

Yogurt. The most suitable carrier for increasing bioavailability of minerals

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Summary. The aim of this paper is to highlight that the incidence of essential micronutrients deficiency is worldwide. Different foods maybe used as a matrix for mineral fortification and enrichment purposes; however, most of them suffer from low bioavailability. Because of appropriate physicochemical and microbial properties such as acidity, inhibitory effect on phytic acid as well as having probiotics and vitamins, yogurt is the best carrier for increasing the bioavailability of mineral.

Key words: yogurt, mineral, bioavailability

Introduction

Functional foods have positive effects on human health particularly decreasing the risk of diseases (1). Due to the importance of the nutritional quality of foods, fortification is performed to deal with various types of deficiencies (2). Essential micronutrients (e.g., iron, calcium, phosphorous and magnesium) deficiency causes learning disabilities, mental retardation, low work efficiency, blindness and early death. Improving nutrients bioavailability results in elevating the society's healthcare. Various strategies such as diet improvement, supplementation and food enrichment maybe employed to achieve this goal (3).

Fortified yogurt containing functional ingredients is of great importance. Low lactose and high calcium concentrations as well as biological effects make this product very important in human diet (4). Several studies suggest that the consumption of yogurt increases the absorption of phosphorous, magnesium, and zinc and reduces the cholesterol level (5).

Effect of chemical components

The acidity of yogurt increases the absorption of certain minerals such as calcium, phosphorous and magnesium at a higher level as compared to other dairy

products. It might also reduce the effect of some inhibitory compounds such as phytic acid; which is known to interfere with mineral absorption (particularly calcium). Many studies performed in animal models have also suggested that the calcium content of yogurt may lead to greater bone mineralization than the calcium present in non-fermented dairy products. Several other factors such as probiotics, soaking, other nutrients and natural sources, can affect the nutrient bioavailability from foods and supplements. Both calcium and phosphorus are minerals involved in the formation and maintenance of bones (6).

Effect of probiotics

Probiotics can increase the bioavailability of nutrients. Probiotics are viable microorganisms which are capable of exerting post-ingestion positive effects such as improving the absorption and utilization of the nutrients by the body and limiting the quantity of pathogenic microorganisms in the digestive tract, upon ingestion (7). Fermentation of soymilk with probiotic organisms, such as *Lactobacillus bulgaricus*, improves the bioavailability of isoflavones and calcium and also the protein digestion.

Effect of phytate

Zinc is a trace mineral found in whole grains. Phytates present in grains impair the absorption of zinc. The inhibitory activity of phytate can be reduced by fermentation, soaking, germination and enzymatic treatment. A decrease in phytate activity increases the bioavailability of mineral (Zinc, iron, phosphorous and magnesium) (8).

Effect of vitamins

Certain yogurt vitamins can enhance the absorption and hence bioavailability of certain minerals. Vitamin D, which is a fat-soluble nutrient, enhances the intestinal absorption and retention of calcium and phosphorous from yogurt. Both calcium and phosphorous are minerals involved in building and maintaining bones. Vitamin C increases the absorption and bioavailability of iron. The addition of vitamin C-fortified water into infant rice cereal increases the bioavailability of iron more than the addition of vitamin C-fortified apple juice. Apple juice may contain substances

that offset vitamin C's positive effects on iron absorption (2).

Natural vitamin B-12 present in cow milk has substantially more bioavailability than the synthetic forms present in dietary supplements. It has been reported that the bioavailability of natural vitamin B-12 is not influenced by enrichment or unit operations.

Effect of natural sources

Natural sources of nutrients have higher bioavailability than synthetic ones. In fact, most of bioavailable calcium present in typical Western diet is supplied by milk, yogurt and cheese in the. Because of the lower pH of yogurt compared with that of milk, calcium and magnesium are present in yogurt mostly in the ionic forms. Schaafsma *et al.* (1988) investigated the effect of dairy products on mineral absorption using rat models and reported that lactose enhances the absorption of calcium, magnesium, and zinc (9). The acidic pH of yogurt ionizes calcium and thus facilitates the intestinal calcium uptake (10). Yogurt of low pH may also reduce the inhibitory effect of dietary phytic acid

Table 1. Fortification of yogurt using minerals

Minerals	Concentration of minerals	Results	Ref
Iron	10 mg/kg	The yoghurt samples showed (12%) of iron was maximum bio-availability from yoghurt fortified with ferrous sulphate followed by control and cow milk-oat milk blended yoghurt showed 10.2% and 8.52% respectively.	(12)
Iron	2.5 mg/100 g	Lactic acidification and fermentation also increased Zn availability, but Ca availability was hardly increased by either treatment.	(13)
Iron	20–60 mg/kg	Quality attributes of the yoghurt fortified using Fe at up to 60 mg iron/kg were similar to those of unfortified control samples, especially in terms of color and flavor.	(14)
Iron	10–40 mg/kg	Results showed that iron were suitable for yogurt fortification.	(15)
Iron	6–8 mg/L	Sensory, rheological and stability properties of the control yogurt were only slightly affected by iron-entrapped niosomes. These results demonstrated that yogurt could be a suitable vehicle for the iron-entrapped niosomes formulated in this work.	(16)
Calcium	800 mg/d	This study in institutionalized elderly at high risk for osteoporotic fracture suggests that fortification of dairy products with vitamin D3 and calcium provides a greater prevention of accelerated bone resorption as compared with nonfortified equivalent foods	(17)
Calcium	250 mg/250 ml	Daily intake of vitamin D-fortified doogh improved inflammatory markers in T2D subjects, and extra calcium conferred additional benefit only for the antiinflammatory adipokine, i.e. adiponectin.	(18)
Zinc	2–34 ppm	Zinc gluconate stabilized with glycine may be considered as a suitable source of zinc for food fortification in a yogurt matrix.	(19)

on calcium bioavailability. These studies may suggest that the bioavailability of calcium in yogurt is greater and therefore, yogurt may increase the bone mineralization more than non-fermented milk products. Literature shows that yogurt has a remarkable effect on bone mineralization in human subjects. The addition of milk and yogurt to a plant-based diet increases the zinc bioavailability without affecting iron bioavailability. Such properties make yogurt a food source with the potential to reduce the negative effect of inhibitors. Some of the other advantages include quality and quantity of protein, the beneficial effect of microorganisms on the gastrointestinal tract, and the buffering capacity of yogurt in digestion and absorption (11).

Conclusion

Yogurt is the most consumed healthy and nutritious dairy product all around the world. Therefore, it has the potential to convey other nutritious components to human body. Researches show that most people in different countries suffer from micronutrient deficiency and fortified food products can dramatically reduce the nutritional-mediated diseases. Due to physicochemical and microbiological properties, yogurt is the best carrier for increasing the bioavailability of mineral.

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