KAPITEL 5 / CHAPTER 5 [77]
FOOD CHEMISTRY AND THE METABOLIC EFFECTS OF ITS COMPONENTS IN THE FORMATION OF BIOLOGICALLY ACTIVE AND ANTI-ALIMENTARY FACTORS

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Introduction.

Modern nutrition science considers food not only as a source of energy and basic nutrients, but also as a complex chemical system capable of significantly influencing the state of the human body. The composition of food products contains thousands of components, among which some perform important physiological functions, while others can have a negative effect on metabolic processes. Studying the interaction of these substances with body systems is key to understanding their role in the formation of biologically active factors and anti-alimentary components. Modern research pays special attention to the mechanisms of the influence of food substances on metabolic processes, detoxification systems, enzyme chains and the internal environment of the body, as well as ways to reduce unwanted effects. In this context, the chapter is devoted to a comprehensive analysis of food chemistry, its metabolic effects, and the role of various components in maintaining the physiological stability and safety of food products[2, 3, 13].

5.1 Food as a carrier and precursor of biologically active substances

Modern nutritional science considers food as a source of essential nutrients, including the notion of it as a source of energy, proteins and other plastic materials, important minerals, trace elements, and vitamins. Also, the science of nutrition, and especially its hygienic section, pays primary attention to the development of sufficiently accurate, sensitive and reliable methods for determining the possible negative effects of food on health and, in particular, the presence of toxic substances, pollution and spoilage of food products, for example, when pesticides, heavy metals,

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bacterial toxins and other potentially harmful agents get into it. These two directions are extremely closely intertwined, and the main scientific basis that connects them together is the modern science of metabolism[1, 4, 11].

Another rather complex and practically significant problem is the consideration of food as a source of sufficiently complex pharmacological effects. Achievements of analytical chemistry allowed us to characterize food as an extremely complex chemical complex that contains thousands of major and hundreds of thousands of minor components capable of exerting pronounced and diverse physiological effects. Even the first consideration of food as a source of natural compounds leaves no doubt about the extraordinary breadth of diversity and the biological importance of knowing its chemical composition.

In modern nutrition science, the term "nutrients" is used to denote food substances - substances necessary for the body to live, grow and function normally. Among them, a group of main food substances - macronutrients, which are a source of energy and plastic materials - should be singled out. They include proteins, fats, carbohydrates. Micronutrients (vitamins, minerals) are usually included in daily rations in fractions of a gram - several milligrams, and sometimes micrograms. Other important components of the diet are fiber, water, essential fatty acids, etc.

Also, the composition of food products includes a fairly large group of substances that are not used by the body either for the purpose of obtaining energy, or for the construction of cellular structures, or for the biosynthesis of enzymes, hormones, mediators or others that are necessary for the vital activity of the body. They are designated by the term "non-alimentary substances" - non-nutritive components of food, which can be both natural and artificial. Non-alimentary substances include neutral (indifferent) substances (food fibers, some organic acids, ballast substances of plants), which are not absorbed by the body and do not significantly affect metabolism. Also representatives of this group are biologically active substances of plant origin (phytonutrients). They do not belong to classic nutrients, but they can affect the body. These are flavonoids, polyphenols, pigments (carotenoids, anthocyanins), essential oils, etc. Food additives (dyes, preservatives, sweeteners, emulsifiers, stabilizers) are

added to products to improve properties, but are not nutritious. Pollutants (contaminants) are unwanted substances that accidentally enter food. These include heavy metals (cadmium, lead); toxins of microorganisms (mycotoxins); pesticides; residues of veterinary drugs[5, 6, 11].

5.2 Some problems of protecting the internal environment of the human body

An important integral criterion for the methods of protecting food (as well as other objects of the external environment), aimed at preventing diseases, should be indicators of the "chemical purity" of the internal environment of the human body, its freedom from foreign, especially resistant substances. Accumulation of any stable foreign compound in the internal environments of the body is quite undesirable, and in some cases dangerous, as it inevitably causes disruption of cellular metabolism. Hence, the prevention of the accumulation of xenobiotics, as well as the products of their metabolism in the internal environments of the body, that is, the protection of the cleanliness of the internal environment of a person should be recognized as one of the main principles of food hygiene and hygienic regulation[5, 7].

Tissues and the internal environment of the human body are contaminated by foreign substances through the alimentary tract. Among them, there is a danger of contamination of the body with a number of pesticides, lead compounds, cadmium salts, etc. Also, one should not underestimate the danger of the possibility of widespread contamination of food products with toxic metabolites of moldy microscopic fungi - mycotoxins; problems of strict protection of the human body from foreign substances of a number of hydrocarbons; from some compounds recommended at one time to stimulate the growth of farm animals - some hormone-like substances; polycyclic compounds, many of which have mutagenic and carcinogenic activity; aromatic hydrocarbons, etc. All these problems are closely related to two fundamental problems. The first of them, which is widely covered in the literature, can be defined as the problem of the accumulation of xenobiotics[6].

All food products have soil, water, and air substances as initial sources.

Depending on the nature of the product, the transformation of these starting substances is more or less long. In the course of evolution on earth, relationships developed in such a way that some organisms served as food for others and, thus, relatively stable food chains were established. Man rebuilt the fauna and flora of the earth so that nature helped him produce the maximum amount of food. She sowed the soil with beneficial plants for her, settled the land with beneficial breeds of animals that give a lot of milk and meat. It has become the main final link of numerous food chains. Nowadays, in order to intensify food production, people have started to use numerous highly active biological compounds at various links of these chains, the consequences of which can be different for the person himself[10, 11].

Today, sufficiently convincing evidence has been obtained in the field of agriculture that many substances used by animals and plants with food eventually accumulate in the human body. At the same time, the degree of accumulation of these substances in the body of animals is usually a function of the stability of these compounds. A very careful approach to the widespread use of new types of fertilizers, plant protection agents, and especially various stimulants in agriculture is necessary if their chemical resistance in the body is significant[3, 9].

In this regard, one of the important tasks of food hygiene, which should be solved with the participation of agricultural specialists, is the study of different fertilizers and methods of soil treatment not only for gross products, but also for the most important indicators of the biological activity of food products. An equally important task is to ensure the safety of the use of food products that come into contact with pesticides. Moreover, the decision about the admissibility of using any xenobiotic in the production of food substances should in no case be based on the indicators of a group analysis of compounds, for example, the total content of hydrocarbons, during which, of course, hydrocarbon components that are necessary components of food products fall into the general series, for example, squalene or wax-like compounds that cover some fruits and vegetables, and a wide range of hydrocarbons that are contained in products thermal treatment of coal, etc. [8].

The importance of the concept of protection of the human internal environment is

confirmed by a number of circumstances: firstly, the discovery of substances in various classes that have a long-term hidden potential danger. These include a number of mutagens and, in particular, carcinogens of hydrocarbon origin, nitrosamines, some mycotoxins (aflatoxins) and other substances. Among them, it is necessary to emphasize the importance of some substances that have a sufficiently long latent period in the process of functional cumulation, for example, numerous food allergens, the number of which is growing catastrophically. special care should be taken when studying a number of substances of microbiological origin, which have structural features that distinguish them from the chemical composition of most ordinary food products (the presence of unusual amino acids, peptide and mucopolysaccharide structures), for the metabolism of which the human body has a limited arsenal of enzymatic means. Some of these substances caused the development of a whole branch of relatively new pathological phenomena, associated, for example, with the intolerance of a number of substances of the antibiotic series[5, 6,7].

The second direction that must be developed when developing the concept of protection of the body's internal environment is the development of adequate methods for assessing the body's metabolic self-cleansing. This special area involves the study of the enzymatic defense of the organism and, in particular, that which ensures the metabolism and detoxification of the most important xenobiotics and various structural formations of the cell, for example, in the composition of the endoplasmic reticulum, mitochondria and lysosomal apparatus, which perform a unique protective function in relation to foreign biopolymers[2, 10].

The third feature, which must be taken into account when discussing the problem of cumulation, is the correct accounting of the protective capacity of the body's compartmentalization systems, including numerous lines of membrane protection, the reliability of which, perhaps, significantly increases as they approach the most vital loci of the cell, that is, the carriers of genetic information[4, 9].

The fourth, quite important circumstance from a practical point of view is the possibility of a regulatory influence on the indicated mechanisms of the chemical composition of food, i.e. strengthening the processes of metabolic protection of the

body against the influence of xenobiotics and, in particular, strengthening the lines of enzymatic protection of the body due to both the induction of the synthesis of specific enzymes of the systems and the stability of the structures of membrane formations under the influence of alimentary factors[5].

It is obvious that the action of numerous xenobiotics, including both medicinal substances and disease-causing agents, in particular carcinogens, in the body is mediated through metabolic systems. Since the metabolism is based on the transformation of food substances and the nature of nutrition to a significant extent determines the metabolic background on which xenobiotics act, it would be a big mistake not to consider the possibility of both preventive and negative effects of nutrition on the final effect of the action of medicinal substances and other xenobiotics on the human body[11].

5.3 Food as a carrier of biologically active substances

Biologically active substances (BAS) in a broad sense are any chemical compounds of natural or synthetic origin that interact with living systems (cells, tissues, organs, the organism as a whole) and are able to change their biochemical, physiological or regulatory processes, even in very small quantities. In a broad sense, biologically active substances include all compounds that affect the vital functions of the body; participate in the regulation of metabolism; can stimulate, inhibit or change the course of biological processes; exhibit activity not only medicinal, but also physiological, toxic or signaling. That is, BAR is not only "useful" substances, but the entire range of compounds capable of acting on living systems[11].

The facts are described, which show that most of the substances in the composition of food products do not show their activity as much as in their pure form. This refers to the combination of some amino acids, vitamins, alkaloids, etc. The long-term evolution of the body's biocatalytic systems, which ultimately finds its expression in the concept and formula of a balanced diet, can serve as the basis for such mitigation of the action of biologically active food substances[3, 4, 8].

The connection of many vitamins with the biosynthesis of a significant number of enzymes has become one of the main provisions of modern enzymology, in particular the theory of active center formation. It seems obvious that most water-soluble vitamins in the body perform these unique functions. Therefore, it is not surprising that a deficiency in the supply of any of the mentioned minor nutrients quickly enough leads to pathological phenomena, which are manifested not only in specific effects, but also in general symptoms (retardation in development, reduced resistance to the action of pathological factors, general weakness, etc.). All these symptoms are an expression of various weakening of some metabolic processes, for example, biological oxidation, phosphorylation, peramination and others, without which life is impossible[6].

But the proposition about a close structural connection between vitamins and enzymes cannot be extended to the entire class of vitamins, and the majority of fat-soluble vitamins remain outside of it. It is hardly necessary to talk about the specific, well-known functions of each of them (formation of visual pigment - for retinol, regulation of calcium-phosphorus metabolism - for calciferol, antioxidant function - for tocopherols, participation in the formation of the blood coagulation system - for phylloquinones, etc.). At the same time, along with these specific functions, a number of fat-soluble vitamins have certain similarities in the nature and place of application of their action. The general target of action of fat-soluble vitamins is to some extent cellular and subcellular membranes[9].

The role of essential nutritional factors as precursors in the synthesis processes of mediators and hormones is important. Meanwhile, the chains of enzymatic reactions that underlie the transformation of micronutrients into the main chemical transmitters of nervous excitement - mediators - are much shorter. Than in the synthesis of many coenzyme structures from vitamins. Indeed, only one stage of esterification separates the minor vitamin-like component of food - choline from its transformation into the most versatile and powerful mediator of synaptic transmission of nerve impulses - acetylcholine. Choline is a fairly common component of food, and it is safe to say that the total intake of choline with food is many times greater than its delivery in the form of various dosage forms. Suffice it to say that a person receives 3-5 g of lecithin with

food every day, which corresponds to approximately 0.7 g of choline. The importance of this food component is emphasized by the pronounced pathological syndrome that occurs in cases of protein-choline deficiency (fatty infiltration, cirrhotic changes - liver hyperplasia and even the development of hepatitis) [2].

Only one stage of decarboxylation separates glutamic acid from gamma-aminobutyric acid, which is widely used in the clinic of nervous diseases under the name gammalone. It should be noted that glutamic acid comes daily with food in quantities that far exceed pharmacopoeial doses (1-2 g per day) [8].

Only two enzyme chains are necessary for the conversion of the amino acid tryptophan into serotonin, a metabolite that is most interesting from the point of view of its influence on the conduction processes of synapses in the central nervous system. A few reactions involving a sequence of hydroxylation and decarboxylation processes characterize the transformation of the amino acid tyrosine into biologically active substances that are of primary importance both in the physiology of the nervous system and in pharmacology: DOPA, norepinephrine, and adrenaline. Only one stage characterizes the transformation of the amino acid histidine into histamine, the role of which in the development of a number of physiological and pathological processes associated, for example, with vascular reactions, is beyond doubt.

Thus, amino acids that come with food, as well as vitamins, are the closest precursors of many biologically active substances, and there is every reason to assume that the level of their supply to the body under certain conditions can have a pronounced effect on the metabolic and physiological status of the body[2, 9].

There are numerous studies of the outstanding role of trace elements in the biosynthesis of biologically active substances. The role of iodine as a precursor in the synthesis of thyroxine and the dependence of the level of formation of this thyroid hormone on the supply of iodine to the body are well known[5,8,9].

We have given only a few examples of the exceptional importance of the manifestation of the biological activity of microcomponents of food in the implementation of vital processes. However, in addition to the indicated highly useful properties of biologically active substances of food as necessary participants in many

physiological processes, there is every reason to talk about micronutrients that manifest their pharmacological effect without participating in the synthesis of enzymes, hormones or mediators. Many of them can have not only a positive, but also a negative effect on the human body. And among them, many classes of chemicals can be represented in food products. They include, for example, stimulants of nervous activity, psychotropic substances, biogenic amines, some vitamins, trace elements, the content of which in food can be quite significant. Among them, stimulating drinks that have gained great popularity among the population - coffee and tea - deserve primary attention. It is well known that they contain the most common stimulants of nervous activity, which include xanthine derivatives such as caffeine, theobromine and theophylline[11].

It has been established that a cup of black tea contains on average about 100-150 mg of caffeine, while tablets produced by the pharmaceutical industry contain only 100 mg of caffeine, which is considered an average single pharmacopoeial dose. However, tablets containing caffeine are not taken by everyone and relatively rarely, and in most countries, the population consumes tea and coffee several times a day[3, 5, 8, 10].

Some combinations of the pharmacological activity of substances in natural materials sometimes make it possible to obtain quite effective results when using them for therapeutic purposes.

5.4 Anti-alimentary factors

Another class of pharmacologically active substances contained in food products are the so-called anti-alimentary factors. Anti-alimentary factors are an important component of modern research in the field of food technologies, since their presence in food raw materials and finished products directly affects the nutritional value, safety and biological effectiveness of diets.

Anti-alimentary factors are substances of natural or man-made origin, contained in food products or formed during their technological processing, storage or culinary preparation and prevent the full absorption of nutrients, reduce their bioavailability or

have a negative physiological effect on the human body.

Unlike essential nutritional factors, antialimentary factors do not perform plastic, energetic or regulatory functions. Their action is realized through a number of mechanisms, in particular, by inactivating vitamins, binding mineral elements into insoluble complexes, suppressing the activity of digestive enzymes, disrupting the processes of hydrolysis, absorption and metabolism of nutrients[9, 10].

Depending on the origin, anti-alimentary factors are divided into natural and anthropogenic. Natural anti-alimentary factors are components of the secondary metabolism of plant raw materials and perform protective functions for plants. These include protease inhibitors, lectins, phytic acid, oxalates, some alkaloids and glycosides. Anthropogenic anti-alimentary factors are formed as a result of technological processes, long-term storage, intensive heat treatment or contamination of food products.

According to the mechanism of biological action, antialimentary factors are classified into several main groups. The first group includes substances that reduce the bioavailability of minerals, in particular phytates and oxalates, which form insoluble complexes with calcium, iron, magnesium and zinc. The second group consists of inhibitors of digestive enzymes capable of suppressing the activity of proteases and amylases, which leads to a decrease in the efficiency of digestion of proteins and carbohydrates. The third group consists of antivitamin substances that destroy or block the action of vitamins, in particular, thiaminases that inactivate vitamin B_1. A separate group consists of substances with an irritating or toxic effect, the negative impact of which is manifested when the permissible levels of consumption are exceeded[3, 7].

According to the degree of influence on the body, anti-alimentary factors are conventionally divided into factors of mild, moderate and severe action. In most cases, their negative effect is reduced or completely eliminated due to the use of rational technological methods, in particular heat treatment, fermentation, soaking, germination and combined technological processing of raw materials[1, 4].

Thus, anti-alimentary factors are a significant factor that determines the nutritional value and functional properties of food products. Taking into account their

nature, mechanisms of action and methods of inactivation is a necessary condition for the development of effective technologies for the production of safe and biologically complete food products.

The dual nature of anti-alimentary factors deserves special attention in the context of food technologies. In moderate concentrations, some of them can exhibit functional properties and even play a regulatory role in metabolic processes. In particular, some phenolic compounds capable of binding minerals are simultaneously characterized by antioxidant activity; under certain conditions, phytates can act as natural chelators of pro-oxidant metals. Thus, the biological effect of anti-alimentary factors largely depends on the dose, product matrix and individual characteristics of the organism[5].

It is also important to take into account the matrix effect of the food product. The interaction of anti-alimentary factors with proteins, lipids and polysaccharides can modify their reactivity and influence on digestive processes. The food matrix is capable of both enhancing and neutralizing negative effects through competitive binding, changing the pH of the medium, or forming colloidal structures that limit the availability of the active centers of molecules.

From the point of view of food industry engineering, it is relevant to control the content of anti-alimentary factors at all stages of the technological cycle — from the selection of raw materials to processing modes. Modern biotechnological approaches, in particular enzymatic modification, the use of starter cultures, controlled germination and the use of specific hydrolases, make it possible to significantly reduce the concentration of enzyme inhibitors and mineral-binding compounds. At the same time, it is important to maintain a balance between reducing anti-alimentary activity and preserving the structural and functional properties of the product.

A promising direction is also selection and genetic selection of plant raw materials with a reduced content of undesirable components, as well as optimization of growing conditions that affect the intensity of synthesis of secondary metabolites. This allows combining agrotechnological and food approaches within a single concept of increasing the biological value of products[7 м].

Therefore, anti-alimentary factors should be considered not only as unwanted

impurities, but as a complex biochemical component of the food system, the management of which is an important component of modern technologies for the production of functional and safe food products.

Conclusion

Modern nutrition science considers food not only as a source of energy and nutrients, but also as a complex chemical complex containing numerous biologically active and anti-nutritional components. Food substances perform various functions in the body, providing energy and plastic exchange, participation in enzymatic and hormonal processes, and also contribute to the regulation of metabolic and physiological functions. At the same time, food can be a source of xenobiotics and anti-alimentary factors that reduce the assimilation of nutrients, form insoluble complexes with minerals, or inhibit the activity of digestive enzymes. The metabolic efficiency of the body largely depends on the balance between the intake of useful components and the level of potentially dangerous compounds, which determines the need for product quality control and the use of technological methods to reduce the activity of anti-alimentary factors. The biological effect of such components is determined by their dose, food matrix and individual characteristics of the body, while some compounds can simultaneously exert a protective or regulatory effect. Therefore, understanding the chemical composition of food, the mechanisms of action of its components and ways of modifying anti-alimentary factors is key to creating safe, functionally valuable and biologically active food products capable of maintaining the metabolic and physiological stability of the body.