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Analysis Of The Functional Properties Of Vitamin-Fortified Food Products

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Abstract

This article discusses the role of functional food products enriched with vitamins in the modern nutritional system, their physiological effects on the human body and their importance in health care. Also, the use of vitamins A, B and C in the food industry, their biological role and the features of their use in functional products are analyzed. The role of products enriched with vitamins in regulating metabolic processes, strengthening the immune system and meeting the needs of the body is substantiated.

Keywords: Functional food, vitamins, enrichment, vitamin A, B vitamins, vitamin C, antioxidants, metabolism, immune system, food technology, immune system, metabolic, minerals, palmitate.

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1. Introduction

In recent years, the demand for vitamin-enriched food products has been extremely high. Functional food products are an important element of the modern nutrition system, they have a positive effect on the physiological properties of the body, and most importantly, they are a preventive measure in maintaining health. Functional food products contain biologically active components that have a targeted physiological effect on the human body, that is, they regulate metabolic processes, strengthen the immune system, and somewhat reduce the risk of chronic diseases. Functional food products, unlike ordinary food, are enriched with components that are beneficial to human health. They contain vitamins, minerals, and antioxidants. Vitamins are biologically active substances that perform regular functions in the body. Their optimal concentration supports physiological processes.

There are different groups of vitamins, and vitamin A used in the production of functional food products contains many compounds, the most important of which are retinol, retinal, retinoic acid and retinol esters - retinyl acetate, retinyl palmitate, etc.

Importance of Vitamins in Functional Food Products

Table 1.

Vitamin type	Main biological function	Products in which it is used	Benefits to the organism
Vitamin A	Strengthens visual function, supports immunity and cell differentiation	Dairy products, yogurt, margarine, eggs	Maintains visual acuity, supports skin and mucosal health, strengthens immunity
Vitamin B_1 (Thiamine)	Participates in energy metabolism	Cereal products, legumes	Supports nervous system function, participates in carbohydrate metabolism
Vitamin B_2 (Riboflavin)	Participates in redox reactions and energy production	Meat products, dairy products, eggs	Supports cellular energy metabolism, maintains mucosal integrity
Vitamin B_6 (Pyridoxine)	Participates in amino acid metabolism	Meat products, legumes, grain products	Supports brain function, participates in neurotransmitter synthesis
Vitamin B_{12}	Participates in nucleic acid synthesis and hematopoiesis	Grain products, dairy products	Supports hematopoiesis, maintains nervous system function
Vitamin C	Powerful antioxidant, supports immunity	Vegetables, fruits, berries, citrus fruits	Strengthens immune system, participates in collagen synthesis, exhibits antioxidant activity

Vitamin A is very important for the perception of light during vision, the maintenance and healthy development of the mucous membranes of the respiratory system, gastrointestinal tract, excretory, reproductive and genital organs, as well as the immune system. Vitamin A is added to vegetable oils, margarine, spreads, yogurts, milk and dairy products, diet and baby foods. Since vitamin A is a fat-soluble vitamin, it must be added to the fat phase of the product. Vitamin A occurs in two forms: - as retinol, found in animal products; - as provitamins - carotenoids, found in plant materials. Commercial forms of vitamin A: oil forms (vitamin A acetate 1.5 million IU/g, vitamin A palmitate 1.7 million IU/g, vitamin A palmitate 1.0 million IU/g); powder forms (vitamin A acetate 500; vitamin A acetate, type 325 CWS/F, vitamin A palmitate 500). Conversion factors: 1 mcg all-trans-retinol; 1 retinol equivalent = 1.147 mcg all-trans-retinyl acetate; 3.33 IU vitamin A activity; 6 mcg β-carotene. The limited availability of animal sources of vitamin A necessitates the consumption of sufficient amounts of plant products containing β-carotene, as well as the fortification of mass-market foods with it. Carotenes and carotenoids. Natural yellow or yellow-orange pigments that give color to plants and animals are called carotenes. In nature, carotenes occur both in free form and as glycosides, carotenoid proteins, or esters. It has been proposed to combine these substances, which are derived from yellow plants, into a single group and call them carotenoids, after the coloring agent carotene found in carrots. Currently, the properties of natural β-carotene, which has the highest biological activity, are well studied. Thus, if its activity is taken as 100%, the activity of α-carotene is 53%, the activity of γ-carotene is 28%, and the remaining carotenoids have low activity or are completely devoid of it. The practical use of carotenoids in human nutrition is based on the biological relationship between them and vitamin A. In the human body, vitamin A is synthesized from β-carotene. The activity of β-carotene is two times lower than the activity of vitamin A. The conversion coefficient of β-carotene to vitamin A is 6:1 (6 mg of β-carotene corresponds to 1 mg of vitamin A in the form of retinol). As an antioxidant, β-carotene helps neutralize free radicals and blocks the development of chain reactions.

In the food industry and public catering, β-carotene is used in the production of confectionery products to color butter, margarine, pasta, cheese, and ice cream. Commercial forms of the product used for food purposes: β-carotene (E160a): fat-soluble form - β-carotene 30% FS; water-soluble forms: β-carotene 10% CWS (cold water soluble); β-carotene - 5% EM (emulsion); β-carotene - 1% CWS (cold water soluble). The carotenoid lycopene is also used for food purposes - lycopene 10%.

Directions of Vitamin Application in the Food Industry

Table 2.

Vitamin	Function in the food industry	Field of application
Vitamin A	Fortification of products and enhancement of their biological value	Fat-containing products, dairy products
β-Carotene	Colouring agent and antioxidant	Margarine, cheese, ice cream
B-group vitamins	Improvement of energy metabolism and nutritional value	Cereal products, bread, pasta
Folic acid (Vitamin B_9)	Support of fetal development	Infant foods, specialized dietary products
Vitamin C	Antioxidant and stabilizer	Beverages, meat products

The B vitamins include B1, B2, B6, B12, biotin, folate, niacin and pantothenic acid. Vitamin B1 (thiamine) is used in the food industry in two forms (thiamine hydrochloride and thiamine mononitrate). Thiamine is involved in carbohydrate metabolism and energy metabolism in the nervous system and muscle tissue. Conversion factors: - 1 mg thiamine = 1.27 mg anhydrous thiamine hydrochloride; - 1 mg thiamine = 1.23 mg thiamine mononitrate. Vitamin B1 is used to enrich flour, rice, baby food, pasta, milk and dairy products, drinks and their concentrates, breakfast cereals, sugary products and to imitate the taste of meat products. Vitamin B2 (riboflavin) is used to enrich food products in the following commercial forms: riboflavin, universal riboflavin and sodium riboflavin-5-phosphate. Vitamin B2 is involved in carbohydrate, protein and fat metabolism, as well as in respiratory processes. Vitamin B2 is involved in carbohydrate, protein and fat metabolism, as well as in respiration. Riboflavin coenzymes play a major role in the conversion of pyridoxine (vitamin B6) and folic acid into active coenzyme forms and in the conversion of tryptophan to niacin. Conversion factors: - 1 mg riboflavin = 1.367 mg sodium riboflavin-5-phosphate; - 1 mg sodium riboflavin-5-phosphate = 0.731 mg riboflavin. In food technology, riboflavin is used as a coloring agent (riboflavin and sodium riboflavin-5-phosphate) for coloring ice cream, dry instant products, spices, instant soups, bouillon cubes, sorbets and ice creams. The addition of this compound produces a color ranging from pale lemon to bright yellow. Riboflavin is also used to enrich food products - cereals, flour, pasta, cereals, milk and dairy products, baby food and dietary products. Vitamin B2 is often included in dry, homogeneous vitamin mixtures, i.e. premixes. Vitamin B6 (pyridoxine) serves as a coenzyme for many enzymes involved in the metabolism of amino acids. Vitamin B6 plays an important role in the metabolism of proteins, fats and carbohydrates, and is involved in the breakdown of adrenaline, vitamin PP and glycogen. It is very important for the functioning of the nervous system, such as the brain, and the health of skin, hair, nails and bone tissue. Vitamin B6 (pyridoxine) serves as a coenzyme for many enzymes involved in the metabolism of amino acids. Vitamin B6 plays an important role in the metabolism of proteins, fats and carbohydrates, and is involved in the formation of adrenaline and vitamin PP, as well as in the breakdown of glycogen. It is essential for the functioning of the nervous system, including the brain, and for the health of skin, hair, nails, and bone tissue. This vitamin is used to compensate for losses during processing to enrich flour, bakery products, and cereal products. It is also used in the production of dairy products, dietary products, baby food, therapeutic and preventive nutrition, and nutrition for pregnant and lactating women and athletes. Pyridoxine hydrochloride is recommended as part of multicomponent vitamin complexes, since niacin, riboflavin, and biotin are synergists of pyridoxine, increasing its activity.

Vitamin B12 (cyanocobalamin). Vitamin B12 is essential for the formation of blood cells, nerve cell membranes, and various proteins. It is involved in the metabolism of fats and carbohydrates and is important for normal growth. It is used to fortify cereals, some beverages, confectionery, dairy products, diet foods, and baby foods. Eating foods fortified with vitamin B12 is especially recommended for strict vegetarians. Cyanocobalamin is a synthetic form of vitamin B12, which is converted into active forms of the coenzyme in the human body. Currently, two forms of cyanocobalamin are used in the food industry: crystalline and spray-dried powder. It is used to fortify cereals, some beverages, confectionery, dairy products, diet foods, and baby foods. Eating foods fortified with vitamin B12 is especially recommended for strict vegetarians. Cyanocobalamin is a synthetic form of vitamin B12, which is converted into active forms of the coenzyme in the human body. Currently, two forms of

cyanocobalamin are used in the food industry: crystalline and powder, obtained by spray drying. The commercial form of the product is folic acid. Vitamins B4 and PP factor (niacin, nicotinamide, niacinamide) participate in reactions in which energy is released in tissues as a result of the biological transformation of carbohydrates, fats and proteins. Niacin is important for the nervous and muscular systems, skin health, the gastrointestinal tract and growth. It is used to enrich products (corn and oat flakes), wheat and rye flour. Niacin is also used to enrich dietary and dry food products, as well as canned meat and fish. Two forms of the vitamin are used in the food industry: nicotinic acid and niacinamide. Conversion factors: - 1 mg nicotinic acid / niacin = 1.008 mg niacinamide; - 1 mg niacinamide = 0.992 mg nicotinic acid (niacin). Pantothenic acid and pantothenates (vitamin B5). Pantothenic acid plays an important role in the metabolism of carbohydrates, proteins and fats. It is involved in reactions that provide cellular energy, as well as in the synthesis of sterols, hormones, phospholipids, etc. Vitamin B5 is added to breakfast cereals, beverages, dietary products, and baby food. Calcium D-pantothenate is used to enrich food products. Conversion factors: - 1 mg panthenol = 1.161 mg calcium pantothenate; - 1 mg calcium pantothenate = 0.861 mg panthenol. A list of food products that can be fortified with vitamins for children and adolescents has been compiled: canned fruits and vegetables, fruit juices and nectars with added vitamins, vitaminized, non-carbonated drinks, vitamin-enriched jams, marmalades, jellies, syrups, food concentrates, soluble vitamin drinks, vitamin-enriched kisels (drinks) with added vitamins, vitaminized cocoa drinks, milk and dairy products, vitaminized sterilized milk, vitaminized sour-milk products, vitaminized cottage cheese products, bakery and confectionery products, bakery products (vitaminized, enriched with iodine), vitaminized products made from grain raw materials, porridges intended for children, toys, candy, chocolate-based products, candy bars enriched with vitamins and minerals.

Fortification of foods with vitamin C; Vitamin C (ascorbic acid). Ascorbic acid maintains healthy blood vessels, skin and bone tissue. It stimulates the body's defenses, strengthens the immune system, helps detoxify and eliminate foreign substances and toxins, and improves iron absorption. In food technology, ascorbic acid and its derivatives are used for the following purposes: - fortification of foods with vitamin C (fruit juices, juice-preserving and water-soluble drinks, lemonades, fruit and vegetable purees, breakfast cereals, candies and marmalade); - standardization of the amount of vitamin C (fruit and vegetable juices, purees and canned goods); - stabilization of foods and beverages (as a natural antioxidant). The addition of ascorbic acid during processing or before packaging helps to preserve the color, taste and nutritional value of meat and meat products, while reducing the mass fraction of added nitrites (NaNO2 and KNO2) and the nitrite residue in the finished product, which are physiologically harmful and toxic to humans. It is also used as a flour and dough improver. The addition of ascorbic acid to freshly ground flour improves its baking properties, reducing the 4-8 weeks required for flour to ripen after grinding. The following commercial forms of the vitamin are used in the food industry: crystalline ascorbic acid (E 300); fine-grained ascorbic acid (E 300); finely powdered ascorbic acid (E 300); oil-coated FC type ascorbic acid; crystalline sodium ascorbate; calcium ascorbate; ascorbyl palmitate.

In conclusion; functional food products enriched with vitamins are an integral part of the modern nutrition system. They play an important role in satisfying the physiological needs of the human body, regulating metabolic processes and strengthening the immune system. In particular, products enriched with vitamins A, B and C are of great importance in ensuring the normal functioning of the body. Such products also serve to prevent nutrient deficiencies, reduce the likelihood of developing various diseases and improve the general health of the population. The possibility of increasing the biological value of products through the effective use of vitamins in the food industry is expanding.

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