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Review paper

PREREQUISITES FOR THE FORMATION OF D - ENANTIOMERS OF AMINO ACIDS OF ANIMAL PROTEINS IN THE MANUFACTURING PROCESS OF MEAT PRODUCTS

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Abstract

The paper presents studies on the presence or formation of d - enantiomers of amino acids in animal tissues or organs, in meat products during its production processes. It is shown that the process of epimerization of L - amino acid residues with the formation of D-enantiomers affect the reduction of the properties of food products, including the formation of oncoassociated subsequent effects on the human body.

Modern control of the quantitative and qualitative composition of d-enantiomers of amino acids in food products, monitoring for stratification of the increased risk of toxic compounds in food are becoming an urgent medical and social problem. The studies planned in this paper are aimed at developing approaches to the creation of food products that reduce the oncogenic alimentary load on human health by solving the problem of technological modification of production, eliminating or minimizing post - translational modifications in proteins that contribute to the formation of d-enantiomers of amino acids. These studies will create a scientific and technological database associated with the risk assessment of carcinogenesis in protein matrices of animal origin. Based on the presented analysis, the task of developing and testing a method to control the accumulation of D-isomers in the course of various technological processes of meat production is extremely popular.

Introduction

There are key aspects and directions in the Strategy of the NTR of the Russian Federation: transition to highly productive and environmentally friendly agro - and water management, development and implementation of systems for the rational use of chemical and biological protection of agricultural plants and animals, storage and efficient processing of agricultural products, the creation of safe and high – quality, including functional, food[1].

Nutrition is the most important element that ensures the maintenance of health, efficiency and creative potential of the nation [2]. Thus in order to reduce the health risks, that are realized in the production of meat products, is necessary to study deeply the nature and depth of post-translational deformations occurring in animal proteins during processing. The study of the processes of epimerization of L-amino acid residues with the formation of D-enantiomers, which affect the properties of food products, including oncoassociated, is one of the most relevant areas of modern biotechnology and biochemistry.

Currently the perspective area of research in the field of determining the composition of finished meat products is the allocation of biomarkers of various components [3,4,5]. Modern control of quantitative and qualitative composition, as well as food safety, monitoring for stratification of increased risk of toxic compounds (formation of carcinogens) in food are becoming an increasingly urgent medical and social problem. The effects of genetic purity, disruption of technological processes, unbalanced formulations, improper storage, transportation and other factors on the chemical, biochemical composition of food is also a major problem of nutrition science.

In this regard, the most important way to ensure the safety and quality of meat products today is the formation of an integrated scientific and technological approach to identify and identify tissue-specific substances of protein-peptide nature, responsible for the formation of various carcinogenic effects and leading to various diseases, including tumors in human cells, with the cumulative effect of consuming a harmful product.

In order to study the carcinogenic effect, it is necessary to study in detail the changes in protein synthesis during the degeneration of the cell into cancer and pay special attention to those proteins that regulate this synthesis. Many proteins and peptides transfer various structural changes as a result of post-translational modifications, especially under the influence of technological operations, primarily affecting enzymatic processes in animal tissues, in the production of products [6].

Recently, in the scientific community of particular

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interest are the optical structures of amino acid isomers. Posttranslational modification (reactions of polypeptide transformation into an active protein) is a covalent chemical modification of a protein after its synthesis on a ribosome. For most proteins, posttranslational modification is the final stage of biosynthesis, which is part of the process that occurs during gene expression. Posttranslational modifications can regulate the duration of proteins existence in the cell, their enzymatic activity and interactions with other proteins [7,8]. Among the covalent posttranslational modifications of peptides synthesized by ribosomes, epimerization of L - amino acid residues with the formation of D-enantiomers takes a special place, the presence of which affects the biological activity of peptides, and also affects the development of cancer, inhibition of flavin enzymes of brain tissue and violation of other metabolic processes associated with amino acids.

Only L-stereoisomers of amino acids are involved in protein synthesis by ribosomes. In natural proteins, D-amino acids are rarely found, as a rule, in the composition of peptide antibiotics, which are synthesized by enzymatic complexes of microorganisms without the involvement of ribosomes. Another source of D-amino acids in proteins may be spontaneous racemization of their L-stereoisomers in polypeptide chains as a result of various processes in protein matrices of animal origin. The amino group (NH2) does not formed in people, therefore, to maintain nitrogen balance, as well as to carry out the biosynthesis of protein compounds, which include amino groups, the body must necessarily receive and assimilate certain amounts of essential and interchangeable amino acids [9,10].

However, not all amino acids from food are available. In some cases, under the influence of hard (thermal) or unusual cooking food proteins acquire special properties, which makes it difficult to dispose of them. In addition, in violation of the functions of the glands of the digestive apparatus, especially with the weakening of the enzymatic activity of digestive juices, which occurs in physiological (in the later stages of ontogenesis) and pathological conditions and diseases, the intensity of the splitting (digestion) of proteins is reduced, the processes of absorption of amino acids are disturbed. In amino acid preparations obtained by acid hydrolysis, the availability of amino acids is also reduced due to the fact that their D-forms are not absorbed by the body. It is possible that d-forms of amino acids are formed during the processing of meat products in an acidic environment, as well as in patients with hyperacid condition. Consequently, in violation of the processes of digestion of protein products and the weakening of the absorption of amino acids, as well as the formation of racemates and D-forms of amino acids, conditions are created to reduce the availability of these metabolites, which generates their deficiency, leads to a violation of amino acid imbalance and significant shifts in nitrogen metabolism. Incomplete utilization of amino acids coming from food adversely affects the biosynthesis of structural proteins, enzymes, hormones, vitamins, mediators and other highly active compounds, the molecules of which include amino acids.

In addition, with functional liver failure caused by age (senile) changes or diseases of the hepatobiliary system, the processes of transamination, deamination of amino acids are weakened or distorted, which exacerbates violations of nitrogen metabolism and contributes to the appearance of amino acid imbalance in the body [9].

The developed topic, aimed at solving the fundamental problem - the design of innovative food products of directed action using the methods of modern applied epigenomics and biomedicine, taking into account the study of the mechanisms of formation in the product of onco-associated substances, will expand approaches to the creation of safe food products based on meat. A significant role in this process is played by food components of different nature. The study of the prerequisites for the formation of carcinogenic load and the determination of post-translational modifications occurring in the protein matrices of animal origin, in the production of products consisting of multi-component protein matrices obtained from raw materials of animal and vegetable origin, are most relevant in the modern study of conformational changes in protein, in the production of functional ingredients actively used in the meat industry.

That confirms the focus of this work in accordance with the direction of the Strategy of the NTR of the Russian Federation, in terms of effective processing of agricultural products, the creation of safe and high-quality, including functional, food.

Research methodology

The studies, planned in this paper, are aimed at developing approaches to technological modification of meat production to exclude or minimize posttranslation processes in proteins that lead to the formation of D - enantiomers of amino acids.

The result of the work will be:

- the development, testing and validation of the method of identification of D-enantiomers of amino acids;
- the recommendations for improving the technological processes of production of products to ensure their safety for the human body.

To achieve the goals set in the work, methods and approaches related to the determination of amino acid composition and its various isomerization forms in protein matrices of animal origin will be integrated. And with the development of methodological solutions for the determination of D-enantiomers of amino acids.

The methodological solutions developed by the authors will be used to identify post-translational modifications occurring in protein matrices of animal origin, including connective tissue proteins, for possible correction of technological modes of meat production. The main methodological solutions implemented in the framework of this research project to perform the

tasks are based on high-performance chromatography with different detection methods (photometric, mass spectrometric) with preliminary derivatization of the analyte. Preliminary study of chromatographic behavior of derivatizing agent - ortho-phthalic aldehyde (OPA) derivatives on reversed-phase sorbents and study of the properties of chiral columns, with the prediction of the order of elution of amino acid derivatives using theoretical calculations and optimization of sample preparation of real objects, will reduce the criteria of reproducibility and precensiveness of the method to not significant relative to the confidence interval of the contents of the component.

Conducting research in this direction will allow to formulate and significantly expand approaches to the creation of safe food by creating a scientific and technological data base associated with the risk assessment of the formation of d-enantiomers of amino acids in protein matrices of animal origin. As part of the work will be identified, studied and systematized epimerization of L - amino acid residues, depending on the technological parameters of the production of the product, as well as an assessment of exposure to d - enantiomers of amino acids with carcinogenic properties, and evaluated their safety during storage of the product.

Discussion

1. Spatial structure of amino acids

The basis of the entire biological system of man, are protein chains, in which the presence of all essential amino acids is crucial. Essential amino acids cannot be synthesized in the human body. Therefore, their intake with food is necessary. Amino acids - a kind of biological atoms of the universe, "privacychoice", from which nature builds the diversity of the surrounding animal and plant microspace. They are formed into topological, sequential chains (polypeptide), which are called proteins, or protein molecules. In the process of digestion, the protein you eat is broken down into amino acid fragments, and then the body collects new protein chains from them, but already such as it needs. Amino acids are derivatives of carboxylic acid invariants, in which one hydrogen atom is replaced by an amino group. Basically, there are two types of amino acids, with the same composition of the substance. They are classified as groups - D and L amino acids. D-form (*deksier-right*) this are right rotating isomers and L – form (*levus-left*) – left rotating isomers. For the first time, the phenomenon of molecular dynamics chirality was discovered by French microbiologist and chemist Louis Pasteur. In modern science, these rotations are called-molecular spin. Both forms have the same composition and topological basis, but differ from each other in the structure and properties of the substance. Their main differences from each other are the opposite, mirror-spatial isomer and chemical structure. In this regard, they can not be combined with each other movement in space. It is like two of our hands, mirror-like, but when we start to combine them finger to finger, the left hand describes a circle to the right, and the right to the left. Right rotating and left rotating amino acids, diametrically, differently act on the same form of life, in whatever form this life was not represented [11].

Today it is well known that in living organisms due to dominate amino acids with left-hand rotation of the L-form. But there are exceptions in nature. If an amino acid is not preceded by the letter L or D, then it does not have a mirror opposite isomer and is represented only in one form. This type of amino acids includes, for example, a replaceable amino acid-glycine. But all, without exception, essential amino acids have opposite isomerism. If we draw the spatial formula D and L of amino acids, we can see that they are identical in composition, but opposite in arrangement of molecules and rotation. Such a phenomenon as the spacial isomer of amino acids is associated with the ability of the molecule to rotate the plane of the polarized light beam in opposite directions. When assembling our body, L-form amino acids are able to affect the D-form amino acids found in plant proteins. This effect occurs with the energy resource of the noradrenaline factor and the redox process. D-isomeric forms of molecules present in the structure of plants, under certain conditions, especially in cellular hypoxia, have a destructive effect on the human body. Scientists today know more than 200 amino acids. But the human body is built only from 21 amino acids, of which 8 are essential and most important for the proper structure of all our cells. Moreover, a prerequisite is that these 8 essential amino acids represent only the left - sided L-form. If the protein chains in the body are built on this principle, then the cell itself will have a left-hand rotation and it will have beta-synthesis processes, which is a natural factor for the life of the human body. If we get essential amino acids from plant food, which have a right-hand rotation-D-form (*deksier-right*), the cells will be built with the right-hand spin, where there will be processes of photosynthesis with an emphasis on oxygen-free existence. This type of cell is almost identical to the cells of plant nature and their body or trying to dispose of accelerated division, or they form colonies in our body, which leads to mutations, and eventually to diseases and tumors. This is an important nuance in the construction of our body, which is often not known to those who make the basis of their nutrition vegetable protein. Complete vegetarianism is possible only if a person has energy practices that allow to activate all the chakras and energies of our spine – Kundalini. But of those who thoughtlessly accept the principles of such nutrition, almost no one owns such practices and all their efforts are limited only to ideological asceticism and self-acceptance, built on the ideas of correctness. Energy practices, many of which are forgotten, allow the body to activate a biophysical resource that is able to twist any form of amino acid into the left spin. In the body of an ordinary person who does not own such practices, this does not happen.

In the normal body, there is only spatial l-correction of the amino acids we obtain from plant foods. This is one of the biophysical functions of our body, which largely depends on the hormonal and electrolyte homeostasis [12,13]. As a result of scientific research at the Pittsburgh Medical University, on the basis of non-invasive methods of cell research, it was found that the cell division of its two halves have a different wave response. This means that cell division is represented by differences in the process of apoptosis and in the topological configuration of protein chains. This is because in the process of life is a constant process of disposal of improperly formed cellular material. If the body is able to disassemble one of these halves to the essential amino acids of the left-hand back and on their basis to produce a new Assembly, it will be a process of longevity. This new understanding of the processes of apoptosis, raises the question of the importance of the essential amino acids of the L-form, in the very first row, when we start to think and talk about the right lifestyle and nutrition. Human nature and nature in General are so arranged that any substance or food carries both benefits and risks. If we talk about our body and nutrition for him, it is necessary to know that the rejection of animal products containing essential amino acids with left-hand rotation, leads to enormous changes in the entire system of cell construction. But human nature is so arranged that animal proteins also carry the risk and disease, if the diet is not balanced. The balance is based on the fact that we have two digestive systems – acid and alkaline. Both of them take different part in the process of life and dangerous long and quantitative shift in one direction or another, when it comes to the choice of animal or plant products. Plant food will not harm the body if it is pre-properly prepared for intake and if the body constantly receives essential amino acids of L-forms. Under the preliminary preparation refers to aerobic salting, watering and fermentation of plant products, resulting in their preliminary fermentation system isomeric correction – spin neutrality. With a lack of essential amino acids left-hand rotation, the body uses not only food, but also what it already has in the form of cell mass. Using what we already have is dismantling our old cells to essential amino acids, which are used again in protein building, to form new cells. And all the other, interchangeable amino acids remaining from the old cells, the body utilizes through our excretory systems. As a rule, young organisms cope better with this work. It is for this reason that many diseases begin in adults. The whole system of construction of living systems is determined by the astrophysical guide of nature, which manifests itself in the biophysical primacy of fields and energies that are foremen in the construction and functioning of the body. American biologists from the Goddard Center, who participated in the research program of the phenomenon of life on Earth, published an analytical article in the scientific journal Proceedings of National Academy of Sciences, which explains the reasons for the dominance in organisms of living beings amino acids left-hand rotation, which became the basis of life on earth living beings. But nature left options, when in animal body these processes can be disturbed by. That is, in the animal world, cells can be built on the principles of photosynthesis using D-amino acids, which nature uses to build the plant world. In these cases, the constructed living system is incomplete for its synthesis of the group, as it begins mutational transformation (rebirth). Therefore, the conflict of two forms of astro-biophysical processes begins in the body, which leads to the destruction of the species determination program [14].

2. Food system

The technologies currently used in the production of protein hydrolysates are carried out by chemical (under the action of mineral acids and alkalis at elevated temperatures) and enzymatic (using proteolytic enzyme preparations) methods. During acid hydrolysis, all types of peptide bonds between different amino acid residues are broken down, and therefore almost complete protein cleavage is possible. However, acid hydrolysis as a technological process has a number of disadvantages (partial or complete decomposition of a number of amino acids, the formation of melanoidins, need to neutralize the acid).

When alkaline hydrolysis of protein occurs racemization of amino acids, resulting in hydrolysate loses biological value. In food production alkaline hydrolysis of protein is not used. The existing methods of obtaining alkaline hydrolysates of proteins are mainly aimed at obtaining preparations for technical (non-food) purposes.

Enzymatic hydrolysis for food enterprises is not economically beneficial. Therefore mainly used chemical under the action of mineral acids and alkalis.

Embedding D-amino acids in the L-polypeptide chain leads to the formation of irregular spatial organization of the molecule, the chain begins to break and change its direction, while changing the orientation of the ligands. The accumulation of D-amino acids in proteins leads to a change in the tertiary and quaternary structure of the protein and, consequently, a decrease in its functional activity. Thus, the appearance of D-amino acids can be self-sufficient factor leading to the formation of abnormal proteins and the development of various diseases, including tumors in human cells, with the cumulative effect of consuming a harmful product.

Modern directions of predictive medicine are aimed at regulating the changes in the activity of genes that are not associated with changes in the DNA itself, which persist steadily in a number of cell divisions. A significant role in this process is played by food components of different nature. Carcinogenic and translational regulatory properties previously identified in food products consisting of multi-component protein matrices obtained from raw materials of animal and plant origin, attract more and more scientists to their study.

In the last 10 years, extensive research has been carried out around the world to study the substances of protein and peptide nature contained in raw meat and finished meat products, as well as formed in the process of various technological processing and in some way determining the quality and functional characteristics, as well as the safety of finished food, however, a comprehensive study of the mechanisms of formation of D - enantiomers is not covered.

The current work in the claimed area is mainly aimed at the study of post-translational modification of D-amino acids in peptides, the study of the role of D-amino acids in the pathogenesis of various diseases, the study of conformational changes in D-amino acids. A large number of works are carried out in farm areas on the influence of amino acid enantiomers in medicines [15].

D-isomeric forms of molecules, under certain conditions, especially in cellular hypoxia, have a destructive effect on the human body. If we get essential amino acids from food, which have a right-hand rotation - (D - form), the cells will be built with the right-hand spin, which will be the processes of photosynthesis with an emphasis on oxygen-free existence. This type of cell is almost identical to the cells of plant nature and their body or trying to dispose of accelerated division, or they form colonies in our body, which leads to mutations, and eventually to diseases and tumors. American biologists from the Goddard Center, who participated in the research program of the phenomenon of life on Earth, published an analytical article in the scientific journal Proceedings of National Academy of Sciences, which explains the reasons for the dominance in organisms of living beings amino acids left-hand rotation, which became the basis of life on earth living beings. But nature gave options, when in animal body these processes can be disturbed by. That is, in the animal world, cells can be built on the principles of photosynthesis using D-amino acids, which nature uses to build the plant world.

The first data on the presence of D-amino acids in animal tissues were obtained in 1950. Free D-alanine was isolated from the blood of some insects by chromatography [16]. Later, the presence of D - amino acids such as D-alanine, D-phenylalanine, D-glutamate, D-ornithine, D-serine, D-asparagine, D-methionine and D-cysteine was revealed in the composition of polypeptides in animals [16,17,18,19,20]. It was suggested that D - amino acids in mammals appeared from the products of endogenous flora or spontaneous racemization of L-amino acids in the structure of polypeptides during aging [21]).

Studies have shown that D-aspartic acid was found in various tissues of the body, such as the lens [22,23], the brain[24,25,26], as well as teeth, skin, bones, aorta, erythrocytes, lungs and ligaments in aging [23]. D-serine is defined in β-amyloid in Alzheimer's disease [25,26].

In certain diseases in the body starts a conflict between two forms of astro-biophysical processes, which leads to the destruction of the program determination. The most characteristic diseases of this group are various tumor processes and partly the processes of blood disease [27,28].

Conclusion

The results of numerous studies show that the epimerization of L-amino acids with their transition to D-form plays the main role in the aging of the body, and aspartic acid is most susceptible to racemization. Racemization accelerates the action of ultraviolet radiation. The accumulation of D-amino acids in proteins leads to a change in the tertiary and quaternary structure of the protein and, consequently, a decrease in its functional activity [29].

The particular interest are also studies aimed at determining the D-isomers of amino acids in food and medicines, and in living matter.

Currently, the following methods can be used to determine the level of D - amino acids [30]:

1 Nuclear-magnetic resonance spectroscopy - is a method that allows to determine the ratio of stereoisomers in solution, as well as to identify individual stereoisomers.

2 Determination of optical activity - the method is carried out using a polarimeter device. A stream of light is passed through the solution and the sign of rotation of the polarized light (right-turning or left-turning) will indicate the absolute configuration of the compound.

3 The diffraction analysis - allows to estimate the absolute configuration of the crystalline product.

4 Immunohistochemistry - is a method based on the binding of an antigen to an antibody.

Usually amino acids are determined by high-performance liquid chromatography (HPLC). There is a direct method for determining amino acids and their optical isomers on chiral stationary phases and a method for determining derivatized amino acids used for the analysis of complex objects. O-phthalic aldehyde (OFA) is often used as a modifying agent in conjunction with various nucleophilic reagents. Derivatization with this reagent occurs in 3-5 minutes, the derivatives formed are easily determined by the method of reversed-phase HPLC with a fluorometric detector [31]. The chromatographic behavior of OFA derivatives has been well studied in the reversed-phase HPLC regime, but there is no data on the separation of derivatized amino acid enantiomers on chiral columns. This is due to the decline in the selectivity of the column due to the interaction of OFA with the functional groups of the sorbent [32]. A promising solution to this problem is the use of HPLC with mass-spectrometric detection.

Multi-stage technology of production of the finished product (fine grinding, Ambassador, heat treatment, formulation) and multi-composition formulations make it difficult to guarantee the output of the product, which would not contain protein conformations.

To date, the provision of high-grade protein and the absence of dangerous contaminants in the finished product, especially provoking allergic reactions, exacerbation of chronic diseases and beer-producing risk of oncological

formations, has become one of the main areas of medicine and veterinary medicine, and methods for the study of these accumulations are actively introduced into the control sphere.

In General, the presented information about the leading groups working in this thematic area, the results of the most successful developments, as well as the general bibliometric analysis reflect the high degree of demand for these studies and indicate the correct choice of subjects of the proposed study. World laboratories are actively developing methodological solutions for the study of epimerization of amino acids, which can be combined with the proposed developments and improve their efficiency [33,34]. At the same time, the study of the formation of D-isomers in raw materials for food production and modification of technological solutions that lead to their reduction by other groups of researchers is not conducted, which ensures the fundamental novelty of the proposed work.

Based on the above analysis, the task of developing and testing a method to control the accumulation of D-isomers in the course of various technological processes of meat production is extremely popular.

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