Fortification of Food with Micronutrients

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Food is fortified in order to overcome nutritional deficiencies in any particular population of a region due to consumption of certain diet that may deprive them of certain nutrients like vitamins and minerals. Several foods were fortified in India, for example iodised salt, lysine enriched bread, infant foods, vanaspati (hydrogenated fat), margarine, milk etc. Fortification and enrichment are similar in the sense that food after both fortification and enrichment, would have nutrient level more than originally present. Some nutrients may not be present at all before adding. The only difference being, fortification is generally undertaken in order to mitigate certain identified deficiency disease in that population, whereas enrichment is carried out to generally elevate the nutritive value of the enriched food. Restoration is also a process in which nutrients are added, but the purpose is to add nutrients so those nutrients lost during processing are added back to restore the original level.

In fortification, a nutrient is added to commonly consumed foods thereby improving the quality of the diet. Food is referred to as the food vehicle and the nutrient is the fortificant. A food fortification is employed when there is a widespread and consistent nutritional deficiency in the population. Globally, three common deficiencies are seen namely, iodine, vitamin A and iron, all of which are needed in small quantities and so are called micronutrients.

Governments with the help of NGOs and international agencies tried to eliminate or reduce micronutrient deficiencies. After laudable results with iodine deficiency disorders through salt fortification, efforts are on to tackle other micronutrient deficiencies through fortification. Although fortification can be done at household or community levels, it is generally undertaken industrially. Different foods may be fortified with a micronutrient e.g. salt with iodine or with more than one e.g. salt with iodine and iron or wheat with several micronutrients. To ensure the greater success and sustainability of fortification, it should be undertaken along with poverty reduction programme, other interventional programmes promoting consumption of adequate nutritious foods, especially among the vulnerable groups.

Fortification does not affect the dietary patterns of the population unlike the supplements. For iron, one may have to eat foods rich in iron in addition to the present diet, which may change the dietary pattern, which may either create resistance or will be unaffordable. Because fortification does not alter the food consumption behaviour the programme can be implemented quickly and sustained for a long time, as it is population based. It is both preventive and very cost effective.

While undertaking food fortification programmes, care must be taken to understand that population groups needing improved nutrition are the poor and have limited access to fortified foods. The poor often suffer from multiple micronutrient deficiencies and deficiencies arise generally due to inadequate intakes of the overall diet. Standards for fortification of different foods have not yet been fully resolved with respect to nutrient levels, stability as well as consumer acceptance among other factors. Nevertheless, fortification is of unquestionable value in protecting nutritional status of vulnerable groups.

Foods to be fortified

Specific criteria should be met when choosing the appropriate food vehicle for fortification.

- Food consumed by all population groups or by most of the target population vulnerable to nutritional deficiencies
- Food used all the time and in regular amounts
- Taste, look and flavour of the food should not change due to fortification
- Fortificant should withstand conditions of cooking, processing, transport and storage
- Food not be consumed in excess amounts which might create a risk of consumption at toxic levels of the fortificant
- Fortified food should be affordable to the target population

FAO assists different governments in several ways in Fortification Programmes. From its experience in earlier projects, it helps in setting criteria and identifying prerequisites in new or ongoing projects, which are considered essential for the success of a programme.

The actual beneficiaries of fortification need to be identified and their nutritional needs and dietary practices must be analysed. If wheat is to be fortified and part of the target group does not consume wheat at all, they need to be excluded from the programme. If rice is to be fortified and washing, a practice commonly used by people removes the nutrient added, then programme will fail. Other inputs that will be given include estimates of population size, helpful in assessment of cost. This includes comprehensive data, including socio-economic data, on prevalence of deficiencies, food consumption (including micronutrient intake) and the food habits and attitudes.

Difficulties to be encountered

Technological problems of fortification can be overcome, but years of trials and development require considerable costs, which can limit their implementation and effectiveness. Analysis of these issues prior to launch of any programme is necessary. Although funds for start-up costs may be available from external sources, sustenance of the programme for alleviating the deficiency on long-term basis needs a lot of support.

Effective participation and interest of the industry requires proper food legislation, laying down clear standards in product development, manufacture, marketing and consumer protection with respect to effective quality assurance. Standards also include regulations for claims and labelling, which may be advantageous in creating awareness.

The planning and implementation of fortification programme is complex and requires involvement of various technical, industrial and civic groups and finally consumers in a coordinated manner. External agencies can support these programmes but for proper sustainability the fortification programme must be “country-driven” rather than “agency-driven”. The programme also must be linked with nutrition education programme, and success cannot be attained unless public concerns are addressed properly and there is a wide involvement of public.

FAO assists the governments in micronutrient fortification of food programmes by providing technical assistance in setting up legal aspects for food control, strengthening existing food control structures after evaluation of present systems, preparation technical manuals and guidelines, facilitating collaboration of industry groups, laboratories and international expertise, developing food composition database, dietary assessment in population groups, technical assistance in nutrition education programmes, and strengthening programmes by facilitating linkages with ongoing programmes.

Technical considerations while formulating fortified foods:

Properties of food product to be fortified such as pH, water activity, water content etc. influence the stability of nutrients added. Macro-ingredients like protein and fibre, may affect the stability and bioavailability of added nutrients. Fortification may alter sensory qualities of the product. Iron can affect colour and flavour adversely. Ascorbic acid can change pH, which can be solved by using its sodium salt. Carotenes can change the colour of food.

It is important to first select the form, from among the chemical form available, of nutrient best suited for the application, e.g. choosing between niacin and niacinamide. The choice will affect price, functional properties, stability and bioavailability.

Interactions between nutrients added with other ingredients have to be considered. Vitamin C improves absorption of iron whereas phytic acid lowers it. Iron accelerates degradation of certain vitamins and also affects flavour and colour ingredients.

Most vitamins are sensitive to high temperatures but their degradation may be reduced by using HTST process. Freezing is beneficial for nutrients. Blanching and washing not only leaches out water-soluble vitamins but many minerals are also lost.

Package plays an important role today and is influence by intended application and shelf-life of product and stability of nutrients. Vitamins C and A and carotenes are sensitive to oxidation and must be protected from air, Vitamin B_2 is sensitive to light and B_1 is heat sensitive. Proper care needs to be taken in processing and package design. Encapsulated forms are sometimes used. While they are more expensive but the cost may be justified by the extra stability against heat, moisture or oxygen.

Once the decision has been made regarding the form of nutrients to be used and their commercial availability, a strategy can be devised to incorporate them into foods. One must decide whether powder or liquid form is to be used, whether to inject or spray on to the product etc. If there are interactions between nutrients are possible, they may be separated either by encapsulation or added at different points of processing stages to minimise their contact. Nutrient mixture must be carefully formulated to optimise their storage, handling and conveying. Some mixtures have a tendency to lump, slowing the production. Since vitamins are heat sensitive, they may be added at a point to minimise exposure to heat and added as late as possible in process to reduce degradation, but not so late that their uniformity throughout the product if affected.

When fortificant is added early in the process and thoroughly mixed into the product during subsequent processes, reliability and accuracy of the metering equipment is very critical. The equipment should also be able to adjust fortification rate to different production rates. When nutrients are applied as sprays, there are additional factors that need consideration such as effective covering most of the surface areas and ensuring that uniformity will be there is any portion of the product. Variability in micronutrient application is unavoidable especially when spray applied so declaration of nutrient on label should assure levels in each serving, consumer unit or shipping case.

Fortification Focus Today

Manufacturer may include nutrients to foods through liquids or dry premixes having desired levels of vitamins, minerals and other nutrients. Many processed foods today are enriched with vitamins and minerals and some of them have a functional role in foods as well. Ascorbic acid and tocopherols are useful in preventing oxidation and carotenes are used as colorants in many dairy and bakery products and beverages.

Recommended Daily Allowances of nutrients have undergone modification so consumers can consume these at levels that prevent deficiency and also avoid intakes having adverse effects. Scientific knowledge regarding their roles has developed substantially since the inception of the RDAs, so the recommended intake may address not only prevention of nutritional deficiency diseases like rickets but also the reduction of risk of osteoporosis, cancer and cardiovascular disease. The new values may focus on both deficiency and promotion of good health. Food & Nutrition Board (USA) in collaboration with Health Canada have coined new title, Dietary Reference Intakes (DRI) to include both the prevention of deficiency and health benefits.

Currently, cereal grain products need to be enriched with iron, vitamins B1, B2, niacin and folate, while enrichment with calcium and vitamin D is optional. Scientists want all to be made mandatory. The benefits of this would be significant in reduction in osteoporosis and colon cancer over time, which would result in savings of $3 billion per year in medical costs while the cost of enrichment would be no more than $19 million.

Food & Nutrition Board has made recommendations for trials to test prevention potential of vitamins C & E, selenium and beta-carotene. It is accepted worldwide that nutraceuticals used in foods will advance health and a large percentage of new products focuses on health.

Fortification is no longer limited to speciality diet food. As the word “health” adds marketing advantage, many food products are fortified with significant levels of nutrients. Breakfast cereals have been competing on this basis for years. A huge ready-to-eat (RTE) and many snack and fast food items are prime candidates for fortification. With lifestyle changes, it is very difficult to avoid eating out and miss out on nutritious square meals, so if these “fast foods” or foods from food service institutions.

Technology is also being developed alongside to minimise the adverse effects of fortification on sensory properties and shelf life. With iron fortification, stability and absorption are very important criteria. Complexing with EDTA has given a desirable product although a bit expensive. Vitamins like A and C are easily oxidised so protecting them with encapsulation would give enhancement in stability.

Future Challenges

Fortification traditionally has been used to safeguard consumers from nutritional deficiencies. This role is changing as foods are produced not only for protection against deficiencies but are tailor-made for maximum health benefits.

Today’s population especially in urban areas consists of large percentage suffering from high blood pressure, high cholesterol level and diabetes. Careful application of science and technology is needed in developing new products to tackle these issues. Foods today are evolving from traditional three meals a day to individual meal solutions wherever possible, in canteens, on roads, cafeteria, or in office. Innovations in packaging and positioning are also required besides innovations in process and ingredients.

Already many products like biscuits have started adding dietary fibre and some vitamins and minerals like Ca. These levels may be added not for overcoming deficiency but to extend health, for example, higher levels of calcium have advantage of bone health. Fibre being useful in diabetes and cardiovascular diseases. When nutraceuticals are permitted in foods and dietary supplements, there will be a large number of products under this category. The scope of fortification may have to be widened.

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