

Scientific and technical aspects of yogurt fortification: A review

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Abstract

Food fortification is one of the most important processes for improvement of the nutrients quality and quantity in food. It can be a very cost effective public health intervention. Due to the high consumption rate of dairy products such as 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 and their role in disease prevention and correction of deficiencies. In this paper, 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.

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1. Introduction

Considering the importance of food safety and quality, more attention is being paid to the health of consumers [1]. However, due to nutrients deficiencies in human societies especially in certain periods of life, embracing, importing, and consumption of fortified foods is increasing [2]. In general, adding one or more essential nutrients to a food and increasing their concentration in that particular food to levels higher than normal is known as fortification and is aimed at preventing and correcting deficiencies in one or more nutrients in the society or specific population groups [3]. Nutrition scientists have mentioned that fortification of food products using natural resources (fruits, cereal, etc.) is one of the best ways to improve the overall nutrient intake of food with minimal side effects [4]. However, compliance notes on the production of fortified foods with the aim of safeguarding

consumers' health and lack of toxicity resulting from the use of this material seem necessary.

Fermentation is a method that has been used for thousands of years to provide longer shelf life for perishable foods and to increase the flavor and odor of final food products [5]. It is known that fermented foods have been made since Neolithic times. The most famous examples of fermented foods are wine, bread, and cheese. Also, in middle Asian regions, yogurt and other fermented milk products (such as kefir and kumys), traditional alcoholic beverages, vinegar and pickles are common [6]. Fermentation is a chemical process in which enzymes break down organic substances into smaller compounds. As the result of fermentation, more digestible, stable and flavored foods with enhanced nutritional value are produced. Fermentation is carried out by molds, yeast or bacteria. During the growth of these microorganisms, fermented foods are produced incidentally [7]. Yogurt is a fermented milk produced by *Streptococcus thermophilus* and *Lactobacillus delbrueckii* spp. *bulgaricus*. The production of yogurt as a fermented milk product has been started in the Middle East and spread all over the world. Compared to milk, yogurt is more nutritious and is an excellent source of protein, calcium, phosphorus, riboflavin, thiamin, vitamin B₁₂, folate, niacin, magnesium and zinc. Since lactose in milk is

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converted to lactic acid during fermentation and due to the presence of lactose fermenting bacteria in yogurt, lactose intolerant people can consume yogurt without any adverse effect. Moreover, consumption of fermented milk products causes a slight reduction in stomach pH which reduces the risk of pathogen transit and the effects of low gastric juice secretion problem [8]. Since fermented milk products are among highly-consumed food in the world, they have been used to deliver nutritional components into human diet. Furthermore, fortification of these products such as yogurt, is a good way to improve nutrient intake in daily food products [2].

2. Yogurt consumption and health effects

Obviously, the nutritional value of any material depends on its components. Because of the presence of precious compounds in milk, yogurt is of great importance. Regarding the chemical composition of milk and yogurt, no changes will occur during fermentation. However, the fermentation process causes a beneficial effect on yogurt [9]. Table 1 shows the components of full-fat milk, non-fat milk, and the corresponding yogurts [10].

Milk is a physiological liquid containing bioactive and nutrients components which have beneficial effects on the newborn infant's growth and the digestive system. It may also improve the symbiotic micro flora and the development of lymphoid tissues. Several bioactive compounds are present in milk, notably in fermented milk products, which are of great importance and include certain specific proteins, vitamins, bioactive peptides, organic acids and oligosaccharides [10].

The consumption of fermented dairy products containing probiotic bacteria would decrease cholesterol absorption [11]. Beneficial effects of dairy foods on the body fat and body mass may be caused by whey proteins, medium-chain fatty acids, and the high level of calcium and other minerals. Milk components containing proteins, peptides, probiotic lactic acid bacteria, calcium, and other minerals have a noteworthy effect on the reduction of blood pressure. There are several components in milk fat with functional properties. Sphingolipids and their active metabolites may exert antimicrobial influences either directly or upon digestion. A review of literature revealed that the consumption of recommended level of milk and fermented dairy products, as part of a healthy diet, can result in reducing the risk of many diseases [12].

Fermented dairy products contain adequate levels of certain live and active cultures, namely probiotics that aid to improve the balance of “beneficial” versus “undesirable” bacteria in the intestinal tract. Several researches on fermented dairy products showed their effect on the immune system, as well as promoting intestinal health. The impact of consuming fermented products such as yogurt on improving the immunity function in body against carcinogens and harmful toxins is being studied. In order to find out the effect of milk and dairy products intake in reducing the risk of diseases, clinical investigations have been done on diseases such as GI system diseases, cardiovascular system diseases, musculoskeletal system diseases, urogenital system diseases, immune system diseases, allergy, nervous system diseases, cognitive system diseases, weight control, obesity, aging and dental health [92].

Table 1
Nutritional composition of full-fat milk, non-fat milk and correspondent yogurts (100 g) [10,16].

Components	Unit	Full-fat milk	Full-fat yogurt	Non-fat milk	Non-fat yogurt
Energy	Kcal	68	70	35	39
Protein	G	3.3	3.8	3.5	4.4
Fat	G	3.8	3.8	0.1	0.1
Lactic acid	G	0	0.8	0	1.0
Potassium	mg	157	157	150	187
Calcium	mg	120	120	123	143
Phosphorus	mg	92	92	97	109
Magnesium	mg	12	12	14	14
Sodium	mg	48	48	53	57
Iodine	mg	0.46	0.46	0.45	0.44
Chlorine	mg	102	102	100	121
Retinol	μg	52	28	1	8
Carotene	μg	21	21	Tr*	5
Vitamin B ₁	μg	30	60	40	50
Vitamin B ₂	μg	170	270	170	250
Vitamin B ₆	μg	60	100	60	90
Vitamin B ₁₂	μg	0.4	0.2	0.4	0.2
Vitamin C	mg	1	1	1	1
Vitamin D	μg	0.03	0.04	Tr*	0.01
Vitamin E	μg	90	50	Tr*	10
Folic acid	μg	6	18	5	17
Nicotinic acid	μg	100	200	100	100
Pantothenic acid	μg	350	500	320	450
Biotin	μg	1.9	2.6	1.9	2.9
Choline	mg	12.1	–	4.8	0.6

Tr*: trace.

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