

PHARMACOLOGICAL ACTIVITY OF AMINO ACIDS AND PROSPECTS FOR THE CREATION OF DRUGS BASED ON THEM

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Amino acids play an extremely important role in human life, as they are responsible for the normal functioning of the entire body. They affect the processes of energy exchange, metabolism, the state of the nervous system, mood, sleep, mental activity. In a certain way, they can be compared to the building material, thanks to which proteins are formed in the body. Amino acids regulate the metabolism of fats in the body, contribute to the conversion of fats into energy, are responsible for the processes of excitation and inhibition in the brain, carry out the transmission of nerve impulses, etc.

For full functioning, the human body uses 22 amino acids, 10 of which it synthesizes by itself, other 9 amino acids must be obtained from the outside [1].

In the diet, it is necessary that all amino acids are presented in certain optimal ratios. Both a deficiency and an excess of one or another amino acid in the diet can lead to an imbalance, that is, to a violation of the balance of amino acids. Imbalance phenomena are especially pronounced in those cases when an incomplete set of essential amino acids is added to the diet, which negatively affects the functions of nutrition, causes a deterioration of the state of nitrogen metabolism and can lead to significant changes in vital activities and health, and can affect the quality of life in the future [1,2].

It is possible to recognize a deficiency of essential amino acids in the body by the following symptoms: drowsiness, constant feeling of fatigue, anemia, dizziness, impaired immunity, nausea, poor appetite, depression, anxiety. Due to their lack, there is no protein synthesis in the body, which mainly causes these symptoms [3].

Animal proteins (milk, meat, eggs) are rich in essential amino acids. Plant proteins are mostly incomplete and less absorbed. The World Health Organization (WHO) gives the following recommendations of the daily norm for an adult (mg per 1 kg of body weight) table 1 [4].

Table 1. Daily norms of amino acids for an adult

Amino acids	WHO mg per 1 kg of body weight
Histidine	10
Isoleucine	20
Leucine	39
Lysine	30
Methionine+Cysteine	10,4+4,1 (in total 15)
Phenylalanine+Tyrosine	25 (in total)
Threonine	15
Tryptophan	4
Valine	26
Arginine	115

Given the frantic rhythm of life, a modern person does not always manage to get all the necessary essential amino acids during the day. Therefore, in cases of insufficient protein nutrition, it is advisable to enrich daily rations with essential amino acids in the form of various medicines based on them in order to prevent the negative impact of amino acids imbalance and for the normal functioning of all systems and organs [3].

Therefore, the **aim** of this study was to summarize modern literary sources on the pharmacological action of essential amino acids, to analyze the existing drugs based on them on the pharmaceutical market of Ukraine, to substantiate the prospects and feasibility of their further inclusion in the composition of drugs for the prevention and treatment of pathologies of various systems and organs.

Research methods

The methods of marketing analysis, comparison and generalization of information were applied. The following sources were used as information materials on medicinal products: the directory of pharmaceuticals "Compendium on-line" and the State Register of Medicinal Products of Ukraine [5,6].

Results and discussion

Amino acids are organic compounds that simultaneously contain amino (-NH₂) and carboxylic (-COOH) groups. They are monomer units of proteins, in the composition of which amino acid residues are connected by peptide bonds (Fig. 1).

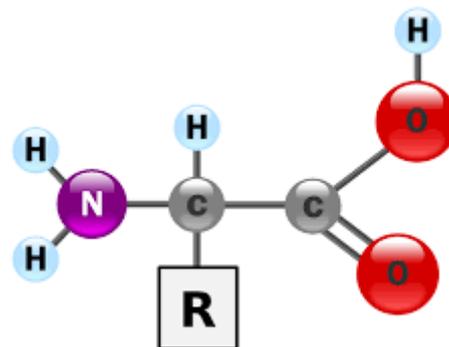


Fig. 1. Amino acid structure

Monomers of proteins are amino acids. A common feature for all amino acids is the presence of carboxylic and amino groups. There are 20 types of amino acids in proteins. As a rule, natural amino acids have the L-configuration, but D-amino acids are also found in the cells of microorganisms. Depending on the location of the NH₂ group, α , β , γ and other L amino acids are distinguished. Proteins contain α - amino acids. More than 200 of them have been discovered worldwide. The human body contains about 60 amino acids and their derivatives [7].

Amino acids are classified in several ways depending on the feature by which they are divided into groups (Table 2.)

Table 2. Classification of amino acids

Classification	The principle of division
Structural	Chemical structure of "side chain" (aliphatic, cyclic)
Biological	The ability to synthesize in the body (replaceable, essential, semi-replaceable)
Physico-chemical	The charge of a side chain (acidic, basic, neutral)
Classification by polarity	Polarity of the "side chain" (polar, non-polar, charged)

Classification by biological value is one of the most widespread. Amino acids are divided into essential and non-essential (Table 3). Amino acids that are synthesized in the body in the required amount are called non-essential, they are formed from essential amino acids or other compounds. Amino acids that cannot be synthesized in the body from other compounds are called essential. These amino acids must come with food [7,8].

Table 3. Biological classification of amino acids

Amino acids		
Non-essential	Essential	
Glycine	Valine	
Alanine	Leucine	
Cysteine (cystine)	Isoleucine	
Glutamic acid	Threonine	
Aspartic acid	Methionine	
Tyrosine	Phenylalanine	
Proline	Tryptophan	
Serine	Lysine	
Asparagine	Histidine	Conditionally essential
Glutamine	Arginine	

Each of the amino acids presented above performs a certain function in the human body. Let's consider in more detail the characteristics of essential amino acids:

Leucine is an essential amino acid that belongs to the three branched-chain amino acids (leucine, isoleucine, valine) (fig. 2). Acting together, they protect muscle tissues and are a source of energy, as well as promote the recovery of bones, skin, muscles, so they are often recommended during the recovery period after injuries and operations [1]. Natural L-leucine is part of all animal and plant proteins, and is also one of the intermediate products of the synthesis and breakdown of protein substances. An excess of leucine can increase the amount of ammonia in the body. A lack of leucine can be caused by poor nutrition or a lack of vitamin B₆, as well as the absence or lack of leucine leads to stunted growth, weight loss, metabolic disorders, and in case of acute deficiency leads to the death of the body [1,9]. Leucine is one of the essential amino acids that cannot be synthesized by animal and human cells and enters the body as part of food proteins. It is part of all natural proteins. Leucine is found in brown rice, beans, hazelnuts, soy flour, egg whites, whole wheat, and meat. Main functions: takes part in ensuring the nitrogen balance, in the exchange of

proteins and carbohydrates [2,10,11]. Protects muscles and all other tissues, except bone, from constant decay. Serves as a specific source of energy for muscles at the cellular level. Necessary for the construction and development of muscle tissue, protein synthesis by the body, for strengthening the immune system, provides some reparative processes in the body. Lowers blood sugar levels and promotes faster wound healing and bone healing. Leucine has the greatest insulinogenic effect compared to the other two BCAA (isoleucine and valine) [9,11]. Leucine is used for liver diseases, anemia, toxicosis, neuritis, muscular dystrophy, poliomyelitis, Menkes syndrome. It is used to lower blood sugar; for growth, as a stimulator of protein synthesis in muscles. Leucine has an immunostimulating and anabolic effect. Activates cellular and humoral immunity, increases the function of phagocytes, activates the processes of biosynthesis of amino acids; alleviates metabolic disorders that occur during stress; is a starting material for protein synthesis and endogenous bioregulators [9,12,13]. Leucine can be included in food supplements and medicines only together with isoleucine and valine, otherwise protein synthesis will not proceed optimally [14]. Available on the pharmaceutical market are Dynamin Forte (Softgel Healthcare Private Limited, India) and Aminol (Yuria-Pharm LLC, Ukraine (Table 4)), which contain all three components [5,6]. They should be taken with caution so as not to cause hypoglycemia. In order for leucine, isoleucine and valine to be fully absorbed, the body must receive an optimal amount of B vitamins, especially B₅ and B₆. Without these two vitamins, the exchange in the liver cannot be carried out in full [1,12,13].

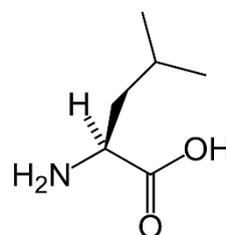


Fig. 2. Leucine

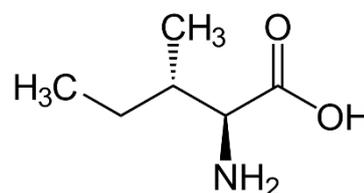


Fig. 3. Isoleucine

Isoleucine, like other essential amino acids (fig. 3), cannot be synthesized in the body of humans or animals, and must come from the outside in the form of proteins [1]. Residues of D-amino acids are part of many natural peptides, primarily antibiotics. D-isoleucine is part of actinomycin

and bacitracin [9]. It is necessary to ensure that the diet is varied and has products rich in this amino acid. Natural sources of isoleucine are milk and dairy products, seafood, meat, soybeans, pumpkin seeds, sunflower seeds, lentils, beans, nuts, cereals [2,10,15]. It is also found in small amounts in cereals and pasta. Isoleucine, like all other amino acids, takes part in the formation of protein molecules. In addition, isoleucine has its unique functions. Thanks to its branched structure, it takes part in the energy exchange that takes place in the body [16]. Isoleucine promotes faster healing of tissues, regulates the level of glucose and cholesterol in the blood, allows muscles to recover after physical exertion, can be a source of energy for muscle cells. The main functions of isoleucine are: weight loss by reducing appetite and accelerating metabolism [17]; increasing the mental and physical endurance of a person; providing muscle tissue with energy; contributes to the flow of biochemical processes during which energy is produced; prevention of feelings of concern, anxiety, fear; reduction of excessive sweating; prevention of raising the level of insulin in the blood; stabilizes blood sugar and energy supply processes; contributes to the recovery of muscle tissue; effective in the treatment of Parkinson's disease; plays a key role in the formation of hemoglobin [9,12,13]. Isoleucine deficiency manifests itself in the loss of muscle mass [3].

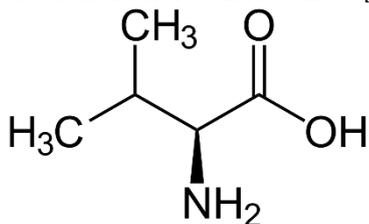


Fig. 4. Valine

Valine is an aliphatic α -amino acid, one of the 20 proteinogenic amino acids, which is part of almost all known proteins, and is an important component of food for animals and humans (fig. 4). The main source of valine is animal products. It is present in all organisms, both as part of proteins and in free form. There is especially a lot of valine in the following products: beef, chicken fillet, salmon fillet, chicken egg, cow's milk, pistachios, walnuts. Valine in protein ranges from 4.1% (horse myoglobin) to 7-8% (human serum albumin, milk casein), sometimes 13-14% (elastin of connective tissues) [2,10,15]. The lack of valine in the diet leads to a negative nitrogen balance [3]. The main functions of valine include: synthesis and growth of body tissues; energy of muscle cells; muscle coordination; nitrogen exchange; protection of the myelin sheath of nerves; regulation of nervous processes; stabilization of the hormonal background; formation and storage of glycogen; protein synthesis [9]. Valine is important for muscles, their metabolism. In case of tissue damage it helps to restore it, supports the processes of normal nitrogen exchange in the body. When the body has a negative nitrogen balance, it is forced to destroy skeletal muscles and functioning tissues in order to produce energy. Valine belongs to the branched-chain amino acids, and thanks to this, it can be used by muscles as a source of

energy [9,16,17]. Valine is often prescribed to treat severe amino acid deficiencies caused by drug addiction. Lack of valine negatively affects the human nervous system. People who are deficient in this amino acid may experience irritability, fatigue, nervous breakdowns, depression, and multiple sclerosis. People who have bad habits and struggle with them - smoking, drug addiction, alcoholism, may experience a breakdown due to a lack of valine [3,9,13].

Valine is also used in the form of biologically active supplements with other branched amino acids (leucine, isoleucine). Valine is recommended for use in muscle building programs and in conventional multicomponent complexes as an auxiliary substance for protein metabolism [13,15,16].

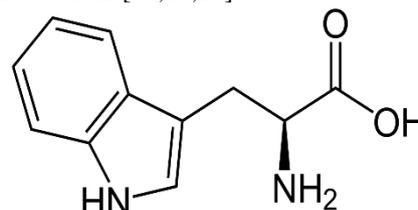


Fig. 5. Tryptophan

Tryptophan is an essential amino acid that is part of many proteins (fig. 5). Tryptophan is a source of neurotransmitters serotonin, tryptamine, melatonin and indoleamine. Tryptophan, contained in the brain, as well as its by-products in the form of neurotransmitter systems, are responsible for maintaining the homeostatic balance of the body [13]. As the supply of tryptophan decreases, there is a proportional decrease in the efficiency of the body's functions. Dehydration causes a sharp decrease in the amount of tryptophan in the brain. In normal amounts, tryptophan has the ability to increase the threshold of pain sensations, helps to tolerate pain more easily. Tryptophan together with lysine forms the tripeptide lysine-tryptophan-lysine, which corrects errors that occur during DNA replication. This characteristic of tryptophan is of primary importance in preventing the formation of cancer cells [1,3,9,18]. Tryptophan, together with biotin, vitamins B₁ and B₆, promotes relaxation and good sleep, is an antidepressant, and increases resistance to stress [19]. The pharmaceutical market of Ukraine presents the following medicinal products that contain tryptophan: Gentasept (PJSC Scientific and Production Center Borshchagiv Chemical and Pharmaceutical Plant, Ukraine), Gentaxan (Pharmaceutical Company FarKoS, Ukraine), Cytovir-3 (Cytomed Oyu, Finland), Custodiol (Dr. Franz Köhler Hemi GmbH, Germany) [5,6].

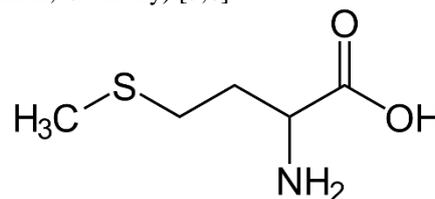


Fig. 6. Methionine

Methionine is an essential amino acid that is necessary for protein synthesis, growth support and nitrogen balance of the body (fig. 6). This amino acid can be regenerated from homocysteine [7]. Foods that contain methionine include red meat, fish, soy, peas, beans, buckwheat, broccoli. It is very important to use products containing vitamins B₁₂, B₆, folic acid, as these vitamins are necessary for the conversion of homocysteine into methionine [2,10]. With a lack of these substances in the body, there is an excess of homocysteine, which is toxic. Thus, overeating products with a high content of methionine, and lack of vitamins in the diet and abuse of some products that inactivate B vitamins (coffee), as well as smoking leads to an excess of homocysteine, which, in turn, further leads to hypertension and atherosclerosis. However, not only an excess, but also a lack of methionine in the body causes a violation of metabolic processes [3]. The ability of methionine to participate in the synthesis of choline and leucine determines its lyotropic effect (removal of excess fat from the liver). In atherosclerosis, methionine reduces the concentration of cholesterol and increases the concentration of phospholipids in the blood. Methionine increases bile secretion and the concentration of bile acids in bile. The significant effect of methionine on liver function is due to the presence of the methionine cycle in hepatocytes. In this connection, the properties of methionine as a hepatoprotector were studied. In the treatment of liver diseases in combination with cardiovascular pathology, when the combination of several active substances with different mechanisms of action shows a faster and more pronounced effect compared to monotherapy [8,13]. For example, the combination of essential phospholipids 300 mg and methionine 100 mg is the drug Eslidin (Nabros Pharma Private Limited, India) [5,6]. With the simultaneous use of methionine and essential phospholipids, the effect of each other is enhanced, which is a source of endogenous and exogenous phospholipids. Methionine is used in anemia. Methionine is also taken in the treatment of mental illnesses, as it reduces the concentration of histamine in the blood. Methionine is used to treat depression [8]. As an effective therapeutic agent, methionine is used in pediatrics. The drug has a therapeutic effect in children with varying degrees of hypotrophy: the general condition and emotional tone improves, appetite increases and body weight increases. In children, the indicator of nitrogen metabolism is normalized. Methionine is a valuable tool in the treatment of hypotrophy of the 1st-3rd degree, which is caused by dysentery [1,8]. Medicinal products "Methionine" (JSC "Kyiv Vitamin Factory", Ukraine) and Metovitan (PJSC "Technolog", Ukraine) are used for the treatment and prevention of diseases and toxic damage to the liver: toxic hepatitis, alcoholic hepatopathy, cirrhosis of the liver, poisoning by arsenic drugs, chloroform, benzene and hepatotoxic substances [3,5]. It is as well used in the combined therapy in chronic alcoholism, diabetes, for the treatment of dystrophies that develop due to protein deficiency after dysentery and infectious diseases, atherosclerosis, in severe surgical operations, burns [13]. Due to its pharmacological activity, methionine is included

in the composition of geriatric drugs - Kvadevit and Decamevit (JSC "Kyiv Vitamin Plant", manufacturer Ukraine) [5,6]. Kvadevit is used for the prevention of premature aging, for conditions associated with vitamin deficiency, in the complex treatment of atherosclerosis, for disorders of cerebral circulation, cardiovascular insufficiency, for strengthening the functional activity of the heart muscle, liver, and kidneys. Dekamevit normalizes metabolism and general condition in old age with mental and physical exhaustion, sleep and appetite disorders, when taking antibiotics, during and after serious illnesses [20,21].

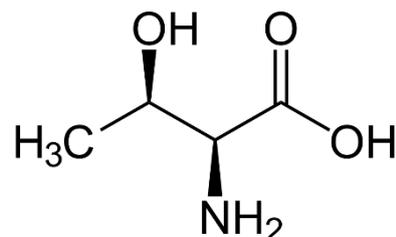


Fig. 7. Threonine

Threonine is an essential amino acid for humans (fig. 7). The source of threonine is meat and dairy products, fish, mushrooms, eggs, cereals, the least amount of it is in nuts, beans, and seeds [1]. A person, as a rule, receives enough amino acids with food, so deficiency states develop quite rarely. The lack of this amino acid is usually observed in vegetarians [3]. Threonine takes part in the formation of collagen and elastin; activates the immune system, takes part in the formation of immunoglobulins and antibodies; stimulates tissue growth processes; improves the condition of the cardiovascular system; increases the strength of bones and tooth enamel; improves the lipotropic function of the liver; promotes energy exchange in muscle cells. Threonine is contained in the human insulin molecule [8]. Lack of threonine in the diet leads to significant changes in both the anabolic and catabolic phases of nucleic acid and protein metabolism. Threonine deficiency leads to: emotional excitation, confusion, digestive problems, loss of appetite, fatty liver [22]. It should be noted that the synthesis of immune proteins and many enzymes of the digestive system is impossible without threonine. It is known that threonine has an antidepressant effect on the body and regulates the transmission of nerve impulses to the brain. In addition, threonine supports the normal functioning of the digestive tract and takes an active part in the processes of digestion and assimilation of nutrients. In the human body, threonine takes part in the process of detoxification of toxins. Additional intake of threonine affects the weakening of muscle tone. An excess of threonine leads to increased accumulation of uric acid [8,23].

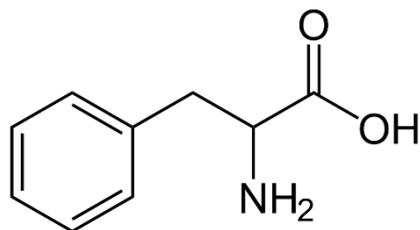


Fig. 8. Phenylalanine

Phenylalanine is an essential amino acid for humans and animals (fig. 8). Phenylalanine is continuously formed in the body during the cleavage of food proteins and tissue proteins. The need for phenylalanine increases in the absence of the amino acid tyrosine in food, which is formed in the liver by hydroxylation of phenylalanine with the participation of the enzyme phenylalanine hydroxylase [7]. Phenylalanine is widespread in nature: it is found in all organisms as part of protein molecules, in particular insulin, egg white, hemoglobin; is a part of peptide sweeteners (Aspartame). L-phenylalanine is a building material in the chain of reactions that result in the formation of neurotransmitters - catecholamines (including norepinephrine and dopamine) [7,13]. Unlike artificial stimulants (coffee, alcohol), which deplete energy reserves and, subsequently, lead a person to a state of desolation and irritation, this amino acid allows you to successfully cope with irritation and feelings of anxiety. L-Phenylalanine helps a person to relieve tension without the use of alcohol by preserving peptides of the endogenous opiate (internal) system in the brain, thereby making a person less dependent on alcohol and opium drugs [9,24]. Phenylalanine is related to the function of the thyroid gland and adrenal glands, participates in the formation of thyroxine, the main hormone of the thyroid gland. Normalizes the work of the thyroid gland. In addition, phenylalanine plays a significant role in the synthesis of proteins such as insulin, papain and melanin, and also promotes the excretion of metabolic products by the kidneys and liver. It helps improve the secretory function of the pancreas and liver. Phenylalanine is useful for Parkinson's disease (reduces the severity of symptoms - depression, speech disorders, stiffness of limbs). Amino acid phenylalanine is the most important "building material" for neurotransmitters that contribute to cheerfulness, good mood, positive attitude and even relief from pain and depression. Phenylalanine acts most effectively in types of depression accompanied by apathy and lethargy [1,9,25]. Indications for the use of phenylalanine: thyroid disease, chronic fatigue syndrome, depression, attention disorders and/or hyperactivity, alcoholism, obesity, arthritis, premenstrual syndrome, migraine, chronic and acute pain (including in cancer), addiction (to caffeine, alcohol, drugs). L-Phenylalanine is recommended as an antidepressant, pain reliever, and antimigraine agent. In addition, it improves intellectual functions, relieves addiction (alcohol, caffeine), suppresses appetite, restores skin pigmentation, etc [9,15,23].

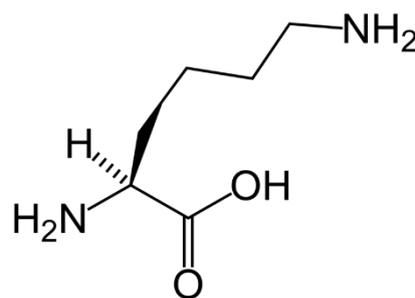


Fig. 9. Lysine

Lysine is an essential amino acid that is vital for building critical body proteins (fig. 9). Lysine is included in the triad of amino acids, which is especially taken into account when determining the overall adequacy of nutrition (lysine, tryptophan, methionine). The lack of lysine in grain products and the relatively high body need for it put the problem of lysine in one of the first places. This amino acid is necessary for growth, tissue repair, production of antibodies, hormones and enzymes. It has been experimentally proven that with a lack of lysine in the diet, the growth of young rats stops with the simultaneous development of hypoproteinemia. There is a violation of hematopoiesis and, as a result, a decrease in the number of erythrocytes and the amount of hemoglobin [3,10]. Administration of lysine contributes to a sharp increase in the number of reticulocytes with an increase in foci of hematopoiesis in the bone marrow. When observing people who did not receive a sufficient amount of lysine in their diet, there was a violation of nitrogen balance, muscle debilitation, and a violation of bone calcification, as well as a number of changes in the liver and lungs [22,26]. Lysine participates in the utilization of fatty acids, which are necessary for energy production. It helps to eliminate some problems related to infertility. Lysine catalyzes the processes of enzymatic transformations. Participates in the exchange of proteins and carbohydrates. The L-form of lysine reduces blood serum triglycerides. Participates in the synthesis of an alkaloid similar to nicotine, anabasine. Promotes calcium absorption and maintains nitrogen balance in the adult body, participates in the production of antibodies, hormones and enzymes, promotes collagen formation and tissue regeneration [1,7,9]. It helps to improve concentration. Lysine deficiency causes headache, dizziness, increased sensitivity to noise, decreased appetite, nausea, vomiting, enzyme disorders, anemia, leukemia, exhaustion, and impaired reproductive function. Lysine deficiency can manifest itself in red eyes, hair loss, inability to concentrate, irritability, lack of energy, and growth retardation. It is administered to children to increase appetite, during the treatment of a severe poisoning. It reduces the elevated level of triglycerides in blood serum, strengthens immunity to viral infections [2,3,13]. The ability of lysine to reduce the likelihood and/or prevent herpes infection should be noted. The best natural sources are fish, milk, beans, meat, cheese, yeast, eggs, soy products, all protein-rich foods. It is found in avocados, peanuts, fish, cheese, eggs, tomatoes,

potatoes, red wine, shrimp [2,15]. L-lysine is included in the composition of medicines L-lysine escinate (PJSC "Halychpharm", Ukraine), many complex medicines, which are listed in Table 4, and the biologically active supplement - Dynamin Forte (Softgel Healthcare Private Limited, India) [5,6]. Deficiency of lysine can manifest itself in the form of severe fatigue, nausea, dizziness, hair loss, anemia [3].

Arginine is a conditionally essential amino acid (fig. 10).

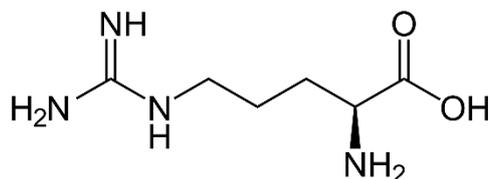


Fig. 10. Arginine

The physiological need of the tissues and organs of most mammals for arginine is satisfied by its endogenous synthesis and/or intake with food, however, for young individuals and adults under conditions of stress or illness, this amino acid becomes essential. Arginine serves as a necessary precursor for the synthesis of proteins and many biologically important molecules, such as ornithine, proline, polyamines, creatine and agmatine [7]. However, the main role of arginine in the human body is to be a substrate for the synthesis of nitric oxide. L-arginine, received with food, is absorbed in the small intestine and transported to the liver, where its main amount is utilized in the ornithine cycle. The part of L-arginine that was not metabolized in the liver is used as a substrate for the production of nitric oxide [13,26]. The main supplier of endogenous arginine is protein metabolism in the body. The available data of evidence-based medicine suggest that the administration of L-arginine improves endothelial function in angina, cardiovascular insufficiency, and hypercholesterolemia. These effects are determined not only by the possibility of increasing the production of nitric oxide by endothelial NO-synthase, but also by indirect antioxidant effects caused by additional amounts of introduced arginine, in combination with a decrease in the concentration of superoxide anion radical released from the endothelium [9,27].

The pharmaceutical market of Ukraine offers domestically produced liquid and solid forms of drugs with arginine - solutions for infusions: Angio-Betargin ("Worvarts Pharma" LLC, Ukraine), Argilife ("Arterium" Corporation, Ukraine), Argitek, Tivomax-Darnytsia, Arginine-Darnytsia (PJSC "Pharmaceutical firm "Darnytsia", Ukraine), Libra (PJSC "Infuzia", Ukraine), Sargin (JSC "Farmak", Ukraine PJSC "Infuzia", Ukraine), Solargin (Subsidiary "Pharmatrade", Ukraine), Tivortin ("Yuria-Pharm" LLC, Ukraine), Tivargin-N ("Pharmasel" LLC, Ukraine); solutions for injections: Glutargin, Cardioarginine-Zdorovya (Pharmaceutical company "Zdorovya" LLP, Ukraine); syrups: Cardioarginine-Zdorovya (Zdorovya Pharmaceutical Company LLC,

Ukraine); concentrate for solution for infusion: Glutargin (LLC "Pharmaceutical company "Zdorovya", Ukraine); oral solutions: Sargin (JSC "Farmak", Ukraine), Tivomax A (PJSC "Pharmaceutical firm "Darnytsia", Ukraine), Tivortin aspartate (TOV "Yuriya-Pharm", Ukraine); tablets: Glutargin, Glutargin Alkoklin (Zdorovya Pharmaceutical Company LLC, Ukraine), Kovargin (Technolog PJSC, Ukraine); powder for oral solution: Glutargin Alkoklin (Zdorovya Pharmaceutical Company LLC, Ukraine) [5,6].

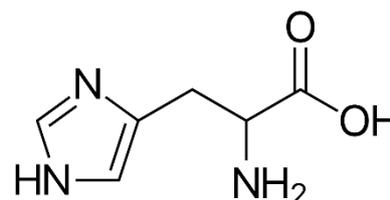


Fig. 11. Histidine

Histidine is a conditionally essential amino acid (fig. 11). The lack of histidine slows down the synthesis of hemoglobin and leads to the development of anemia due to the fact that the protein part of hemoglobin needs more histidine. It takes an active part in the synthesis of carnosine, improves nitrogen balance, liver function, increases gastric secretion and intestinal motility, immunity, normalizes heart rhythm [28]. The hydrogen chloride salt of histidine is used in medical practice for peptic ulcer disease of the stomach and duodenum, gastritis, hepatitis, atherosclerosis, and reduced immunity. There are data on the beneficial effect of histidine on lipoprotein metabolism in patients with atherosclerosis [9,13].

It should be noted that on the pharmaceutical market of Ukraine there is a number of complex preparations that simultaneously contain a complex of amino acids, depending on the indications: Aminoplasmal Hepa - 10%, Aminoplasmal B. Brown 10% E, Nutriflex Lipid special, Nutriflex Lipid Peri (B. Brown Melzungen AG, Germany), Aminosteril N-Hepa, Aminoven Infant 10%, Aminoven 10%, Aminoven 15%, Nephroprotect (Fresenius Kabi Austria GmbH, Austria), Kabiven Peripheral, SmofKabiven central (Fresenius Kabi AB, Sweden), Olimel N7E, Olimel N4E, Olimel N9E, Numeta G16E, Numeta G13E, (Baxter S.A., Belgium), Aminol (LLC "Yuria-Pharm", Ukraine), Hepasol Neo 8%, Aminosol Neo 10%, Aminosol Neo 15% ("Hemopharm" AD, Republic of Serbia), Ketosteril (Labesfal Laboratorios Almiro, S.A., Portugal), Nutrinil PD4 with 1.1% amino acid content (Baxter Healthcare S.A., Ireland) [5,6].

Detailed information on drugs based on amino acids available on the pharmaceutical market of Ukraine is given in Table 4 [5,6].

Table 4. Preparations based on amino acids, available on the pharmaceutical market of Ukraine

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
1	L-lysine escinate	Solution for injection	1 mL of the solution contains escin salt of 2,6-diaminohexanoic acid, in terms of 100% substance, 1.0 mg;	PJSC "Halychpharm", Ukraine
2	Angio-Betargin	Solution for infusions	1 vial (100 mL of solution) contains: arginine hydrochloride 4.2 g;	"Worvats Pharma" LLC, Ukraine
3	Argilife	Solution for infusion	1 mL contains arginine hydrochloride - 42 mg;	"Arterium" Corporation, Ukraine
4	Argitek	Solution for infusion	1 mL of solution contains arginine glutamate 8 mg;	PJSC "Pharmaceutical firm "Darnytsia", Ukraine
5	Glutargin	Tablets	1 tablet contains arginine glutamate 250 mg (0.25 g)	LLC "Pharmaceutical company "Zdorovya", Ukraine
6	Glutargin	Tablets	1 tablet contains arginine glutamate 750 mg (0.75 g)	LLC "Pharmaceutical company "Zdorovya", Ukraine
7	Glutargin	Solution for injection	1 mL of solution contains arginine glutamate 40 mg;	LLC "Pharmaceutical company "Zdorovya", Ukraine
8	Glutargin	Solution for injection	1 mL of solution contains arginine glutamate 200 mg;	LLC "Pharmaceutical company "Zdorovya", Ukraine
9	Glutargin Alcoclean	Tablets	1 tablet contains arginine glutamate 1 g	LLC "Pharmaceutical Company "Zdorovya", Ukraine
10	Glutargin	Concentrate for solution for infusion	1 mL of the drug contains arginine glutamate 400 mg;	LLC "Pharmaceutical company "Zdorovya", Ukraine
11	Glutargin Alcoclean	Powder for oral solution	solution 1 package (3 g) contains arginine glutamate 1 g	LLC "Pharmaceutical company "Zdorovya", Ukraine
12	Libra	Solution for infusion	100 mL of solution contain 4.2 g of arginine hydrochloride (1000 mL contain 200 mmol of arginine and 200 mmol of chlorides)	PJSC "Infusion", Ukraine
13	Sargin	Solution for infusion	1 mL of solution contains L-arginine hydrochloride 42 mg	Farmak JSC, Ukraine
14	Sargin	Oral solution	1 mL of solution contains Arginine aspartate (L-arginine aspartate) – 200 mg	Farmak JSC, Ukraine
15	Solargin	Solution for infusion	1 mL of solution contains 42 mg of arginine hydrochloride;	Subsidiary "Pharmtrade", Ukraine
16	Tivomax-Darnytsia	Solution for infusion	1 mL of solution contains arginine hydrochloride 42 mg	PJSC "Pharmaceutical firm "Darnytsia", Ukraine
17	Tivomax A	Oral solution	1 mL of solution contains L-arginine L-aspartate 200 mg	PJSC "Pharmaceutical firm "Darnytsia", Ukraine
18	Tivortin	Solution for infusion	1 mL contains 42 mg of arginine hydrochloride (100 mL contains 20 mmol of arginine and 20 mmol of chlorides)	"Yuria-Pharm" LLC, Ukraine
19	Tivortin aspartate	Oral solution	1 mL of solution contains L-arginine aspartate 200 mg	"Yuria-Pharm" LLC, Ukraine
20	Aminol	Solution for infusion	active substances: 1 mL of solution contains: alanine - 6.4 mg; arginine hydrochloride - 6.4 mg; valine - 4.9 mg; histidine hydrochloride monohydrate - 3.2 mg; glycine - 8.0 mg; isoleucine - 4.4 mg, leucine - 9.8 mg; lysine hydrochloride - 11.5 mg; methionine - 5.7 mg; proline – 6.4 mg, threonine – 4.3 mg; tryptophan - 1.44 mg; phenylalanine - 7.0 mg;	"Yuria-Pharm" LLC, Ukraine

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
21	Glycine	Sublingual tablets	1 tablet contains 100 mg of glycine	"Arpimed" LLC Republic of Armenia
22	Glycine	Sublingual tablets	1 tablet contains 100 mg of glycine;	PJSC "Chervona Zirka", Ukraine
23	Glycine-Zdorovya	Sublingual tablets	1 tablet contains glycine 100 mg	LLC "Pharmaceutical company "Zdorovya", Ukraine
24	Glycine-Darnytsia	Sublingual tablets	1 tablet contains glycine (calculated as 100% dry substance) 100 mg;	PrJSC "Pharmaceutical firm "Darnytsia", Ukraine
25	Glycysed	Tablets	1 tablet contains glycine 100 mg (in terms of 100% substance)	PJSC "Kyivmedpreparat", Ukraine
26	Glutamic acid	Film-coated tablets	active substance: 1 tablet contains 250 mg of L-glutamic acid;	JSC "Kyiv Vitamin Plant", Ukraine
27	Methionine	Coated tablets	1 tablet contains DL-methionine 250 mg	JSC "Kyiv Vitamin Plant", Ukraine
28	Hepa-Mertz	Granules	1 package contains 3 g of L-ornithine-L-aspartate;	Acino Merz Pharma GmbH and Co. KGaA, Germany
29	Hepa-Mertz	Concentrate for solution for infusion	10 mL of concentrate contain L-ornithine-L-aspartate 5 g	Acino Merz Pharma GmbH & Co. KGaA, Germany
30	Hepatox	Concentrate for solution for infusion	1 mL of concentrate contains L-ornithine-L-aspartate 500 mg	Holopak Verpackungstechnik GmbH, Germany
31	Heptor-Pharmex	Concentrate for solution for infusion	active substance: L-ornithine-L-aspartate;	"Pharmex Group" LLC, Ukraine
32	Heptor-Pharmex	Granules	1 package contains 3 g of L-ornithine-L-aspartate	"Pharmex Group" LLC, Ukraine
33	Larnamine	Granules for oral solution	1 sachet contains: L-ornithine-L-aspartate in 100% of the substance - 3 g	Farmak JSC, Ukraine
34	Larnamine	Concentrate for solution for infusion	1 mL of the drug contains L-ornithine-L-aspartate in 100% substance 500 mg	Farmak JSC, Ukraine
35	Stymol	Effervescent powder for preparation of oral solution	1 sachet contains citrulline malate 1 g (equivalent to 566.44 mg of L-citrulline and 433.56 mg DL-malic acid (E 296))	Biocodex, France
36	Stymol	Oral solution	1 sachet contains citrulline malate 1 g	Biocodex, France
37	Medichronal-Darnytsia	Granules	package No. 1: active substance: 1 package contains: glucose monohydrate 17.5 g; package No. 2: active substances: 1 package contains: glycine 7 g; sodium formate 3.5 g;	PrJSC "Pharmaceutical firm "Darnytsia", Ukraine
38	Kvadevit	Film-coated tablets	1 tablet contains: vitamin A - 2500 IU; vitamin E – 3 mg; vitamin B1 – 2.5 mg; vitamin B2 – 2.5 mg; vitamin B6 – 2 mg; folic acid - 0.1 mg; rutin - 10 mg; nicotinamide - 20 mg; vitamin C – 75 mg; vitamin B12 – 10 µg; L-glutamic acid - 50 mg; DL-Methionine - 50 mg; calcium D-pantothenate - 5 mg;	JSC "Kyiv Vitamin Plant", Ukraine

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			phytin - 30 mg; potassium - 10.5 mg; copper - 0.4 mg.	
39	Decamevit	Film-coated tablets	1 tablet contains: vitamin A 6600 IU; vitamin E (α-tocopherol acetate) or dry vitamin E 50% 10 mg; vitamin B ₁ (thiamine hydrochloride) 20 mg; vitamin B ₂ (riboflavin) 10 mg; vitamin B ₆ (pyridoxine hydrochloride) 20 mg; vitamin C (ascorbic acid) 200 mg; folic acid (vitamin B) 2 mg; nicotinamide (vitamin PP) 50 mg; rutin (vitamin P) 20 mg; methionine 200 mg; vitamin B ₁₂ (cyanocobalamin) 0.1 mg;	JSC "Kyiv Vitamin Plant", Ukraine
40	Aminoplasmal - Hepa 10%	Solution for infusion	1000 mL of solution contain 8.8 g of isoleucine; leucine 13.6 g; lysine acetate 10.6 g (equivalent to lysine 7.51 g); methionine 1.2 g; phenylalanine 1.6 g; threonine 4.6 g; tryptophan 1.5 g; valine 10.6 g; arginine 8.8 g; histidine 4.7 g; glycine 6.3 g; 8.3 g of alanine; proline 7.1 g; aspartic acid 2.5 g; asparagine monohydrate 0.55 g (equivalent to asparagine 0.48 g); acetylcysteine 0.8 g (equivalent to cysteine 0.59 g); glutamic acid 5.7 g; ornithine hydrochloride 1.66 g (equivalent to ornithine 1.3 g); serine 3.7 g; 0.86 g of acetyltyrosine (equivalent to 0.7 g of tyrosine); content of amino acids - 100 g/L; total nitrogen content – 15.3 g/L concentration of electrolytes: sodium – 0.3 mmol/L; acetates – 51 mmol/L; chlorides – 10 mmol/L;	B. Braun Melzungen AG, Germany
41	Aminoplasmal B. Braun 10% E	Solution for infusion	Isoleucine - 5.0; leucine - 8.90 g; lysine hydrochloride - 8.56 g (equivalent to lysine - 6.85 g); methionine - 4.40 g; phenylalanine - 4.70 g; threonine - 4.20 g; tryptophan - 1.60 g; valine - 6.20 g; arginine - 11.50 g; histidine - 3.0 g; alanine - 10.50 g; glycine - 12.00 g; aspartic acid - 5.60 g; glutamic acid - 7.20 g; proline - 5.50 g; serine - 2.30 g; tyrosine - 0.40 g; sodium acetate, trihydrate - 2.858 g; sodium hydroxide - 0.360 g; potassium acetate - 2.453 g; magnesium chloride, hexahydrate - 0.508 g; disodium phosphate, dodecahydrate - 3.581 g. Concentrations of electrolytes (mmol/L): sodium - 50; potassium - 25; magnesium - 2.5;	B. Braun Melzungen AG, Germany

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			acetates – 46; chlorides – 52; phosphates - 10; citrate - 2.0.	
42	Aminosteril H-Hepa	Solution for infusion	1000 mL of solution contains active substances: L-isoleucine 10.4 g; L-leucine 13.09 g; L-lysine monoacetate 9.71 g; (L-lysine) 6.88 g; L-methionine 1.1 g; N-acetyl-L-cysteine 0.7 g; (L-cysteine) 0.52 g; L-phenylalanine 0.88 g; L-threonine 4.4 g; L-tryptophan 0.7 g; L-valine 10.08 g; L-arginine 10.72 g; L-histidine 2.8 g; aminoacetic acid 5.82 g; L-alanine 4.64 g; L-proline 5.73 g; L-serine 2.24 g; glacial acetic acid 4.42 g;	Fresenius Kabi Austria GmbH, Austria
43	Kabiven Peripheral	Emulsion for infusion	The composition of the medicinal product after mixing 3 chambers: Active substances (2400 mL/1920 mL/1440 mL): Refined soybean oil - 85/68/51g; Glucose monohydrate, corresponding to anhydrous glucose - 178 (162)/143 (130)/107 (97) g; Alanine - 8.0/6.4/4.8 g; Arginine 5.6/4.5/3.4 g; Aspartic acid - 1.7/1.4/1.0 g; Valine - 3.6/2.9/2.2 g; Histidine - 3.4/2.7/2.0 g; Glycine - 4.0/3.2/2.4g; Glutamic acid - 2.8/2.2/1.7 g; Isoleucine - 2.8/2.2/1.7 g; Leucine - 4.0/3.2/2.4 g; Lysine hydrochloride corresponding to lysine - 5.6 (4.5)/4.5(3.6)/3.4(2.7) g; Methionine - 2.8/2.2/1.7g; Proline - 3.4/2.7/2.0 g; Serine - 2.2/1.8/1.4 g; Tyrosine - 0.12/0.092/0.069 g; Threonine - 2.8/2.2/1.7 g; Tryptophan - 0.95/0.76/0.57 g; Phenylalanine - 4.0/3.2/2.4 g; Calcium chloride dihydrate, which corresponds to calcium chloride - 0.49 (0.37)/0.39(0.30)/0.29(0.22)g; Sodium glycerophosphate anhydrous - 2.5/2.0/1.5 g; Magnesium sulfate heptahydrate, corresponding to magnesium sulfate - 1.6 (0.80)/1.3(0.64)/0.99(0.48) g; Potassium chloride - 3.0/2.4/1.8 g; Sodium acetate trihydrate corresponding to sodium acetate – 4.1 (2.4)/3.3(2.0)/2.5(1.5);	Fresenius Kabi AB, Sweden
44	SmofKabiven central	Emulsion for infusion	The composition of the medicinal products after mixing 3 chambers: Active substances (986/1477/1970/2463 mL); Alanine - 7.0/10.5/14/17.5 g; Arginine - 6.0/9.0/12.0/15.0 g; Glycine - 5.5/8.2/11/13.8g; Histidine - 1.5/2.2/3.0/3.7 g; Isoleucine -	Fresenius Kabi AB, Sweden

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			<p>2.5/3.8/5/6.2g; Leucine - 3.7/5.6/7.4/9.4g; Lysine (in the form of lysine acetate) - 3.3/5/6.6/8.4g; Methionine - 2.2/3.2/4.3/5.4 g; Phenylalanine - 2.6/3.8/5.1/6.4g, Proline - 5.6/8.4/11.2/14.0g; Serine - 3.2/4.9/6.5/8.1g; Taurine - 0.50/0.75/1.0/1.2g; Threonine - 2.2/3.3/4.4/5.4 g; Tryptophan - 1.0/1.5/2.0/2.5g; Tyrosine - 0.20/0.30/0.40/0.49g; Valine - 3.1/4.6/6.2/7.6g; Calcium chloride (in the form of calcium chloride dihydrate) - 0.28/0.42/0.56/0.69g; Sodium glycerophosphate (in the form of sodium glycerophosphate hydrate) - 2.1/3.1/4.2/5.2g; Magnesium sulfate (in the form of magnesium sulfate heptahydrate) - 0.60/0.90/1.2/1.5 g; Potassium chloride - 2.2/3.4/4.5/5.7g; Sodium acetate (in the form of sodium acetate trihydrate) - 1.7/2.6/3.4/4.2g; Zinc sulfate (in the form of zinc sulfate heptahydrate) - 0.0065/0.0097/0.013/0.016g; Glucose (in the form of glucose monohydrate) - 125/187/250/313g; Refined soybean oil - 11.3/16.9/22.5/28.1g; Medium chain triglycerides - 11.3/16.9/22.5/28.1g; Refined olive oil - 9.4/14.1/18.8/23.4g; Fish oil, saturated with omega-3 fatty acids - 5.6/8.4/11.3/14.0g</p>	
45	Olymel N7E	Emulsion for infusion	<p>The composition of the medicinal products after mixing 3 chambers: Active substances (1000/1500/2000 mL): alanine – 6.41/9.61/12.82 g; arginine – 4,34/6,51/8,68 g; aspartic acid - 1,28/1,92/2,56 g; glutamic acid - 2,21/3,32/4,42 g; glycine 3,07/4,60/6,14 g; histidine - – 2,64/3,97/5,29 g; isoleucine 2,21/3,32/4,42 g; leucine - 3,07/4,60/6,14 g; lysine acetate (which is equivalent to lysine) 4,88/7,31/9,75 g (3,48/5,23/6,97 g);; methionine – 2,21/3,32/4,42 g; phenylalanine 3,07/4,60/6,14 g; proline – 2,64/3,97/5,29 g; serine 1,75/2,62/3,50 g; threonine – 2,21/3,32/4,42 g; tryptophan – 0,74/1,10/1,47 g; tyrosine – 0,11/0,17/0,22 g; valine – 2,83/4,25/5,66 g; sodium acetate trihydrate - 1,50/2,24/2,99 g; potassium chloride – 2,24/3,35/4,47</p>	Baxter S.A., Belgium

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			g; magnesium chloride hexahydrate - 0,81/1,22/1,62 g; sodium glycerophosphate, hydrated – 3,67/5,51/7,34 g; glucose, monohydrate (which is equivalent to anhydrous glucose) 154,00/231,00/308,00 g (140,00/210,00/280,00 g);; calcium chloride, dehydrate - 0,52/0,77/1,03 g; refined olive oil; refined soybean oil – 40,00/60,00/80,00 g.	
46	Olimel N4E	Emulsion for infusion	The composition of the medicinal products after mixing 3 chambers: Active substances (1000/1500/2000 mL): Alanine - 3,66/5,50/7,33 g; arginine – 2,48/3,72/4,96 g; aspartic acid – 0,73/1,10/1,46 g; glutamic acid 1,26/1,90/2,53 g; glycine – 1,76/2,63/3,51 g; histidine – 1,51/2,26/3,02 g; isoleucine 1,26/1,90/2,53 g; leucine – 1,76/2,63/3,51 g; lysine acetate (equivalent to lysine) – 2,81/4,21/5,62 g (1,99/2,99/3,98 g); methionine – 1,26/1,90/2,53 g; phenylalanine – 1,76/2,63/3,51 g; proline – 1,51/2,26/3,02 g; serine – 1,00/1,50/2,00 g; threonine – 1,26/1,90/2,53 g; tryptophan – 0,42/0,64/0,85 g; tyrosine – 0,06/0,10/0,13 g; valine - 1,62/2,43/3,24 g; sodium acetate trihydrate - 1,16/1,73/2,31 g; potassium chloride – 1,19/1,79/2,38 g; magnesium chloride hexahydrate 0,45/0,67/0,90 g; sodium glycerophosphate, hydrated – 1,91/2,87/3,82 g; glucose, monohydrate (equivalent to anhydrous glucose) 82,50/123,75/165,00 g (75,00/112,50/150,00 g);; calcium chloride, dehydrate - 0,30/0,44/0,59 g; refined olive oil; refined soybean oil – 30,00/45,00/60,00 g.	Baxter S.A., Belgium
47	Olimel N9E	Emulsion for infusion	The composition of the medicinal products after mixing 3 chambers: Active substances (1000/1500/2000 mL): Alanine – 8,24/12,36/16,48 g; arginine – 5,58/8,37/11,16 g; aspartic acid 1,65/2,47/3,30r; glutamic acid – 2,84/4,27/5,69 g; glycine – 3,95/5,92/7,90 g; histidine – 3,40/5,09/6,79 g; isoleucine – 2,84/4,27/5,69 g; leucine –	Baxter SA, Belgium

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			<p>3,95/5,92/7,90 g; lysine acetate (equivalent to lysine) 6,32/9,48/12,64 g (4,48/6,72/8,96 g); methionine – 2,84/4,27/5,69 g; phenylalanine – 3,95/5,92/7,90 g; proline – 3,40/5,09/6,79 g; serine – 2,25/3,37/4,50 g; threonine 2,84/4,27/5,69 g; tryptophan 0,95/1,42/1,90 g; tyrosine – 0,15/0,22/0,30 g; valine 3,64/5,47/7,29 g; sodium acetate trihydrate – 1,50/2,24/2,99 g; potassium chloride – 2,24/3,35/4,47 g; magnesium chloride hexahydrate - 0,81/1,22/1,62 g; sodium glycerophosphate, hydrated – 3,67/5,51/7,34 g; glucose, monohydrate (equivalent to anhydrous glucose) 121,00/181,50/242,00 g (110,00/165,00/220,00 g); calcium chloride, dehydrate - 0,52/0,77/1,03 g; refined olive oil; refined soybean oil – 40,00/60,00/80,00 g.</p>	
48	Nutriflex Lipid special	Emulsion for infusion	<p>ready-to-use emulsion after mixing the contents of the chambers contains. Active substances (625/1250/1875 mL): Glucose, monohydrate (equivalent to anhydrous glucose) - 99/198/297g (90/180/270 g),, sodium dihydrogen phosphate dehydrate - 1,56/3,12/4,68 g, zinc acetate dehydrate - 4,39/8,78/13,17 mg, refined soybean oil – 12,5/25/37,5 g, medium-chain triglycerides – 12,5/25/37,5 g, isoleucine – 2,06/4,11/6,16 g, leucine 2,74/5,48/8,22 g, lysine hydrochloride (equivalent to lysine) – 2,49/4,98/7,46 g (1,99/3,98/5,96 g), methionine – 1,71/3,42/5,13 g, phenylalanine - 3,08/6,15/9,22 g,, threonine -1,59/3,18/4,76 g, tryptophan – 0,50/1,00/1,50 g, valine 2,26/4,51/6,76 g, Arginine – 2,37/4,73/7,09 g, Histidine hydrochloride monohydrate (equivalent to histidine) - 1,48/2,96/4,44 g (1,10/2,19/3,29 g), Alanine - 4,25/8,49/12,73 g, Aspartic acid - 1,32/2,63/3,94 g, Glutamic acid – 3,07/6,14/9,20 g, Glycine – 1,45/2,89/4,33 g, Proline – 2,98/5,95/8,93 g, Serine 2,63/5,25/7,88 g, Sodium hydroxide - 0,732/1,464/2,196 g, Sodium chloride 0,237/0,473/0,710 g,</p>	B. Braun Melzungen AG, Germany

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			Sodium acetate trihydrate 0,157/0,313/0,470 g, Potassium acetate 2,306/4,611/6,917 g, Magnesium acetate tetrahydrate 0,569/1,137/1,706 g, Calcium chloride dihydrat – 0,390/0,779/1,168 g.	
49	Nutriflex Lipid Peri	Emulsion for infusion	Active substances (1250/1875 mL): ready-to-use emulsion after mixing the contents of the chambers contains: Glucose, monohydrate (equivalent to anhydrous glucose) – 88/132 g (80/120 g) , sodium dihydrogen phosphate dehydrate – 1,17/1,755 g, zinc acetate dehydrate – 6,625/9,938 mg, refined soybean oil – 25/37,5 g, medium-chain triglycerides – 25/37,5 g, isoleucine – 2,34/3,51 g, leucine - 3,13/4,70 g, lysine hydrochloride (equivalent to lysine) – 2,84/4,26 g (2,26/3,39 g),, methionine – 1,96/2,94 g, phenylalanine – 3,51/5,27 g, threonine – 1,82/2,73 g, tryptophan – 0,57/0,86 g , Valine 2,6/3,9 g, Arginine -2,7/4,05 g, Histidine hydrochloride monohydrate (equivalent to histidine) 1,69/2,54 g (1,25/1,88 g), Alanine 4,85/7,28 g, Aspartic acid 1,5/2,25 g, Glutamic acid 3,5/5,25 g, Glycine – 1,65/2,48 g, Proline – 3,4/5,1 g, Serine – 3,0/4,5 g, Sodium hydroxide – 0,8/1,2 g, Sodium chloride – 1,081/1,622 g, Sodium acetate trihydrate 0,544/0,816 g, Potassium acetate 2,943/4,415 g, Magnesium acetate tetrahydrate – 0,644/0,966 g, Calcium chloride dehydrate – 0,441/0,662 g .	B. Braun Melzungen AG, Germany
50	Numeta G16E	Emulsion for infusion	active substances: L-alanine - 4,66 g/l; L-arginine - 4,89 g/l; L-aspartic acid - 3,50 g/l; L-cysteine – 1,10 g/l; L-glutamic acid – 5,83 g/l; glycine – 2,33 g/l; L-histidine – 2,21 g/l; L-isoleucine – 3,90 g/l; L-leucine – 5,83 g/l; L-lysine monohydrate (which is equivalent to lysine) – 7,20 g/l (6,41 g/l); L-methionine – 1,40 g/l; L-ornithine hydrochloride (which is equivalent to ornithine) – 1,85 g/l (1,45 g/l); L-phenylalanine – 2,45 g/l; L-proline – 1,75 g/l; L-serine – 2,33 g/l; taurine – 0,35 g/l; L-threonine - 2,16 g/l; L-tryptophan - 1,17 g/l; L-tyrosine – 0,45 g/l; L-valine – 4,43 g/l; sodium chloride – 1,37 g/l;	Baxter SA, Belgium

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			potassium acetate – 5,05 g/l; calcium chloride, dehydrate – 2,06 g/l; magnesium acetate, tetrahydrate – 1,51 g/l; sodium glycerophosphate, hydrate – 4,43 g/l; glucose, monohydrate (which is equivalent to anhydrous glucose) – 550 g/l (500 g/l); refined olive oil and refined soybean oil – 125 g/l;	
51	Numeta G13E	Emulsion for infusion	Active substances: L-alanine – 4,66 g/l; L-arginine – 4,89 g/l; L-aspartic acid – 3,50 g/l; L-cysteine – 1.10 g/l; L-glutamic acid – 5,83 g/l; glycine – 2,33 g/l; L-histidine – 2,21 g/l; L-isoleucine – 3,90 g/l; L-leucine 5,83 g/l; L-lysine monohydrate (which is equivalent to lysine) – 7,20 g/l (6,41 g/l); L-methionine– 1,40 g/l; L-ornithine hydrochloride (which is equivalent to ornithine) – 1,85 g/l (1,45 g/l); L-phenylalanine – 2,45 g/l; L-proline – 1,75 g/l; L-serine – 2,33 g/l; taurine – 0,35 g/l; L-threonine - 2,16 g/l; L-tryptophan – 1,17 g/l; L-tyrosine – 0,45 g/l; L-valine – 4,43 g/l; potassium acetate – 3,83 g/l; calcium chloride, dehydrate – 3,45 g/l; magnesium acetate, tetrahydrate 0,63 g/l; sodium glycerophosphate, hydrate – 6,15 g/l; glucose, monohydrate (equivalent to anhydrous glucose) – 550 g/l (500 g/l); refined olive oil and refined soybean oil – 125 g/l;	Baxter SA, Belgium
52	Aminoven Infant 10%	Solution for infusion	Active substances: 1000 mL of solution contains L-arginine 7.50 g, L-leucine 13.0 g, L-isoleucine 8.0 g, L-methionine 3.12 g, L-phenylalanine 3.75 g, L-alanine 9.3 g, L-proline 9.71 g, L-valine 9.00 g, L-threonine 4.40 g, L-lysine acetate (monoacetate) 12.0 g (equivalent to L-lysine 8.51 g), glycine 4.15 g, L-histidine 4.76 g, L-serine 7.67 g, N-acetyl-L-tyrosine 5.176 g (which is equivalent to L-tyrosine 4.20 g), L-tryptophan 2.01 g, N-acetyl- L-cysteine 0.700 g (which is equivalent to L-cysteine .52 g), L-malic acid 2.62 g, taurine 0.40 g	Fresenius Kabi Austria GmbH, Austria
53	Aminoven 15%	Solution for infusion	L-alanine 25.00 g, L-arginine 20.00 g, L-valine 5.50 g, L-histidine 7.30 g, Glycine 18.50 g, L-leucine 8.90 g, L-lysine acetate 15.655 g in terms of L-lysine 11.10 g, L-isoleucine 5.20 g, L-methionine 3.80 g, L-serine 9.60 g, Taurine 2.00 g, L-proline 17.00 g, L-	Fresenius Kabi Austria GmbH, Austria

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			tyrosine 0.40 g, L-threonine 8.60 g, L-tryptophan 1.60 g, L-phenylalanine 5.50 g	
54	Aminoven 10%	Solution for infusion	L-alanine 14.00 g, L-arginine 12.00 g, L-valine 6.20 g, L-histidine 3.00 g, Glycine 11.00 g, L-leucine 7.40 g, L-lysine acetate 9,31 g in terms of L-lysine 6.60 g, L-isoleucine 5.00 g, L-methionine 4.30 g, L-serine 6.50 g, Taurine 1.00 g, L-proline 11.20 g, L-tyrosine 0.40 g, L-threonine 4.40 g, L-tryptophan 2.00 g, L-phenylalanine 5.10 g	Fresenius Kabi Austria GmbH, Austria
55	Nephrotec	Solution for infusion	active substances: 1000 mL of solution contain L-isoleucine 5.80 g, L-leucine 12.80 g, L-lysine monoacetate 16.9 g (in terms of L-lysine 12.00 g), L-methionine 2.00 g, L-phenylalanine 3, 50 g, L-threonine 8.20 g, L-tryptophan 3.00 g, L-valine 8.70 g, L-arginine 8.20 g, L-histidine 9.80 g, L-alanine 6.20 g , N-acetyl-L-cysteine .54 g (in terms of L-cysteine 0.40 g), glycine 5.305 g, L-proline 3.00 g, L-serine 7.60 g, L-tyrosine 0.60 g, glycyL-L-tyrosine 3.155 g;	Fresenius Kabi Austria GmbH, Austria
56	Hepasol Neo 8%	Solution for infusion	1000 mL of solution contains: L-valine - 10.08 g; L-isoleucine - 10.4 g; L-leucine - 13.09 g; L-lysine (in the form of L-lysine acetate 9.71 g) – 6.88 g; L-methionine - 1.1 g; L-threonine - 4.4 g; L-phenylalanine - 0.88 g; L-tryptophan - 0.7 g; L-alanine - 4.64 g; L-arginine - 10.72 g; glycine - 5.82 g; L-histidine - 2.8 g; L-proline – 5.73 g; L-serine – 2.24 g; L-cysteine (in the form of N-acetylcysteine 0.7 g) – 0.52 g	Chemopharm JSC, Republic of Serbia
57	Aminosol Neo 10%	Solution for infusion	500 mL of solution contain: L-valine 3.1 g; L-isoleucine 2.5 g; L-leucine 3.7 g; L-lysine (in the form of L-lysine acetate 4.655 g) 3.3 g; L-methionine 2.15 g; L-threonine 2.2 g; L-phenylalanine 2.55 g; L-tryptophan 1 g; L-arginine 6 g; L-histidine 1.5 g; L-alanine 7 g; glycine 5.5 g; L-proline 5.6 g; L-serine 3.25 g; L-tyrosine 0.2 g; taurine 0.5 g The total content of amino acids is 100 g/L, the total nitrogen content is 16.2 g/L.	"Hemopharm" JSC, Republic of Serbia
58	Aminosol Neo 15%	Solution for infusion	500 mL of solution contain: L-valine 2.75 g; L-isoleucine 2.6 g; L-leucine 4.45 g; L-lysine (in the form of L-lysine acetate 7.83 g) 5.55 g; L-methionine 1.9 g; L-threonine 4.3 g;	"Hemopharm" JSC, Republic of Serbia

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			L-phenylalanine 2.75 g; L-tryptophan 0.8 g; L-arginine 10 g; L-histidine 3.65 g; L-alanine 12.5 g; glycine 9.25 g; L-proline 8.5 g; L-serine 4.8 g; L-tyrosine 0.2 g; taurine 1 g Total content of amino acids - 150 g/L, total nitrogen content - 25.7 g/L	
59	Ketosteril	Film-coated tablets	1 tablet contains: alpha-ketoisoleucine, calcium salt 67 mg; alpha-ketoleucine, calcium salt 101 mg, alpha-ketophenylalanine, calcium salt 68 mg, alpha-ketovaline, calcium salt 86 mg, alpha-hydroxymethionine, calcium salt 59 mg, lysine acetate equivalent to 75 mg lysine 105 mg, threonine 53 mg, tryptophan 23 mg, histidine 38 mg, tyrosine 30 mg The total nitrogen content per tablet is 36 mg. Calcium content per tablet 1.25 mmol = 50 mg	Labesfal Laboratorios Almiro, S.A., Portugal
60	Gentasept	Powder for external use	1 vial, dropper vial of 2 g contains a substance that consists of: gentamicin sulfate in terms of gentamicin and anhydrous substance - 0.048 g (48 mg), L-tryptophan - 0.028 g (28 mg), zinc sulfate heptahydrate - 0.020 g (20 mg), methoxan - a sufficient amount to obtain the mass of the contents of the vial of 2 g; 1 vial, dropper vial of 5 g contains a substance consisting of: gentamicin sulfate in terms of gentamicin and anhydrous substance - 0.120 g (120 mg), L-tryptophan - 0.070 g (70 mg), zinc sulfate heptahydrate - 0.050 g (50 mg), methoxan - a sufficient amount to obtain the mass of the contents of the vial of 5 g	PJSC "Scientific and Production Center "Borshchagiv Chemical and Pharmaceutical Plant", Ukraine
61	Gentaxan	Powder for cutaneous application	1 g of powder contains: Gentaxan® substance consisting of: gentamicin sulfate (in terms of gentamicin and anhydrous substance) 0.024 g, L-tryptophan 0.014 g, zinc sulfate heptahydrate 0.010 g	LLC "Pharmaceutical Company "FarKoS", Ukraine
62	Cytovir-3	Capsules	active substances: 1 capsule contains sodium alpha-glutamyl-tryptophan (thymogen® sodium) 0.5 mg, ascorbic acid 50 mg, bendazole hydrochloride (dibazol) 20 mg	Cytomed Oyu, Finland
63	Custodiol	Perfusion solution	1000 mL of solution contains: sodium chloride 0.8766 g, potassium chloride 0.671 g, magnesium chloride, hexahydrate 0.8132 g; histidine 27.9289 g, histidine hydrochloride, monohydrate 3.7733	Dr. Franz Köhler Hemi GmbH, Germany

N.	The name of the medicinal product	Release form	The composition of the medicinal product	Manufacturer
			g; tryptophan 0.4085 g, mannitol 5.4651 g, calcium chloride, dihydrate 0.00221 g; alpha-ketoglutaric acid 0.1461 g	
64	Nutrinil PD4 with 1.1% amino acid content	Solution for peritoneal dialysis	1000 mL of solution contain L-tyrosine 0.3 g, L-tryptophan 0.27 g, L-phenylalanine 0.57 g, L-threonine 0.646 g, L-serine 0.51 g, L-proline 0.595 g, glycine 0.51 g, L-alanine 0.951 g, L-valine 1.393 g, L-methionine 0.85 g, L-isoleucine 0.85 g, L-leucine 1.02 g, L-lysine hydrochloride 0.955 g, L-histidine 0.714 g, L-arginine 1.071 g, calcium chloride dihydrate 0.184 g, magnesium chloride hexahydrate 0.051 g, sodium lactate 4.48 g, sodium chloride 5.38 g	Baxter Healthcare SA, Ireland
65	Metovitan	Hard capsules	1 capsule contains: DL-methionine - 291 mg; α -tocopherol acetate (vitamin E) – 7.5 mg; thiamine hydrochloride (vitamin B ₁) – 0.9 mg; nicotinamide (vitamin B ₃) – 0.68 mg; zinc sulfate heptahydrate, which is equivalent to zinc 0.03 mg - 0.14 mg	PJSC "Technolog", Ukraine
66	Cardioarginine-Zdorovya	Syrup	7.5 mL of the drug contains arginine asparaginate 1700 mg, diarginine succinate 1400 mg, magnesium asparaginate 175 mg, potassium asparaginate 175 mg	LLC "Pharmaceutical Company "Zdorovya", Ukraine
67	Cardioarginine-Zdorovya	Solution for injection	1 mL of solution contains arginine asparaginate 170 mg, diarginine succinate 140 mg, magnesium asparaginate 40 mg, potassium asparaginate 45 mg	LLC "Pharmaceutical Company "Zdorovya", Ukraine
68	Kovargin	Coated tablets	1 tablet contains riboxin 100 mg and L-arginine monohydrochloride in a dose equivalent to 100 mg of L-arginine	PJSC "Technolog", Ukraine
69	Tivargin-N	Solution for infusion	1 mL contains 42 mg of arginine hydrochloride (100 mL contains 20 mmol of arginine and 20 mmol of chlorides)	Pharmacel LLC, Ukraine
70	Arginine-Darnytsia	Solution for injection	1 mL of solution contains arginine glutamate 40 mg	PJSC "Pharmaceutical firm "Darnytsia", Ukraine

Based on the results of the analysis, it was established that the majority of medicinal products (58.6%) on the pharmaceutical market of Ukraine are manufactured by domestic pharmaceutical enterprises. A smaller share

(41.4%) of medicines is imported from other countries of the world.

The analysis of medicinal products by composition showed that the majority of drugs are monopreparations - 51.4%, however the share of combined drugs is significant and amounts to 48.6%;

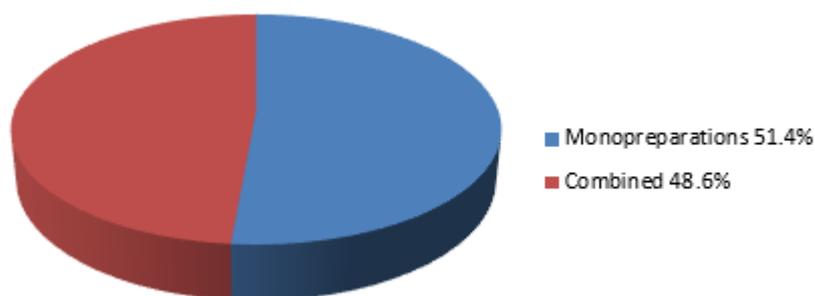


Fig. 12. Distribution of medicinal products according to the quantitative composition of active substances.

According to the results of the research of the pharmaceutical market by type of dosage form, it was found that infusions make up 51.4%, tablets - 20%, a

smaller share belongs to drugs in the form of solutions for injection - 7.1%, granules - 5.7%, oral solutions - 5.7%, powders - 5.7%, capsules - 2.9%, syrups - 1.4%.

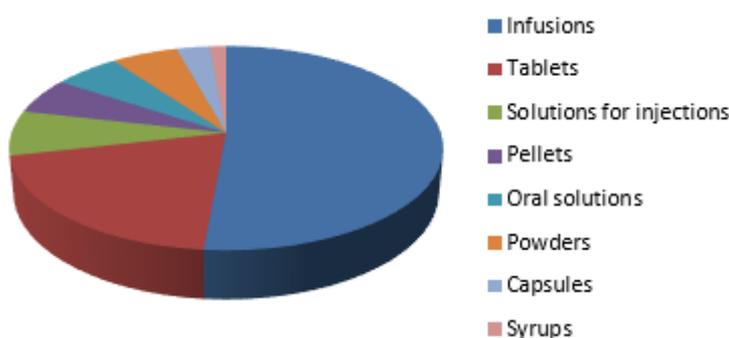


Fig. 13. Distribution of amino acid preparations by dosage forms on the pharmaceutical market of Ukraine.

According to the results of the analysis, in most cases, drugs based on amino acids are presented in the form of infusion drugs, a smaller share - 34.3% is allocated to solid dosage forms. Solid dosage forms are convenient, do not require special conditions for use, and often ensure the beginning of the process of absorption by the mucous membrane of the oral cavity. All this is the reason for the prospect of expanding this segment of the pharmaceutical market.

Conclusions

Therefore, the analysis of the literature shows that essential amino acids are necessary for the processes of formation of hormones, neurotransmitters, formation of new cells, support of immunity, regeneration of tissues, increase of muscles, strengthening of the nervous system and increased concentration of attention, etc. In cases where deficiency of a certain amino acid is found, a course of treatment with drugs containing the necessary amino acids is prescribed.

The analysis of the pharmaceutical market of drugs based on amino acids showed that, in general, infusion drugs prevail, which are usually prescribed to patients with acute deficiency of amino acids and are used within the inpatient treatment. However, today's realities indicate the impossibility of a balanced diet for most categories of people, which indicates the need to use drugs based on amino acids in more convenient dosage forms, capable of normalizing metabolic processes, functional

activity of organs and systems, increasing the body's reactivity, improving health and increase efficiency.

Taking into account the wide spectrum of pharmacological action of essential amino acids, it is advisable to develop new domestic medicines in solid dosage forms based on them for the prevention and treatment of pathologies of various systems and organs, which will ensure ease of use and help eliminate the deficiency of amino acids in the body.

Pharmacological activity of amino acids and prospects for the creation of drugs based on them

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Introduction. Amino acids play an extremely important role in human life, as they are responsible for the normal functioning of the entire body. For full functioning, the human body uses 22 amino acids, 10 of which it synthesizes by itself, other 9 amino acids must be obtained from the outside. In the diet, it is necessary that all amino acids are presented in certain optimal ratios. Both a deficiency and an excess of one or another amino acid in the diet can lead to an imbalance, that is, to a violation of the balance of amino acids. Therefore, in cases of insufficient protein nutrition, it is advisable to enrich daily rations with essential amino acids in the form of various medicines based on them in order to prevent the negative impact of amino acids imbalance and for the normal functioning of all systems and organs. Therefore, the **aim** of this study was to summarize modern literary

sources on the pharmacological action of essential amino acids, to analyze the existing drugs based on them on the pharmaceutical market of Ukraine, to substantiate the prospects and feasibility of their further inclusion in the composition of drugs for the prevention and treatment of pathologies of various systems and organs. **Material & methods.** The methods of marketing analysis, comparison and generalization of information were applied. The following sources were used as information materials on medicinal products: the directory of pharmaceuticals "Compendium on-line" and the State Register of Medicinal Products of Ukraine. **Results & discussion.** Based on the results of the analysis, it was established that the majority of medicinal products on the pharmaceutical market of Ukraine are manufactured by domestic pharmaceutical enterprises. A smaller share of medicines is imported from other countries of the world. The analysis of medicinal products by composition showed that the majority of drugs are monopreparations. According to the results of the analysis, in most cases, drugs based on amino acids are presented in the form of infusion drugs, a smaller share is allocated to solid dosage forms. **Conclusion.** The analysis of the pharmaceutical market of drugs based on amino acids showed that, in general, infusion drugs prevail, which are usually prescribed to patients with acute deficiency of amino acids. However, today's realities indicate the impossibility of a balanced diet for most categories of people, which indicates the need to use drugs based on amino acids in more convenient dosage forms. It is advisable to develop new domestic medicines in solid dosage forms based on them for the prevention and treatment of pathologies of various systems and organs, which will ensure ease of use and help eliminate the deficiency of amino acids in the body. Solid dosage forms are convenient, do not require special conditions for use, and often ensure the beginning of the process of absorption by the mucous membrane of the oral cavity. All this is the reason for the prospect of expanding this segment of the pharmaceutical market.

Keywords: amino acids, market analysis, solid dosage forms, research.

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