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# FOOD ENRICHED WITH DIETARY SUPPLEMENTS®

## Żywność wzbogacana w suplementy diety®

*The article deals with the subject of fortified foods and dietary supplements. Methods of food enrichment, their forms and doses, examples of fortification and its effects on health were discussed. Then, the subject of dietary supplements was introduced, their basic chemical composition, health risks resulting from inept use of supplementation were presented, and a criterion for the division of dietary supplements was created. Dietary supplements can be divided according to their composition and chemical structure, function and form. An example of a dietary supplement was a drink with green tea extract based on nano-water, which was created in low-temperature plasma.*

**Key words**: dietary supplements, low-temperature plasma, food, nanowater, health risks, functional food.

*W artykule zajęto się tematem żywności wzbogacanej oraz suplementów diety. Omówiono metody wzbogacania żywności, ich formy oraz dawki, przykłady fortyfikacji i jej skutki dla zdrowia. Następnie przybliżono temat suplementów diety, przedstawiono ich podstawowy skład chemiczny, zagrożenia zdrowotne będące następstwem nieumiejętnego korzystania z suplementacji oraz stworzono kryterium podziału suplementów diety. Suplementy diety można podzielić ze względu na skład oraz budowę chemiczną, spełnianą funkcję oraz formę. Za przykład suplementu diety posłużył napój z ekstraktem z zielonej herbaty na bazie nanowody, która powstała w niskotemperaturowej plaźmie.*

**Słowa kluczowe:** suplementy diety, niskotemperaturowa plazma, żywność, nanowoda, zagrożenia zdrowotne, żywność funkcjonalna.

## ADMISSION

It has been known since ancient times that one of the most important determinants of health is diet. Proper human nutrition is based on the complete coverage of the body's demand for energy and all the ingredients necessary for the development of life and maintaining health. The key to this is a properly varied diet that will provide all the necessary nutrients in the right amounts [7].

Food has undergone a great evolution over the centuries. The translation of technological progress into everyday life is the reason for significant changes in lifestyle, unfortunately, it should be remembered that these are not always only changes beneficial to health. At the same time, this situation is accompanied by a great deal of consumer interest in maintaining health and slowing down the aging processes. People want to live in full health as long as possible, which is why the demand and interest in food with a targeted, desired effect on the body has been growing for many years.

The term functional food began to appear in world literature from the early 90's. The concept of such food comes from the philosophical tradition of the East in which there is no discernible difference between medicines and food. It has been practiced for centuries to add plant extracts to food and drink to improve human health. Functional food is therefore a continuation of this long-chosen direction. Today, thanks to a very in-depth knowledge of the characteristics of human health and the use of the latest technologies of treatment, it is possible to produce additional substances, the production of which will result in further development of this currently "free" activity in the field of pro-health food, as well as its legal regulation [10].

Another way to avoid macro and micronutrient deficiencies is to use dietary supplementation. This is one type of nutrition rationalization strategy. Dietary supplements using the form of pharmaceutical preparations are in the form of tablets, but remember that they are not drugs. In developing countries, they are a tool for the authorities to combat the most common shortages among the population, in developed countries they are a product that fits in the new trend of taking care of health, using prophylaxis, improving well-being, increasing physical performance or maintaining a slim figure. Reaching for

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synthetic substitutes for vitamins and ingredients is not fully safe and known.

## PURPOSE AND SCOPE OF WORK

The aim of the work presented in the article was to analyze, characterize and classify dietary supplements and food additives as enrichment ingredients. The paper presents the criteria for the division of these substances, and also discusses one of the dietary supplements available on the market, which is a drink with green tea extract. This drink is a nano-water dietary supplement. It is an example of one of the dietary supplements available.

The scope of work includes:

– literature review (characterization of food enrichment substances, characteristics of dietary supplements, literature division of these substances, chemical composition, organoleptic evaluation, division of food containing enrichment ingredients, dietary supplements available on the market, their advantages and disadvantages.
– research methodology (criteria, conditions for the classification of dietary supplements, enrichment ingredients).

## ENHANCING FOOD

The term functional food first appeared in 1984 in Japan, and in 1991 legal regulations and a special procedure were created that allowed for the granting of status to functional food products. In 1996, the FUFOSE (Functional Food Science in Europe) research program was launched, financed by the European Union, the aim of which was to scientifically define the foundations for the concept of functional food in the European Union and to develop criteria, directions and ways of implementing functional food products in Europe.

Many countries have their own interpretations of the concept of functional food, but work on creating a universal definition is ongoing. The most famous definitions are:

- they are specially prepared food products that have a proven beneficial effect on health [2],
- "A food can be considered functional if it has been proven to have a beneficial effect on one or more bodily functions over and above the nutritional effect of improving health and well-being and / or reducing the risk of disease. Functional foods must resemble conventional foods and have beneficial effects in amounts that are expected to be consumed normally with the diet – they are not tablets or capsules, but part of a healthy diet "[5],
- food and drinks that improve the physical and mental quality of life, facilitate the increase of physical performance or the proper development or recovery after suffering severe illnesses, may also improve health or reduce the risk of its risks, thus meeting the expectations of high-awareness consumers health [1].

Food enrichment, also known as fortification (enchrimentfortification), as defined by the FAO / WHO (CodexAlimentarius 1994) is the addition of one or more nutrients to a food, whether normally present in the food or not, in to prevent and correct existing deficiencies of one or more nutrients in entire populations or specific groups of the population [4]. Groups that are at risk of such deficiencies are children, adolescents during intensive growth and development, pregnant and breastfeeding women, elderly people, people exposed to a high stress factor, people practicing sports, people on dieting, people taking drugs with a destructive effect on the body, convalescents, alcoholics, smokers, as well as people with diseases of the digestive system.

There are three basic options for food enrichment depending on the desired goal: intervention enrichment is directly related to the prevention and combating of specific shortages; compensatory enrichment consists in directly increasing the nutritional value of a food product; Improved enrichment consists in imparting properties desired by the consumer to food, often creating new characteristics and significantly improving the health quality of such products.

According to the recipes, you can enrich both products that already contain a certain amount of a given nutrient in their composition, as well as those products that naturally do not contain a given ingredient. In order to choose the right carrier, one should have the necessary information, such as knowledge of the nutritional situation of a given population, knowledge about the amount and type of deficient nutrients. The product intended to be a carrier should be easily available and commonly consumed among consumers in the population at risk. In developing countries, the most vulnerable population is poor villagers whose diets are self-produced. This is related to the fact that industrially manufactured products are not used, which makes it difficult to select the appropriate carrier. In such a situation, salt or sugar is enriched, or specific commercial preparations are distributed for the self-enrichment of meals prepared in households. However, it should be remembered that producers and consumers not threatened with a deficit of a given ingredient should also have access to products that do not contain enriching substances. An example is the inhabitants of coastal areas, where the consumption of iodized salt could lead to thyrotoxicosis.

In the ideology of food enrichment in various countries of the world, products such as flour, rice, long-lasting and confectionery bread, cereal products, pasta, milk and milk drinks are used as a carrier [3].

"Only those micronutrients which are a source of food and which are considered essential for the nutrition of the human body should be added to food products, and at the same time in the form and dose in which they are safe and digestible" [6].

The enrichment substances are most often synthetic compounds, but also concentrates or isolates from natural sources are used. Their important feature should be low price and stability, without losing the bioavailability of a given nutrient.

Food is most often enriched with substances such as: dietary fiber, vitamins A, C, D, E and B vitamins, minerals, lecithin, polyunsaturated fatty acids, amino acids, caffeine. Table 1 shows the most commonly used enrichment substances, and table 2 shows the bioactive ingredients used in food fortification.

**Table 1. The most commonly used enrichment substances and their doses [6]**

**Tabela 1. Najczęściej stosowane substancje wzbogacające i ich dawki [6]**

| Nutrient (enrichment substance) | Products – carriers | The added amount per 100 g of the product |
|---|---|---|
| Amino Acids (Synthetic Amino Acids) | Grain products, soy meat substitutes, preserves for children and babies | 0,01 – 0,1 g |
| Calcium (calcium carbonate, CCM, calcium phosphate, dried whey, calcium lactate) | Wheat flour, corn flour, bread, breakfast cereals, powdered milk | 100 – 400 mg |
| Iron [iron (II) sulfate (VI), iron (III) fumarate, iron (III) citrate, iron (II) gluconate] | Wheat flour, corn flour, bread, breakfast cereals, powdered milk | 0,5 – 5,0 mg |
| Iodine (potassium iodide, potassium iodate) | Salt, butter, and bread | 0,5 – 3,0 mg |
| Vitamin A (retinol, β – carotene, retinyl acetate, retinyl citrate, | Margarines, vegetable oils, milk, flour, cereals, pasta, desserts, drinks, sugar, monosodium glutamate | 0,1 – 2,0 mg |
| Vitamin D (cholecalciferol, ergocalciferol) | Margarines, milk, dairy products, cereal products | 1,5 – 10,0 μg |
| Vitamin E (α – tocopherol acetate, tocopherol concentrate, γ and δ tocopherol) | Vegetable oils, margarines, salad dressings, confectionery fats, lard | 5 – 20 mg |
| Vitamin C (L – ascorbic acid) | Fruit and carbonated drinks, vegetable preserves, powdered milk, dry grain products, powdered drinks, salt | 5 – 20 mg |
| B vitamins | Fruit juices, drinks, flour, cereals, pasta, rice, bread, dairy products | 10 – 100 mg<br>np. B1, B2, B6 0,1 – 2,0 mg, PP do 10,0 mg |

**Table 2. Bioactive natural ingredients used in food fortification**

**Tabela 2. Bioaktywne składniki naturalne stosowane we wzbogacaniu żywności**

| Natural bioactive ingredients | Examples | Health benefits |
|---|---|---|
| Dietary fiber | betka – glucans, pectins, guar, alginates, resistant starch | reducing blood cholesterol levels, preventing constipation |
| Amino acids, peptides, proteins | creatine, carnitine, glutamic acid, taurine, tyrosine, protein hydrolysates, protein concentrates and isolates | proper tissue structure, regulation of metabolic processes, easier absorption of minerals |
| Oligosaccharides (so-called prebiotics) | stachiosis, inulin, raffinose, lactulose, oligofructose | stimulating the development of probiotic intestinal flora, reducing blood cholesterol levels, preventing constipation |
| Polyols | xylitol, maltitol, lactitol, isomalt, sorbitol | reducing blood glucose levels, inhibiting the development of caries |
| Polyunsaturated fatty acids | from the omega 3 group: lionolenic acid, ecosapentaenoic acid, docosahexanoic acid | preventing cardiovascular diseases, inhibiting inflammation and allergies, proper development of the nervous system |
| Vitamins | from group B, D, antioxidant (A, C, E) | regulation of metabolic processes, neutralization of free radicals, stimulation of the immune system |
| Minerals | calcium, magnesium, iron, zinc, selenium, iodine, manganese | ensuring proper bone mineralization, regulation of metabolic processes, stimulation of the immune system |
| Choline and lecithin | soybean, rapeseed, egg | improving the functioning of the central nervous system, easier digestion of fats |
| Lactic fermentation bacteria (so-called probiotics) | Lactobacillusacidophilus, L. plantarum, L. rhamnosus, Bifidobacteriumbifidum | preventing constipation, reducing cholesterol, preventing colon cancer, stimulating the immune system |
| Phytochemicals | polyphenolic compounds, flavonoids, caffeine, glycosides, phytosterols | different depending on the substance, e.g. counteracting cancer, cardiovascular diseases, general improvement of mood and others. |

**Source:** [1, 5, 6]

**Źródło:** [1, 5, 6]

## EXAMPLES OF FORTIFICATION AND ITS EFFECTS ON HEALTH

The most common salt iodization procedure is in Europe and South America, while in Australia the carrier for iodine is bread, and in South America – butter. The idea of salt iodization was born in 1922 in Switzerland, where there was a problem of iodine deficiency among the inhabitants. Table salt was first enriched with a dose of 3.75 and then it increased to 15 mg KJ / kg, thanks to which over time the problem of iodine deficiency in the Swiss diet was eliminated. In Poland, salt iodization began in 1935, adding 5 mg KJ / kg of the product [3]. Already during the Second World War, due to large calcium deficiencies in Europe and North America, flour was enriched with calcium carbonate. In Poland, calcium carbonate is fortified mainly with flour and cereal products in the amount of up to 3 g / kg of the finished product. Table margarines belong to the most frequently fortified foodstuff. In Poland, when the production of margarines began, they were immediately enriched with vitamins A and D, and recently with vitamin E. „Vitamin preparations in the form of an oil solution are introduced together with other components into the tank where mixing and emulsion production takes place. The addition of vitamins can be carried out by means of a slurry system – or a continuous system – the vitamin solution is dispensed successively by means of a multi-head dosing pump. The latter system ensures a more even distribution of the enrichment additive and reduces fluctuations in the vitamin content of the finished product" [6]. Sugar began to be used as a carrier in Central America since 1970, when several countries in the area experienced large vitamin A deficiencies among the inhabitants. The reason why this carrier was chosen was the fact that sugar was a product commonly consumed also among the poor and rural population. Sugar is enriched by adding 15µg of retinol / g of freshly crystallized sugar, followed by homogenization and drying. As a result, in the group of people at risk (ie preschool and school-age children and nursing mothers) an increase in serum vitamin A level by half and a reduction in the incidence of clinical symptoms of the disease was observed [3].

## RESEARCH METHODOLOGY

The experimental object discussed in the article is a drink with green tea extract by NANTES LIFE, which is an example of one of the available dietary supplements. Thanks to the treatment of water in a low-temperature plasma reactor, its structure is changed, or more precisely, the structure is ordered, thanks to which the water acquires new properties – no it does not freeze or boil at its usual temperatures, it is highly absorbable (the ability to easily penetrate cells).

Cold plasma formation process.

Plasma is the fourth gas-like state of matter. In order to generate plasma, a certain amount of energy must be supplied, which will allow the first phase to change substances from a solid to a liquid, then into a gas, and finally into a plasma [9,11].

"In plasma technologies, plasma is divided into three types, namely: high-temperature plasma (in the Anglo-Saxon nomenclature it is called high plasma temperature, equilibriumplasma), low-temperature spot (thermalplasma, quasi-equilibriumplasma) and plasma known as non-thermal, cold (non-thermalplasma, non-equilibriumplasma, coldplasma)" [8].


**Fig.1. Drink with green tea extract.**
**Rys. 1. Napój z ekstraktem z zielonej herbaty.**
**Source:** Owen study
**Źródło:** Opracowanie własne

The energy necessary to convert the neutral gas to plasma depends on the ionization and dissociation of the gas. Plasma, due to the wide range of temperature and pressure within which it can occur, is the state of aggregation that most often occurs in the universe. However, on our planet, the state of plasma is rare, only in the form of aurorae. Plasma generated at low temperatures, known as cold or low-temperature plasma, is a mixture of ionized and non-ionized particles, ground and excited atoms, free radicals and electrons. Currently, scientists have developed a method for producing low-temperature plasma under atmospheric pressure. Many research teams construct low-temperature plasma generators on their own. "The prototype set of devices (Fig. 2) for plasma generation in laboratory conditions under atmospheric pressure consists of a ceramic tube through which an appropriate mixture of gases, an electrode assembly and a high-voltage generator is supplied" [11].

"The tube is surrounded by a copper coaxial electrode connected to a high voltage generator (6.5 – 16 kV, 23 – 38.5 kHz). In turn, the second electrode (earth electrode) is placed at such a distance from the end of the ceramic tube to allow the flow of the generated plasma and create a place for placing the sample. The plasma generated in this way in the vicinity of the air appears as a bright purple cloud, which is called CAP-pen (coldatmosphericplasmapen)" [11].

Basic features of nanowire:

Unlimited penetration properties through any, even damaged cell membrane. The combination of water with preparations, thanks to the maintenance of nanoparticle bonds at the level of individual molecules, increases the penetration and concentration of dissolved active components. Maintaining atomic bonds, preserving the achieved nanostructure,

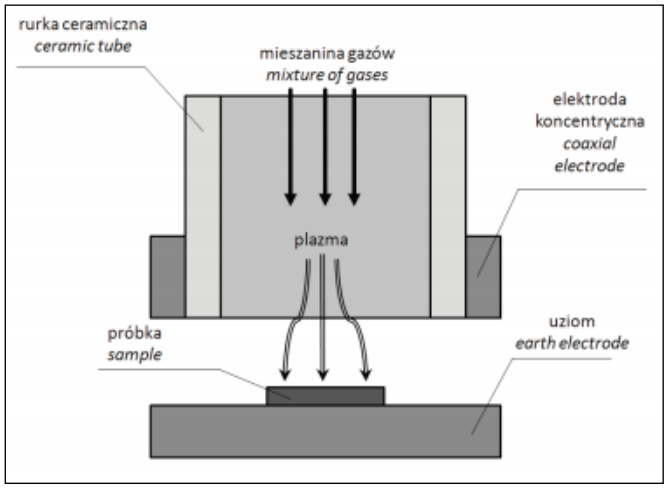


**Fig. 2. Diagram of a device for the production of low-temperature plasma CAP – pen [11].**
**Rys. 2. Schemat urządzenia do wytwarzania niskotemperaturowej plazmy CAP – pen [11].**

preventing re-aggregation, up to 60 days. The increased chemical and biological activity of nanowires allows for the dissolution of sparingly soluble organic compounds.

GREEN TEA EXTRACT

Drink with green tea extract

The ingredients transported by water nanoparticles reach the places that require regeneration. Thanks to nanoparticles, polyiefenols and strong antioxidants contained in green tea capture free radicals in the body with double their power. The substances contained in green tea, transported thanks to nanoparticles, can lower the risk of a heart attack and atherosclerosis, and even serve as cancer prophylaxis. The uniform crystal lattice of declustered water in the form of pure or nutrient solutions not only helps to eliminate anomalies, but also stimulates the regeneration processes of tissues and organs affected by the lesion.

## SUMMARY

Enriched foods and dietary supplements are becoming more and more popular among consumers. They are commonly available in pharmacies, shops or on websites. All negative aspects of food and everyday diet resulted in the appearance of enriched foods with added chemical compounds that are a source of vitamins and minerals. Products with probiotics such as kefirs and yoghurts are enriched, as well as salt (iodine), flour (folic acid), cereals, margarines, eggs, etc. Consuming fortified products should not reduce efforts to plan a balanced and varied diet. Thanks to the increasing knowledge about a healthy lifestyle, with the simultaneous lack of time for careful diet planning, people turn to vitamin and mineral substitutes. The effect of using supplementation may be an improvement in the functioning of, for example, the immune, digestive and blood systems, concentration or vitality, beauty, vision or increased physical performance and reduction of the negative effects of intense physical effort. The effects of substances used in dietary supplements are not fully understood, and the evidence for the advantages and disadvantages of consumption is unclear. Therefore, the topic requires further work, in particular the development of the role of substances at the cellular level throughout life. When using dietary supplementation, remember to control the amount of vitamins and minerals from food in relation to the amount of synthetic forms of vitamins and minerals.

In the above work, nanowater with green tea extract from Nantes was used as an example of a dietary supplement. The basic element of this dietary supplement is nanowater, which was formed in a low-temperature plasma reactor. Thanks to the declastation process, water acquires new properties, e.g. it permeates through any, even damaged membrane. This feature is the most important in terms of consuming the supplement, because the taken preparation is absorbed with great efficiency, and the final health effects will still have to wait – with further research in this area.

## PODSUMOWANIE

Żywność wzbogacona i suplementy diety cieszą się coraz większą popularnością wśród konsumentów. Dostępne są powszechnie w aptekach, sklepach lub na stronach internetowych. Wszelkie negatywne aspekty dotyczące żywności oraz codziennej diety spowodowały, iż pojawiła się żywność wzbogacana do której dodano związki chemiczne które są źródłem witamin i składników mineralnych. Wzbogaca się produkty z probiotykami czyli kefiry, jogurty, a także sól jodowaną, mąkę z kwasem foliowym, produkty zbożowe, margaryny i jaja itd. Spożywanie produktów wzbogacanych nie powinno zmniejszać wysiłków na rzecz planowania zbilansowanej i zróżnicowanej diety. Dzięki zwiększającej się wiedzy o zdrowym trybie życia przy jednoczesnym braku czasu na dokładne układanie diety ludzie sięgają po substytuty witamin i minerałów. Efektem stosowania suplementacji może być poprawa funkcjonowania np. układu immunologicznego, trawiennego, krwionośnego, koncentracji lub witalności, urody, widzenia lub zwiększenia wydajności fizycznej i zmniejszenie negatywnych skutków intensywnego wysiłku fizycznego. Działanie substancji stosowanych w suplementach diety nie jest w pełni poznane a dowody na zalety i wady dotyczące spożywania są niejasne. W związku z tym temat wymaga dalszych prac a w szczególności opracowania roli substancji na poziomie komórkowym na przestrzeni całego okresu życia. Stosując suplementację diety należy pamiętać aby kontrolować ilości dostarczanych witamin i składników mineralnych pochodzących z pożywienia w stosunku do ilości przyjmowanych syntetycznych form witamin i składników mineralnych.

W powyższej pracy za przykład suplementu diety posłużyła nanowoda z ekstraktem z zielonej herbaty firmy Nantes. Zasadniczym elementem tego suplementu diety jest nanowoda, która powstała w reaktorze niskotemperaturowej plazmy. Dzięki procesowi deklastracji woda przyjmuje nowe właściwości np.. przenikanie przez każdą nawet uszkodzoną błonę. Ta cecha jest najbardziej istotna w ujęciu spożywania suplementu, ponieważ przyjmowany preparat wchłania się z dużą skutecznością, a na ostateczne efekty zdrowotne trzeba będzie jeszcze poczekać – prowadząc dalsze badania w tym zakresie.

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