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Original Article

Study of physicochemical properties of the preparation from the bursa of Fabricius of broiler chickens

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ABSTRACT

In today's world, there is a pressing need for environmentally friendly drugs of natural origin, with high bioavailability, no side effects or addiction, for immune reconstitution and enhancement, in particular, after viral or bacterial infections, and for prevention of diseases. It is expected that new drugs derived from the bursa of Fabricius of broiler chickens, one of which is Bursanatal, will aim to influence the damaged part of the immune system caused by various diseases, of both viral and bacterial etiology, and to restore the damaged part of the immune system, since Bursanatal contains essential and non-essential amino acids, vitamins, micronutrients, which beneficially contribute to the restoration of the human body after an infection, and by immune enhancement, they facilitate prevention of several diseases.

In this study, an attempt was made to develop biostimulating substances and obtain a number of drugs, one of which is Bursanatal based on extraction from the bursa of Fabricius of broiler chickens. The study aims to characterize the new immunomodulatory drug Bursanatal and identify its biostimulating and bioenhancing potential. An analysis of the physicochemical properties of Bursanatal showed that due to its unique composition and several components, such as proteins with a molecular weight between 10.0 and 1 kDa, amino acids, macro- and micronutrients, water-soluble and fat-soluble vitamins, Bursanatal has various biological properties, including immunomodulatory, immunostimulating, apoptogenic, anti-inflammatory, antiviral and metabolism-correcting effects.

Keywords: Bursanatal, Tissue preparation, Bursa of Fabricius, Immune enhancement, Immune modulation, Physicochemical properties

Introduction

Tissue preparations obtained from animal organs and tissues in the form of various extracts, decoctions, applications, and rubs have been used for centuries to treat and prevent diseases, maintain good health, and improve overall body tone. These tissue preparations, which have been used for a long time, have demonstrated not only high efficacy and safety but also tissue and organ tropism. In contrast, many chemotherapeutic and synthetic drugs do not show the desired effectiveness and demonstrate addiction to several chemicals, moreover, undesirable side effects are observed [1]. Therefore, increasingly, more and more doctors and scientists are turning to preparations made from natural biological materials, such as animal cells, organs, and tissues.

Natural biologically active preparations differ significantly from chemical preparations not only in the mechanism of action, but also in the structure of the protein molecule, the composition of amino acids, the presence of auxiliary cellular and humoral substances and impurities in this protein molecule, and, as a consequence, storage conditions and shelf life. All of the above differences result in a significant impact on both the pharmacokinetic properties of the drug (absorption, distribution

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in the body, deposition, metabolism, and excretion from the body) and the pharmacodynamic properties (biological effects of the tissue preparation, its localization, its mechanism of action, its specialization).

According to Soldatov A. A., the mechanism of the therapeutic action of the drug can be divided into two stages. The first stage is associated with the entry of the drug into the bloodstream and its accumulation at the site of the "target organ". The second stage is associated with the interaction of the drug with the so-called "target receptor" and is accompanied by a cell/tissue/organ response to the drug.

Based on the latest data from several scientific experiments, we can draw the following conclusions: organic drugs have several mechanisms of action and several physiological effects on individual organs, tissues, and the body as a whole. The main mechanism considered is "similarity", i.e., the action of the active substance in an organic drug is based on the principle of organ-tissue similarity or homology. This was pointed out in the work of the American biochemist Günter Blobel, who was a Nobel Prize winner in 1999. He described the results of his experiments in 1975, demonstrating the movement of proteins through the extensive membrane of an organelle (endoplasmic reticulum), which plays a crucial role in the life support of eukaryotic cells, thanks to a "selected" signal, i.e., a special sequence of amino acids that is an integral part of a protein molecule.

Penetration, accumulation of the preparation, and development of pharmacological effects primarily occur in those organs and tissues that the drug originates from. The "like attracts like" principle works due to increased homology and tropism of the resulting biomolecular mass towards homologous organs or tissues. Tissue preparations exhibit another property - they function as carriers for other medicinal substances, bringing them to a homologous organ when administered together in the body [2]. Increased penetration into any tissue, absorption, and immediate inclusion in metabolism is determined by the "relatedness" of the biomolecules that compose organic substances [3, 4].

There is a unique characteristic of tissue preparations derived from central immune organs, such as the bone marrow, thymus, and bursa of Fabricius [5-7]. These preparations have a tropism and homology with different organs, tissues, and cells. This ability of drugs derived from these central immune organs to penetrate various tissues and cells in the body is due to the development and function of hematopoiesis.

According to several scientists, physiological regenerative reactions as part of organotherapy are triggered by the effect of replenishing the deficiency of cellular biomolecules and eliminating "cellular defects" at the biochemical level. Thanks to these properties, biologically active tissue preparations normalize physiological regeneration processes in homologous organs, and preparations obtained from central immune organs normalize processes throughout the body, which helps relieve inflammation, eliminate loci of pathological proliferation, exhibit antidegenerative effects, inhibit oncogenic growth, and slow down the aging process and atrophy [4, 8, 9].

Various cells, organs, tissues, and their components are used as raw materials for tissue preparations. One such material is the bursa of Fabricius, a unique central organ of the immune system. It is a promising raw material due to its functional role, on the one hand, and accessibility for pharmaceutical production, on the other.

Numerous studies have shown that tissue preparations or individual peptides isolated from the bursa of Fabricius of chickens contain an extensive set of biologically active substances, i.e. amino acids, both nonessential and essential, vitamins, macro- and micronutrients that are homologous with the cells and tissues of the human body [10-13]. By consuming eggs, meat, and poultry organs, humans have genetically adapted to these types of foods, and therefore preparations obtained from the bursa of Fabricius are easily absorbed by the body. These preparations have both specific and general nonspecific positive effects on the body as a whole, as well as being safe and molecularly tailored [14-16]. Organic preparations derived from the bursa of Fabricius have an effect on the metabolic processes of both ill and healthy individuals. This feature is made possible thanks to a whole complex of biologically active substances contained in the tissue of the bursa of Fabricius, as well as a unique method and technology for extracting and preserving biologically active substances. Due to all of this, the resulting biologically active substances of the bursa of Fabricius have antioxidant, immunomodulatory, and immunostimulating properties, which increases their effectiveness, optimizing metabolic processes, thereby increasing the body's resistance and protective mechanisms to the action of unfavorable exo- and endogenous factors of various etiologies, since the presence in their composition of bursal peptides and free nucleotides, potentially capable of stimulating the general resistance of the body, exhibiting the properties of adaptogens, immunomodulators, immunostimulants, actoprotectors, antioxidants, and stress correctors, activate and strengthen the body's innate and acquired defenses [17-20].

Materials and Methods

Methods

Analysis of Bursanatal (a tissue preparation)

VELP UDK 129, VELP DK 6, VELP SMS, VELP JP, VELP SER 148, AND GR- 200, ШС-40-02, VELP FIWE 3, LOIP LF – 7/11 –G1, Agilent 1260 Infinity II, IKA RV 3 V, Tagler HT – 170ХПК, ПЛ – 0,1, AND GR – 200, ШС – 40 – 02, TitroLine 5000, УФ – 1200.

Agilent 1260 Infinity II quaternary pump (G7111B) serial number DEAEZ01217 and Agilent 1260 Infinity II bio-engineered pump (G5654A) serial number DEADED10589; Agilent 1260 Infinity II columns (G7165A) serial number

DEAC800987; Agilent 1260 Infinity II spectrophotometer 1260 MCT (DEAED10569) serial number USHKB10662; Agilent 1260 Infinity II Master Assembler 1260 Vialsambler (G7129A) serial number DEAEQ2190.

Emission spectrometry with inductively coupled plasma. Emission spectrometer «Optima 4300 DV» by «Perkin Elmer» (USA). Serial number 1101801. (Institute of High-Temperature Electrochemistry of the Ural Branch of the Russian Academy of Sciences).

Methods. VELP UDK 129, VELP DK 6, VELP SMS, VELP JP, VELP SER 148, AND GR- 200, ШС-40-02, VELP FIWE 3, LOIP LF – 7/11 –G1, Agilent 1260 Infinity II, IKA RV 3 V, Tagler HT – 170ХПК, ПЛ – 0,1, AND GR – 200, ШС – 40 – 02, TitroLine 5000, УФ – 1200, and according to technical requirements: OFS.1.2.3.0017.15 "Methods for the quantitative determination of vitamins" and SOP "Determination of vitamin composition by high-performance liquid chromatography (HPLC) with pre-column derivatization with OPA and FMOC agents in food products, food and medicinal raw materials" Federal State Budgetary Scientific Institution "FEDERAL RESEARCH CENTER FOR FOOD SYSTEMS named after Gorbatov V.M. " of the Russian Academy of Sciences.

Bursanatal is a biologically active tissue preparation that has immunomodulatory and immune-enhancing preventive and therapeutic properties for the treatment and prevention of diseases of various etiologies. Bursanatal was developed in the Russian Federation (Ekaterinburg) at the Institute of Gene and Cell Technologies in Yekaterinburg, in co-operation with the research laboratory of the unified laboratory complex of the Ural State University of Economics.

Results and Discussion

The study of the physicochemical properties of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens) has shown that it contains a variety of macro- and micronutrients, including amino acids, organic substances, lipids, and other biologically active substances with multidirectional biological and physiological activities, such as immunomodulatory, immuno-correcting, adaptogenic, regenerating, anti-inflammatory, metabolizing properties.

As demonstrated by **Table 1** the physical and chemical analysis of several batches of Bursanatal, revealed that the dry residue contained more than 25% of protein, approximately 2% of ash, approximately 5% of fat, and approximately 74% of moisture.

Table 1. Composition of the dry residue of some batches of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens)

Parameter	Standard
Appearance	opaque aqueous slurry without foreign solids of cream color
Odor	faint specific
Weight of the bursa, grams	0,91±0,09
Moisture, mass %	74,94±1,15
Fat, mass %	5,45±0,31
Total protein, mass %	25,35±1,87
Ash, mass %	1,82±0,12
Reducing the capacity of the extract from Bursa Fabricius, %	74,52±6,12
Amino ammonium content, mg	determined for each batch
Solubility of proteins in solution	N/A*
Content of SH groups	determined for each batch
Free moisture content	N/A*
Solubility	N/A*
pH	determined for each batch
Sterility	determined for each batch

* Determined if required

As can be seen from the composition of the fat-soluble and water-soluble vitamins in Bursanatal, vitamin A (retinol), a fat-soluble antioxidant vitamin, is the most abundant, with levels ranging from 15.7 to 17.4 micrograms per liter. This vitamin is essential for growth, youth, and beauty, as well as preventing xerophthalmia. The presence of vitamin A in Bursanatal indicates that the drug may enhance the barrier function of mucous membranes, particularly in the respiratory tract. This could help to prevent the replacement of epithelial cell mucoproteins with keratin and increase the phagocytic activity of leukocytes, among other benefits for nonspecific body defense mechanisms.

It is known that vitamin A plays a crucial role in various metabolic processes, stimulating oxidative reactions in the body and participating in the biosynthesis of lipids that make up cell membranes. Retinol, one of the forms of vitamin A, is involved in glycoprotein synthesis and ensures the normal function of the

eyes by helping to regenerate visual pigments in the retina, which are sensitive to light. Vitamin A also takes part in steroid hormone production, sperm formation, and embryonic development. It contributes to the production of myelin, which insulates nerve fibers, as well as iron transport and red blood cell production. Additionally, vitamin A is involved in antibody production by leukocytes and T-lymphocyte activity. Retinol is also known to act as an antagonist to thyroid hormone, helping to regulate its levels in the body.

Large doses of vitamin A can lead to intoxication. The recommended daily intake for adults varies from 1.0 to 2.0 milligrams. Bursanatal contains fat-soluble vitamin E (0.18 micrograms) and water-soluble vitamin C (1.8 milligrams), both of which enhance optimal absorption of vitamin A. Bursanatal also contains fat-soluble vitamin E at concentrations ranging from 0.18 to 0.23 micrograms per liter, representing a group of eight different forms of vitamins known as tocopherols. Vitamin E assists muscles to work with less oxygen, enhancing endurance. This vitamin also prevents the formation of blood clots by decreasing blood viscosity. It protects low-density lipoproteins from oxidation, acting as an antioxidant and affecting the biosynthesis of proteins and hemoglobin-containing enzymes. Antioxidant properties of vitamin E help slow down the aging process. Vitamin E is important for sperm production in men and conception and pregnancy in women.

Regular intake of vitamin E can help slow down skin aging. It is also used to treat conditions such as eczema and herpes. Applying the vitamin topically may help reduce scar formation. Adults need between 15 and 20 milligrams of vitamin E per day. A deficiency of vitamin E may cause damage to red blood cells, leading to hemolysis and anemia. Nerve cell degeneration can also occur. Increased risks of cancer, arthritis, atherosclerosis, cataracts, atrophy of reproductive organs, and infertility may occur due to a vitamin E deficiency.

The vitamin D content in Bursanatal varies from 0.18 to 0.23 micrograms per liter (mcg/l). Vitamin D is a group of fat-soluble vitamins that include vitamin D2 (ergocalciferol), vitamin D3 (cholecalciferol), and other related compounds such as vitamin D4, D5, and D6. These vitamins play a role in bone mineralization, helping to ensure normal calcium levels in the body. They help the body absorb calcium and other minerals needed for healthy bones. Vitamin D is also important for cell growth and function, especially in leukocytes and epithelial cells. It helps activate immune cells to fight off infections and other harmful substances.

Calciferols play a crucial role in the functioning of the nervous and immune systems, as well as the heart. They help regulate the levels of phosphorus and calcium in the body and are involved in the production of hormones. The recommended daily intake of this vitamin for adults is between 5.0 and 10.0 micrograms. A lack of vitamin D can lead to a range of health problems, including slow growth, rickets in children, and other symptoms such as irritability, muscle weakness, joint pain, insomnia, and decreased immunity. In addition, vitamin D deficiency can increase the risk of infection, delay tooth development, and impair bone formation. Vitamin D can have several toxic effects. If taken in excess of 100 micrograms (mcg) per day, it can cause calcium deposits in soft tissues and hypercalcemia in children. At a dose of 1,000 mcg per day, vitamin D can cause calcification of the kidneys and other soft tissues.

As mentioned above, ascorbic acid was also found in Bursanatal at concentrations ranging from 1.8 to 4.3 mg/L. The optimal daily intake for normal body functioning ranges from 100 to 500 mg. Vitamin C plays a role in redox reactions and amino acid metabolism and aids in the absorption of fats and carbohydrates. It is essential for the formation of collagen, which is a component of connective tissues such as skin, ligaments, and bones. Ascorbic acid also contributes to the formation of red blood cells, maintaining the activity of white blood cells, promoting iron absorption, and preventing hemorrhage and bleeding gums. Vitamin C has antioxidant properties that protect low-density lipoproteins from oxidative damage and support the immune system, helping to prevent cancer. Additionally, ascorbic acid has been shown to have a protective effect against the harmful effects of pesticides and heavy metals. The vitamin affects the activity of nitric oxide, which plays a crucial role in strengthening the endothelial cells lining the walls of blood vessels. This helps to reduce high blood pressure and prevent arterial spasms. The main symptoms of vitamin C deficiency include hair loss, weak vision, early wrinkles, bleeding gums, varicose veins, hemorrhoids, frequent depression, insomnia, increased fatigue, weight gain, frequent colds, and a tendency to inflammation of the mucous membranes.

Vitamin B3 (niacin), which ranks second among the water-soluble vitamins in Bursanatal, contains 7.8-8.3 mg/L. Niacin is a co-enzyme that plays a crucial role in the metabolism of carbohydrates, fats, and proteins. This vitamin affects metabolic processes and has cofactor properties for various enzymes. Vitamin B3 is part of two important molecules: nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP). NAD and NADP are essential for the biosynthesis of purines and pyrimidines, as well as the normal metabolism of amino acids and cholesterol. Niacin also helps reduce blood sugar levels. This vitamin has a positive effect on brain function, expanding capillary beds and increasing blood flow. It also improves the motor function of the stomach as well as the secretory functions of the liver and pancreas, thereby strengthening the immune system's ability to fight off infections. The recommended daily dose of the vitamin is 50 mg.

The next vitamin affecting the functional composition of Bursanatal is vitamin B12 (cyanocobalamin), which is present in the range of 0.35 to 0.38 milligrams per liter. Cyanocobalamin is a growth factor that is essential for the normal maturation of red blood cells and hematopoiesis. It also plays a role in the synthesis of labile methyl groups, and the formation of choline, creatine, nucleic acids, and methionine. Vitamin B12 enhances the efficiency of vitamin C and improves its effect. This vitamin is involved in hematopoiesis and the processing of carbohydrates, fats, and proteins. It is effective in the treatment and prevention of chronic fatigue syndrome, with a success rate ranging from

53% to 83%. It also improves memory and concentration, and the recommended daily dose is 20 micrograms. A lack of vitamin B12 can lead to pernicious anemia, nervousness, irritability, and headaches, including migraines, dizziness, hallucinations, eye problems, changes in gait, and brittle bones.

Folic acid (FA), which is also present in small quantities - 0.08 - 0.12 mg/l in Bursanatal, helps to improve the absorption and utilization of vitamin B12. In conjunction with cyanocobalamin, folic acid regulates the level of homocysteine, an excess of which can lead to heart disease, stroke, osteoporosis, and Alzheimer's disease. The biological properties of folic acid are linked to its hydrogen acceptor capabilities, which determine its participation in redox reactions. In tandem with cyanocobalamin, it plays a role in regulating the functions of blood-forming organs. For macrocytic anemia, folic acid has an anti-anemic effect. Vitamin B9, or folic acid, is involved in chromosome duplication during cell replication, which accelerates during pregnancy as the fetus develops. It is also involved in DNA and RNA synthesis during cell growth and division, as well as in the formation and growth of a fully-formed fetus and the synthesis of functional and structural proteins. Folic acid prevents congenital abnormalities of the neural tube and palate It plays a role in converting homocysteine into methionine, which helps to reduce oxidative stress in the body. The recommended daily intake of folic acid for adults is between 0.4 and 0.6 milligrams per day.

In the case of folic acid deficiency, there may be poor sleep, a feeling of fear, depression, fatigue, reduced body defenses, frequent inflammatory lesions in the oral cavity, bleeding gums, and slowed growth in children.

B6 (pyridoxine) is present in Bursanatal at a concentration of 0.28 - 0.33 mg/L. This substance has a wide range of properties, and thanks to its presence, the balance between potassium and sodium in body fluids is maintained. One of the main functions of this vitamin is its involvement in the regulation of protein metabolism and the transportation of amino acids across cell membranes. Pyridoxine participates in transamination reactions and the synthesis of several amino acids, including asparagine, glutamic acid, methionine, and cysteine. By increasing the level of creatinine in skeletal muscles, it contributes to muscle contraction. It also improves the absorption of unsaturated fatty acids, plays a role in fat and lipid metabolism, and is essential for the production of hemoglobin and erythrocytes. Vitamin B6 also has an impact on hematopoiesis, immunity, and antibody production. Pyridoxine plays a role in the production of melatonin, dopamine, and serotonin, all of which are necessary for the proper development and maintenance of the nervous system.

In case of optimal intake, this vitamin can help protect humans from dozens of different diseases. The production of hydrochloric acid, which is part of gastric juice, as well as normal carbohydrate and fat metabolism, and blood sugar levels depend on this vitamin. Since this vitamin is water-soluble, it cannot accumulate in the body. Therefore, if this vitamin is deficient, one may experience muscle weakness, fatigue, and depression. Other signs of deficiency include hair loss, swollen extremities, oily seborrhea, and disturbances in fat metabolism that can lead to conditions such as atherosclerosis, arthritis, numbness in the extremities, circulatory problems, and cardiovascular system diseases. The daily requirement for this vitamin for adults is between 2.0 and 3.5 milligrams.

Biotin has been found in the amount of 0.18 – 0.21 mg/l. Biotin plays a crucial role as a coenzyme (coenzyme R) in the metabolism of proteins, fats, and carbohydrates. It takes part in glucose gluconeogenesis, in the synthesis and breakdown of fatty acids, in the production of purine nucleotides, and it is a source of sulfur, which is essential for the synthesis of collagen, as well as in the activation and growth of cells and the metabolism of amino acids. Biotin is necessary for the synthesis of antibodies, fatty acids, enzymes (digestive), and the metabolism of nicotinic acid. It is involved as a coenzyme of acetyl-CoA carboxylase and b-methyl-crotonyl-CoA carboxylase in decarboxylation processes. Biotin has insulin-like effects in lowering blood sugar. This water-soluble vitamin is essential for good hair growth, strengthening brittle nails, and maintaining skin structure, and it lowers blood glucose levels, preventing diabetic neuropathy.

It has no toxic effects if taken in doses of more than 60 mg regularly. The recommended daily dose is 30-60 mcg. The consequences of biotin deficiency include lack of appetite, nausea, anorexia, fatigue, myalgia, anxiety, depression, decreased immunity, and alopecia. Folic acid, or vitamin Bc, plays a role in regulating the function of hematopoietic organs and preventing macrocytic anemia. It is involved in the synthesis of DNA and RNA, cell growth, and cell division. It also helps form a healthy fetus, synthesize proteins, convert amino acids, and protect the cardiovascular system from atherosclerosis.

In the case of folic acid deficiency, there are disturbances in the development and growth of the fetus, which can lead to birth defects and atrophy of the gastrointestinal epithelium. Additionally, anemia may occur. When folic acid levels are low, people may experience symptoms such as depressed mood, fatigue, and poor sleep. They may also feel anxious or fearful. Folic acid is not toxic even when taken in high doses. However, in people with epilepsy, high doses of folic acid can act as an antagonist to anti-seizure medications. The recommended daily intake for adults is between 200 and 400 micrograms.

B1 (thiamine) is essential for the normal functioning of nerve cells and the formation of adenosine triphosphate (ATP) in every cell. It plays a crucial role in carbohydrate metabolism, particularly in the decarboxylation of pyruvic acid and the formation of acetyl coenzyme A. This process is important for protein and lipid metabolism, energy production, and the synthesis of proteins such as collagen. Vitamin B6 also promotes the transmission of nerve impulses between the brain and the spinal cord.

In the case of thiamine deficiency from food intake, an increase in the level of keto acids in the blood and tissues may occur, leading to a shift in the acid-base balance. This can cause a decrease in protein biosynthesis in the body, leading to a negative nitrogen balance and metabolic effect. There may be disturbances in nerve impulse perception and reflexes, as well as

possible mental retardation and learning difficulties in children. Other possible consequences include muscle weakness, cardiomyopathy, and slow wound healing. Thiamine is generally considered non-toxic, but daily doses exceeding 150 mg may cause drowsiness. It is recommended to consume between 0.8 and 2.0 milligrams per day.

B2 (riboflavin) - 0.08 mg/l. Riboflavin is a part of enzymes that are involved in the process of energy production using fats and carbohydrates. It plays a role in cell respiration and fat and carbohydrate metabolism, and also stimulates hematopoiesis and normalizes the nervous system. Riboflavin protects the retina from ultraviolet rays, and in combination with vitamin A, it helps maintain normal vision and restores the trophism of skin, hair, and nails. The recommended daily intake of riboflavin for adults is 2.0 - 3.5 mg. If this vitamin is deficient, symptoms may include angular cheilitis (inflammation of the corners of the mouth), inflammation of the tongue, increased hair loss, and flaky or oily skin, especially around the nose.

Percentage ratio of fat-soluble and of water-soluble vitamins of some batches of Bursanatal are shown in **Figures 1 and 2**.

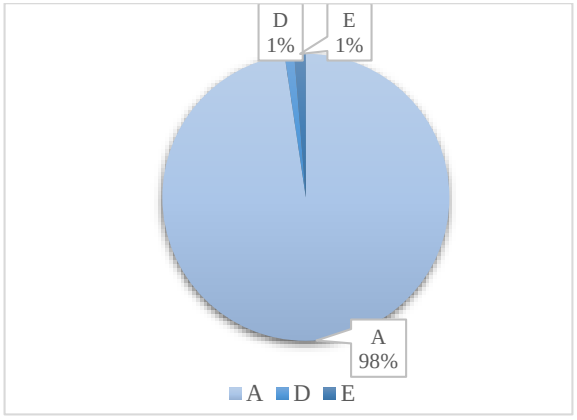

Figure 1. Percentage ratio of fat-soluble vitamins of some batches of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens)

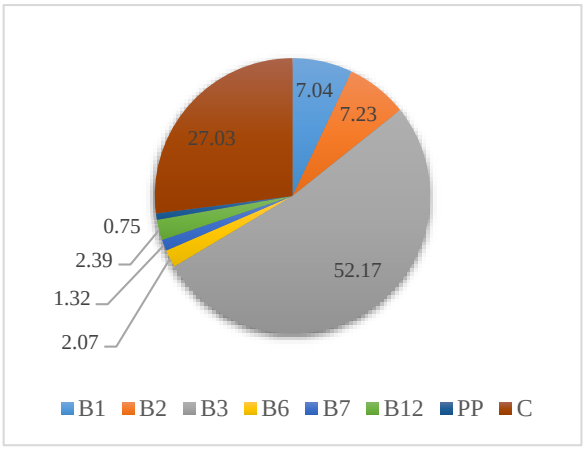

Figure 2. Percentage ratio of water-soluble vitamins of some batches of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens)

The macronutrient and micronutrient composition of the product is presented in **Table 3** and **Figures 3 and 4**. Thirty-five indicators were identified, of which potassium ranks first as seen in **Table 2** and **Figures 3 and 4**. Potassium is the main intracellular ion and plays an active role in the transmission of impulses between cells, contributing to the formation of resting and excitation potentials. Its main function is energy generation and maintaining membrane excitability. Next, we have the micronutrient phosphorus, which is essential for maintaining acid-base balance in the body and energy metabolism in cells, molecules, organs, and tissues. This mineral is also required for the proper functioning of the neuromuscular system and bone tissue growth. Phosphorus is also involved in glucose formation from food. Sulfur ranks third in importance. It is necessary not only for the functioning of proteins and enzymes throughout the body but also for the production of antibodies. Sulfur actively participates in the neutralization of foreign compounds in the body. Additionally, it helps protect cells, tissues, and organs from oxidation and toxic substances. Sulfur can be found in amino acids such as methionine and cysteine. Sodium is a vital mineral element that plays a crucial role in transmitting impulses in the nervous system, both at the cellular and organ levels. It is also involved in muscle contraction and, together with other minerals, helps maintain the body's water-salt balance.

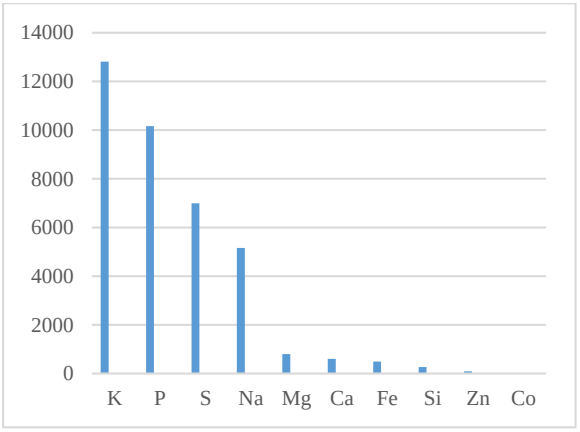

Figure 3. Micro- and macronutrient composition of some batches of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens), mcg/g

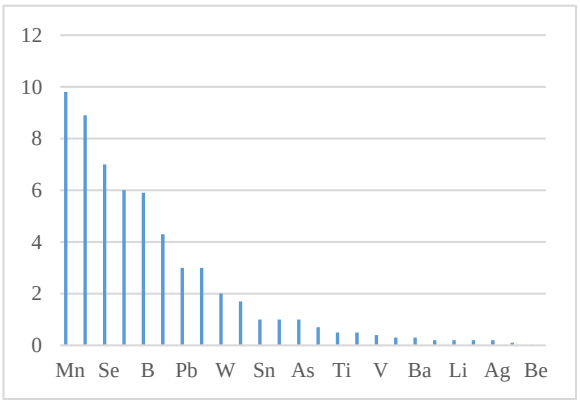

Figure 4. Micro- and macronutrient composition of some batches of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens), mcg/g

Table 2. Macronutrient and micronutrient composition of some batches of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens).

№	Parameter	Indicator, mcg	№	Parameter	Indicator, mcg
1	Ag	<0,2	19	Mo	<1
2	Al	4,3	20	Na	5160,0
3	As	<1	21	Ni	1,7
4	B	5,9	22	P	10160,0
5	Ba	0,3	23	Pb	<3
6	Be	<0,02	24	Re	<0,5
7	Bi	<3	25	S	6993,0
8	Ca	604,0	26	Sb	<6
9	Cd	<0,2	27	Se	<7
10	Co	22,6	28	Si	268,6
11	Cr	<0,3	29	Sn	<1
12	Cu	8,9	30	Sr	0,7
13	Fe	491,0	31	Ti	0,5
14	Hg	<0,1	32	V	<0,4
15	K	12810,0	33	W	<2
16	Li	<0,2	34	Zn	89,4
17	Mg	802,3	35	Zr	<0,2
18	Mn	9,8			

Minerals are an essential part of the human body. The proper functioning of any living organism is not possible without an adequate amount of minerals. Sodium, potassium, calcium, magnesium, and phosphorus are the most important macronutrients for metabolism. Minerals, micronutrients, and vitamins are essential for maintaining and strengthening the immune system. They also have a wider impact on health, going beyond the prevention of deficiency conditions that are currently recognized by scientists and doctors. Scientific research has shown that the active use of macronutrient and micronutrient elements, vitamins, and nutrients can effectively and safely influence various pathological processes, such as osteoporosis and cardiovascular diseases. In some cases, it has even been shown to reverse these conditions. By studying micronutrients in Bursa Natal, we can consider them as a preventive and therapeutic preparation, both independently and as an additional means of achieving therapeutic effects in modern medicine.

Amino acids are the main building blocks of proteins and play a crucial role in all essential biological processes, alongside lipids, carbohydrates, and nucleic acids. They are necessary for both protein renewal and synthesis, taking part in the formation of vital immune substances, vitamins, enzymes, hormones, and other important molecules.

Many authors have noted that amino acids serve as metabolites for maintaining life within a living organism, while all living organisms can accumulate amino acids, forming a reservoir of "free" amino acids that are found in tissues and cell sap. These "free" amino acids maintain a dynamic balance during metabolic reactions, performing special transfer functions such as transamination and remethylation.

Amino acids perform several essential functions in a living organism. They serve as a building block for proteins and peptides, they provide energy as they are metabolized by cells to produce ATP, and they play a role in nitrogen metabolism.

Some researchers have classified certain amino acids into a group called "functional amino acids" because they are essential for the reproduction, growth, and survival of organisms. These functional amino acids include glutamate, glycine, leucine, tyrosine, methionine, arginine, proline, and cysteine. The composition of these amino acids in Bursanatal can be found in **Table 3**, which provide more detailed information.

Table 3. Amino acid profile of some batches of Bursanatal (a tissue preparation from the bursa of Fabricius of broiler chickens)

Parameter	Indicator
Aspartic acid (Asp)	1211,8
Glutamic acid (Glu)	2800,8
Serin (Ser)	603,6
Histidine (His)	340,0
Glycine (Gly)	1020,7
Threonine (Thr)	654,5
Arginine (Arg)	1330,9
Alanine (Ala)	1064,6
Tyrosine (Tyr)	410,5
Cystine (Cys)	584,6
Valine (Val)	641,1
Methionine (Met)	206,6
Phenylalanine (Phe)	697,3
Isoleucine (Ile)	1006,6
Leucine (Leu)	895,6
Lysine (Lys)	1063,0
Proline (Pro)	901,8
Total amino acids:	15433,9

As can be seen from **Table 3** Bursanatal contains a total of 17 amino acids of protein origin, of which aliphatic/neutral amino acids are glycine, alanine, valine, leucine, isoleucine, aliphatic hydroxy amino acids: serine, threonine, amino acids containing sulfur: cysteine, methionine, amino acids: proline, basic amino acids: lysine, arginine, histidine, acidic amino acids and half amides: aspartic acid, glutamic acid, aromatic and heteroaromatic amino acids: phenylalanine, tyrosine.

From a biochemical perspective, Bursonatal contains 7 essential amino acids (threonine, valine, methionine, phenylalanine, isoleucine, leucine, and lysine), 5 conditionally essential (histidine, arginine, tyrosine, cystine, and proline), 4 non-essential amino acids (aspartic acid, glutamic acid, glycine, and alanine).

Non-essential amino acids, such as proline and arginine, are not only essential components of collagen, but they are also

substrates for the enzymatic production of nitric oxide. This is one of the most important local signaling molecules in the body. Catecholamines, which are produced from tyrosine, play a crucial role in various immune and endocrine processes, as well as neurohumoral regulation.

The follicular cells in the thyroid gland actively utilize tyrosine to produce thyroxine and triiodothyronine, hormones that collaborate with other glands such as the pituitary and hypothalamus, and the immune system to regulate the function of various organs and tissues, including the heart, brain, and kidneys. By supplying tyrosine through dietary intake, we can reduce the levels of stress hormones and experience beneficial restorative effects in cases of chronic fatigue caused by mental and physical stress.

Conclusion

Bursanatal is a tissue preparation obtained from the bursa of Fabricius of broiler chickens. It contains approximately 25.4% protein, approximately 2% ash, and approximately 5.54% total lipids. The vitamins present in Bursanatal include fat-soluble vitamins A (15.7-17.3 mcg/l), D (0.14-0.19 mcg/l), and E (0.18-0.23 mcg/l). Water-soluble vitamins include C (1.8-4.3 mg/l), B1 (0.08-1.12 mg/l), B2 (0.08 - 1.15 mg/l), B3 (7.8 - 8.3 mg/l), B6 (0.28 - 0.33 mg/l) and B12 (0.35 - 0.38 mg/l). Biotin is also present at 0.18 - 0.21 mg/l. In addition to vitamins, Bursanatal contains a variety of minerals, including potassium (12,810 mcg/l), phosphorus (10,160 mcg/l), sulfur (6,993 mcg/l), magnesium (802 mcg/l), iron (491 mcg/l), zinc (89.4 mcg/l), cobalt (22.6 mcg/l) and many other trace elements. Amino acids are also present in Bursanatal in a total mass of approximately 15,433.9 mg/100 g. Thus, Bursanatal contains several components with multidirectional biological activity, including immunomodulatory, immunostimulating, adaptogenic, anti-inflammatory, antiviral, and metabolism-correcting effects.

Due to the presence of vitamins, minerals, amino acids, and other nutrients in Bursanatal, we suggest that it may have regulatory properties that affect basic physiological processes in cells, tissues, and the entire body. The rich composition of Bursanatal may demonstrate restorative abilities for the immune, nervous, and endocrine systems, among others.

The regulation of body metabolism is achieved through the coordinated action of cells, tissues, organs, and systems operating at the molecular level. This includes the regulation of specific genes that trigger complex interactions between hormonal, neuronal, and nutritional factors such as proteins, carbohydrates, fats, minerals, vitamins, and other nutrients.

Bursanatal suggests that it could be a plastic material for the construction of peptides, amino acids, and protein molecules with different morphological and immunological functions. At the same time, the amino acid composition and vitamin-mineral complex in Bursanatal suggest that it could modify the expression of target genes, thus playing an important role in signaling molecules and facilitating the regulation of homeostasis.

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