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Staples – The Fortification Revolution Transforming Everyday Foods

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Micronutrient deficiencies are more common in diets with little diversification and little animal product consumption. As a result, even when they consume enough calories, people in the world's poorest regions, whether in industrialized or developing nations, may have terrible diets. Due to the food industry's heavy reliance on processed grains, sugar, salt, and vegetable fats-all of which are inadequate sources of vitamins and minerals-one effect of industrialization is a decrease in the consumption of several micronutrients. Many micronutrients daily requirements are frequently not met by those whose diets are primarily dependent on these goods. There are negative effects on both health and the economy associated with micronutrient deficiency, which is a global issue. This shortage is made worse in developing nations by systemic infections and parasitic [6]. Food fortification, or the addition of nutrients to food by a variety of biological or mechanical processes, is a strategy used to counteract such losses.

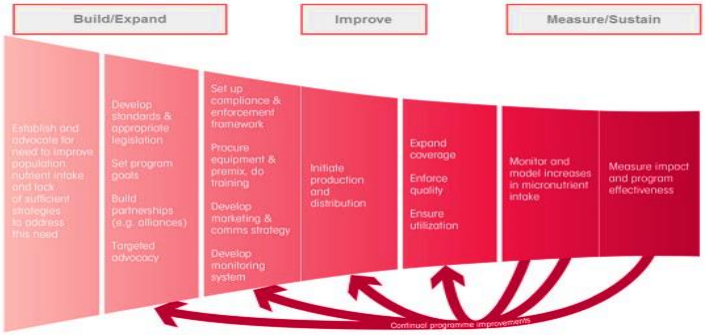

Fig 1: National impact model for food fortification https://doi.org/10.1016/B978-0-12-802861-2.00005-5)

Within larger nutrition, health, and development goals, national food fortification programme can be a useful tool to assist addresses the issue of hidden hunger where there is a clear need, a fortifiable food vehicle, and the appropriate amount of industrial food processing. Utilizing current delivery methods, national food fortification programme can improve food systems by increasing intakes of vital vitamins and minerals. When properly executed, they serve as a supplement to long-term nutrition-specific and nutrition-sensitive policies aimed at bolstering food systems, boosting dietary variety, and addressing nutrient deficits. Food fortification is therefore a component of a suite of evidence-based therapies that aid in the elimination of micronutrient malnutrition [3]. For instance, the image to mimic in the production of artificial soft drinks is orange or lemon juice; in the case of vegetable milks, it is cow milk; and in the case of textured vegetable proteins, it is meat or animal derivatives. As a result, depending on what is most practical, the phrases enrichment, fortification, and nitrification are sometimes used interchangeably [5].

Types of fortification

Voluntary fortification

When a food company uses a profit-driven strategy and, typically willingly but in compliance with legal requirements or regulations, adds specified levels of one or more micronutrients to processed meals. Despite the fact that voluntary reinforcement broad enterprises often undertake these initiatives, and in low- and middle-income nations, they have hardly been implemented on a broad scale.

Fig 2: Food product pyramid for fortification (Mannar and Sankar, 2004)

Mandatory fortification

In response to proven micronutrient deficiencies or in situations where a population, or subpopulation, may benefit, the government sector typically mandates and regulates the addition of one

or more micronutrients to foods that are typically consumed by the general public, such as grains, salt and condiments, or edible oil. Large- and medium-sized businesses as well as the organized food processing sector are usually the focus of these initiatives.

Small-scale fortification

The inclusion of one or more micronutrients in meals that are often produced by tiny, cottage industries and consumed by rural communities. Even in contexts where fortification is required, these industries and their products are rarely controlled since they are not usually registered and labeled.

Targeted fortification

Targeted fortification refers to the process of fortifying foods to enhance the consumption of particular subgroups of people rather than the general population. Examples of this include children's school meals, emergency feeding, and supplemental foods for babies and children.

Household and community fortification

Micronutrient powders for household and community fortification are also referred to as point-of-use products [3].

Biofortification

The process of breeding and altering plants to increase their nutritional uptake or content. Even though sorghum, millets, and other minor food crops made up a very small portion of the food supply in 1960, diversified and nutrient-dense food grains from productive farms were a staple of many people's diets, even in urban homes. These days, a balanced diet is unattainable due to our preference for starchy foods (rice, wheat, potatoes, etc.), which supply us enough calories but not enough nutrients, and our lack of attention for crops like millets, which are incredibly nutritious [5].

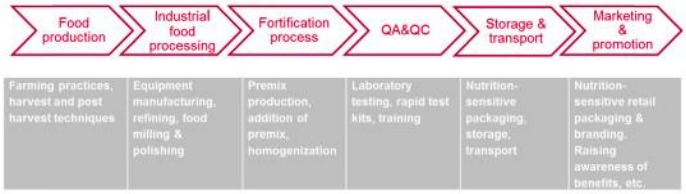

Fig 3: Fortification value chain (https://doi.org/10.1016/B978-0-12-802861-2.00005-5)

Micronutrient Fortification

When it comes to the human diet, minerals are inorganic chemical elements or, more accurately, their dissociated ions that are necessary for a variety of biological and biochemical activities, such as the build-up of electrolytes. Since carbon, hydrogen, nitrogen, and oxygen are present in most organic compounds, they are not included in the list. Of the sixteen essential minerals, eleven are needed in such minute quantities and/or are present in such large quantities in food and water that a deficit may occur only in extremely rare cases. The remaining five are found in little levels in a wide variety of foods, so a diet deficient in any one of them is likely. Iodine, iron (Fe), zinc (Zn), calcium (ca) and selenium (Se) are these minerals. When diets are mostly composed of staple foods with low accessible mineral content, like milled grains, deficiencies develop. Because of this, mineral deficiencies are more common in impoverished nations with limited availability to fresh foods, while ca deficiencies are also common in industrialised nations globe [4].

Iodine

The thyroid hormones triiodotyronine and thyroxine, which control growth and development and uphold the baseline metabolic rate, require iodine as a necessary component. Nevertheless, the thyroid gland only stores 30 % of the iodine in the body and 70 % is dispersed in other tissues. It could conflict with how other minerals like Se, Fe and Zn work. With over 50 million instances of goitre and over two million cases of crevism, India is among the worst-affected nations in the world.

Iron

Due to its dual roles as an electron donor and acceptor, iron serves a variety of vital purposes in the human body. In poor nations, iron deficiency affects not just newborns and expectant mothers but also school-age children, adolescents, adults, and even adult males. Consequently, broad-based interventions are appropriate for both preventing and controlling this deficiency. Staple food fortification is a sufficient method to provide populations more iron. Iron fortification in food hasn't worked out as well as fortification with vitamin A, iodine, or B vitamins,

though. Because iron alters the original qualities of the food it is fortifying, it is a reactive molecule whose amount in food is restricted [2, 9].

Zinc

Thousands of proteins depend on zinc to operate properly. The zinc finger and zinc twist are examples of prosthetic groups made of zinc, and over 100 enzymes need zinc as a cofactor. Without zinc, certain olfactory receptors are unable to operate. As a signalling molecule, zinc is secreted by several body cells, including those in the neurological and immunological systems. Because iron can both donate and collect electrons, it serves a variety of vital purposes in the human body. A serious health issue with zinc deficiency is not simply due to the direct consequences of low zinc levels as well as the fact that it increases the risk of developing and worsening other illnesses, particularly infectious disorders as a young child.

Calcium

Many low- and middle-income countries (LMICs) have daily calcium intakes below recommended levels, creating significant disparities with high-income nations. Low calcium consumption is also noted in specific age groups, including elderly people, teenagers, and low-income individuals from high-income nations. Problems with bone health have often been linked to inadequate calcium consumption. Enhancing calcium intake has also been demonstrated to have numerous positive effects on health, including a decrease in hypertensive disorders associated with pregnancy, a reduction in blood pressure, especially in young individuals, a preventive measure against recurrent colorectal adenomas, a decrease in cholesterol, and a decrease in high blood pressure cases in the progeny of pregnant women who took supplements [1].

Improvement stage of fortification

A regulation frequently has a transition period between the time it is enacted and when it is put into effect. This is frequently required to give time for updating food labels, buying equipment for fortification, and modifying production procedures. Moreover, past experiences indicate that it may need several years for a country to attain high coverage, quality, and compliance. To increase fortification programme coverage and compliance, hundreds of essential actions are needed. The main ones are which are described in this article. In order to guarantee that appropriate production, storage, and handling procedures are in place internally throughout the enhance stage, industry frequently requires periodic training in fortification processes and quality assurance or internal monitoring along with final product quality assurance. In order to enhance procedures and practices linked to enforcement at manufacturing sites, ports of entry or customer sites, retail locations, and commercial sites, government inspectors usually demand continuous training on best practices [7].

Conclusions

Among public health measures, food fortification stands out as the most successful way to avoid nutritional deficiencies. For complicated human health conditions, one ounce of prevention is worth several rounds of treatment measures. Given the pervasiveness of malnutrition worldwide and its detrimental effects on human resources and national development objectives, there is an urgent need for a National Commission on Public Health and Healthcare, as well as corresponding policy adjustments in emerging nations. Currently, biofortification is a workable alternative for poor nations without the aforementioned capabilities, whereas fortification is a realistic choice for industrialised nations with well-established infrastructure and delivery systems and the ability to maintain investment. By boosting daily sufficiency of micronutrient intakes among persons across the lifetime, biofortification aims to help avoid micronutrient deficiencies. It is a straightforward method that will help reduce overall micronutrient deficiency. The goal of biofortification should not be to treat severe micronutrient deficiencies or eradicate them in all population groups; rather, it should be viewed as an auxiliary tool to other strategies that are in place to sustainably increase base levels of household food and nutritional security over time. Therefore, increasing the production of biofortified crops by partially subsidising inputs (mineral-dense

seed, fertiliser, and electricity for irrigation) will have a significant positive impact on food and nutrition security, especially for small and marginal farmers (primary targets). Surplus produce will also find its way into the value chain market, benefiting secondary and tertiary target populations.

References

1. Gómez-Galera, S., Rojas, E., Sudhakar, D., Zhu, C., Pelacho, A. M., Capell, T., & Christou, P. (2010). Critical evaluation of strategies for mineral fortification of staple food crops. Transgenic research, 19, 165-180.
2. Cormick, G., Betrán, A. P., Metz, F., Palacios, C., Beltrán-Velazquez, F., García-Casal, M. D. L. N., ... & Belizán, J. M. (2020). Regulatory and policy-related aspects of calcium fortification of foods. Implications for implementing national strategies of calcium fortification. *Nutrients*, *12*(4), 1022.
3. Gupta, A. (2014). Fortification of foods with vitamin D in India. *Nutrients*, *6*(9), 3601-3623.
4. Garrett, G. S. (2018). National mandated food fortification programs. In *Food fortification in a globalized world* (pp. 53-62). Academic Press.
5. Govindaraj, M. (2015). Is fortification or bio fortification of staple food crops will offer a simple solution to complex nutritional disorder in developing countries?. *Journal Nutrition Food Science*, *5*(2), 1-4.
6. Mannar, M. V., & Sankar, R. (2004). Micronutrient fortification of foods—rationale, application and impact. *The Indian Journal of Pediatrics*, *71*, 997-1002.
7. Martorell, R., & de Romaña, D. L. (2017). Components of successful staple food fortification programs: lessons from Latin America. *Food and nutrition bulletin*, *38*(3), 384-404.
8. Dary, O. (2002). Staple food fortification with iron: a multifactorial decision. *Nutrition Reviews*, *60*(suppl_7), S34-S41.
9. Vatanparast, H., Calvo, M. S., Green, T. J., & Whiting, S. J. (2010). Despite mandatory fortification of staple foods, vitamin D intakes of Canadian children and adults are inadequate. *The Journal of steroid biochemistry and molecular biology*, *121*(1-2), 301-303.

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