharashtra and Tamil Nadu
Maize: Pusa Vivek QPM9 Improved	ICAR- IARI, New Delhi, 2017	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	*Kharif* season in Jammu and Kashmir, Uttarakhand (Hill region), North Eastern states, Maharashtra, Karnataka, Telangana and Tamil Nadu
Lentil: Pusa Ageti Masoor	ICAR-IARI, New Delhi, 2017	Contains 65.0 ppm iron as compared to 55.0 ppm iron in popular varieties	Uttar Pradesh, Madhya Pradesh, Chhattisgarh
Mustard: Pusa Mustard 30	ICAR-IARI, New Delhi, 2013	Contains low erucic acid (<2.0%) in oil as compared to >40% erucic acid in popular varieties	Uttar Pradesh, Uttarakhand, Madhya Pradesh and Rajasthan
Mustard: Pusa Double Zero Mustard 31	ICAR-IARI, New Delhi, 2016	Low erucic acid (<2.0%) in oil and glucosinolates (<30.0 ppm) in seed meal as compared to >40.0% erucic acid and >120.0 ppm glucosinolates in popular varieties	Rajasthan (North and Western parts), Punjab, Haryana, Delhi, Western UP, Plains of Jammu and Kashmir, Himachal Pradesh
Cauliflower: Pusa Beta Kesari 1	ICAR-IARI, New Delhi, 2015	Contains high β-carotene (8.0-10.0 ppm) in comparison to negligible β-carotene content in popular varieties	Nation Capital Region of Delhi
Sweet potato: Bhu Sona	ICAR-CTCRI, Thiruvananthapuram 2017	High β-carotene (14.0 mg/100 g) content as compared to 2.0-3.0 mg/100 g β- carotene in popular varieties	Odisha

Table 2: Selected vehicles for carrying the micronutrients by food fortification resource centre (Anonymous, 2020)

Food	Micronutrients and recommended levels
Edible oil	• Vitamin A: 25 IU/g of oil (Retinyl acetate, Retinyl palmitate and Retinyl propionate) • Vitamin D2: 4.5 IU/g of oil (Ergocalciferol, Cholecalciferol)
Milk	• Vitamin A (Retinyl acetate, Retinyl palmitate and Retinyl propionate): 770 IU/litre of milk • Vitamin D2 (Ergocalciferol, Cholecalciferol): 550 IU/ litre of milk
Double fortified salt	• Iodine (Potassium Iodate): Manufacture level (not less than 30ppm on dry weight basis); Distribution level (not less than 15ppm on dry weight basis) • Iron (Ferrous sulphate or Ferrous fumarate): 850-1100 ppm
*Rice	• Iron (Ferric pyrophosphate: 28-42.5 mg/kg; Sodium Iron (III) EDTA: 14-21.25 mg/kg • Folic acid: 75-125 µg/kg • Vitamin B12 (Cyanocobalamine or Hydroxycobalamine): 0.75-1.25 µg
*Wheat flour	• Iron (Ferrous citrate or lactate or ferrous sulphate or ferric pyrophosphate or electrolytic iron or ferrous fumarate or ferrous BisGlycinate): 28-42.5 mg/kg; Sodium Iron (III) EDTA: 14-21.25 mg/kg • Folic acid: 75-125 µg/kg • Vitamin B12 (Cyanocobalamine or Hydroxycobalamine): 0.75-1.25 µg/kg

*Also, can be fortified with Zn, vitamin A and vitamin B (B1, B2, B3 and B6) singly or in combination.

Conclusions

Indian Council of Agricultural Research (ICAR) has initiated biofortification in crops as a sustainable and cost-effective solution to alleviate malnutrition. National Nutrition Strategy' by the NITI Aayog, Govt. of the India, also provide impetus to utilize these biofortified varieties more effectively towards achieving *'Kuposhan Mukt Bharat'*. The Food Fortification Resource Centre also initiated the post fortification practices and initiate novel techniques to fortify foods at fast scale. The benefits of fortification positively impact the entire life cycle of mankind by fighting against hidden hunger. It is one of the most effective way to overcome malnutrition, especially in children and pregnant women and preventing the birth of intellectually impaired children with malformations or deficiencies.

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