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Efficacy of the Tribulus food supplement used by athletes

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Introduction. Tribulus is a popular food supplement used by a big number of athletes. It is made from the puncture (*Tribulus terrestris*) plant growing in the Mediterranean region. *Tribulus terrestris* increases activity of protein synthesis and muscular mass and facilitates recuperation after physical loads. The analysed literature sources present clinical researches on Tribulus, however, data on the efficacy of this food supplement to athletes' body are not sufficient.

The aim of the research was to establish the influence of the Tribulus food supplement on athletes' physical development, physical working ability and aerobic capacity as well as on some blood biochemical indices.

Materials and methods. The sample of the research included thirty-two 20–22-year-old athletes. The experimental group consisted of 20 individuals who used one capsule of Tribulus of the Optimum Nutrition Company (USA) in the morning and two capsules in the evening for the next 20 days. The control group consisted of 12 individuals who did not consume any food supplement. The physical development, physical working ability and aerobic capacity of the athletes were measured.

The research **results** showed that the Tribulus food supplement increased mixed anaerobic alactic glycolytic muscular power at 30-s work and reduced lactate concentration in the blood.

Conclusions. The Tribulus food supplement has a positive influence on athletes' anaerobic alactic glycolytic power and aerobic capacity when energy is produced in the aerobic way.

Key words: Tribulus food supplement, physical development, muscular power, aerobic capacity

INTRODUCTION

Tribulus is one of the rather popular food supplements used by a big number of athletes. Its main ingredient is the 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 for several hundred years to cure hormone deficit, diseases of liver, kidneys, ureters and to eliminate cardiovascular system problems (1–4). Targeted investigations of the effect of *Tribulus terrestris* have shown that this herb influences the level of the masculine hormone testosterone in the blood (5–8), strengthens immunity, improves endurance. Natural testosterone and lutropine levels in the body increase when a food supplement containing *Tribulus terrestris* is consumed, positively influencing muscular growth, strength and endurance (9–12). Saponins and steroids of *Tribulus terrestris* have a positive effect on the cardiovascular system, regulate myocardial contraction power, improve coronary blood circulation, dilate blood vessels, reduce blood pressure under hypertonia and decrease the probability of arteriosclerosis. *Tribulus terrestris* increases activity of protein synthesis and muscular mass, facilitates recovery after physical loads (3, 12–15). The analyzed literature sources present clinical effects of Tribulus rather than its effect on athletes with regard to their sport specification; studies of its effect on physical efficiency are still

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missing. Considering the fact that a lot of representatives of power sports use this food supplement, we were interested in the effect of this food supplement on other sport athletes.

The aim of the research was to establish the influence of Tribulus food supplement on athletes' physical development, physical working ability, the functional capacity of the aerobic, circulatory and respiratory systems.

MATERIALS AND METHODS

The sample of the research included thirty-two 20–22-year-old athletes whose physical activity was related to training in an endurance sport and the study programme of physical education. The participants took trainings for approximately 12 hours per week. Two groups of athletes were formed after the first testing when the indices of physical development, physical working ability and functional capacity were established. The experimental group (E) consisted of 20 individuals who used one capsule of the Tribulus food supplement (Optimum Nutrition Company, USA) in the morning and two capsules in the evening for 20 days. One Tribulus capsule contained 625 mg of powder, so athletes consumed 1875 mg per day, i. e. approximately 25 mg of *Tribulus terrestris* powder per one kg of body mass.

The control group (C) consisted of 12 individuals who did not consume any food supplements. Individuals of this group were tested twice – at the beginning and at the end of the experiment. The second testing of the experimental group was performed after 10 days and the third testing was performed after 20 days of consuming Tribulus.

The athletes' physical development, physical power in various energy production zones, the functional capacity of blood circulation and respiratory systems were established in the laboratories of the VPU Sport Science Institute. Standard methodologies were applied to establish physical development (16). The testees' height, body mass, body mass index (BMI), hand power, muscle and fat mass were estimated. Tests of various duration were employed to evaluate their physical capacity. Single muscular contraction power (SMCP) (17) and anaerobic alactic muscular power (AAMP), using the step ergometry 2–3-s test with the running rate and jump height fixed (18), were measured. Anaerobic alactic glycolytic power, when anaerobic alactic glycolytic reactions in the generation of muscle mechanical energy predominate, was estimated applying a 30-s veloergometer (Monark-894E) test on maximum exertion (19). Total and relative, maximum instantaneous and average working powers were measured (Wingate test). Aerobic capacity was measured with a gas analyzer (Ergooxyscreen). Functional blood circulation power was estimated by establishing pulse rate (PR) while lying, in the middle of orthostatic sampling and standard physical load, after a 60-s rest; the Roufier index was also calculated (20).

Blood biochemical analyses were carried out with an express analyser (Reflotron-IV). Hormone – testosterone (TTE) and cortisol (COR) – concentration was established employing the Architect system, using the Architect testosterone reagents and cortisol measuring.

The obtained data were calculated applying the methods of mathematical statistics. The arithmetical mean ($\overline{X}$) and standard deviation (SD) were calculated. The method of dispersion analysis (ANOVA) was used to evaluate the reliability of differences.

Biomedical analyses were carried out with the permission of the Lithuanian Bioethics Committee.

RESULTS

While analyzing separate diagnostic indices of physical development (Table 1) we can see that the body mass of the experimental group participants varied a little during the

Table 1. **Changes of physical development indices in athletes who consumed Tribulus food supplement during the experimental period**

Group	Indices	Height, cm	Body mass, kg	BMI kg/m²	Hand power, kg		Muscle mass, kg	Fat mass, kg
					R	L		
1st testing								
E	$\overline{X}$	180.7	75.3	23.1	52.3	50.4	41.1	8.3
	SD	7.3	7.7	1.9	6.5	4.1	4.8	2.7
C	$\overline{X}$	182.3	76.0	22.9	45.0	40.4	40.6	9.0
	SD	7.9	8.2	1.7	6.7	7.9	4.4	2.7
2nd testing								
E	$\overline{X}$	180.7	75.8	23.2	54.1	52.8	41.3	7.9
	SD	7.3	7.5	1.7	6.1	4.5	4.8	2.6
C	$\overline{X}$	182.3	75.6	22.7	48.4	45.8	40.9	8.9
	SD	7.9	7.8	1.5	6.9	4.5	4.1	2.6
1st–2nd testings								
E	**F**	0	0.03	0.07	2.65	2.53	0.01	0.08
	p	1	0.88	0.80	0.12	0.13	0.92	0.78
1st–2nd testings								
C	**F**	0	0.01	0.01	0.01	0.34	0.02	0.04
	p	1	0.91	0.93	0.95	0.57	0.90	0.84

Table 2. **Changes of muscle power in athletes who consumed Tribulus food supplement during the experimental period**

Indices		SMCP		AAMP		Power, W				La, mmol/l
		W	W/kg	W	W/kg	30 s				
						max	W/kg	aver.	W/kg	
1st testing										
E	$\bar{X}$	1818.1	24.3	1215.5	16.3	1125.3	15.0	612.3	8.2	13.2
	SD	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
	SD	245.8	3.2	83.6	1.1	205.9	2.4	89.9	0.8	2.3
2nd testing										
E	$\bar{X}$	1858.8	24.7	1282.0	16.6	1158.1	15.3	640.6	8.5	11.6
	SD	313.4	4.1	177.2	1.1	200.9	2.0	95.0	0.8	1.9
3rd testing										
E	$\bar{X}$	1982.8	26.2	1305.6	17.2	1242.0	16.5	656.1	8.7	12.7
	SD	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
	SD	289.8	3.8	66.8	0.9	226.5	2.9	77.5	0.8	1.1
1st–2nd testings										
	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**
1st–3rd testings										
	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
2nd–3rd testings										
	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**

study period. The body mass index also varied but little, and its common level can be evaluated as normal.

The right-hand power of the experimental group members increased on average from 52.3 ± 6.5 to 54.1 ± 6.1 (F = 2.65) kg and the left hand power from 50.4 ± 4.1 to 52.8 ± 4.5 (F = 2.53) kg. The muscular mass of experimental group participants had a tendency to grow and fat mass to diminish, but these changes were statistically unreliable during the period of 20 days.

Our research demonstrated that after using the Tribulus food supplement for 20 days, the absolute and relative single muscle contraction power (SMCP) of members of the experimental group had a tendency to increase (Table 2). The relative SMCP from the first to the third test increased on average from 24.3 ± 5.2 to 26.2 ± 4.3 W/kg. From the analysis of individual changes of this index we may visibly see that SMCP increased in 17 athletes out of 20 (85%).

The absolute anaerobic alactic muscular power (AAMP) in members of the experimental group upon using Tribulus for 20 days increased on average from 1215.5 ± 146.6 to 1305.6 ± 177.3 W. This index increased in 16 participants of the experiment i. e. in 80%.

In the experimental group, the relative maximal moment muscle power in the 30-s test during 20 days of the experimental period increased from 15.0 ± 2.7 to 16.5 ± 3.0 W/kg (F = 2.44). This index increased in 17 athletes, i. e. 85%. In the control group, the increase of the maximal muscular power was lower.

The absolute anaerobic alactic-glycolytic working power (AAGP) of members of the experimental group, when work duration was 30 s and ATP in muscles was re-synthesized from creatine phosphate and glycogene in an anaerobic way, in 20 days of the experimental period increased on average from 612.3 ± 80.6 to 656.1 ± 79.0 W and the relative AAGP from 8.2 ± 0.8 to 8.7 ± 0.8 W/kg (F = 4.34, $p < 0.05$). The indices of the control group representatives who did not use the food supplement, veloergometer test data changed less. Lactate concentration in the blood of representatives of the experimental group during 10 days of supplement use after a 30-s load decreased from 13.2 ± 1.9 to 11.6 ± 1.9 mmol/l ($p < 0.05$).

To evaluate the influence of this food supplement on athletes' aerobic capacity, we measured it on the thresholds of critical intensity and anaerobic exchange. Lung ventilation at the critical intensity threshold increased on average from 111.8 ± 22.3 to 126.8 ± 18.1 l/min, and VO_2max at this threshold increased from 50.3 to 55.4 ml/min/kg (F = 3.63, p = 0.07), while working capacity at this level increased from 269.3 ± 27.0 to 296.7 ± 26.0 W (F = 4.12, p = 0.05) (Table 3).

Lung ventilation at the level of anaerobic exchange threshold increased on average from 75.8 ± 13.3 to 83.9 ± 30.0 l/min. Absolute and relative VO_2 ($p < 0.05$) and working capacity ($p < 0.01$) increased statistically reliably.

The results of the study showed that the functional capacity of the blood circulation and respiratory systems increased in the testees who consumed the Tribulus food

Table 3. **The influence of Tribulus food supplement on athletes' aerobic power**

Indices	Critical intensity limit				Anaerobic threshold limit				Index Roufier	HR at rest, b/min
	VE l/min	HR b/min	VO_2 max ml/min/kg	W	VE l/min	HR b/min	VO_2 ml/min/kg	W		
1st testing										
$\overline{X}$	111.8	180.2	50.3	269.3	75.8	164.4	41.7	220.3	7.1	65.2
SD	22.3	8.3	7.2	27.0	13.3	8.5	7.2	28.5	2.9	9.4
2nd testing										
$\overline{X}$	126.8	181.8	55.4	296.7	83.9	167.0	48.1	252.2	4.3	58.4
SD	18.1	8.4	4.9	26.0	30.0	7.3	4.4	17.9	1.8	6.5
1st–2nd testings										
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**

Table 4. **Changes of biochemical blood indices in athletes who consumed Tribulus food supplement during the experimental period ($\overline{X} \pm SD$)**

Indices	Ck, u/l	Crea, µmol/l	Ua, µmol/l	Urea, mmol/l	Chol, mmol/l	Tg, mmol/l	Bil, µmol/l	TTE, ŋmol/l	COR, ŋmol/l
Physiological marks									
Groups	**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**
1st 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		
2nd 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		
3rd 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

supplement during the experimental period. The Roufier index of the experimental group participants who consumed Tribulus improved statistically reliably ($F = 13.11$, $p = 0.001$), as did also pulse rate at rest ($F = 7.04$, $p = 0.012$). The related changes in the control group testees were less significant.

The dynamics of biochemical indices in athletes after 20 days of using Tribulus is presented in Table 4. At the beginning of the study (1st testing), all average levels of the indices were within normal limits. During the first 10 days of Tribulus use, a significant increase of creatinkinase concentration ($p = 0.002$) as well as a tendency of creatinine concentration increase were detected. In the first 10 days, also a tendency of urea, cholesterol and uric acid concentration decrease was found. Also, it should be mentioned that the decrease of bilirubin concentration was statistically reliable ($p < 0.05$) (2nd testing) and further remained the same (3rd testing).

At the beginning of the study, testosterone concentration in blood was 25.4 ± 6.1 ŋmol/l, and after 10 days of using Tribulus it increased statistically reliably ($p < 0.05$) and amounted to 28.6 ± 7.7 ŋmol/l.

Cortisol concentration in the blood of members of the experimental group during the 1st and 2nd testing was close to the maximal norm limit; after 20 days it increased even more and reached 509.1 ± 86.7 ŋmol/l, but this change was not statistically reliable.

DISCUSSION

The present study and analysis of literature revealed that the physical development of individuals who had been consuming Tribulus for 20 days (1875 mg per day) was not considerably influenced, although their hand power increased. Some authors (16, 11, 13, 14) confirm our data that hand power has a tendency to increase under the influence of this supplement. Muscular capacity of our testees in 30-s work rose due to consuming Tribulus. The reduction of lactate concentration in athletes' blood proved that the activity of glycolytic reactions decreased during the experimental period due to a rise in aerobic capacity, regardless of the fact that the work capacity showed an upward tendency (14). This can be considered as a positive result of our research. The results of our study confirmed the opinion (3, 4, 21) that the Tribulus food supplement exerts a positive effect on athletes' aerobic capacity at the limits of critical intensity and anaerobic exchange threshold as well as on the functional capacity of the circulatory and respiratory systems.

Some annotations and various advertising articles affirm that in individuals who consume food supplements containing *Tribulus terrestris*, the concentration of blood testosterone grows, whereas others state that if *Tribulus terrestris* is used in such amounts as in our experiment, blood testosterone concentration doubles or even triples in 8–10–20 days (6, 8). However, despite this information, some studies state that there is no evidence to show an increase of blood testosterone or its increased release in urine while consuming Tribulus (10, 11). Nevertheless, there is a noticeable increase of blood testosterone while using a food supplement containing *Tribulus terrestris*.

After analyzing our results, the following conclusion can be formulated: the Tribulus food supplement positively influences working ability while executing short-term work, anaerobic alactic-glycolytic 30-s term working power and anaerobic capacity when energy is produced in the aerobic way, and also positively influences blood biochemical indices.

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SPORTININKŲ VARTOJAMO MAISTO PAPILDO „TRIBULUS“ VEIKSMINGUMAS

S a n t r a u k a

Įvadas. Tarp daugelio sportininkų vartojamų maisto papildų pakankamai populiarus yra „Tribulus“, gaminamas iš Viduržiemio jūros regione, daugiausia Balkanų šalyse, paplitusio augalo *Tribulus terrestris* (gulsčioji ragužė). Šia žole jau daugelį šimtmečių liaudies medicina Europoje ir kitose pasaulio šalyse gydė įvairias ligas. Nustatyta, kad *Tribulus terrestris* didina baltymų sintezės aktyvumą ir raumenų masę, padeda greičiau atsigauti po fizinių krūvių. Apžvelgtuose literatūros šaltiniuose daugiau kalbama apie klinikinius „Tribulus“ tyrimus, tačiau pasigendama duomenų apie šio papildo veiksmingumą sportininkų organizmui.

Darbo tikslas – nustatyti maisto papildo „Tribulus“ įtaką sportininkų fiziniam išsivystymui, fiziniam darbingumui, anaerobiniam pajėgumui, taip pat kai kuriems kraujo biocheminiams rodikliams.

Tyrimo objektas ir metodai. Ištirti 32 sportininkai 20–22 metų. Eksperimentinę grupę sudarė 20 asmenų, kurie 20 dienų vartojo JAV firmos „Optimum nutrition“ maisto papildą „Tribulus“ po kapsulę ryte ir dvi vakare. Kontrolinės grupės 12 tiriamųjų nevartojo jokių maisto papildų. Tirtas sportininkų fizinis išsivystymas, fizinis darbingumas, anaerobinis pajėgumas.

Rezultatai. Tyrimais nustatyta, kad maisto papildas „Tribulus“ padidino mišrų anaerobinį alaktatinį-glikolitinį raumenų galingumą dirbant 30 s. Mažėjanti laktato koncentracija tiriamųjų kraujyje rodo, kad glikolitinių reakcijų aktyvumas eksperimento metu mažėjo didėjant anaerobiniam pajėgumui.

Išvados. Maisto papildas „Tribulus“ daro teigiamą poveikį sportininkų anaerobiniam alaktatiniam-glikolitiniam raumenų galingumui ir anaerobiniam pajėgumui, kai energija gaminama anaerobiniu būdu.

Raktažodžiai: maisto papildas „Tribulus“, fizinis išsivystymas, raumenų galingumas, aerobinis pajėgumas