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The influence of the *Tribulus terrestris* extract on the parameters of the functional preparedness and athletes' organism homeostase

The influence of the Tribulus terrestris extract on the parameters of the functional preparedness and athletes' organism homeostase was investigated. It was established the positive impact of dietary supplement "Tribulus" (Optimum Nutrition, USA) using per 1 capsule 3 times a day during 20 days on athletes' physical power in various energy producing zones: anaerobic alactic muscular power and anaerobic alactic glycolytic power statistically reliable increased. Tribulus terrestris extract, after 20 days of consuming it, did not have essential effect on erythrocytes, haemoglobin and thrombocytes indices. During the experimental period statistically importantly increased percentage of granulocytes and decreased percentage of leucocytes show negative impact of this food supplement on changes of leucocytes formula in athletes' blood. Creatinkinase concentration in athletes' blood statistically importantly has increased and creatinine amount has had a tendency to decline during 20 days period of consuming Tribulus terrestris extract. The declining tendency of urea, cholesterol and bilirubin concentrations has appeared. The concentration of blood testosterone increased statistically reliable during the first half (10 days) of the experiment; it did not grow during the next 10 days while consuming Tribulus still.

Key words: Tribulus terrestris extract, athletes, functional preparedness, homeostase, blood.

INTRODUCTION

Tribulus is one of the quite popular food supplements used by a big number of athletes. Its main ingredient is *Puncture (Tribulus terrestris)* plant growing mainly in the Balkan countries, the Mediterranean region. This herb has been used in folk medicine in Europe and other regions all over the world to cure hormone deficit, diseases of liver, kidneys, ureters and to eliminate cardiovascular system problems for several hundred years already [2, 5, 6, 7]. When investigation of the effect of Tribulus Terrestris had been started more widely, it was found out that this herb had influence on masculine hormone testosterone level in blood [8, 13, 14, 20], on strengthening immunity, improving endurance, when its effect was started to be analyzed widely. Natural testosterone (TTE) and lutropine (LH)

amounts in organism increase when food supplement with Tribulus terrestris is consumed and this positively responds to muscle growth, strength and endurance [15, 16, 18, 20]. Saponins and steroids of *Tribulus terrestris* have positive effect on cardiovascular system, regulate myocardial contraction power, improve coronary blood circulation, dilate blood vessels, reduce blood pressure under hypertonia and decrease arteriosclerosis probability. *Tribulus terrestris* increases activity of protein synthesis and muscle mass, facilitates recovery after physical loads [1, 5, 8, 14]. The analyzed literature sources present clinical *Tribulus* studies more than its effect on athletes, regarding their sport specification; its influence on physical efficiency is missed still. The impact of *Tribulus* on representatives of power sports is revealed in literature more widely [3, 15] that is why we were interested

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in what is the effect of this food supplement use on endurance sport athletes.

The aim of the research was establishing the influence of food supplement *Tribulus* on athletes' physical development, physical working ability, aerobic functional capacity, blood circulation and respiratory systems.

METHODS

The sample of the research included thirty-two 20-22 year old athletes whose physical activity was related to training in chosen endurance sport and the study programme of physical education. Two groups of athletes under the research were formed after the first testing (1st testing), when the indices of physical development, physical working ability and functional capacity were established. The first experimental group consisted of 20 individuals whose body mass was approximately $75,3 \pm 7,7$ kg and the body mass index (BMI) was $23,1 \pm 1,9$. The first group participants used 1 capsule of the food supplement *Tribulus* (Optimum Nutrition, USA) in the morning and 2 capsules in the evening for the next 20 days. One *Tribulus terrestris* capsule consisted of 625 mg powder, so athletes consumed 1875 mg per day; one kg of body mass approximately got 25 mg of *Tribulus terrestris*. The second testing was performed partway of consuming of food supplement (after 10 days, 2nd testing), and the third testing was performed after 20 days of consuming (3rd testing). The control group consisted of 12 individuals whose body mass was approximately $76,0 \pm 8,2$ kg and BMI was $22,9 \pm 1,7$. The control group participants did not consume any food supplements. Individuals of experimental group were tested twice – at the beginning and at the end of the experiment.

Single muscular contraction power (SMCP) [12] and anaerobic alactic muscular power (AAMP), while using step ergometry 2-3-s test with running rate and jump height fixed [17], were measured. Anaerobic alactic gly-

colytic power, when anaerobic alactic glycolytic reactions in the generation of muscle mechanical energy predominate, was estimated with applied 30-s veloergometer "Monark-894E" test on max exertion [4]. Total and relative, maximum instantaneous and average working powers were measured (Wingate test). Aerobic capacity was measured with gas analyzer „Ergooxyskreen“. Functional blood circulation power was estimated by establishing pulse rate (PR) while lying, in the middle of orthostatic sample and standard physical load, after the 60-s rest, Roufier index was calculated too.

Research data was calculated applying the methods of mathematical statistics. Arithmetic average (\bar{X}) and statistic deviation (S) of athletes were calculated. The method of dispersive analysis (ANOVA) was used to evaluate reliability of indexes differences.

RESEARCH RESULTS

Our research have demonstrated that after using food supplement *Tribulus* for 20 days, absolute and relative SMCP of the members of experimental group had tendency to increase. Relative VSRG from the first to third research have increased in average from $24,3 \pm 5,2$ to $26,2 \pm 4,3$ W/kg, though there was not found statistically reliable increase of indexes. From the analysis of individual changes of this index we may visibly see that SMCP increased in 17 athletes out of 20 participants of the experimental group (86 %). The same indices in the control group were changing even less.

Absolute AAMP in the members of experimental group, having used food supplement *Tribulus* for 20 days, have increased in average from $1215,5 \pm 146,6$ to $1305,6 \pm 177,3$ W. In 16 participants of experiment (out of 20, i.e. 80 %) this index have increased. Their relative AAMP increased from $16,3 \pm 1,1$ to $17,2 \pm 1,5$ W/kg ($F = 5,12$, $P = 0,03$) during the experimental period.

In experimental group relative maximal muscular power (RMMP) in the 10-s test during the 20 day duration experimental period have increased from 15.0 ± 2.7 to 16.5 ± 3.0 W/kg. This index had increased in 20 athletes (out of 20, i.e. 85 %). In control group increase of maximal muscular power was lower.

Alactate glycolyte working capacity (AGWC) of the members of experimental group, when work duration is 30-s and ATP in muscles is re-synthesized from creatine phosphate and glycogene in anaerobic way, in 20 days have increased in average from 612.3 ± 80.6 to 656.1 ± 79.0 W, and relative AGWC have increased in average from 8.2 ± 0.8 to 8.7 ± 0.8 W/kg ($F=4.34$, $P=0.04$). Indices of control group representatives having used lower dose of food supplement, in

the 10-s and 30-s veloergometer tests have changed less. Lactate concentration in the blood of representatives of experimental group after 10 days of supplement use (after 30-s duration load) have decreased from 13.2 ± 1.9 to 11.6 ± 1.9 mM ($P<0.05$), though at the end of experiment after the same load test (30-s) lactate concentration was higher again, nevertheless it have not exceeded initial level.

Aiming to evaluate influence of this food supplement on athletes' aerobic capacity, we have measured it on the thresholds of critical intensity and anaerobic exchange. Lungs' ventilation at the critical intensity threshold have increased in average from 111.8 ± 22.3 to 126.8 ± 18.1 l/min, and VO_2 max at this threshold have increased from 50.3 to 55.4 ml/min/kg ($F=3.63$, $P=0.07$), while working capacity

Table 1. The changes of muscle power in athletes who consumed food supplement Tribulus during the experimental period

Indices	Single muscular contraction power		Anaerobic alactic muscular power		Power, W				Blood lactate concentration, (La), mM	
	W	W/kg	W	W/kg	30 s					
					max	W/kg	average	W/kg		
I testing										
E	\bar{X}	1818.1	24.3	1215.5	16.3	1125.3	15.0	612.3	8.2	13.2
	S	353.5	5.2	146.6	1.1	213.9	2.7	80.6	0.8	1.9
C	\bar{X}	1743.5	22.9	1251.7	16.5	1093.6	14.5	610.0	8.2	10.4
	S	245.8	3.2	83.6	1.1	205.9	2.4	89.9	0.8	2.3
II testing										
E	\bar{X}	1858.8	24.7	1282.0	16.6	1158.1	15.3	640.6	8.5	11.6
	S	313.4	4.1	177.2	1.1	200.9	2.0	95.0	0.8	1.9
III testing										
E	\bar{X}	1982.8	26.2	1305.6	17.2	1242.0	16.5	656.1	8.7	12.7
	S	352.0	4.3	177.3	1.5	245.5	3.0	79.0	0.8	1.4
C	\bar{X}	1761.2	23.2	1255.9	16.6	1108.4	14.8	613.9	8.2	12.4
	S	289.8	3.8	66.8	0.9	226.5	2.9	77.5	0.8	1.1
I-II										
F		0.14	0.10	1.59	0.70	0.24	0.21	0.98	1.97	6.49
P		0.71	0.75	0.22	0.41	0.63	0.65	0.33	0.17	0.02
I-III										
F		2.07	1.62	2.91	5.12	2.44	2.86	2.87	4.34	0.74
P		0.16	0.21	0.10	0.03	0.13	0.10	0.10	0.04	0.39
II-III										
F		1.32	1.17	0.17	2.39	1.33	2.18	0.30	0.49	4.09
P		0.26	0.29	0.68	0.13	0.26	0.15	0.59	0.49	0.05

Note: E – experimental group, C – control group.

at this level have increased from 269.3 ± 27.0 to 296.7 ± 26.0 W ($F=4.12$, $P=0.05$) (Table 2).

Lung ventilation at the level of anaerobic exchange threshold have increased in average from 75.8 ± 13.3 to 83.9 ± 30.0 l/min. At this level increase of relative VO_2 ($P<0.05$) and working capacity was statistically reliable ($P<0.01$).

Results of our research demonstrate that during the experimental period functional capacity of blood circulation and breathing system of testees who have used food supplement *Tribulus* have increased. Roufier index of the members of experimental group (who used *Tribulus*) increased statistically reliably ($F=13.11$, $P=0.001$), as well as heart rate at rest ($F=7.04$, $P=0.012$). Changes of control group members' indices of blood circulation and breathing systems' functional capacity were lesser.

Blood circulation has different functions in human body: it supplies tissues and organs with oxygen and nutrition, removes products of metabolism, maintains homeostasis in body, protects body from infection, regulates hormonal level etc. Thus it is very important to evaluate athletes' morphologic and biochemical composition as well as changes occurring under the influence of sporting activity or used food supplements.

At the beginning of research all mean and individual athletes' blood composition indices were in norm.

After the 10 days use of *Tribulus* (2nd testing) there was noticed insignificant decrease of erythrocyte sedimentation rate, in average 4.4 ± 3.4 to 4.0 ± 2.8 mm/h (Table 3). After the 20 days use of *Tribulus* (3rd testing) ESR remained in lower level comparing to initial (before starting using *Tribulus*).

In first 10 days of *Tribulus* supplement use amount of leucocytes in experimental group testees have increased in average from 6.2 to $6.5 \cdot 10^9/l$, but in more 10 days (3rd testing) their level again had reached initial level. During the experimental period, percentage indices of lymphocytes and monocytes decreased and of granulocytes - had increased (Table 3). After the 20 days of *Tribulus* use in leucocytes' formula percentage of lymphocytes have decreased, and of granulocytes - have increased statistically reliably ($P<0.05$). During the experimental period percentage of granulocytes in leucocytes' formula have increased in 17 testees out of 20 (85.0 %).

Dynamics of biochemical indices of athletes after the 20 days use of *Tribulus* presented in Table 4. At the beginning of research (1st testing) all average amounts of indices were in normal limits. During the first 10 days

Table 2. The influence of food supplement *Tribulus* on athletes' anaerobic power

Indices	Critical intensity limit				Anaerobic threshold limit				Index Roufier	heart rate at rest, b/min
	pulmonary ventilation (VE) l/min	heart rate, b/min	$VO_{2\max}$ ml/min/kg	W	pulmonary ventilation (VE) l/min	heart rate, b/min	$VO_{2\max}$ ml/min/kg	W		
I testing										
\bar{X}	111.8	180.2	50.3	269.3	75.8	164.4	41.7	220.3	7.1	65.2
S	22.3	8.3	7.2	27.0	13.3	8.5	7.2	28.5	2.9	9.4
II testing										
\bar{X}	126.8	181.8	55.4	296.7	83.9	167.0	48.1	252.2	4.3	58.4
S	18.1	8.4	4.9	26.0	30.0	7.3	4.4	17.9	1.8	6.5
I-II										
F	2.43	0.12	3.63	4.12	0.83	0.59	5.85	9.04	13.11	7.04
P	0.13	0.74	0.07	0.05	0.37	0.45	0.02	0.007	0.001	0.01

of *Tribulus* use there was detected significant increase of creatinase concentration ($P=0.002$) as well as tendency of creatinine concentration increase. In first 10 days it also had been detected tendency of urea, cholesterol and uric acid concentration decrease. It is also to be mentioned that decrease of bilirubin concentration was statistically reliable ($P<0.05$) in 2nd testing and further level remained the same (3rd testing).

At the beginning of research testosterone concentration in blood of reached 25.4 ± 6.1 KM, and after 10 days of *Tribulus* use it have increased statistically reliably ($P<0.05$) and amounted 28.6 ± 7.7 KM.

Cortisol concentration in blood of members of experimental group during the 1st and 2nd

testing was near the maximal norm limit, and after 20 days increased even more and reached 509.1 ± 86.7 KM, but this change was not statistically reliable.

DISCUSSION OF THE RESEARCH RESULTS

The research and the analysis of literature revealed that physical development of individuals who were consuming *Tribulus* for 20 days (1875 mg per day) had not been considerably influenced. Mixed anaerobic alactic muscular capacity in 30-s work rose due to the food supplement *Tribulus*. The reduction of lactate concentration in athletes' blood prove that the activity of glycolytic reactions decreased

Table 3. The changes of complete blood counts in athletes who consumed food supplement Tribulus during the experimental period $\bar{X}\pm S$

Indices	Red Blood Cells(RBC), $10^{12}/l$	Hemoglobin, g/l	Hematocrit, %	Mean Cell Volume (MCV), fl	erythrocyte sedimentation rate, mm/h	White Blood Cells(WBC), $10^9/l$	Lymphocytes, %	Mono-cytes, %	Granulo-cytes, %
Groups	Physiological mares								
	3,8-5,8	110-165	35-50	80-97	1-15	3,5-10	17-48	4-10	43-76
I testing									
E	5.08	144.0	42.9	84.4	4.4	6.2	35.3	5.8	58.9
	0.28	8.1	2.5	2.8	3.4	1.4	5.3	1.1	5.9
C	4.94	146.3	44.0	84.0	5.2	5.3	34.1	6.1	59.9
	0.46	10.7	3.3	2.7	2.1	1.1	7.5	2.4	8.7
II testing									
E	5.08	144.0	43.0	84.8	4.0	6.5	33.2	5.7	61.1
	0.23	7.5	2.6	2.9	2.8	1.1	7.1	0.9	7.5
C	5.00	147.1	43.9	83.7	4.6	5.2	33.3	5.7	62.0
	0.35	6.9	2.3	2.4	2.0	1.7	7.4	1.2	9.8
III testing									
E	5.10	143.5	43.3	84.9	4.2	6.2	31.4	5.6	63.1
	0.26	8.4	2.4	2.7	2.5	1.1	6.3	1.2	6.8
C	4.98	146.70	42.8	86.1	4.6	5.5	30.5	5.2	63.6
	0.24	5.30	1.5	2.4	2.7	0.7	5.4	1.4	9.1
Reliability of E group index differences									
F I-II	0.00	0.00	0.02	0.19	0.19	0.42	1.11	0.15	1.04
P	0.97	1.00	0.88	0.66	0.66	0.52	0.30	0.70	0.31
F I-III	0.06	0.04	0.30	0.00	0.05	0.00	4.51	0.58	4.48
P	0.81	0.85	0.59	0.96	0.83	0.98	0.04	0.45	0.04
F II-III	0.09	0.04	0.14	0.00	0.40	0.54	0.74	0.19	0.83
P	0.77	0.84	0.71	0.96	0.53	0.47	0.39	0.67	0.37

Note: E – experimental group, C – control group.

during the experimental period due to a rise in aerobic capacity regardless the fact that the work capacity showed an upward tendency [9, 14, 20]. The results of the research have confirmed the opinion of different authors [1, 4, 5] that the food supplement *Tribulus* has a positive influence on athletes' aerobic capacity at the limits of critical intensity and anaerobic exchange threshold as well as on functional capacity of circulatory and respiratory systems.

Percentage of agranulocytes (lymphocytes, monocytes) and granulocytes (neutrophils, basophils, eosinophiles) on the leucogramma turned to granulocytes. Such changes, that show the decrease of lymphocytes, are thought to be negative. Lymphocytes are vari-

ous cellular components of immunologic response and, equally, they belong to a different blood stem cells group which is the basis for all the blood cells development [22].

Some annotations and various advertising articles affirm that individuals', who consume food supplement with *Tribulus terrestris* in it, concentration of blood testosterone grows. And others state that if *Tribulus terrestris* is used in such amounts as it is in this experiment, blood testosterone concentration grows double or even triple in 8-10-20 day period [10, 13, 20]. But, despite this information, some studies announces that there is no such evidence that would show increasing blood testosterone or increased its release in urine while consuming food supplement *Tribulus* [18, 20].

Table 4. The changes of biochemical blood indexes in athletes who consumed food supplement Tribulus during the experimental period $\bar{X} \pm S$

Indices Groups	Creatine phosphokinase, u/l	Creatinin, μM	Uric acid, μM	Urea, mM	Cholesterol, mM	Triglycerides (Tg), mM	Bilirubin, μM	Natural testosterone (TTE), ηM	Cortisol, ηM
	Physiological marcs								
	27-195	53-190	180-420	1,8-8,3	2,6-5,2	0,5-2,3	3,4-17	6,3-26,3	138-690
I testing									
E	133.0	102.4	365.7	6.8	4.0	1.0	16.8	25.4	489.2
	42.0	21.8	68.4	1.8	0.7	0.5	8.0	6.1	88.4
C	92.4	93.9	307.0	5.6	3.8	2.5	18.1		
	52.4	9.8	34.0	1.6	0.8	1.5	7.0		
II testing									
E	178.9	110.3	356.1	6.2	3.9	1.1	13.0	28.6	488.0
	45.3	19.8	45.9	1.3	0.5	0.5	2.2	7.7	68.5
C	97.1	90.5	321.0	6.2	3.7	0.9	16.4		
	63.2	14.0	67.9	1.2	0.8	0.3	6.8		
III testing									
E	167.1	100.7	341.3	6.5	3.6	1.1	13.3	26.6	509.1
	49.3	14.1	50.0	1.0	0.5	0.4	2.3	7.0	86.7
C	96.8	94.5	340.4	6.8	3.8	1.1	18.1		
	56.7	9.4	59.7	1.2	0.7	0.5	6.5		
Reliability of E group index differences									
F	11.05	1.46	0.27	1.39	0.07	0.69	4.35	4.10	0.00
P	0.002	0.23	0.60	0.25	0.79	0.41	0.04	0.05	0.96
F	5.55	0.08	1.67	0.25	3.72	0.38	3.63	0.00	0.51
P	0.02	0.77	0.20	0.62	0.06	0.54	0.06	0.98	0.48
F	0.62	3.15	0.95	0.90	4.09	0.09	0.21	0.02	0.73
P	0.43	0.08	0.34	0.35	0.05	0.77	0.65	0.88	0.40

Note: E – experimental group, C – control group.

But still, this research carries out that there is noticeable increase of blood testosterone of examined individuals while using food supplement with *Tribulus terrestris*.

CONCLUSIONS

1. Food supplement *Tribulus* has positive impact on athletes' physical power in various energy producing zones:

- total and relative indices of experimental group athletes' single muscular contraction power had a tendency to grow, but statistically reliable increase regarding to wide indices spread was not established;

- anaerobic alactic muscular power in 2-3-s test on max exertion increased statistically credibly in 75,0 % ($P < 0.05$) relating to *Tribulus* consumption;

- anaerobic alactic muscular power in 10-s test on max exertion had a statistically credibly tendency to grow (85.0 % of experimental group individuals'). Athletes' from control group maximal work power had lesser increase;

- experimental group athletes' anaerobic alactic glycolytic power increased from 612.3 ± 80.6 to 659.1 ± 79.0 W ($P < 0.05$). The reduction of lactate concentration that points to the activity of glycolytic reactions decreased statistically reliable ($P < 0.05$) in athletes' blood during the experimental period;

- athletes' who consumed food supplement *Tribulus* aerobic capacity at the limits of critical intensity and anaerobic exchange threshold increased statistically reliably. VO_{2max} at critical intensity limit increased from 50.26 to 55.41 ml/min/kg in average. Major changes in aerobic power were fixed at the limit of anaerobic exchange.

2. Food supplement *Tribulus*, after 20 days of consuming it, did not have positive effect on erythrocytes, haemoglobin and thrombocytes indices and on their changes of derivative indications in athletes' blood. During the experimental period still growing erythrocyte sedimentation rate, statistically

importantly increased percentage of granulocytes and decreased percentage of leucocytes show negative impact of this food supplement on changes of leucocytes formula in athletes' blood. Accordingly, complete blood counts (CBC) for athletes who consume food supplement *Tribulus* 25 mg per 10 kg of body mass for the period of 10 days or longer must be carried out.

3. Creatinkinase concentration in athletes' blood statistically importantly has increased and creatinine amount has had a tendency to decline during 20 days period of consuming food supplement *Tribulus*. The declining tendency of urea, cholesterol and bilirubin concentrations has appeared. The concentration of blood testosterone increased statistically reliable during the first half (10 days) of the experiment; it did not grow during the next 10 days while consuming *Tribulus* still.

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ВПЛИВ ЕКСТРАКТУ *TRIBULUS TERRESTRIS* НА ПОКАЗНИКИ ФУНКЦІОНАЛЬНОЇ ПІДГОТОВЛЕНОСТІ ТА ГОМЕОСТАЗУ ОРГАНІЗМУ СПОРТСМЕНІВ

Досліджували вплив екстракту *Tribulus terrestris* на фізичний розвиток, фізичні та функціональні можливості, морфологічний і біохімічний склад крові спортсменів. У спортсменів експериментальної групи, котрі протягом 20 днів приймали по три капсули "Tribulus" ("Optimum Nutrition", США), відзначалося зростання фізичних можливостей в різних зонах енергозабезпечення: достовірно підвищувалася анаеробна алактатна потужність м'язів та анаеробна гліколітична потужність. Застосування цього екстракту не виявило суттєвого впливу на показники червоної крові, в той час як у формулі лейкоцитів знизився відсоток лімфоцитів і підвищився – гранулоцитів. Останнє може свідчити про негативний вплив біологічно-активних речовин *Tribulus terrestris* на кількісні показники формули лейкоцитів. За період прийому екстракту *Tribulus terrestris* в крові спортсменів статистично достовірно підвищилася креатинкіназна активність, а концентрація креатиніну мала тенденцію до зменшення. Крім того, спостерігалася тенденція до зменшення в крові спортсменів вмісту холестеролу та білірубину. Концентрація тестостерону статистично достовірно підвищилася протягом перших 10 днів прийому екстракту *Tribulus terrestris*, а в наступні 10 днів суттєвих змін не зазнала.

Ключові слова: екстракт *Tribulus terrestris*, спортсмени, функціональна підготовленість, гомеостаз, кров.

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ВЛИЯНИЕ ЭКСТРАКТА TRIBULUS TERRESTRIS НА ПОКАЗАТЕЛИ ФУНКЦИОНАЛЬНОЙ ПОДГОТОВЛЕННОСТИ И ГОМЕОСТАЗА ОРГАНИЗМА СПОРТСМЕНОВ

Исследовали влияние экстракта Tribulus terrestris на физическое развитие, физические и функциональные возможности, морфологический и биохимический состав крови спортсменов. У спортсменов экспериментальной группы, которые на протяжении 20 сут принимали по три капсулы “Tribulus” (“Optimum Nutrition”, США), отмечалось возрастание физических возможностей в разных зонах энергообеспечения: достоверно повышалась анаэробная алактатная мощность мышц и анаэробная гликолитическая мощность. Применение экстракта Tribulus terrestris на протяжении 20 сут не оказало существенного влияния на показатели красной крови, в то время как в формуле лейкоцитов снизился процент лимфоцитов и повысился – гранулоцитов. Последнее может свидетельствовать об отрицательном влиянии биологически-активных веществ Tribulus terrestris на количественные показатели формулы лейкоцитов. За период приема экстракта Tribulus terrestris в крови спортсменов статистически достоверно повысилась креатинкиназная активность, а концентрация креатинина проявила тенденцию к уменьшению. Кроме того, имела место тенденция к уменьшению в крови спортсменов содержания холестерина и билирубина. Концентрация тестостерона статистически достоверно повысилась на протяжении первых 10 сут приема экстракта Tribulus terrestris, а в последующие 10 сут существенных изменений не наблюдалось.

Ключевые слова: экстракт Tribulus terrestris, спортсмены, функциональная подготовленность, гомеостаз, кровь.

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