Fortification and enrichment of milk and milk products

Fortification defines as "the practice of deliberately increasing the content of an essential micronutrient, i.e. vitamins and minerals (including trace elements). Food is the only source of all nutrients like water, carbohydrates, protein, fat, minerals and vitamins, required for the growth and maintenance of humans. The micronutrients which are found in the food, we consume on a regular basis, are sometimes available in lower amounts or not present in them. Hence, people suffer from deficiency diseases of these nutrients. The WHO and FAO recognized that there are over 2 billion people worldwide, who suffer from a variety of micronutrient deficiencies. Statistically discovered that approximately 1 in 3 people worldwide were at risk for either iodine, vitamin A, or iron deficiency. For obtaining compensation of micronutrients in the foods, innovation technologies like food fortification or enrichment of food products used through which these micronutrients are compensated in the regular diet of the common people.

Fortification in milk and milk products

The micronutrients which are commonly used in the fortification of the food products such as milk and its products are:

- Essential minerals
- Essential fatty acids
- Essential amino acids
- Phytonutrients
- Enzymes

Methods of food fortification

- **Bio Fortification** (i.e. breeding crops to increase their nutritional value – conventional selective breeding and modern genetic modification)
- **Synthetic Biology** (i.e. addition of probiotic bacteria to foods)
- **Commercial and Industrial Fortification** i.e. flour, rice, oils (common cooking foods).
- **Home Fortification** (e.g. vitamin D drops)

Nutrient for fortification

Iron fortification

Iron fortification of milk or dairy products induces several bio physicochemical modifications with important consequences.Iron fortification of food is regarded as the most cost-effective method for reducing the prevalence of nutritional iron deficiency. Nutritional anemia remains very prevalent in developing countries, and iron fortification appears until recently to have had little impact.

Iodine fortification

Iodine concentration of organic summer milk was significantly lower than the iodine concentration of organic winter milk. No significant relation between iodine content and milk fat percentage with regard to geographical sampling location. Whey cheese iodine concentration was significantly higher than iodine concentration in casein cheeses. Goiter can be regulated by use of iodine fortified dairy products.

Vitamin fortification

Natural and added forms of vitamin A (all- trans-retinol, retinyl esters and beta-carotene) and vitamin E (alpha-tocopherol, alpha tocopheryl acetate) were determined in commercially available dairy products that are frequently consumed. Retinyl esters, beta carotene and alpha-tocopherol are in natural dairy products, whereas retinyl and alpha-tocopheryl acetate occur in most vitamin-fortified products. Since Vitamin D is a fat-soluble vitamin, it cannot be added to a wide variety of foods. Foods that it is commonly added to margarine, vegetable oils and dairy products.

Rickets could be cured by these foods. Their results showed that sunlight exposure and cod liver oil were the cure. It was not until the 1930s that vitamin D was actually linked to curing rickets. This discovery led to the fortification of common foods such as milk, margarine, and breakfast cereals. The astonishing statistics of approximately 80–90% of children showing varying degrees of bone deformations due to vitamin D deficiency to being a very rare condition. The current RDA for infants aged 0–6 months is 10 μg (400 International Units (IU))/day and for adults over 19 years of age it is 15 μg (600 IU)/day.

Fish oil fortification

Fortification of dairy products with long-chain polyunsaturated fatty acid, however, the level of fortification was limited. The highest level of fortification was obtained for solid, high-fat dairy products (spreadable fresh cheese, butter and processed cheeses), especially when flavorings were present.

Probiotic fortification

Lactobacillus acidophilus or *bifdus* does not grow and survive in yogurt for a long period of time. A differential inoculation procedure has been developed where *by Lactobacillus acidophilus* is first inoculated into heat treated. Later, the regular yogurt cultures *Streptococcus thermophiles* and *Lactobacillus bulgaricus* are inoculated into the acidophilus growing yogurt mix. Dietetic fiber was introduced into the fruit base and then mixed with yogurt. Dietetic fiber enhances the population of *L. acidophilus*.

Casienate fortification

Yoghurt fortification with caseinates, co-precipitate and blended dairy powders in low-fat yoghurt. These dairy products were characterised for pH, moisture, lactose, mineral and protein fractions. Yoghurts enriched with caseinates had higher viscosity and syneresis index than yoghurts based on concentrated skimmed milk fortified with co-precipitate or blended dairy products. One blended dairy product was tested to manufacture low-fat yoghurt on an industrial scale, yielding good rheological properties and lower cost than traditional enrichment with skimmed milk powder.

Fiber fortification

Insoluble dietary fiber from five different sources (soy, rice, oat, corn and sugar beet) were used to fortify sweetened plain yogurt. In general, fiber addition led to lower overall flavor and texture scores. A grainy flavor and a gritty texture were intense in all fiber-fortified yogurts, except in those made with oat fiber. The evolution of organic acids during the fermentation and cold storage of control and oat-II-fiber-fortified yogurts showed a simila pattern; only acetic and propionic acids were found in significantly higher amounts in the fiber- fortified product.

Limitations

WHO, FAO, Health Canada, and the Nestle Research Centre have acknowledged very few limitations regarding Food Fortification, which are investigated to rectify the limitations. Some are:

- Fortification of nutrients in foods may deliver toxic amounts of nutrients to an individual and also cause its associated side effects. Excessive fluoride intakes result in irreversible staining to the teeth.
- Fortification of foods with folic acid has been mandated in many countries solely to improve the folate status of pregnant women to prevent Neural Tube Defects. High blood concentrations of folic acid may decrease natural killer cell cytotoxicity, and high folate status may reduce the response to drugs used to treat malaria, rheumatoid arthritis, psoriasis, and cancer. Folate has a dual effect on cancer, protecting against cancer initiation but facilitating progression and growth of pre neoplastic cells and subclinical cancers.
- In many cases, the micronutrients added to foods in fortification are synthetic.
- In some cases, certain forms of micronutrients can be actively toxic in a sufficiently high dose, even if other forms are safe at the same or much higher doses. Retinol, the active form of Vitamin A, is toxic in a much lower dose than other forms, such as beta carotene.
- Menadione, a phased-out synthetic form of Vitamin K, is also known to be toxic.

Conclusion

Although it is recognized that food fortification alone will not combat this deficiency, it is a step towards reducing the prevalence of these deficiencies and their associated health conditions. Hence, research and technological application of food fortification will be a greater scope of compensation of deficient nutrients in food.