

Micronutrient Fortification of Foods: Developing A Program

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Rationale and Objectives

Food fortification is the addition of one or more nutrients to foods. The main objective is to increase the level of consumption of the added nutrients to improve nutritional status of a given population. It should be noted that the primary role of the food fortification is prevention of deficiency, thereby avoiding the occurrence of disorders that lead to human suffering and socioeconomic disadvantages. Nevertheless, food fortification can also be practised to eliminate and control dietary deficiencies and their disorders.

To describe the process of nutrient addition to foods, other terms such as enrichment, nutrification (Harris 1968), or restoration have been used interchangeably, although each may imply a specific course of action. Although fortification refers to the addition of nutrients at levels higher than those found in the original or comparable food, enrichment usually refers to addition of one or more nutrients to processed foods at levels specified in the international standards of food identity. Restoration refers to compensation for nutrient losses during processing, and nutrification means making a dietary mixture or a food more nutritious. According to Bauernfeind (1994), the term nutrification is more specific to nutritional sciences, whereas all other terms have originally been borrowed from other disciplines or applications than food use.

The joint Food and Agriculture Organization/World Health Organization (FAO/WHO) Expert Committee on Nutrition (FAO/WHO 1971) considers the term fortification to be the most appropriate to describe the process whereby macro- or micronutrients are added to foods commonly eaten to maintain or improve the nutritional quality of individual foods in the total diet of a group, community, or population. It applies primarily to the use of relatively small quantities of added nutrients/micronutrients.

The terms double fortification and multiple fortification are used when two or more nutrients, respectively, are added to a food or food mixture. The food that carries the nutrient is the vehicle, whereas the nutrient added is called the fortificant.

Generally speaking, food fortification can be employed for the following purposes:

- To correct a demonstrated dietary deficiency of those nutrient(s) that are added;
- To restore nutrients initially present in significant amounts in a food but lost as a result of food processing manufacturing;
- To increase the nutritional quality of manufactured food products that are used as the sole source of nourishment, e.g., infant formulas and formulated liquid diets and weaning foods; and
- To ensure nutritional equivalency of manufactured food products substituting other foods, e.g., fortified margarine as a substitute for butter.

The important steps in developing a generic food fortification program are mentioned in Table 1. The generic model is valid for food fortification programs focused on single as well as multiple - fortified products. Adjustments must be made when designing a specific food fortification program.

In this document, we are dwelling with fortification of foods, food items, and food mixtures with only three major micronutrients: iodine, iron, and vitamin A.

Iodine Fortification

Iodine deficiency results from irreversible geological conditions, therefore, dietary diversification using food grown in the same deficient soil cannot improve the iodine intake of an individual or a community. Among the strategies for the elimination of IDD, presumably the only feasible, long-term approach is still the fortification of foods with iodine.

Over the past 60 years, several ways of supplementing iodine in the diet have been proposed. A variety of vehicles such as salt, bread, sweets, milk, sugar, and water have been tried. The iodization of salt has become the most commonly accepted method of iodine prophylaxis in most countries of the world because salt is widely and uniformly consumed by all sections of any population. The process is simple and inexpensive. The fortificants commonly used are potassium iodide (KI) and potassium iodate (KIO₃). Iodate is more stable in impure salt subjected to poor packaging and a humid environment. The addition does not change the colour, appearance, or taste of salt. Countries with effective iodized salt programs have shown sustained reductions in IDD prevalence. In hyperendemic areas where immediate action is needed and/or where logistical problems could delay the development of iodization programs, the administration of iodized oil either by injection or orally, is the alternative strategy.

Iron Fortification

Compared with other strategies used for correcting iron deficiency anaemia, iron fortification of the diet is considered by many investigators to be the cheapest strategy to initiate,

Table 1. Steps in the development of a food fortification program.

1. Determine the prevalence of micronutrient deficiency.
2. Segment the population if prevalence data indicate the need.
3. Determine the micronutrient intake from a dietary survey.
4. Obtain consumption data for potential vehicles.
5. Determine micronutrient availability from the typical diet.
6. Seek government support (policy makers and legislators).
7. Seek food industry support.

8. Assess the status of potential vehicles and the processing industry chain (including raw material supply and product marketing).
9. Choose the type and amount of micronutrient fortificant or mixes.
10. Develop the fortification technology.
11. Perform studies on interactions, potency, stability, storage, and organoleptic quality of the fortified product.
12. Determine bio-availability of the fortified food.
13. Conduct field trials to determine efficacy and effectiveness.
14. Develop standards for the fortified foods.
15. Define final product and packaging and labelling requirements.
16. Develop legislation and regulation for mandatory compliance.
17. Promote campaigns to improve consumer acceptance.

maintain, reach the largest number of people, and guarantee the best long-term approach (Cook and Reuser 1983). Iron fortification does not have the gastro-intestinal side effects that iron supplements often induce. This is a major advantage in terms of consumer acceptability and marketing of iron fortified products.

Targeted iron fortification to those beneficiaries who are most likely to be iron deficient has proven to be a safe and effective strategy to combat IDA (Ballot 1989). The choice of approach is determined by the prevalence and severity of the deficiency (INAGG 1977). A critical step in the design of an iron fortification program is the selection of an iron compound that is both acceptable and well absorbable (Cook and Reuser 1983). It should be noted that for pregnant women iron requirements are very high during the last two trimesters of pregnancy. Even where iron fortification programs are in place, these groups need to continue to receive iron supplements in combination with other nutrients such as folic acid. There are a number of fortificants commonly used for iron fortification such as ferrous sulphate, elemental iron, ferric orthophosphate, etc.

Vitamin A Fortification

Food fortification with vitamin A holds considerable potential as a tool to alleviate vitamin A deficiency by bridging the gap between dietary intake of Vitamin A and requirement. Fortification with vitamin A is a long-term strategy capable of maintaining adequate vitamin A status over time. In Guatemala, fortification of sugar with vitamin A has proved to be more cost effective and sustainable than other strategies that are being employed.

Most vitamins that are produced commercially are chemically identical to those naturally occurring in foods. A fat-soluble vitamin (such as vitamin A) is usually prepared in the form of an oil solution, emulsion or dry, stabilised preparations that can be incorporated into multivitamin-mineral premises or added directly to food.

The most important commercial forms of vitamin A are vitamin A acetate and vitamin A palmitate. Vitamin A in the form of

retinal (the important active compound in such preparations) or carotene (as beta-carotene and beta-apo-8' -carotenal) can be made commercially for addition to foods. These pure chemicals have mainly been added to foods as food improvers and colorants, but foods can also carry them to increase vitamin A intake of the populations consuming these foods. Vehicles such as sugar, fats and oils, salt, tea, cereals, and monosodium glutamate (MSG) have been fortified with vitamin A. For instance, sugar has been fortified with vitamin A in Costa Rica, El Salvador, Guatemala, Honduras, and Panama. Various oils and fats have been selected for fortification with vitamin A.

Role of Food Industry In Fortification Programs

The food industry plays a key role in any food fortification program in any country. Micronutrient deficiencies are public health problems. Many aspects of a food fortification program, however, such as determination of prevalence of deficiencies, selection of an appropriate intervention, calculation of dietary intake levels of micronutrients, and daily consumption of the food vehicle selected or levels of fortificants to be added and even technology development, should be evaluated by the scientific community and health/agriculture authorities and others. The act of fortification of a food vehicle with fortificants, however, is carried out by the private food industry. Unfortunately, in a majority of cases, ministries of health are often not able or willing to exercise control and motivate (private) industry.

At best, linkages between the health and industry/agriculture ministries are usually weak or nonexistent. In such cases, it may be necessary to help formalize an institutional linkage between government and (private) industry such as those proposed in Pakistan and the Philippines. This institutional model is the independent intermediary between governmental institutions and private industry.

In general, however, national governments do not fortify foods themselves. This is the task and responsibility of the (private) food processing enterprises. Government staff should act as advocates, consultants, coordinators, and supervisors to enable the food industry to fortify appropriate foods effectively and profitably.

The food industry can also play a significant role in the relatively long-term food diversifications strategy through providing improved preservation techniques, improved semi-processed foods, and by promoting consumption of locally available micronutrient-rich foods in the diet or as a food fortificant.

A successful approach to the micronutrient malnutrition problem through micronutrient fortification of food in a country is possible only if the participation of the food industry is incorporated into a national program. The cooperation of the food industry should be sought at a very early stage of program development. Both the promotion and regulative aspects of a fortification program need to be elucidated. The positive incentives will include the profitability of the fortified product. Product prices should be at a level that enables the producer to recover the cost of fortification plus a modest profit and ensure that the consumer can buy a wholesome product for a fair price.

Food fortification also provides the opportunity for the industry

to diversify its products range. A positive press coverage or promotion of the fortified product by government could create consumer-demand for the fortified product. Political and financial positive incentives can be offered in the form of tax exemptions; import licenses and loans for equipment and raw materials; initial subsidies to procure fortificants; assistance in developing an in-process quality control system; training of production, administrative, and marketing personnel; training of the wholesale and retail sector; and prohibition of illegal imports. Mandatory compliance can be ensured through legislation and regulations.

Specifically, the industry (both national and multinational) needs to:

- Participate from the very beginning in the planning of the national program that will define a feasible fortification strategy;
- Identify mechanisms for collaboration between national governments, food industry and its marketing system, and nongovernmental organizations (NGOs) and donor agencies;
- Assist in the identification of appropriate fortificants and food vehicles;
- Define and develop quality assurance systems; and
- Participate in promotional and educational efforts to reach the target population.

Food technologists work within one or more food chains. They are, therefore, well positioned as sources of information with regard to raw material supply (national or imported), availability of processing equipment and technologies, and the marketing/distribution network for the final products.

The conditions for a successful food fortification program, supported by the food industry and national government, are summarized in Table 2. Apart from the food industry and the government, other partners may include consumers, educationists/teachers unions, sport or youth clubs, teacher-parent unions, disabled persons unions, women's organizations, pregnant women's groups, gynaecologists or midwife's unions, paediatrician or ophthalmologist unions, the media, communication services, extension workers, political parties, religious leaders, cultural leaders, members of parliament,

Table 2. Conditions necessary for the success of food fortification programs.

- Political support;
- Industry support;
- Adequate application of legislation including external quality control;
- Appropriate fortification level;
- Good bio-availability of the compound;
- No inhibitory effect of the common diet;

- Human resource training at industry and marketing level;
- Consumer acceptability;
- No cultural or other objection against fortified foods;
- Adequate laboratory assessment of micronutrient status;
- Adequate study design or statistical evaluation;
- In case of IDA, absence of parasitism or other non-dietary causes of anaemia; and
- No constraint regarding procurement of micronutrients.

Chambers of commerce, etc. They can all contribute to the creation of demand and/or monitoring of the fortified product and thus to the success of the food fortification program.

Although simple nutritional and technological solutions to the problems of micronutrient malnutrition exist, these are often complicated by economic, social and political factors. Any intervention strategy must take these factors into account. This is the challenge as well as the opportunity for the food industry. In this endeavour, the food industry can draw upon active support from the other sectors. What is urgently needed is to identify a set of priority actions and initiate process of continuous dialogue between the various sectors to move quickly toward the implementation of schemes that will permanently eliminate the problems of micronutrient malnutrition.

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