FORTIFICATION

The addition of nutrients to foods in order to maintain or improve the nutritional quality of individual foods or the total diet of a group, a community or a population is referred to as food fortification. Fortification as defined by the Codex Alimentarius as "the addition of one or more essential nutrients to a food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups. It can be carried out by food manufacturers or by governments as a public health policy which aims to reduce the number of people with dietary deficiencies within a population

Food technologists frequently refer to fortification as nitrification. The food that carries the nutrient is the vehicle; the nutrient added is the fortificant. Multiple fortifications are the addition of marc than one nutrient to a single food vehicle. ***Restoration,*** on the other hand, means the addition to a food of essential nutrients which are lost during the course of Good Manufacturing Practices (GMP), or during normal storage and handling procedures, in amounts which will result in the presence in the food of the levels of the nutrients present in the edible portion of the food before processing, storage or handling. **Enrichment**, however, has been used interchangeably with fortification, but it has also been defined as the restoration of vitamin and minerals lost during processing.

FOOD FORTIFICATION IS USED FOR 2 PURPOSES

1. It can restore nutrients lost during food processing by enriching a food with the depleted nutrients.
2. It can increase the level of specific nutrient in a food.

METHODS OF FORTIFICATION:

1. Commercial and industrial fortification: (wheat flour, corn meal, cooking oils)
2. Biofortification: (breeding crops to increase their nutritional value, which can include both conventional selective breeding, and genetic engineering)
3. Home fortification: (example: vitamin D drops)

OBJECTIVES OF FOOD FORTIFICATION

1. Restoration: Restore nutrients lost during processing of foods, so that the nutrient content is restored to the level originally present in the raw food.eg, addition of vitamin C to fruit juices and other processed fruit products.

2. Fortification above natural levels: Addition of nutrients to certain foods for special dietary uses is allowed, i.e. foods for infants / geriatric food or foods for use in weight reducing diets, nutrients may be added in quantities well above the natural level with the intention of supplying the total nutrients requirements in the minimum amount of food consumed, perhaps in a normal daily portion of the particular food.

3. Enrichment: Addition of nutrient to a staple food deficient in one or more nutrients to improve the nutrition quality of the food with a view to ensuring an improvement in the nutrient intake of the population. Eg: thiamine & other B vitamins – enriched polished rice.

4. To improve the quality of the diet: The process of adding small quantities of nutrients to a food to improve the nutrient intake of a population.

5. To prevent the deficiency disease: Food fortification can help to deliver a nutrient to a population suffering from the deficiency of that nutrient so as to prevent the deficiency disease.

PRINCIPLES OF FORTIFICATION / CRITERIA FOR FOOD FORTIFICATION

The basic principles for the addition of essential nutrients to foods, as stated by the Codex Alimentarius Commission are:

1. There should be a demonstrated need for a nutrient in one or more population groups.
2. Food selected as a vehicle for the nutrients must reach the population at risk.
3. The amount of nutrient added to food will supply adequate intake when the food is consumed in normal amounts by the population at risk.
4. The amount of nutrient added will not be toxic or harmful to individuals with a high intake of the fortified food.
5. The nutrient is biologically available in the form in which it is added and is stable in the food selected as a vehicle.
6. The food selected does not seriously interfere with the utilization of the nutrient.
7. Addition of the nutrient has no detrimental effect on flavour, shelf-life, colour, texture or cooking properties of the food.
8. Fortification is technically feasible for the particular food.
9. The cost of fortification does not result in a significant change in the cost of food.

10. A method of controlling and / or enforcing the level of fortification is available.

SELECTION AND BASIS OF FORTIFICANTS

The choice of fortificant compound is often a compromise between reasonable cost, bioavailability from the diet, and the acceptance of any sensory changes. When selecting the most appropriate chemical form of a given micronutrient, the main considerations and concerns are thus:

- Sensory problems: Fortificants must not cause unacceptable sensory problems (e.g. colour, flavour, odour or texture) at the level of intended fortification, or segregate out from the food matrix, and they must be stable within given limits. If additional packaging is needed to improve stability of the added fortificant, it is helpful if this does not add significantly to the cost of the product and make it unaffordable to the consumer.
- Interactions. The likelihood or potential for interactions between the added micronutrient and the food vehicle, and with other nutrients (either added or naturally present), in particular any interactions that might interfere with the metabolic utilization of the fortificant, needs to be assessed and checked prior to the implementation of a fortification programme.
- Cost.The cost of fortification must not affect the affordability of the food nor its competitively with the unfortified alternative.
- Bioavailability. The fortificant must be sufficiently well absorbed from the food vehicle and be able to improve the micronutrient status of the target population.
- Safety. Safety is also an important consideration. The level of consumption that is required for fortification to be effective must be compatible with a healthy diet.

CRIETERIA FOR SELECTING VECHILES FOOD FORTIFICATION

1. It should be an edible item that is consumed by majority of the population.
2. Relatively inter and intra individual variation occurs in the amount of the fortified food consumed. This will ensure that nutrient intakes remain within a safe range.
3. There should be no change in the physical properties of the food (consumer acceptability).
4. Nutrients added should not adversely affect the metabolism of any other nutrients.
5. The nutrients added should be sufficiently stable in the food under customary conditions of packaging, storage, distribution & use.
6. The nutrient added should be physiologically available from the food.
7. A food product that cannot be consumed excessively.
8. It should be a low-cost food product that can be bought by every section of the society.

ADVANTAGE OF FORTIFICATION

- Fortification is one of the most cost effective strategies that can be implemented on a larger scale since the cost of fortification is generally less than other techniques to address nutrition deficiencies.
- Fortified foods are considered to be better at lowering the risk of multiple deficiencies that can result from seasonal deficits in the food supply or a poor quality diet.
- Fortification does not require any behaviour modification or compliance that is expected in supplementation. It does not require a change in the individual& food habits and consumption pattern.
- The quantity of micronutrients added to the food product is small and well regulated, and so the likelihood of an overdose of nutrients is unlikely.

- Fortification is planned in such a way that the intrinsic characteristics of the food are not altered, such as the taste, the appearance and the texture.
- The food fortification process can be initiated quickly after formulating a set of regulations and standards. This means that the objective of improving the health of needy communities can be attained in a short period of time

LIMITATIONS

- A fortified food product is rich in a particular micronutrient but in low-income countries people may often suffer from multiple micronutrient deficiencies and hence they may not benefit by consuming a fortified product rich in a particular micronutrient.
- Population groups who consume relatively small amounts of food, such as infants, young children and the elderly are less likely to benefit from the consumption of fortified foods.
- Individuals in the community who cannot afford to buy the staples or are dependent on government's PDS system for their staples may not get benefitted via normal food fortification plans. For such populations, fortified staples must be circulated to them via the PDS system.
- Fortified foods have some added micronutrients. Many researchers believe that dietary diversity is a better approach to attain the nutrient requirements in a natural manner.
- There are technological issues relating to food fortification, especially with regard to appropriate levels of nutrients, stability of fortificants, nutrient interactions, physical properties, as well as acceptability by consumers.
- More knowledge is required about the impact of interactions among nutrients. For example, the presence of large amounts of calcium can inhibit the

absorption of iron from a fortified food; the presence of vitamin C has the opposite effect and increases iron absorption.

- While it is often more cost-effective than other strategies, there are nevertheless considerable costs associated with the food fortification process. These may range from start-up costs and the costs of conducting trials for micronutrient levels, physical qualities and taste, to a realistic analysis of the purchasing power of the probable beneficiaries

THE TECHNIQUES OF FOOD FORTIFICATION

Foods can be fortified with nutrients either in powder or liquid form. The techniques of food fortification depends on the food processing technology used,\ and are as follows:

- **Dry mixing** for foods like cereal flours and their products, powder milk etc
- **Dissolution in water** for liquid milk, drinks, fruit juices etc
- **Spraying** for corn flakes and other processed foods
- **Dissolution in oil** for oily products such as margarine
- **Adhesion** for sugar fortification. Vitamin A in powder form is absorbed onto the surface of the sugar crystals when used witha vegetable oil
- **Coating** for rice. The vitamins sprayed over the grain must be coated to avoid losses when the grains are washed before cooking
- **Pelleting** for rice. The vitamins are incorporated into pellets reconstituted from broken kernels.

FOOD FORTIFICATION PROGRAMMES

A. Iodization of salt for controlling goitre

IDD is due to reduced uptake of iodine by human body from the environment, the control measures essentially aim to ensure sufficient intake of iodine by persons living in iodine deficient environment. The oldest and the

commonest control measure is fortification of common salt with potassium iodate. In India, the efficacy of iodized salt in the control of endemic goitre was first established in Kangra Valley of Himachal Pradesh. Subsequently, the Government of India launched the National Goitre Control Programme, in 1962, to supply iodized salt in endemic areas. Although the programme has been in operation for the last three decades, it has gained momentum only recently. Available evidence indicates that iodized salt consumption is quite safe even in non-endemic areas.

Double fortified salt: Since iron deficiency anaemia and iodine deficiency disorders often co-exist, the most effective approach to control these public health problems would be simultaneous fortification of salt with iron and iodine. The technology for double fortification of salt has been successfully developed at NIN. Laboratory studies have shown satisfactory results with respect to stability and bioavailability of iron and iodine. Large-scale coinlnunity trials are underway for field-testing the double fortified salt.

B. Vitamin A fortification for controlling of vitamin A deficiency

Vitamin A fortification programme using sugar as a vehicle. Fortification of sugar has been in operation in Central American countries with reasonable success. In India, sugar may not be the suitable vehicle for the most needy segments of population who are very poor and cannot afford the same. A premix of sugar sprayed with a water dispersible vitamin A

C. Iron fortification programmes

Studies conducted at the National Institute of Nutrition clearly indicate the feasibility of fortification of salt as a simple method to prevent and control iron deficiency anaemia. Other food items that are being fortified are wheat flour and breakfast cereals, Infant weaning foods are also fortified with iron, as milk is a

poor source of iron. In India, the national nutrition policy recommends implementation of food fortification as a method of control of anaemia. Since iodized salt is already being I distributed in different parts of the country, the technology of fortification of salt with both iodine and iron has been successfully developed at the National Institute of Nutrition, Hyderabad.