Study of the combined effect of a biologically active composition based on apiculture products and peptides extracted from fish scale in the training of athletes in speed and strength athletics disciplines

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Abstract. The efficiency indicators of using a biologically active composition based on apiculture products and low-molecular-weight peptides extracted from fish scales were studied. The food supplement for athletes was named "Apicoltonus". Spectrophotometry has shown that sardine scale peptides with molecular weight under 10 kDa with concentration of 1 mg/ml exhibit the greatest resistance to cytotoxicity when exposed to cobalt chloride on mesenchymal stem cells. The safety indicators of the food supplement "Apicoltonus" meet the requirements of the technical regulations of the Eurasian Customs Union. The physiological effect of the food supplement "Apicoltonus" on the body of female track and field athletes specializing in the long jump during the training process was evaluated. According to the results of clinical and biochemical blood tests of the testees a positive dynamics of growth in the levels of red blood cells, hemoglobin, total protein, calcium and iron was established, while reducing the content of urea, uric acid, lactate, total cholesterol and low-density lipoproteins. Improved adaptation of the test group to physical activity in terms of heart rate (HR) was noted. The positive effect of the bio-product on the speed and strength indicators of the athletes in terms of long jump from a standstill, triple jump from a standstill, long jump with 4 running steps, multi-jumps from foot to foot 30 m, shuttle run 3 to 10 m, run 30 m was indicated. It is recommended to use the bio-product for athletes and people with active lifestyle.

1. Introduction
Sports nutrition is a type of diet that includes natural food components and correctly calculated amount of supplements [1]. Proper nutrition is crucial for athletes to optimize his or her performance for training and competition. Future research should focus on increase in consumption of vegetables, fish/seafood, fruit and decrease in consumption of red meat as a source of protein as well as carbonated sugar-sweetened drinks [2].

Food scientists and dietitians should keep an eye on the trends shaping the food industry in order to understand consumer changes in preferences, expectations and dietary patterns; and to identify those areas that should be added to the research agenda [3].

Protein hydrolysates (PH) are rich sources of proteins for muscles. PHs are enriched in di- and tripeptides and are better than free amino acids or intact proteins when muscle anabolic effect is considered. Digestion, absorption and muscle uptake of amino acids are faster and more efficient when
PH is ingested in comparison to the respective intact protein. PHs not only enhance endurance in high intensity exercise regimen, but also help in faster post-exercise recovery of muscle by promoting glycogen synthesis, although the latter effect requires more convincing evidence [4].

Protein is a highly nutritious, commercially available alternative food source that is used primarily as a food supplement by athletes and physically active individuals to provide them with essential amino acids and bioactive peptides, and additional benefits have been attributed to the consumption [5].

Peptides of marine origin with molecular weight (MW) of less than 10 kDa have a pronounced pharmacological activity (tissue-specific, immune, antioxidant, antiseptic, anticoagulant, antistress, hypocholesterolemic, hypotensive) [6]. Thus, an increased transdermal permeability of fish scale collagen peptides was demonstrated using the cell diffusion model. At the same time, peptides with MW 3.5 and 4.5 kDa showed the highest penetrating cumulative capacity compared to the lighter peptides with MW 2.0 and 1.3 kDa, since they penetrated more effectively the stratum corneum of the epidermis and dermis, including fibroblasts, and accelerated the synthesis of their own collagen [7]. The use of low-molecular-weight fish scale peptides as immunomodulatory agents in the prevention and treatment of various inflammations and injuries of connective tissue associated with oxidative or inflammatory stress has also been proven to be appropriate [8].

Production technology and formulation of a biologically active composition using apiculture products and low-molecular peptides extracted from sardine scales (Apicolltonus bio-product) for athletes of speed and strength sports was scientifically substantiated at the Department of food biotechnology of the Kaliningrad state technical university [9].

The aim of the study was to establish the effectiveness of using this biologically active composition as sports nutrition, which is determined comprehensively by the combination of physical, chemical, clinical and biochemical parameters of female athletes (effect on mesenchymal stem cells, content of harmful substances, blood test results, performance, adaptation, recovery rate, etc.).

2. Material and methods

The object of the study was a protein-carbohydrate bio-product "Apicolltonus" recommended for nutrition of athletes of speed and strength orientation. Biologically active substances of the bio-product composition are represented by apiculture products (honey, pollen, bee bread, propolis) and low-molecular peptides of ichthyocollagen nature. Peptides were produced using a technology developed jointly with the German company ANiMOX GmbH by the method of enzymatic-thermal hydrolysis of sardine (Sardina) scales. This raw material is accumulated during the production of canned food at the fish processing plants in the Kaliningrad region [10,11].

Low molecular weight peptides were added to the composition of the biological product as a protein supplement containing 93% protein and 5% water. The fraction of peptides in the food supplement of molecular weight (MW) less than 10 kDa was 91.7% of the total protein fraction, of which 13.1% were peptides with MW 10-5 kDa; 62.7% with MM 5-1 kDa; 15.9% with MM 5-1 kDa. These peptides were separately evaluated for cytotoxicity induced by CoCl2 at various concentrations (0.01, 0.1 and 1 mg / ml) per adipose tissue mesenchymal stem cells (MMSC). This research was carried out by the scientists of the IKBFU Kant University PhD Levada K. and PhD Rodionov V. The absorption of the samples was estimated by the calorimetric method using WST-1 dyes at a wavelength of 450 nm [12]. The bio-product "ApikollTonus" before the tests with athletes was preliminarily assessed according to the safety indicators for compliance with the requirements of the technical regulations of the customs union TR CU 021/2011 at the accredited testing laboratory of OOO "Kaliningrad Center for Food Technologies and Testing".

Toxic elements such as lead, cadmium, arsenic and mercury were determined by stripping voltammetry by voltammetric analyzer AKV-07MK. Pesticides α, β, γ-isomers of hexachlorocyclohexane (HCCH), dichlorodiphenyltrichloroethane (DDT) and its metabolites, heptachlor and aldrin were detected by gas chromatography using specialized equipment "Crystal 2000M". Radionuclides cesium (Cs-137) and strontium (Sr-90) were determined using a universal
radiometer-spectrometer RSU-01 "Signal-M". Mass fraction of 5-hydroxymethylfurfural was detected by colorimetric determination in the presence of barbituric acid and paratoluidine using spectrophotometer PromEcoLab PE-5400-UV. Research of the physiological influence of "ApikollTonus" on the speed-strength indicators of athletes was carried out during the training process in the preparatory period of athletes (November). The study involved 12 athletes aged from 17 to 24 years practicing regular training (5 times a week for 1.5-2 hours a day) at sport school No. 4 "Specialized Children and Youth Sports School of the Olympic Reserve" in Kaliningrad, Russia. Athletes specialized in the speed-strength discipline of athletics "long jump". All athletes agreed to participate in the test. During the experiment the athletes were provided with the same volume of loads, regime conditions, nutrition and medical control. Before the test all the athletes passed in-depth medical examination at the medical and physical dispensary of the State Budgetary Healthcare Institution "Center for Medical Prevention and Rehabilitation of the Kaliningrad Region" and received a conclusion "healthy and admitted to training and competitions without load restrictions".

The athletes were divided into 2 groups of 6 people according to the results of the preliminary submaximal test "PWC 170":

1) control group with physical performance in the submaximal zone "PWC 170" = 148 W/min (below average); aerobic capacity in terms of maximum oxygen consumption (MOC) = 3.1 l/min; due MOC = 2.3 l/min; adaptation to endurance load "good"; type of adaptation for blood pressure (BP) "normotonic";
2) test group with physical performance in the submaximal zone "PWC 170" = 90 W/min (low); aerobic capacity MOC = 2.3 l/min; due MOC = 2.3 l/min; adaptation to endurance load "unsatisfactory"; type of adaptation for blood pressure "normotonic".

The test group consumed "ApikollTonus" in the amount of 15 g two times a day for one month once 30 minutes before training and then within 30 minutes after finishing their training. The athletes of the control group were in the normal diet. The repeated test "PWC 170" revealed changes in the level of aerobic capacity of the athletes of the test group up to the value of MOC = 2.7 l/min. Adaptation of the test group to the endurance load improved to "satisfactory". The recovery time for heart rate and blood pressure to the initial state was also reduced by 1 minute. The athletes of the control group did not have any changes in the recorded indicators. This test is not valid in assessing the impact of a given biological product on the speed and strength indicators of the athletes since the sports specifics are associated with short-term significant physical activity. In this regard, on the basis of the athletics arena Municipal autonomous institution "Palace of sports "Yunost" following indicators were evaluated:

1) test speed and strength indicators (long jump from a standstill, triple jump from a standstill, long jump with 4 running steps, multi-jumps 30 m, shuttle run 3x10 m, run 30 m);
2) heart rate was measured by Polar A300 Sports Watch heart rate monitor.

The influence of the bioproduct "ApikollTonus" on the body of athletes was simultaneously assessed by a clinical blood test using automatic hematological analyzer "MEK-6410K" and fixing some biochemical blood parameters by semi-automatic biochemical analyzer "Stat Fax 3300". Blood samples were taken in the test group at the beginning of the study, then after two and four weeks of daily intake of the bioproduct, in the control group it was done at the beginning and at the end of the study. Blood sampling was performed in the morning with empty stomach of the athletes at rest after a day of rest. The research program included determination of working capacity, recovery rate, biochemical control, daily medical monitoring with heart rate and blood pressure measurements.

3. Results and discussion

Professional activity of the athletes is daily associated with oxidative stress and other undesirable biochemical processes in the body caused by daily physical activity. In this work the protective effect of low-molecular-weight peptides that were added to the composition of the bioproduct was evaluated using mesenchymal MMSC stem cells. MMSC are multipotent cells that have high proliferative activity and ability to differentiate into mesenchymal cells (osteocytes, chondrocytes). The wide range
of biologically active actions of MMSCs has made them a popular source for cell therapy of various 
diseases. MMSCs are an excellent model for studying the cytotoxicity of various substances, as well 
as for evaluating the protective effect of biologically active compounds. Figure 1 shows that the low-
molecular fraction of the protein supplement in the composition of "Apicolltonus" at a concentration 
of 1 mg/ml significantly reduced the cytotoxic effect of CoCl$_2$ on the mesenchymal stem cells of 
adipose tissue. Cobalt chloride is a hypoxiemic, which causes the formation of reactive oxygen species 
and cytotoxicity [13].

The amino acid composition of the protein supplement includes tyrosine, proline, and cysteine 
amino acids with proven antioxidant properties [14]. Their concentrations in the additive are 1.89, 3.86 
and 0.65%, respectively. The protective effect of the low-molecular fraction of the protein supplement 
is obviously due to both the binding of the toxicant itself to the functional groups of amino acids and 
peptides as well as their antioxidant action against reactive oxygen species formed under the influence 
of CoCl$_2$.

![Figure 1. Effect of the low-molecular fraction of the protein supplement in the composition of 
"Apicolltonus" on the cytotoxicity of CoCl2 in relation to MMSC.](image)

The assessment of the quality of biological products by the content of toxic elements, pesticides, 
radionuclides and 5-oxymethylfurfural confirmed its food safety as a specialized sports nutrition 
product (Table 1).

| Indicator, units | Test norms | Results | Acceptable level value |
|------------------|------------|---------|------------------------|
| Toxic elements, mg/kg: | GOST R 51301-99 | 1.27±0.55 | Below 10.0 |
| - lead | GOST 31628-2012 | 0.47±0.16 | Below 12.0 |
| - arsenic | GOST R 51301-99 | 0.10±0.05 | Below 2.0 |
| - cadmium | GOST 26927-86 | 0.16±0.07 | Below 0.5 |

Pesticides, mg/kg:

| - HCCH | Measurement procedure MVI NM 3252-2005 | Less than 0.004 | Below 0.2 |
| - DDT and ist metabolites | Measurement procedure MVI NM 3252-2005 | Less than 0.005 | Below 2.0 |
Aldrin, mg/kg  
Guidelines MU 2142-80  
Not detected  
Not allowed  
(Less than 0.002)  
Heptachlor, mg/kg  
Guidelines MU 2142-80  
Not detected  
Not allowed  
(Less than 0.002)  
Radionuclides:  
- cesium-137  
GOST 32161-2013  
Less than 7  
130  
- strontium-90  
GOST 32161-2013  
Less than 3  
100  
Mass fraction of  
5-hydroxymethylfurfural, 
mg/kg  
GOST 19792-2001  
19.2±3.8  
Below 25

The following tables show the comparative results of the clinical blood analysis of female athletes in the control and test groups using "ApikollTonus" (Tables 2 and 3). According to the criteria of doping control guidelines "ApikollTonus" has no restrictions, its use was approved by the head of the department of medical control of the medical-physical dispensary S. Timoshenko as an object of physiological research.

### Table 2. Results of the clinical blood test of female athletes.

| Indicator                                | Norm (SI units) | Study period | Control group (n=6) |
|------------------------------------------|-----------------|--------------|---------------------|
|                                          | Study period    |              |                    |
|                                          | Start           | 2 weeks      | 4 weeks             |
| Leukocytes (LEU)                         | 4.0–9.0 × 10⁹   | 5.4 × 10⁹ ± 0.67 | 7.1 × 10⁹ ± 0.75    |
| Erythrocytes (RBC)                       | 3.9–5.0 × 10¹²  | 4.36 × 10¹² ± 0.06 | 4.23 × 10¹² ± 0.08  |
| Hemoglobin (HGB)                         | 120–140         | 138 ± 1.50   | 131 ± 1.17          |
| Hematocrit (HCT)                         | 39–49           | 40.8 ± 0.23  | 39.9 ± 0.21         |
| Average erythrocyte volume (MCV)         | 80–95           | 93.6 ± 3.82  | 94.3 ± 3.88         |
| Average hemoglobin content in erythrocyte (MCH) | 30–35          | 31.7 ± 1.91  | 31.0 ± 1.87         |
| The degree of saturation of erythrocytes with hemoglobin (MCHC) | 300–380        | 338 ± 0.76   | 328 ± 0.82          |
| Platelets (PLT)                          | 180–320         | 300 ± 6.79   | 320 ± 7.39          |
| The relative content of lymphocytes (LV) | 25–40           | 39.4 ± 2.15  | 25.4 ± 1.21         |
| Relative content of monocytes (MO)       | 4–11            | 3.9 ± 1.35   | 3.2 ± 1.31          |
| The relative content of granulocytes (GR) | 47–72           | 56.7 ± 2.38  | 71.4 ± 3.06         |
| Erythrocyte heterogeneity index (RDW)    | 11.5–14.5       | 12.4 ± 0.03  | 11.9 ± 0.04         |
| Thrombokrit (PCT)                        | 0.108–0.282     | 0.15 ± 6.14  | 0.16 ± 5.93         |
| Average platelet volume (MPV)            | 7–10            | 4.9 ± 0.09   | 5.1 ± 0.08          |
| Parameter                              | Value 1            | Value 2            | Value 3            |
|----------------------------------------|--------------------|--------------------|--------------------|
| Platelet heterogeneity index (PDW)     | 15–17              | 16.8 ± 0.06        | 16.3 ± 0.06        |
| Colour index                           | 0.85–1.05          | 0.95 ± 0.02        | 0.93 ± 0.02        |
| Neutrophils (NEUT):                    |                    |                    |                    |
| – stabs                                | 1–6                | 2 ± 0.3            | 2 ± 0.4            |
| – segmented                            | 47–72              | 54 ± 2.8           | 64 ± 3.1           |
| Eosinophils (EO)                       | 0.5–5              | 2 ± 0.3            | 2 ± 0.2            |
| Monocytes (MONO)                       | 3–11               | 2 ± 0.4            | 2 ± 0.4            |
| Lymphocytes (LYMPH)                    | 19–37              | 40 ± 5.8           | 30 ± 6.6           |
| Erythrocyte sedimentation rate (ESR)   |                    |                    |                    |
| Leukocytes (LEU)                       | 4.0–9.0 x 10⁹      | 5.9 x 10⁹ ± 0.66   | 6.1 x 10⁹ ± 0.67   |
| Erythrocytes (RBC)                     | 3.9-5.0 x 10¹²     | 4.26 x 10¹² ± 0.07 | 4.40 x 10¹² ± 0.07 |
| Hemoglobin (HGB)                       | 120–140            | 126 ± 1.35         | 132 ± 1.35         |
| Hematocrit (HCT)                       | 39–49              | 40.2 ± 0.22        | 39.2 ± 0.22        |
| Average erythrocyte volume (MCV)       | 80–95              | 88.2 ± 3.77        | 89.1 ± 3.79        |
| Average hemoglobin content in erythrocyte (MCH) | 30–35              | 29.8 ± 1.69        | 30.0 ± 1.68        |
| The degree of saturation of erythrocytes with hemoglobin (MCH) | 300–380            | 338 ± 0.73         | 337 ± 0.73         |
| Platelets (PLT)                        | 180–320 x 10⁹      | 215 x 10⁹ ± 5.21   | 194 x 10⁹ ± 5.40   |
| The relative content of lymphocytes (LV)| 25–40              | 36.0 ± 1.17        | 33.0 ± 1.16        |
| Relative content of monocytes (MO)     | 4–11               | 5.4 ± 1.34         | 4.2 ± 1.31         |
| The average content of granulocytes (GR)| 47–72              | 58.6 ± 2.30        | 62.8 ± 2.32        |
| Erythrocyte heterogeneity index (RDW)  | 11.5–14.5          | 12.7 ± 0.03        | 12.5 ± 0.03        |
| Thrombokrit (PCT)                      | 0.108–0.282        | 0.14 ± 6.05        | 0.12 ± 6.03        |
| Average platelet volume (MPV)          | 7–10               | 6.4 ± 0.07         | 6.3 ± 0.07         |
| Platelet heterogeneity index (PDW)     | 15–17              | 18.0 ± 0.06        | 18.0 ± 0.06        |
| Colour index                           | 0.85–1.05          | 0.89 ± 0.02        | 0.9 ± 0.02         |
| Neutrophils (NEUT):                    |                    |                    |                    |
| – stabs                                | 1–6                | 2 ± 0.03           | 1 ± 0.01           |
| – segmented                            | 47–72              | 52 ± 2.87          | 60 ± 2.90          |
| Eosinophils (EO)                       | 0.5–5              | 2 ± 0.27           | 1 ± 0.22           |
| Monocytes (MONO)                       | 3–11               | 4 ± 0.04           | 3 ± 0.04           |
| Lymphocytes (LYMPH)                    | 19–37              | 40 ± 5.54          | 35 ± 5.52          |
The results of clinical and biochemical analyses averaged using mathematical statistics are presented in Tables 2 and 3.

**Table 3. Results of biochemical blood analysis of the athletes.**

| Indicator | Norm (SI units) | Study period |
|-----------|-----------------|--------------|
|           | Control group (n=6) | Test group (n=6) |
| Amount of bilirubin: | | |
| – total | up to 20.5 | 11.4 ± 1.32 | 11.9 ± 1.35 |
| – direct | 1.0 ± 0.01 | 1.2 ± 0.03 | 1.1 ± 0.02 |
| – indirect | 11.3 ± 1.31 | 10.7 ± 1.32 | 10.7 ± 1.31 |
| Activity of alkaline phosphatase | up to 240 | 120.4 ± 1.53 | 120.4 ± 1.5 |
| Aspartate aminotransferase | 41 | 20.7 ± 1.33 | 22.0 ± 1.35 |
| Alanine aminotransferase | up to 41 | 15.1 ± 2.78 | 14.4 ± 2.77 |
| Creatinine | 53–97 | 92.6 ± 0.38 | 91.7 ± 0.37 |
| Sugar level | 3.9–5.6 | 5.3 ± 0.23 | 4.0 ± 0.28 |
| Lactate | 0.5–2.2 | 2.0 ± 0.21 | 1.83 ± 0.23 |
| Urea | 2.5–6.5 | 4.2 ± 0.41 | 3.5 ± 0.40 |
| Gamma-glutamyl transpeptidase | up to 38 | 10.1 ± 1.77 | 8.9 ± 1.82 |
| Total cholesterol | up to 5.17 | 5.45 ± 0.1 | 5.01 ± 0.08 |
The data in Tables 2 and 3 show that the results of the study did not reveal any harmful effects of the bio-product "ApikollTonus" on the body of athletes during the 4-week intake. At the same time, there was a positive dynamics of an increase in the level of red blood cells, hemoglobin, total protein, calcium and iron with a decrease in the level of urea, uric acid, lactate, total cholesterol and low-density lipoproteins in the blood of athletes from the test group. These effects were not observed in the control group. These research results can potentially be associated with the influence of the studied factors.

Table 4 shows the results of test speed-power indicators of athletes and the level of adaptation to physical activity in terms of heart rate as a result of the intake of "ApikollTonus" bio-product for 4 weeks.

| Indicator | Study duration, weeks | Control group (n=6) | Test group (n=6) |
|-----------|----------------------|---------------------|-----------------|
|            |                      | 2.61±3.2            | 2.56±2.8        |
| Long jump from a standstill, m | 0                    |                     |                 |
|            | 2                    | -                   | 2.58±2.7        |
|            | 4                    | 2.60±2.6            | 2.63±2.5        |
|            | 0                    | 7.55±2.5            | 7.52±3.1        |
| Triple jump, m | 2                    | -                   | 7.66±3.8        |
|            | 4                    | 7.61±3.3            | 7.75±2.5        |
|            | 0                    | 4.52±2.8            | 4.40±2.6        |
| Long jump with 4 steps,m | 2                    | -                   | 4.46±3.1        |
|            | 4                    | 4.50±2.6            | 4.62±2.7        |
| Multiple jumps from foot to foot | 0                    | 13/3.97±2.3        | 13/4.43±3.1     |
| 30 m, number / sec | 2                    | -                   | 13/4.18±2.9     |
|            | 4                    | 13/4.05±2.8        | 12/4.35±3.0     |
|            | 0                    | 6.90±3.26           | 7.34±2.86       |
| Shuttle run 3x10 m, sec | 2                    | -                   | 7.26±3.04       |
|            | 4                    | 6.94±2.88           | 7.03±3.69       |
|            | 0                    | 4.12±3.02           | 4.25±4.11       |
| Run 30 m | 2                    | -                   | 4.17±3.23       |
|            | 4                    | 4.05±3.55           | 4.01±2.99       |
Table 5. Evaluation of the effect of the bio-product "ApikollTonus" on the heart rate of athletes in comparative modes of physical activity.

| Duration of the study, weeks | Warm-up (15 min) | Special exercises (10 min) | Main training (60 min) | Recovery period (5 min) | Holdback (5 min) |
|-----------------------------|-------------------|---------------------------|------------------------|------------------------|-----------------|
|                             |                   |                           | Control group (n=6)    | Control group (n=6)    |                 |
|                             |                   |                           | 160.7 ± 2.3            | 120.3 ± 2.7            | 176.2 ± 4.8     | 85.6 ± 2.2 | 162.2 ± 3.3 |
| 0                           |                   |                           | 161.2 ± 3.1            | 119.4 ± 2.6            | 175.5 ± 4.1     | 85.0 ± 2.6 | 161.8 ± 3.2 |
| 4                           |                   |                           | 164.1 ± 2.6            | 121.9 ± 3.1            | 184.4 ± 4.4     | 96.1 ± 2.9 | 165.6 ± 3.2 |
|                             |                   |                           | 162.6 ± 2.4            | 121.0 ± 2.8            | 179.8 ± 4.6     | 92.3 ± 2.7 | 163.4 ± 2.8 |
| 2                           |                   |                           | 161.5 ± 2.5            | 118.5 ± 2.9            | 176.1 ± 4.7     | 86.0 ± 3.2 | 159.9 ± 2.8 |
| 4                           |                   |                           | 161.2 ± 2.3            | 120.3 ± 2.7            | 176.2 ± 4.8     | 85.6 ± 2.2 | 162.2 ± 3.3 |
|                             |                   |                           | 161.2 ± 3.1            | 119.4 ± 2.6            | 175.5 ± 4.1     | 85.0 ± 2.6 | 161.8 ± 3.2 |
|                             |                   |                           | 164.1 ± 2.6            | 121.9 ± 3.1            | 184.4 ± 4.4     | 96.1 ± 2.9 | 165.6 ± 3.2 |
|                             |                   |                           | 162.6 ± 2.4            | 121.0 ± 2.8            | 179.8 ± 4.6     | 92.3 ± 2.7 | 163.4 ± 2.8 |
|                             |                   |                           | 161.5 ± 2.5            | 118.5 ± 2.9            | 176.1 ± 4.7     | 86.0 ± 3.2 | 159.9 ± 2.8 |

Table 4 shows that the intake of the biological product made it possible to improve the speed-strength indicators of the female athletes of the test group in all test exercises. It was detected that the use of the biologically active composition "ApikollTonus" contributed to the improvement of the athletes' recovery after physical activity that is supported by the heart rate indicator after physical activity, which is similar to its initial level before the start of training (Table 5).

4. Conclusion
The complex positive effect of the biologically active composition "ApikollTonus" produced from apiculture products and low-molecular peptides extracted from fish scales on the organism of female athletes has been demonstrated.

Assessment of the quality of the bio-product by the content of toxic elements, pesticides, radionuclides and 5-hydroxymethylfurfural confirmed its food safety as a specialized sports nutrition product.

The protective effect of low-molecular peptides included in the composition of the biological product on mesenchymal stem cells was shown that indirectly indicates the activation of the regeneration process of the body musculoskeletal tissues, which are most susceptible to pathologies in athletes.

In the test group there was a positive dynamics of the results of clinical and biochemical blood tests: an increase in the level of red blood cells, hemoglobin, total protein, calcium and iron with a decrease in the content of urea, uric acid, lactate, total cholesterol and low-density lipoproteins.

Bio-product intake allowed to improve the speed and strength indicators of the athletes after physical training in terms of heart rate and blood pressure was detected.

The biologically active composition "ApikollTonus" can be recommended for use as a specialized product by the athletes of speed and power sports and people who lead an active lifestyle according to the results of the analysis of the indicators of its combined effects.

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