MAXIMIZING MICRONUTRIENT INTERVENTION EFFICIENCY WITH FOOD FORTIFICATION

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INTRODUCTION

Food fortification has received increasing attention in the developing world as a main strategy to prevent and to control micronutrient deficiencies. As any other nutritional intervention, its has some advantages but also some limitations. Therefore, it is important to have a fair view of its characteristics in order to understand better its potential as a resource to reach the goal of overcoming preventable deficiencies. In this presentation, I will list a few examples of food fortification both in the developed countries as well as in the developing countries. I will summarize the results obtained with fortified foods that were presented in this meeting. Then, I will remind you of important requirements that food fortification should fulfill to have an effective and efficient impact. And finally, I will discuss some issues about this subject that need our attention in the near future.

FOOD FORTIFICATION IN THE DEVELOPED WORLD

Nowadays, food fortification is a normal practice in the food industry of the developed countries

The successful launching of food fortification probably started as early as the XIX Century, when France initiated the addition of iodine into salt. In the 1920´s, this practice had been established. Now, this fortification is the most efficient method to control cretinism, mutism, mental retardation, goiter and other Iodine Deficiency Disorders.

In the United States, during the years of the Second World War, it was recognized that many soldiers were suffering from micronutrient deficiencies because of the poor quality, specifically the micronutrient content, of their diets. One of the solutions was to add iron, thiamin, riboflavin, niacin, and calcium to wheat flour and other flours. The overall effect was the control of beri-beri, ariboflavinosis and pellagra in the population of this country.

In developed countries, mostly in temperate zones of the Earth, selected food fortification was used to control rickets. Milk and its derivatives were fortified with vitamin D and vitamin A.

In 1955, Switzerland introduced the fortification of salt with fluoride, and achieved a remarkable reduction in tooth decay. Since then, many other countries are using the double fortification of salt with iodine and fluoride.

In addition to these examples, many other foods, for example breakfast cereals are fortified with micronutrients in amounts proportional to 10 to 25% of the RDA values per portion.

FOOD FORTIFICATION IN THE DEVELOPING WORLD

Food fortification has been adopted for many developing countries. For example, in Guatemala, since the 60´s several foods made with the combination of cereal and legume flours (composite flours), which provide a balanced diet of essential amino acids, have been fortified. The purpose was to offer affordable foods with adequate amounts of good quality protein, energy and iron, calcium, vitamin A, thiamin, riboflavin and niacin. A serving size of these foods satisfies from 25 to 50% of the RDA of the micronutrients. In 1987, a cookie made with the combination of these flours with wheat flour was introduced in school feeding programs. By this means, the school children of the public system are receiving approximately 50% of the RDA of iron, vitamin A, folic acid, vitamin B_{12} and other vitamins of the B complex.

In 1974, the fortification of sugar with vitamin A was launched in Central America because it was recognized that, in spite of the introduction of the fortified composite flours, a more aggressive intervention was needed to overcome the deficiency of this vitamin at the national level. The sugar fortification program has been continuous and enforced from 1987 in Guatemala, and from 1992 in El Salvador and Honduras. Nowadays, sugar provides between 50 to 125% of the RDA of vitamin A to the population older than 2 years of age, and 25% of the RDA to infants from 6 to 24 months old.

In 1993, Venezuela started a program of fortification of pre-cooked corn flour with iron and vitamins, which is becoming one of the most successful cases to provide important amounts of iron to the population. It is estimated that through this food, the Venezuelan population is receiving about 30% of the RDA for vitamin A, thiamin, niacin, and iron.

In December of 1996, Thailand launched the initiative of the triple fortification of instant noodle seasoning with iron, iodine and vitamin A at one third of the RDA values. The program is voluntary, and in the market approximately 10% of total production of this food is currently fortified.

And from 1997, some African countries such as Namibia, Zimbabwe and South Africa started adding vitamin A, iron, and some vitamins of the B complex to maize meal, with the purpose to supply at least 25% of the RDA values of these micronutrients.

EFFECTS OF FOOD FORTIFICATION PROGRAMS IN THE IMPROVEMENT OF VITAMIN A STATUS

At this conference, we have been informed about results of field trails and national programs that demonstrate the positive effects of food fortification.

In the Philippines, the consumption of a popular bread, called "pandesal", made with wheat flour fortified with vitamin A, by school-age children produced in 6 months a reduction of vitamin A deficiency measured by means of the MRDR method. The percentage of cases with low liver reserves of retinol reduced from 29 to 15%.

In 1996 in South Africa, the Medical Research Council evaluated the effect on school children of the fortification of a biscuit with B-carotene. The amount provided was equivalent to 50% of the RDA of Vitamin A. After 12 months of consumption, the number of cases with marginal vitamin A deficiency dropped from 39 to 12%.

In Ghana, a collaborative study between the departments of Nutrition of the University of Ghana at Legon, and the University of California at Davis, assessed the effect of vitamin A fortification of a locally formulated complementary food, given to breast-feed infants from 6 to 12 months old. After 6 months of consumption, the group that received the fortified food presented only 10% of cases with marginal vitamin A deficiency against 27% of the control group.

Guatemala and Honduras summarized the first experimental evidence to demonstrate the successful achievement of a fortification program with vitamin A in a national context. Both countries carried out national nutritional surveys in preschool age children. Sixteen percent of children in Guatemala and 14% in Honduras show retinol levels lower than 20 µg/dL. Those figures are much lower than the 27 and 40%, respectively, obtained previously to the initiation of the sugar fortification program with vitamin A. In the case of Guatemala, it was additionally revealed that populations that do not consume sugar are still in a marginal deficient condition (26% deficiency). Furthermore, the data split by age reveals that children older than 24 months old are nearly free of vitamin A deficiency, because only about 10% presented retinol levels lower than 20 µg/dL.

All the presented cases confirmed that synthetic retinol or ß-carotene are highly bioavailable in fortified foods, and that the improvement of the vitamin A status due to the consumption of these foods can be seen in a few months. However, the data shared by Guatemala and Honduras raised to our attention that one could not depend on the use of fortification of only one food to cover the whole population. Despite the fact that sugar supplies 25 to 30% of the RDA for infants 6-24 months of age, this group still shows some degree of deficiency. These two countries need to apply simultaneously other alternative interventions, such as fortification of complementary foods or preventive supplementation. This fact does not make food fortification programs unsuccessful. On the contrary, they can be seen as the most efficient strategy to improve the efficacy of other interventions. For example, in the case of Central America, only preventive supplementation on infants from 6 to 24 months is needed to complement fortification and to declare the region free of vitamin A deficiency.

TECHNOLOGICAL REQUIREMENTS

The success of a fortification program in true life must fulfill several requirements. A summary of these requirements follows:

- ✓ **Appropriate food vehicles should be produced in a small number of adequate factories.** Food fortification is a technology, and therefore a minimum of facilities and expertise should exist in the producing industries of the food vehicle. A low number of involved industries are a desirable characteristic, because the control and supervision of the final product will be easier and more efficient, favoring the permanence, effectiveness and safety of the fortification process.

- ✓ **The food vehicle should be consumed by the target population**. Obviously, the most important prerequisite is that the food to be fortified constitutes part of the normal diet of the population we want to help with the added nutrient.

- ✓ **Food intake variability among all consumers should be small.** In most cases the fortified food is consumed by other social groups beyond the target group, and in amounts that are usually larger than those of the target group. In my experience, this is the main limiting factors that prevents the addition of higher levels of micronutrients into foods, due to a risk of reaching the recommended safe level of tolerance.

- ✓ **Cost should be affordable.** In practical terms, it should not be higher than 2.0% of the final price of the fortified food. This percentage may seem low for public health workers, but for industry in the developing world even lower figures have generated opposition to adopt fortification programs.

- ✓ **Fortification should not affect the acceptability of the food.** For some nutrients, especially minerals, the limiting factor to fortification levels is the change in the characteristics of the food vehicle, such as taste, odor and color. Currently, this is the case for iron and zinc fortification. For this reason, fortification of several foods should be considered for these nutrients.

- ✓ **The added nutrient should have adequate stability and not separate under normal conditions of storage and use.** Particles of the fortificant compound should have the same size and similar nature as those of the food vehicle, or be adhered in some way to the food, in order to avoid separation during storage. Stability of the nutrient, especially in the case of vitamins, must be determined, because it is important to establish the extra amount that should be added at the moment of production.

- ✓ **The nutrient should be bioavailable.** Bioavailability is a condition that should be proven in all cases, because it is imprudent to assume that the analytically determined presence of a nutrient in a food has the biological effect that it is intended. Furthermore, it is not possible to extrapolate results from one case to another, because many interactions among the components of a food can interfere with the absorption of the added nutrient. In all cases, biological absorption and utilization of the nutrient from the fortified food should be evaluated.

In addition to the technical requirements, there are also some strategic and political requirements for the food fortification programs. I will only briefly mention them: **coverage and effect of the program should be continuously monitored; proper legislation is frequently needed for adequate compliance; public should be aware of the benefits; and a reliable quality control and monitoring system must be implemented.**

TOPICS FOR THE FUTURE

All the fortification cases that I have described refer to public health programs, either because they are staple foods or because they are distributed in social feeding programs. However, the cost and simplicity of the technology makes fortification very attractive for the food industry. Many food companies have recognized that fortification is a way to improve the added value of its products. Two examples were given in this conference. An orange-flavored beverage designed to provide 30-120% of the RDA for 10 micronutrients was evaluated in Tanzania. The consumption of this product by school children during 6 months improved the biochemical indicators of iron and vitamin A. There was also a gain in weight and height. The other case, is the creation of a seal of nutritional enrichment, that the government of Philippines is promoting, under the name of the Sangkap Pinoy Seal Program, for the products that include **at least one third** of the RDA of vitamin A, iron and iodine, alone or in combination. It was reported that twenty-four different commercially produced foods have already acquired this label. Among these products are cheese, margarine, infant cereals, instant soups, noodles, powder drinks, sardines, waffle mix and chips. The adoption of the food industry to improve the micronutrient content of their products might benefit the nutritional status of the general population under certain conditions. High levels of micronutrients are appropriate in foods destined to social programs, because their consumption is controlled, but it could be inadequate to put high amounts in the many foods freely available in the market. On the other hand, one should be aware that the addition of micronutrients does not necessarily make some products better foods. This statement is valid not only because the risk that some persons could reach the recommended maximum intake of some nutrients but also because it is unnecessary to raise the price of some foods due to the addition of unneeded amounts of micronutrients. The food industry should not be discouraged to continue adding micronutrients into their products, but the type of food to fortify and the amount of micronutrients to add should be a matter of governmental regulation.

A major challenge that the fortification programs should face in the near future is to convince the world economist that fortification constitutes a human right and not technical barriers to trade, as it appears under the concepts of the World Trade Organization. To reduce this criticism by the promoters of free trade agreements, it is basic to harmonize technical requirements and regulations about fortified foods among neighboring countries. It is important to reach consensus in basic principles of labeling and enforcement criteria, and then to obtain the approval of the Codex Alimentarius. If these efforts do not take place, food fortification programs are at risk to be halted by unwise but powerful economical decisions.

In conclusion, food fortification is a very important intervention to overcome micronutrient deficiencies. It is effective, simple, practical, and relatively safe, and it is highly cost effective. To improve its role and acceptance in the nutrition field, food fortification should be carefully planned and analyzed in order to decide about its characteristics, as well as to respond when and how it is necessary to complement its effects with other health interventions and policies. Food fortification is an achievement of the human civilization, which helps the natural diet to carry out its expected functions.