RELEVANT PROBLEMS OF SPORTS NUTRITION

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Abstract: Nutrition is one of the primary factors of achievements in sports and sportsmen's health, on par with methodological and psychological aspects of training. A special place in sports nutrition is occupied by biologically active additives (BAA) made with plant and animal raw materials, amino acids, ferments, other irreplaceable nutrients and minor food constituents – energy, fat, protein and mineral exchange correctors, considering their efficiency and availability. Biologically active substances of the food components are also able to stimulate compensatory-adaptive reactions, prevent trauma and numerous diseases in professional sports, protect from common cold and other viral diseases before and during competitions. Great attention is paid to the scientific approbation of BAA formulae, with consideration of age, gender, sport type and synergic effect of separate components on metabolic processes in human organism. New types of BAA's for sports nutrition have been developed. The formulae have been created on the basis of data from literature and research on characteristics of active ingredients and their influence on the metabolic processes during training, competitions and recreational activities. Organoleptic, physical and chemical, hygienic and toxicological customer properties have been examined. Regulated quality indices (including nutritional value), which establish functional goals, have been determined. Considering the directions of BAA testing, the characteristic of several sport types has been given. The distinctive features of nutritional support have been investigated. The efficiency of specialized products has been determined by their inclusion into the diet and observation of specific properties, which characterize metabolic processes in sportsmen's organisms. The developed products have passed anti-doping control. They have been included into the Federal register and approved in the practice of sport competitions.

Keywords: Sports nutrition, principles of creation, specialized products, efficiency assessment

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INTRODUCTION

Modern sports and training of sportsmen of higher qualification are characterized by the availability of two factors:
– physical and psychological stress, which generally reaches the limits of physiological functions;
– the necessity of applying different approaches to achieve the final result.

The latter is associated with an increase in general and special performance of athletes during training and competitions, the recovery of the organism after overstress, prevention of possible complications and adaptation breakdowns.

One of the primary solutions of the presented problem is the development of scientifically approbated diets with consideration of type of sport, age, gender, and other basic factors. There is a need for new types of specialized products (including BAA), based on the achievements of modern pharmacology and nutrition sciences, which aim at the increase of sports achievements, prevention of professional disease and preservation of health [1–3, 9].

MATERIALS AND METHODS

The materials of research have been constituent components and created on their basis experimental and production samples of BAA's - "Vasoton", "Arovitol', "Vitalife", "Discovery", "Yohimbe Plus" complex, as well as representative groups of athletes.

Conventional assessment methods of organoleptic and physical and chemical quality indices have been used. Vitamin value tests have been performed with the use of spectrophotometry, high-efficiency liquid chromatography and fluorometry [8]. The criteria of safety have been estimated according to the requirements of technical regulations [11].

To evaluate the effectiveness of the developed products well-known and special clinical research methods have been used. They characterize the BAA

quality and the condition of metabolic processes of athletes.

The effectiveness evaluation of BAA "Discovery" and complex "Yohimbe Plus" was performed on a group of highly qualified swimmers (18 men, age 18.7 ± 1.7 years, height 1.86 ± 0.08 m, weight 74.6 ± 5.7 kg, experience 10.8 ± 1.7 years). Out of them 10 men were in the experimental group, and 8 were in the control group. The following parameters were investigated: level of performance using the electronic diagnostic complex "ART-2", external respiration analysis systems "BECKMEN" and "CORTEX", cardio-monitoring system POLAR ELECTRO "ACCUREX PLUS". The sportsmen performed rowing motions in several tests: 10 rows with maximal intensity (T-10), 1 minute with "competition" intensity (T-1) and multi-stage test - 10 tests 1 minute each with growing intensity. In these tests power measurements, heartbeat rate, oxygen consumption rate, lung ventilation were observed.

The effectiveness of BAA's "Discovery Strength" and "Lecitina" is studied on a group of 10 sportsmen during training for the Russia Championship and World Championship - 5 candidate masters of sports (a degree in Russian sporting awards scale), 4 masters of sports and 1 master of sports of the international level in skiing. The primary goal of training was the achievement of highest competitive condition of sportsmen by the middle of December and its retention until the middle of March.

RESULTS AND ANALYSIS

Present data from literature and research allowed composing the basic principles of sports nutrition [4–7, 10]:

– supply of the necessary amounts of energy to sportsmen according to energy expenditure during physical exertion;

– adherence to the principles of balanced nutrition in connection with certain types of sports and intensity of exercise, including the distribution of calories among basic food substances (which changes severely depending on the stage of preparation for the competitions); correlation of quantity and quality of amino acids composition in protein products; retention of expedient relations in fatty-acidic formula of diet, based on deep research of the influence of fats on lipidic metabolism in the whole organism or separate organs, cells and membranes; rational relations of mineral substances; balance of primary food substances, vitamins and microelements;

– choice of adequate forms of nutrition (products, food substances, their combinations) for periods of intense exercise, preparation for competitions, competitions themselves and recovery.

– use of inductive influence of food substances for activation of aerobic oxidization and associated phosphorylation, transglicosidatic processes, coenzymic forms, ATP reactions, accumulation of monoglobin and other metabolic processes that are especially important in physical exercise;

– use of food substances to build metabolic background, which is beneficial for bio-synthesis and realization of humoral regulators (catechins, prostaglandins, corticosteroids etc.);

– use of alimentary factors for accelerated muscle growth and strength increase;

– choice of adequate nutrition timetable , corresponding with the exercise schedule;

– use of alimentary factors for quick weight loss when adjusting the sportsman to the weight category;

– development of principles of nutrition individualization, depending on anthropomorphic-typometric, physiological and metabolic characteristics of the sportsman, condition of their digestive system, tastes and habits, allergic reactions to nutrients and their complexes.

Considering the principles mentioned, the specialized products of the examined function may serve the following purposes: nutrition in transit and between training sessions; acceleration of organism's recovery after training and competitions; mineral exchange regulation and thermal regulation; sportsman's weight correction; targeted development of muscle mass; reduction of daily ration during competitions; change of quality orientation of daily ration depending on the training exercise or during the preparations for competitions; individualization of nutrition, especially in cases of great psychological stress; urgent correction of unbalanced diet; increase of nutritional value during multi-step training.

It is shown, that correct sportsmen's diet allows increasing their capacity to adapt to extremely high levels of stress, achieving greater results, accelerating recovery processes of the organism, improving its function after intensive exercise, establishing higher psychological resilience[1–2].

Rational methodology of sports nutrition calls for specialized food rations, which include standard consumer food products combined with enriched products and BAA's that allow compensating a relative deficiency of necessary substrates, physiologically active substances and their complexes.

Consequently, the current accumulated experience in specialized sports nutrition enables to increase their capacity to adapt to extremely high levels of stress, achieving greater results, accelerating recovery processes of the organism, improving its function after intensive exercise, establishing higher psychological resilience.

In this work, scientifically approbated formulae and technology for specialized nutrition of sportsmen of different qualification in different activity periods were developed: BAA's "Discovery Strength", "Lecithin", "Yohimbe Plus", "Discovery", "Arovitol", "Vitalife".

Qualitative and quantative structure of the BAA formulae is developed on the basis of research of the pharmacological properties of their active components and their involvement in the metabolic processes in sportsman's organism with consideration of their combined synergic effect.

On the basis of organoleptic and physical-chemical research the regulated quality parameters of the developed product were determined (tables 1–4).

Formula of BAA "Discovery" consists of two pill forms, which include:

Form 1: manganic sulfate, cupric citrate, potassium iodate, ammonium vanadate, sodium molybdate sodium metasilicate, quercetin, calcium pantothenate, cholecalciferol, cyanocobalamin, thiamine mononitrate, papain, hesperidin, sodium selenite, rutin, nicotinamide, folic acid, pyridoxine chlorhydrate, riboflavin, tocopheryl acetate, retinol acetate, "CHROME-BIO" – raw material, alimentary trihydrate zinc zitrate, food additive "Sibel" (dihydroquercetin), ginkgo biloba (dry extract), hill saltwort (dry extract), beta-carotene 20% FS, food additive for protease "Bromeline 1200", coenzyme Q_{10}, ferric pyrophosphate, food additive "Sodium ascorbate", meal of milk thistle fruit (dried extract), silver sulphate, biotin, raw materials for BAA "FRUITEX-B™" – fruitoborate.

Form 2: parsley leaf, magnesium oxide, food additive "Redivivo (licopin)", alimentary trihydrate zinc zitrate, tea hedysarum (dry extract), prairieweed (dry extract), chinese magnolia vine (dry extract), reishi mushroom, damiana.

Regulated quality indices of the BAA are presented in tables 1–2.

Table 1. Regulated quality indices of the BAA "Discovery Strength" (Form 1)

Index name	Index value
Appearance	Pill
Color	Yellow
Taste and scent	Peculiar
Average mass, g	0.8±5%
Disintegration time, minutes, max	30
Durability to breaking, N, min	90
Durability to attrition, %, min	97
Content of one pill, mg:	
Vitamin A	0.50 (0.42–0.57)
Vitamin E	5.0 (4.2–5.7)
Vitamin D_3	0.0025 (0.0021–0.0028)
Vitamin C	35 (30–40)
Vitamin B_6	1.00 (0.85–1.15)
Vitamin B_1	0.75 (0.64–0.86)
Vitamin B_2	0.90 (0.76–1.04)
Vitamin B_3	10.0 (8.5–11.5)
Vitamin B_5	2.5 (2.1–2.8)
Vitamin B_9	0.10 (0.08–0.12)
Chromium	0.025 (0.021–0.028)
Selenium	0.035 (0.029–0.04)
Copper	0.50 (0.42–0.57)
Manganese	1.00 (0.85–1.15)
Iron	7.0 (5.9–8.0)
Zinc	7.5 (6.4–8.6)
Iodine	0.075 (0.064–0.086)
Vanadium, mcg	20 (15–25)
Boron	1.00 (0.85–1.15)
Silver, mcg	15 (10–20)
Silicon	2.5 (2.1–2.8)
Molybdenum, mcg	22 (18–33)
Rutin	15.0 (12.0–17.5)
Quercitin	15.0 (12.0–17.5)
Hesperdine	10.0 (8.5–11.5)
Flavone glycosides, min	2.4 (2.1–2.8)
Coenzyme Q_{10}	0.8 (0.5–1.0)
Flavolignanes (silibinin)	5.0 (4.2–5.7)
Beta-carotene	0.87 (0.74–1.00)
Proteolytic activity, F.I.P/g, min	3.0

Table 2. Regulated quality indices of BAA "Discovery Strength" (Form 2)

Index name	Index value
Appearance	Round pills
Color	Light grey
Taste and smell	Peculiar
Average mass, g	0.8 ± 0.5%
Disintegration time, minutes, max	30
Durability to breaking, N, min	90

Table 2. Ending. Regulated quality indices of BAA "Discovery Strength" (Form 2)

Index name	Index value
Durability to attrition, %, min	97
Content of one pill, mg:	
Lycopin	0.25 (0.21–0.29)
Zinc	0.25 (2.20–2.80)
Magnesium	200 (180–220)
Polysaccharides	9.5
Schizandrin	0.24
Tannins, min	1.6

Granular soya lecithin (corresponding to the requirements of SEC 77.99.916.Д.003770.06.03) was used as a raw material for BAA "Lecithin". Regulated quality indices of the developed product are presented in table 3. Complex "Yohimbe Plus" includes: starch, zinc oxide, royal jelly, ginger root, panthogematogen, vitamin E, ginseng root, flagroot, microcrystallic cellulose, carthamoid rhapontic, ginkgo biloba (extract), yohimbe (bark extract).

Regulated quality indices of the BAA are presented in table 4.

Formula of BAA "Discovery" includes: ferric sulfate, copper sulfate, potassium chloride, magnesium oxide, L-phenylamine, zinc oxide, sodium molybdate, cayenne pepper, parsley leaf, DNA, RNA, wheat sprouts, lactic bacteria, damiana, spirulina, raspberry leaf extract, maitake, nettle leaf, knot-grass, ginseng root, dandelion root, laminaria, lemon (bioflavonoids), histidine, aloe vera, calcium carbonate, pancreatin, microcrystallic cellulose, inositol, sodium selenite, L-glycin, papain, L-lysin, horse sorrel root, lipase, p-amino-benzoic acid, L-alanine, hesperidin, rutin, bromeline, lucerne grass, L-valine, L-threonine, L-tyrosyne, L-leucine, L-glutaminic acid, asparaginic acid, L-serine, L-proline, L-arginine, L-cysteine, premix 730/4, coenzyme Q_{10}, cola nut, choline bitartrate, chrome picolinate, cat's claw bark, pycnogenol, methionine.

Regulated quality indices of the BAA are presented in table 5.

Table 3. Regulated quality indices of BAA "Lecithin"

Index name	Index value
Appearance	Plain granules
Color	Yellow
Taste and smell	Peculiar
Phospholipids content, %, min	93
Peroxide value, moles of active oxygen/kg, max	10
Acid number, mg of KOH/g, max	35

Table 4. Regulated quality indices of BAA "Yohimbe Plus"

Index name	Index value
Appearance	Oval pill
Average mass, g	0.47 to 0.53
Color	Brown and red
Taste and smell	Peculiar, consistent with the formula
Disintegration time, minutes, max	30
Durability to breaking, N, min	90
Durability to attrition, %, min	97
Zinc content per 1 pill, mg, min	2.0
Vitamin E content per 1 pill, mg, min	10.0

Table 5. Regulated quality indices of BAA "Discovery"

Index name	Index value
Appearance	Oval pills
Average mass, g	0.47 to 0.53
Color	Green and grey
Taste and smell	Consistent with raw materials
Disintegration time, minutes, max	30
Durability to breaking, N, min	90
Durability to attrition, %, min	97
Content of one pill, min:	
Vitamin C, mg	12.5
Selenium, mcg	12.5
Chrome, mcg	42.0

Studying the safety parameters of the BAA has shown their correspondence with the actual sanitary-hygienic documentation.

Vasoton. A capsular BAA form, containing 0.5 g of L-arginine. The influence of the amino acid on the functional state of the organism is connectd to the following metabolic aspects:

– It is one of precursors of nitrogen oxide, which plays a key role in the functioning of CVS. L-arginine supplies with nitrogen the system of enzymes called NO-synthases, which synthesize NO, or nitrogen oxide. NO is a mediator of miorelaxation of arterial vessels. It is called an endothelial relaxation factor due to its ability to relax smooth muscles in blood vessels. It prevents adhesion and aggregation of thrombocytes - elements necessary for blood coagulation. In some cases their abundance may lead to heart disease and blood clots;

– It removes the dysfunction of blood vessel endothelium, restores the smooth muscles' relaxation ability (vasodilative, angioprotective, antiproliferative, disaggregative factors), thus ensuring the synthesis of NO;

– It is involved in the cycle of reamination (transamination) of amino acids, synthesis and extirpation of urea - the product of breakdown of proteins and amino acids. The blood vessels, the liver and the kidneys are cleared of toxic substances and may function normally;

– It stimulates the synthesis of the somatotropic hormone ("the growth hormone"), and through it the synthesis of proteins, regeneration of damaged tissue - tendon sprains, muscle trauma etc.;

– It plays a key role in the metabolism of muscles, able to increase their relative strength and muscle mass, at the same time decreasing fat;

– It stimulates the synthesis of anabolic hormone - insulin, serves as a precursor of creatine, which, joining with the phosphate group, creates phosphocreatine, which holds more energy and is necessary for maximal muscle power. All these factors support and stimulate the immune system.

– It possesses a psychotropic effect, intensifies spermatogenesis, giving a motivated mood, activity, and endurance - important factors for sport achievements.

Considering the role of L-arginine in metabolism, the following areas for utilizing of BAA "Vasoton" were designated:

– Optimization of coronary and periphery blood flow during extreme physical exertion, during training or competitions, especially with maximal or sub-maximal intensity;

– Acceleration of post-exertional restoration by synthesis of the metabolite - the product of breakdown of worked-out protein and amino acids.

– Stimulation and synthesis of hormones - somatotropic hormone and insulin for acceleration of protein synthesis, regeneration of damaged tissue, intensification of growth of young sportsmen, digestion of sugars and synthesis of glycogen;

– Intensification of synthesis of creatine (phosphor-creatine precursor) in liver, as well as glycine and methionine;

– Support of the immune system in times of great physical and psychological stress.

Recommendations for application were developed:

– Myocardial overstress (especially with symptoms of ischemia);

– Reduction of alactatic, lactatic, aerobic endurance, fatigue after extreme exertion, especially with maximal or sub-maximal intensity;

– Damage and inflammation of muscle tissue, tendons and connective tissue;

– Interruption of biological development with insufficient growth dynamic;

– Impairment of blood vessel function after intensive exertion;

The BAA is recommended for inclusion into the diet of the sportsmen, 1–2 capsules 2–3 times per day, for 2–3 months. The course can be repeated if necessary. It is classified as a substrate additive.

Arovitol - tableted form of BAA, a vitaminic complex in a form of chewing tablets 1.2 g each. It contains crushed fruit of the chokeberry tree and 12 vitamins (B1-0.6; B2-0.57; B6-0.6; E-2.5; C-60; B12-1.2 mcg; B5-0.12; Bc-0.12; H-0.073; niacene – 6.6; D3-147 IU; A – 166 IU; mg/1 tablet)

Chokeberry is a relatively rich natural source of biologically active substances: vitamins (P, C, E, K, B1, B2, B6, beta-carotene), macro- and microelements (iodine, iron, copper, manganese etc.), carbohydrates (glucose, fructose, sacharose), pectic and tannic substances, organic acids, bioflavonoids.

The content of P-vitamin active flavonoids in chokeberry is 2 times greater than in blackcurrant, 20 times greater than in apples or oranges. Those are catechins, flavones, hesperidin, rutin, quercetin, cyanidine etc., which are involved in bioregulation and stimulation of physiological functions in the organism, especially the reinforcement of blood vessel, increasing their elasticity and flexibility. The content of these substances may reach 2%.

Pectic substances of chokeberry (up to 0.5%), possess sorptive properties regarding heavy metals, toxic radioactive substances, remove various pathogenic microorganisms. Pectins normalize bowel functioning, improve the peristalsis of digestive system, accelerate mass peristaltic movement, remove spasms, improve the condition of large intestine, bind bile acids, provide the biligenic effect and reduce the probability of cholelithiasis.

Chokeberry exceeds tangerines, strawberry, raspberry and redcurrant in content of organic acids.

The content of iodine in chokeberry is 3-5 times greater than in blackcurrant, raspberry, gooseberry, strawberry and apples.

The natural properties of chokeberry are supported by the synergic influence of additional complex of vitamins, which protect the organism from various diseases, increase antioxidant properties, increase blood vessel flexibility, and normalize blood formation. The BAA is recommended for prevention and supportive therapy of cardiovascular diseases, correction of other impairments:

– strengthens blood vessels, increases their flexibility, increases tonicity;

– improves capillary blood flow;

– normalizes heightened arterial pressure;
– correct fat exchange, decreases cholesterol;
– normalizes intestine function;
– facilitates the removal of toxic metabolic products and radioactive substances;
– decreases the hyper-function of thyroid.

The BAA may be used for treatment of hypovitaminosis and avitaminosis, especially in winter and spring.

The total activity of natural components strengthened with the vitaminic complex, opens the possibility for sportsmen of any qualification (as well as people with active lifestyle) to use "Arovitol.". The maintenance of vitamin-mineral balance during training and competitions, as well as during restorative periods after exertion in aerobic and mixed areas of varying intensity and duration, allows achieving the following effects:
– removal of damage form toxic metabolites during restoration;
– improvement of capillary blood flow, prevention of cardiovascular diseases, chance of which may increase due to various biochemical and functional abnormalities, which appear with physical exertion of high intensity;
– facilitation of normalization of arterial pressure, which may increase during physical stress.

It is recommended to use the BAA on all stages of training and competitions: 1–2 tablets 2–3 times per day following meals for duration of 2–3 months. The course may be repeated after 2–4 months.

Vitalife. A series of vitaminized drink powders "Vitalife" are made using local natural materials. A selection of macro- and micronutrients is made with consideration of acquired experience in the field of sports nutrition and their synergic influence on metabolic processes in various periods of competitive activity.

Organoleptic and physical-chemical research was carried out during production and storage, which allowed establishing the regulated quality indicators (tables 6 and 7), including nutritional value (table 8).

Table 6. Organoleptic quality indices of vitaminized drink powder "Vitalife"

Index name	Characteristics
Appearance	Intimate plain dry substance. Clots are acceptable if they dissolve during intensive mixing
Color	Similar to the color of fruit and berry extracts used
Taste and smell	Smell of the corresponding flavoring agent, sour and sweet taste

Table 7. Physical-chemical quality indices of vitaminized drink powder "Vitalife"

Index name	Value of indicator
Mass fraction of moisture, %, max	3.0
Mass fraction of titrated acids (by malic acid), %, min	2.0
Preparation time, minutes, max	15.0

Table 8. Vitamin value of soft drink powder "Vitalife"

Content, mg	Per 100g of dry powder	Per one glass (100 cm^3) of the drink	% of daily requirement
Vitamin C	85.0	17.0	24.3
Nicotinamide	21.5	4.3	21.5
Vitamin E	12.5	2.5	25.0
Calcium pantothenate	8.75	1.75	25.0
Vitamin B6	2.5	0.5	25.0
Vitamin B2	2.125	0.425	24.0
Vitamin B1	1.75	0.35	23.4
Vitamin A	1.75	0.25	25.0
Folic acid	0.5	0.1	50.0
Biotin	0.25	0.05	33.4
Vitamin D3, IU	500.0	100.0	50.0
Vitamin B12, mcg	3.75	0.75	25.0

The drink also contains carbohydrates (sugar, glucose), extract (condensed juice) of sea buckthorn, chokeberry and viburnum.

Biologically active ingredients of sea buckthorn, chokeberry and viburnum (pectic substances, bioflavonoids, water-dissolving vitamins, organic acids, microelements) supplement the introduced vitaminic complex, increase their physiological influence on a human body:
– Replenishment of digestible carbohydrates;
– Prevention of hypovitaminosis;
– Increase of organism's resilience during psychological and physical stress, in adverse environments.

Bioflavonoids and pectic substances in extracts (condensed juices) of chokeberry:
– Normalize bowel functioning, improve the peristalsis of digestive system, accelerate mass peristaltic movement, remove spasms, improve the condition of large intestine;
– Bind bile acids, provide the biligenic effect and reduce the probability of cholelithiasis;

– Possess sorptive properties regarding heavy metals, toxic radioactive substances.

Considering the role of ingredients in metabolism, the following areas for utilizing of BAA were designated:

– Supplement of carbohydrates after exertion in aerobic and mixed areas of varying intensity and duration;

– Maintenance of vitamin-mineral balance during physical exertion in designated areas, as well as during restoration;

– Improvement of adaptation of sportsman's organism and acceleration of restoration after extreme physical and psychological stress by introduction of biologically active substances from extracts and juices.

Recommendations for application were developed:

– During exertion in aerobic area of energy supply: 30 g of drink powder in 300 ml of still water 30 minutes before exercise;

– During exertion in mixed area of energy supply: 30 g of drink powder in 200 ml of still water 30 minutes before exercise and 10 g of drink powder in 100 ml of water divided into 3–4 small portions during the exercise;

– 20 g of drink powder in 200 ml of water after the exercise to restore liquid balance and maintain vitamin-mineral balance.

Average recommended daily dosage during extreme physical stress is 60 g of drink powder in 600 ml of still water.

Not being restricted by any anti-drug regulations, the BAA is recommended for regular use in sports nutrition during training and exercise, including periods of extreme physical exertion as a means to maintain an energy supply, compensate the loss of liquids and vitamin-mineral substances, especially in cyclic or endurance sports to increase aerobic endurance, shorten the period of restoration after exertions.

The developed product has been analyzed with procedures of anti-doping control by methods of gas chromatography and mass-spectrometry in correspondence with the requirements of WADA. Expert resolutions for BAA usage in sports nutrition have been acquired from anti-doping center (Moscow), All-Russian Scientific Research Institute of Physical Culture and Sports (Moscow).

The choice of the separated or complex application of the developed BAA is made by sportsman's doctor and trainer with consideration of sportsman's state and specifics of training routine.

Merchantability evaluation of the specialized products including sports nutrition involves clinical studies, which are carried out to examine priority consumer properties. The natural observations are performed with consideration of specifics of the sport type, qualification level, the period of competition, age, gender and other factors that influence the metabolism in sportsman's organism.

Despite the abundance of methods of sports therapy, the key role is played by products with specialized metabolic effect, which are BAA's with scientifically approbated complex of vitamins, minerals, and other biologically active compounds with synergic influence. The efficiency of such BAA's is connected to different aspects of optimal relation between the processes of exertion and restoration, which are responsible for long-term physiological adaptation to physical stress. The ability to control said processes is one of the most important factors of training efficiency, improvement of sportsman's proficiency and sports achievements, at the same time preserving health during intensive training and competitions.

Considering the areas of BAA tests it is necessary to characterize particular sports disciplines - swimming and skiing.

Swimming. Swimming is a cyclic sport type, which has specific features in training and competitions.

The training process is characterized by high intensity, duration (up to 4 hours) and high movement frequency of exercises, which places special requirements upon sportsmen's nutrition (Sharp.2000):

– High energy supply (average energy loss during single 4-hour training session is 4000–5400 kcal for men and 3400–4000 kcal) (Sherman&Maglisho, 1992);

– Carbohydrate consumption not less than 600 g per day. Shortage of carbohydrates leads to insufficiency of glycogen in muscles, resulting in overstress and weaker results. Glycogen replenishment after physical stress is influenced by following factors: exercise type, carbohydrates quantity, their type, time of consumption of carbohydrate components and their quantity, combination with other nutritional components;

– Protein nutrition is highly important due to intensive training leading to the breakdown of proteins. Average protein consumption norm for swimmers is 1.5–2 g per kg of body weight, which ensure muscle catabolism at glycogen exhaustion.

Skiing. Considering present knowledge of muscle metabolism, this sport type may be characterized from the following standpoints:

– Muscle metabolism generally follows the aerobic path;

– Long duration of races leads to the exhaustion of glycogen;

– Maximal cardiovascular stress.

In skiing, the competitions are held on rugged terrain, which leads to functional and biochemical shifts in organism. Sportsmen of high qualification level develop high muscle metabolism, where high-oxide fibers with developed capillary network is dominating. This leads to faster gaseous metabolism and transfer of substances from blood to muscle cells, making aerobic metabolism more efficient.

High energy expenditure is characteristic to ski sportsmen during both training and competition. This problem is solved by three meals a day diet and additional nutrition.

Restoring the exhausted glycogen supply is also necessary after continuous and intensive work. Consumption of carbohydrate-rich products after exercise and before sleep is critical to glycogen resynthesis.

Liquid consumption of the sportsmen, despite low environment temperatures, reaches up to 8-10 l of water per day, which is justified by increased sweat secretion. Especially effective are carbohydrate drinks, consumed during the race.

The research performed and the present literature data enabled to define primary effects of components

of BAA "Discovery" and complex "Yohimbe Plus", which may serve as a nutritional supplement for the organism in addition to the regular diet.

Clinical studies of BAA's are performed on a group of highly qualified swimmers in collaboration with All-Russian Scientific Research Institute of Physical Culture and Sports Medicine (Saint-Petersburg).

Experimental group consisted of 10 swimmers; control group consisted of 8 swimmers.

The swimmers from experimental group consumed the BAA's in addition to the regular diet for duration of 20 days: BAA "Discovery" - 3 pills, complex "Yohimbe Plus" - 1 pill at breakfast and dinner. The control group received no BAA's. All examined received similar regular diet, were practically healthy and trained according to schedule. The research took place during the spring period. The sportsmen performed rowing motions in several tests: 10 rows with maximal intensity (T-10), 1 minute with "competition" intensity (T-1) and multi-stage test - 10 tests 1 minute each with growing intensity. In these tests power measurements, heartbeat rate, oxygen consumption rate, lung ventilation were observed.

The most prominent differences were observed in tests T-10 with maximal intensity and T-1 with competitive intensity. In experimental group the average cycle power has prominently changed from 171.3 ± 26.8 W (T-10) to 180.0 ± 31.8 W after receiving the treatment ($p<0.05$). In control group these changes were not prominent: from 148.3 ± 40.8 W to 146.4 ± 28.1 W.

In test T-1 average cycle power in experimental group prominently changed from 134.5 ± 20.3 W to 139.2 ± 23.4 W ($p<0.05$). In control group the value hasn't changed: 126.0 ± 17.8 W и 127.3 ± 17.4 W respectively.

It is known, that during developmental exercise the use of products, which regulate protein synthesis in muscle tissue, is recommended. During the experiment with BAA "Discovery" and complex "Yohimbe Plus" the increase in rowing motion power due to improved metathesis was observed. The creatine phosphokinase path of ATP resynthesis plays a key role in energy supply of a short-term work of maximal intensity for duration of 15–30 s (test T-1) (Volkov N.I. etc., 2000) ATP supply by creatine phosphate is limited by their supplies, which depend on creatine supply. The sources of creatine are meat, liver etc., and its synthesis in liver from amino acids arginine, glycine, and methionine. Consequently, one of the ways to increase the power of sportsmen's work (10 rows) may be introduction of BAA "Discovery", which supplies a complex of necessary amino acids (including creatine and methionine synthesizing), into the diet.

The acquired data show practicability of using the combination of BAA "Discovery" and complex "Yohimbe Plus" during the basic period of training, when one of the primary tasks of training exercise is increasing the power of swimmers' motions. It should be noted, that the comprised formula of used products allows foregoing the use of other vitaminic complexes, the amount of which is usually 5 or 6.

Unlike pharmaceuticals, which include biologically active substances in amounts 10–100 times higher than a daily dosage and which are introduced into the organism by mouth or parenterally, BAA's are designed for people with physical and psychological stress and are used to remove deficiency of these substances in limits of human physiological need and they are consumed only with food.

Clinical tests of efficiency of BAA "Discovery" and "Lecitina" are performed in collaboration with specialists from the regional sports prophylactic center by introduction of the BAA into the diet of skiers from the Krasnoyarsk State University team during training in preparation for the Russia championship and world championship in skiing. Ten sportsmen took part in the experiment: 5 candidate masters of sports (a degree in Russian sporting awards scale), 4 masters of sports and 1 master of sports of international level. The primary goal of training was the achievement of highest competitive condition of sportsmen by the middle of December and its retention until the middle of March. During this period several stages of major Russian and international competitions take place. Therefore the quantity, intensity and quality of training exercise during winter are constant.

The sportsmen used BAA "Lecitina" (1 teaspoon two times per day) and "Discovery" (1 pill two times per day) in their diet for the duration of 25 days. Recommendations were provided by nutritiologists from company "ArtLife". The quantity and quality of the completed work were compared with the corresponding values of the same sportsmen from the previous month. The functional exercise quantity of this group was determined with ECG control immediately after the exercise. A correction of the exercise quantity was performed to achieve the maximal training effect without overloading the sportsmen.

A prominent increase of cyclical load quantity by 30% during the experimental period was observed. The average load quantity increased from 478 km in January to 623 km in February. The change in work quality manifested itself in increase of high-intensity work percentage from 16% (77 km) in January to 33 % (204 km) in February. High-intensity work is a skiing exercise with heartbeat rate of 170 per minute or more. The dynamic of high-intensity performance in control and experimental periods is illustrated in Fig. 1.

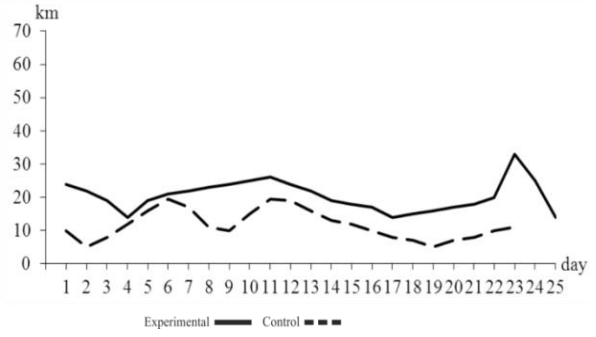

Fig. 1. The dynamic of high-intensity performance by training days in experimental and control periods.

The results of the experiment performed were not only the ability of sportsmen to withstand greater amounts of training work, but also the improvement of psychological resilience. It is evident from the achievements of the experiment participants in the world and state championships in skiing, which were the highest throughout the whole sports career.

The product has been tested and approved and is being produced by pharmaceutical company "Altaivitamins" (Biysk) and SPA "ArtLife" (Tomsk). The stability of the quality and safety of BAA's are ensured by the development and implementation of the management systems according to the requirements of the international standards ISO 9001:2000;22000:2005 and GMP rules.

REFERENCES

1. Avstrievskyh, A.N., Vekovcev, A.A., and Poznyakovskiy, V.M., *Produkty zdorovogo pitaniya: novye technologii, obespechenye kachestva, effectivnost' primeneniya* (Products of healthy nutrition: new technologies, quality assurance, application efficiency), Novosibirsk: Sib. Univ. Publ., 2005. 416 p.
2. Kalinin, V.M., and Poznyakovskiy, V.M., *Aktualniye voprosy pitaniya: vitaminy i mineralnye veshchestva pri zanyatiyah phiskulturoi i sportom: monografiya* (Modern issues of nutrition: vitamins and minerals for physical exercise and sports: monograph), Tomsk: Tomsk State Univ. Publ., 2008. 160 p.
3. Latkov, N.Yu., and Poznyakovskiy, V.M., *Makro- i mikronutrienty v pitanii sportsmenov: monografiya* (Macro- and micronutrients in sportsmen's nutrition: monograph), Kemerovo: Kemerovo Institute of Food Technology, 2011. 172 p.
4. Latkov, N.Yu., Poznyakovskiy, D.V., and Avstrievskyh, A.N., Experimentalnoe obosnovaniye I prakticheskaya realisatsia ratsionov pitanya dlya sportsmenov razlichnoy qualificacii (Experimental justification and practical realization of diet for sportsmen of various qualification), *Tekhnika i tekhnologiia pishchevykh proizvodstv* (Food Processing: Techniques and Technology), 2010, no. 3, pp. 77-81.
5. Latkov, N.Yu., Trubchaninov, S.A., and Koschelev, Yu.A., Suhie vitaminizirovannie napitki dlya sportivnogo pitanya: reglamentiruemiye pokazately kachestva, effectivnost' (Vitaminized drink powders for sports nutrition: regulated quality indicators, efficiency), *Polzunovskij vestnik* (Polzunovsky Vestnik), 2011, no. 3 / 2, pp. 109-113.
6. Latkov, N.Yu., Poznyakovskiy, D.V., and Avstrievskyh, A.N., Specializirovannye produkty dlya pitanya sportsmenov: tovarovednaya harakteristika, effektivnost' (Specialized products for sportsmen's nutrition: merchantability evaluation, efficiency), *Tovaroved prodovol'stvennyh tovarov* (The expert in the field of foodstuff), 2011, no. 11, pp. 25-30.
7. Latkov, N.Yu., Koshelev, U.A., and Poznyakovskiy, V.M., Issledovaniye potrebitel'skyh svoystv I aprobacia novogo sportivnogo napitka (Research of consumer properties and approbation of the new sports drink), *Tovaroved prodovol'stvennyh tovarov* (The expert in the field of foodstuff), 2014, no. 7, pp.15-18.
8. Tutel'an, V.A., and Eller, K.I., *Metody analysa minornih biologichesky aktivnyh veshestv pishi* (Methods of analysis of minor biologically active food substances), Moscow: Dinastiya Publ., 2010. 160 p.
9. Poznyakovskiy, V.M, Gur'anov, Yu.G., and Bebenin, V.V., *Pisheviye I biologicheski aktivniye dobavki: harakteristika, primeneniye, kontrol'* (Food and biologically active additives: characteristics, application, control), Kemerovo: Kuzbassvuzizdat, 2011. 275 p.
10. Semenov, V.A., Latkov, N.U., Koshelev, Yu.A., and Poznyakovskiy, V.M., Primenenye pantogematogena v sportivno-meditsinskoy praktike (Application of panthogematogen in sports medicine), *Tekhnika i tekhnologiia pishchevykh proizvodstv* (Food Processing: Techniques and Technology), 2014, no. 2, pp. 113-117.
11. *Technical regulation TS 027/2012. O bezopasnosty otdelnyh vidov spezializirovannoi pishevoi produkcii, v tom chisel dieticheskogo, lechebnogo I dieticheskogo profilakticheskogo pitanya* (About safety of separate types of specialized food products, including clinical, curative and preventive nutrition). (In Russ.).
12. Ascherio, A, and Willett, W.C., Are body iron stores related to the risk of coronary heart disease? *N. Engl. J. Med.*, 1994, 300, pp. 1152–1154.
13. Aulin, K.P. *Minerals: Calcium* / K.P. Aulin // Nutrition in Sport/ Maugham R.M. (Ed). – Blackwell Science Ltd., 2000, pp. 318–325.
14. Barr, S.I. Introduction to dietary reference intakes, *Appl. Physiol. Nutr. Metab*., 2006, vol. 31, pp. 61-65.