Scientific and Technical Aspect of Functional Probiotic Yogurt Fortification: a Review

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Abstract

Foodfortification is the process of adding micronutrients (essential trace elements and vitamins) infood. As defined by the World Health Organization (WHO) and the Food and Agricultural Organization of the United Nations(FAO), fortification refers to "the practice of deliberately increasing the content of an essential micronutrient, i.e. vitamins and minerals (including trace elements) in a food, so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to health", whereas enrichment is defined as "synonymous with fortification and refers to the addition of micronutrients to a food which are lost during processing". Foods based on fruits and vegetables, such as its juices and pulp represent a new potential carrier and source of probiotic microorganism. Yogurt, the best carrier of probiotics, traditionally is manufactured *streptococcus thermophiles* and *lactobacillus deldrueckii ssp. Bulgaricus (L. bulgaricus*) as starter cultures. Raw and fermented fruits represent an excellent vehicle for probiotics due to their natural structure that allows the easy availability of usual nutrients for microbial growth. Majority 70% of people in India do not consume enough micronutrients such as vitamins and minerals in day to day life. Due to the high consumption rate of dairy products such as probiotic yogurt, fortification of these products will effectively reduce or prevent diseases associated with nutritional deficiencies. The aim of this investigation is to study the technical aspects involved in production of different types of fortified yogurts, firstly, fortification is defined and the main reasons behind carrying out this process are presented and then yogurt production process and a variety of minerals, vitamins, and functional ingredients which are used in the process are briefly discussed.

Keyword: probiotic yogurts, micronutrients, yogurt fortification functional food

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Introduction

Yogurt is a functional dairy product known for its therapeutic, nutritional, and probiotic effects. It is produced by fermentation of milk with the thermophilic homofermentative lactic acid bacteria *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp*. *Bulgaricus.*During recent years, an increasing interest has developed in foods that contribute to a positive effect on health beyond their nutritional value. Among these functional foods, much attention has been focused on probiotic products and food containing dietary fiber. Probiotics can be defined as living microorganisms that have proved beneficial effects on health of the host and that improve the intestinal microbial balance. Beneficial effects of probiotics include improving the gut microbial balance, stimulation of the immune system, reduction of blood cholesterol level, and reduction in the incidence of cancer, cardiovascular diseases, diarrhea and osteoporosis. One of the approaches to increase the number of probiotic bacteria in the intestinal microbiota is including prebiotics in food systems, which are non-digestible dietary fiber components, mainly carbohydrates.

The fermentation of fruit-based probiotic products requires proper selection of microbial strains, the type of fruit pulp with appropriate physicochemical properties and cultivation conditions for the optimal growth. The optimum cultivation factors include the water activity, processing and storage temperature, oxygen content and mechanical stress Results revealed that fruit pulp might be suitable to be a medium to cultivate probiotic lactic acid bacteria. This is mainly due to the favorable acidic pH of fruit juices, typically between 2.5 and 3.7 for the growth of probiotics. Possibly, the low pH and high acidity of fruit pulps appear to be good for the survival of probiotic strains, even though they are not growing in the pulp. The strains are able to resist the acidic condition after transported from stomach to intestine. Their impressive acidic tolerance makes them eligible to be developed into functional supplements in fruit pulp. Fruit pulp are also good sources of saccharides for the growth of probiotic bacteria, and rich in phenolic compounds for the inhibition of pathogenic microorganisms. Dairy-based probiotic foods and drinks are one of the industrial scaled production of probiotic products in the market. Several researchers explained about the physicochemical composition of milk which is rich in protein and substantial lipid amount could be a protective matrix for probiotics.

Microbial-derived functional foods include probiotics, prebiotics, symbiotic, and synbiotics. Probiotics are natural microflora that occur in the gut, such as *L. casei* or numerous Bifidobacter species, which promote health (Hassler 2002). Prebiotics are dietary components that promote growth of probiotic bacteria. Symbiotics contain probiotics and prebiotics combined randomly, while synbiotics contain specific probiotics and prebiotics mixed together to benefit one another. Functional foods of microbial origin act by promoting the growth of probiotic bacteria so that the growth of pathogenic bacteria is limited.

Prebiotic, Probiotic, and Symbiotic Properties the colonizationof the gastrointestinaltract by microorganisms, known as the gut microbiota, creates an important barrier between the environment and the individual that protects against disease. The gut microbiota can be enhanced when probiotics, live health-promoting organisms, are ingested in sufficient quantities to remain viable after passage through the gastrointestinal tract. On the other hand, prebiotics, which are dietary components—most often nondigestible carbohydrates—that induce the growth and activity of beneficial bacteria, provide fermentable substrate for bacteria in the colon and remain unsusceptible to viability issues during digestion. Prebiotics are 100% transferable to the colon, where they can be used to balance the microbiota, thereby providing beneficial systemic effects. Both prebiotics and probiotics play a role in modulating the microbiota. Research into probiotic foods has established the symbiotic effect of combining probiotic with prebiotic foods. Enhancing the health benefits of the microbiota can be achieved with the use of synbiotics, defined by Gibson and Roberfroid as “a mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract, by selectively stimulating the growth and/or by activating the metabolism of one or a limited number of health-promoting bacteria”.

Nutrients in Yogurt

Yogurt is often included on healthy foods and for good reason. Yogurt is highly nutritious and is an excellent source of protein, calcium and potassium. It provides numerous vitamins and minerals and is relatively low in calories. The Dietary Guidelines for Americans recommend that individuals ages 9 and older consume 3 servings of milk, cheese or yogurt each day; children 4-8 years should consume 2-1/2 servings. One serving of yogurt is one 8-ounce cup or container. Yogurt is a cultured milk product that is soured and thickened by the action of specific lactic acid-producing cultures added to milk. The lactic acid produced by the culture coagulates the milk protein, thickening the milk and adding the characteristic sour flavor. The starter cultures—or probiotics—used to make yogurt are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

Fortification with vitamins

Vitamins are compounds which play a role as cofactors in the body. Fermented milk products such as yogurt can be thought as vitamin sources. However, due to the ability of some starters to synthesize vitamin B that is necessary for their growth, there are different vitamin contents in yogurts. Thus, yogurt and fermented milk products which are produced by strains, may have different vitamins according to the starter that is used Furthermore, evaluation of vitamins is more difficult since processes like heat treatment,incubation time, temperature and storage conditions change the vitamins content in yogurt The approximate vitamin content of full fat and nonfat yogurt, and comparison of whole milk and skimmed milk aVitamin D is vital for appropriate skeletal development which plays a fundamental role in regulating serum calcium and phosphorus concentrations in the body. Due to the photosynthesis of vitamin D in the skin after exposure to solar UV radiation, it is not included in the category of essential nutrient of the body. On the other hand, at latitudes above 40°N or below 40°S and forseveral months of the year, no photosynthesized vitamin D is produced in the skin; thus,in order to prevent deficiency, supplementation of vitamin D is required. Furthermore, the amount of vitamin D produced in the skin as a result of exposure to the sun is limited by application of sunscreen Diseases such as childhood rickets, osteoporosis and osteomalacia are influenced by vitamin D deficiency. It has also been shown that the increase in the risk of developing cancers,osteoporotic fractures, and autoimmune diseases have a direct relationship with vitamin D deficiency Since vitamin D is a hormone, its receptor, which belongs to the family of steroid/thyroid hormone nuclear receptors, mediate its genomic mechanism of action. Ant proliferative, differentiative and apoptotic effects of this vitamin were observed on prostate cancer cells in vitro. Concerning the epidemiological studies, vitamin D has negative effects on breast and colon cancers. Also, vitamin D deficiency might result in type I diabetes, hypertension, multiple sclerosis and some other cancers. Several researches have been conducted on the stability of vitamin D in milk and other dairy product, which all have claimed that vitamin D is stable during processing and storage. There are not adequate amount of vitamins A and C in low fat dairy products which are not fortified. Usually, low fat milk and other dairy products are enriched with vitamin A but not with vitamin C. Fortification of dairy products with vitamins A and C leads to improvement in their nutritive quality and consequently,increases their acceptability .Vitamin A is toxic in high amounts. But, the provitamins such as carotene are not toxic. It is reported that doses such as 40,000-50,000 and 25000 IUs are toxic for adults and children respectively. So, it is recommended to use β-carotene for fortification of dairy products.Health risks begin to increase, by the intake of more than 100 µg/day of vitamin D. Also, very high doses of vitamin D (more than 250 µg/day) are known to cause tissue and kidney damages. Although, Hanson and Metzger (2010) reported no adverse effects at level of 250 µg/day of vitamin D, during 5 months of consumption.

Fortification with Iron

Yogurt is a good source of protein and Ca, while dairy products are poor in iron and some other minerals Fortification of farm product with Fe would facilitate organic process deficiencies.Iron-fortified yogurt has a relatively high iron bioavailability.However, before doing any method like fortification, the effects of added iron to yogurt must be assayed. The parameters together with oxidization of fat, taste, shelf life and microbial physiology are important, and the sensory quality and overall acceptance of a fortified yogurt must be ascertained.Properties of fortified farm product square measure influenced by the sort of mineral supply and also the quantity of element that is additional to the merchandise.Two principal off-flavors are created with fortified yogurt oxidised flavor and bimetallic flavor, which are due to the catalytic role of iron and the presence of iron salts, respectively.Oxidation of fat occurred in yoghourt and milk that were fortified with metal salt, ammonium and ferric, reduced the absorption of this element in the fortified milk.Fat oxidization in milk and similar product wasn't promoted by fortification with a metallic element polyphosphate-whey super molecule complicated .Chocolate milk was fortified by iron and had acceptable flavor properties.But other products with ferric chloride or ferrous gluconate were not acceptable.Such oxidization has been effective on sensory characteristics and thiobarbituric acid (TBA) values that were high within the fortified milk.Although ferric ammonium citrate increases the oxidation in milk, it is not observed in solid dairy product such as cottage cheese. Several researches indicated that the lipid oxidation process evaluated by TBA test was reduced using capsulated iron, compared to encapsulated iron fortified yogurt. During three weeks of experiment, no change was found in microcapsulated iron and vitamin C in the fortified yogurt in terms of sensory parameters and acceptance.Therefore, these researches showed that microcapsules of iron and vitamin C are effective means of fortification, and can be used to fortify dairy product without any changes in sensory aspects. Yogurt fortification with iron can be an important and effective strategy to control iron deficiency anemia, but adding iron to yogurt still remains a problem. Compared to ferrous sulphate, iron compounds which are water insoluble, are less absorbed. Thus, concerns about their benefit as yogurt fortificants has been increased in the past, especially because the target is young. For many reasons ferric pyrophosphate is one of those compounds that have been widely assayed in many products difficult to fortify such as cereals, salt, rice, infant formulas, and even dairy products. Nonetheless, these data about ferric pyrophosphate will be important in the development of food-fortification strategies to fight anemia and iron deficiency in highly vulnerable populations. Chronic overload of iron would cause some adverse effects including, cirrhosis, hepatitis, liver cancer, intestinal irritation, vomiting and diarrhea, articular pain, hormonal disturbance, heart disorder and osteoporosis.

Fortification with Calcium

Osteoporosis is a very common disease that affects not only elder women but also elder men and has been related to increased bone fracture risk. Due to the fact that calcium and vitamin D are very important in reducing the risk of fracture, several supplementation researches have examined their effects on bone mass and bone metabolism indices. Still, there are only a few clinical trials examining the effect of these nutrients when supplemented to susceptible population groups via fortified dairy products. The sensorial properties of fortified yogurt shouldn't be influenced by using high concentration of minerals.In this regard, Ocak and Rajendram (2013) have reported that calcium must be used in micronized type to prevent the adverse impact on the sensorial properties.Thus a potential thanks to enhance the amount of minerals within the dairy farm product is achieved by micronization of the minerals that is especially because of the very fact thatultrafine particles ease dispersion, improve mouth feel, acceptance and texture of dairy products. The premium choice in Ca fortified dairy product and dairy farm product is that the application of micronized tricalcium turn, which can give rise to good technological properties and nutritional value.Indeed, in distinction to Ca, fortification with Mg and Zn is not important in developed societies.The tricalcium citrate can be used in yogurts and other dairy products at concentrations of more than 1g/l calcium.In yogurts and different dairy farm product, a liquid mineral suspension is used and also the addition of substance or starch would end in the stabilization of those suspensions byreducing sedimentation of minerals. All around the world, especially in Europe, where health claims on products are regulated by the new EFSA (European Food Safety Authority) health claim regulation, Mg and Zn offer various options for new fortified product concepts. By raising the awareness of these minerals and their various beneficial effects on human health, they should gain importance in dairy products as well as calcium and other nutritional ingredients. As technological problem will increase with higher fortification levels of mineral, trimagnesium and zinc citrate will be able to prove their superior application in dairy products.

Fortification with fiber

There is no fiber in dairy product and farm merchandise. Fiber could be a part of the plasma membrane of fruits, grains, seeds and vegetables. Invigorating dairy product or farm merchandise with fiber is of accelerating interest to form purposeful foods with health advantages and improve their practicality. Invigorating dairy product with dietary fiber would complement its healthy properties. The most acceptable quantity of date fiber in fortified dairy product with potential helpful health effects is third-dimensional. Several researchers evaluated the result of dietary fiber on farm merchandise and dairy product quality. The addition of one. Oat fiber improved the body and texture of sugarless dairy product and slashed the flavor quality.

Conclusion

Yogurt is that the most consumed healthy and alimental food round the world. Therefore, it offers associate applicable potential to convey alimental ingredients to human diet. Analysis shows that almost all folks in developing or underdeveloped countries suffer from matter deficiency and enriched food merchandise will dramatically scale back the nutritionary diseases. During this study, a spread of various alimental parts and therefore the manner of victimization them in farm merchandise were mentioned and therefore the impact of enriched food on preventing or treating illness was shown.

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