Ergogenic effects of Tribulus terrestris supplementation in men

by

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The main objective of this research project was to evaluate the effects of Tribulus terrestris supplementation on body composition, muscular strength and serum hormone profile in men. The research material included 24 competitive basketball players (age- 26.2±3.4 years, body height 191.2±6.7 cm, body mass- 91.5±9.8 kg) divided into 3 groups of 8 subjects each. One group received a supplement called "Tribusteron" which contained only saponins from Tribulus terrestris; another was supplemented with "Acetosteron", a product containing the same amount of saponins but fortified with zinc, magnesium and vitamin B_6. The third group of players received a placebo containing gelatin and was treated as a control group. The experiment lasted for 4 weeks during which all subjects performed six basketball training sessions weekly and three specific strength workouts. Body composition (electrical impedance), muscular strength (hack squat and bench press) and serum hormone profile (testosterone, estradiol and luteinizing hormone) were evaluated before and after the cessation of the experiment. The results indicate that in young, physically active men serum testosterone concentrations are high and supplementation with Tribulus terrestris do not influence these values significantly. Supplements containing saponins do not stimulate significant changes in body mass and composition as well as muscular strength in well trained athletes.

***Key words**: Tribulus terrestris, strength, body composition, testosterone*

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Introduction

Herbs have been used throughout history to enhance physical performance but scientific scrutiny with controlled clinical trials has only recently been used to study such effects. The following herbs are currently used to enhance physical performance despite the lack of scientific evidence of effect: Chinese, Korean, and American ginseng; Siberian ginseng, mahuang – Chinese ephedra; ashwagandha; rhodiola; yohimbe; *Cordyceps* fungs, shilajit or mummio; smilax; wild oats; Muira puama; Tribulus terrestris; saw palmetto berries; β-sitosterol and other related sterols; and wild yams (Antonio et al. 2000, Bedir and Khan 2000, Brown et al. 2001).

Several herbal extracts have been shown to alter steroid metabolism. Indole-3-carbinol is an extract from cruciferous vegetables that has been shown to enhance oxidative metabolism and excretion of estrogen (Michnovicz and Bradlow 1991). Although ingestion of an extract from Tribulus terrestris has been claimed to increase serum testosterone concentration subsequent to increased serum luteinizing hormone (LH) concentration, scientific evidence is lacking.

Tribulus terrestris (tribulus), a member of the Zygophyllaceae family is an annual herb found in many areas of the world, including the USA, Mexico, the Mediterranean region, and throughout Asia. It has been used in traditional medicine of many areas, such as India, China and Turkey. It also has a reputation for having anabolic effects in some areas of the world. A large amount of potential active components have been identified in tribulus, including steroidal saponins, lignanamides, alkaloids and flavonoids (Bedir and Khan 2000). Current research indicates that the steroidal saponins, particularly the dominant saponin protodioscin, are responsible for the pharmacological activities of tribulus (Ganzera et al. 2001).

Humans consume herbs to enhance endurance performance (e.g. in running, cycling, rowing, swimming, walking, dancing, aerobics, cross-country skiing and mountain climbing) to induce muscular hypertrophy and strength (e.g. for bodybuilding, weight lifting, wrestling, strength track and field events) or to enhance performance in recreational events. Tradition, identity of ingredients, advertisements, personal endorsements, use by other athletes, and the desire to succeed represent the extent of validation for most herbs in physical performance (Bucci 2000, Ganzera et al. 2001).

Endogenic stimulation of anabolic hormones such as testosterone and growth hormone may be influenced by supplements containing acetyl L-carnitine, zinc, magnesium and vitamin B_6 (Elder et al. 2001, Williams 1997).

The data on Tribulus terrestris and the above mentioned mineral and vitamin supplementation effects on anabolic hormone profile as well as body composition and muscular strength are scarce.

The main objective of this study was to determine the ergogenic effects of supplementation with products containing saponins from herb Tribulus terrestris and zinc, magnesium, acetyl L-carnitine on body mass and body composition, muscular strength and the concentration of chosen hormones.

Material and methods

The research was conducted on 24 well trained basketball players, which were randomly divided into 3 groups of 8 subjects each. All subjects were informed of the purpose and nature of the study before giving their written consent to participate in the experiment, which had been approved by the Ethics Committee at the Silesian Medical Academy in Katowice. The average age, body mass and body height of the tested basketball players equaled respectively 26±3.4 years, 91.5±9.8 kg and 191.2±6.7 cm.

Group I was supplemented for 4 weeks with a specimen called "Acetosteron" which contained the following active ingredients per one capsule: steroidal saponins from herb Tribulus terrestris (170 mg/capsule), acetyl L-carnitine (220 mg/caps.), magnesium (83.5 mg/caps.), zinc (5.5 mg/caps.) and vitamin B_6 (1.9 mg/caps). The daily dose of acetosteron was 4 capsules over the first 2 weeks of the experiment which increased to 6 capsules for the last 2 weeks. Group II received a supplement called "Tribusteron 90", which contained only steroidal saponins from Tribulus terrestris (450 mg/caps.). The supplementation procedure was identical to group I, thus the athletes received 4 capsules initially and 6 in the second part of the experiment, what amounted to 1800 and later 2700 mg of steroidal saponins daily. The third group served as a control and received a placebo capsules in the same amount containing gelatin. The supplements were taken twice daily, 30 min before training and 20 min before going to sleep. The experiment was conducted during the second part of the preparatory period, thus all athletes were well conditioned. All of them performed 6 basketball training sessions per week and 3 specific strength workouts.

Body mass and body composition were evaluated with the use of bioelectrical impedance (Tanita TB-300). The following variables were registered: Body mass (BM-kg), fat content (Fat-%), fat free mass (FFM-kg). Muscular strength of the upper and lower limbs was evaluated by the bench press and the hack squat when athletes reached one repetition maximum (1RM). Blood samples for biochemical analysis were drawn at rest from the antecubital vein before and after

4 weeks of the experiment. The serum concentration of estradiol was evaluated with the use of radioimmunoassay kit DSL-4400 (Diagnostic System Laboratories, Inc. USA) with a normal value for men ranging between 0.05-0.24 nmol/l. The concentration of testosterone was evaluated with radioimmunoassay kit Testosterone RIA – DSL 4000 (USA) with values for men establishes at 9.7 to 30.5 nmol/l. The concentration of luteinizing hormone was evaluated by immunoradiometric method with the use of BioSource Europe SA kits (Belgium). The normal values of this hormone for healthy men ranged from 1.0 to 5.3 IU/l.

For statistical purposes the "Statistica" (Softwere 1995) was used, as mean values (x) and standard deviations (SD) were calculated. To determine the influence of supplementation and time on muscular strength, body composition and hormone concentration a 2-way analysis of variance (ANOVA) was used.

Significant main effects were further analyzed using the RIR-Tukey post hoc test. The level of significance for all analyses was accepted at $p < 0.05$.

Results

The results of ANOVA show no significant effect of supplementation with "Acetosteron" and "Tribusteron 90" on serum concentration of testosterone, and luteinizing hormone but a significant affect ($F = 3,56$, $p<0.01$) on estradiol level (tab. 1). In group I supplemented with steroidal saponins and acetyl L-carnitine, zinc, magnesium and vitamin B_6 there was a 14% increase in the level of testosterone while in group II supplemented with a specimen containing only steroidal saponins from Tribulus terrestris a 22% drop in the concentration of this anabolic hormone occurred (tab. 1). It must be stated that there was a significant difference ($p<0.05$) in initial concentration of testosterone between groups I and II. After supplementation they reached a similar level. A significant ($p<0.05$) rise in the level of estradiol was observed only in supplemented groups (tab. 1). A slight tendency for increased concentration of LH was observed in all three groups taking part in the experiment, yet these differences were statistically insignificant.

The results also indicate no effect of supplementation with "Acetosteron" and "Tribusteron 90" on muscular strength of the upper and lower limbs (tab. 2). Group I improved the bench press result by 7.61 % yet no progress was observed in results of the hack squat. In group II the results of the squat improved by 6.59 % with minor changes in the bench press results (1.91 %) (tab. 2).

Supplementation with both specimens containing steroidal saponins did not influence significantly body mass and body composition (tab. 3). It must be noticed that in group I changes in BM (5.3 kg) and FFM (3.9 kg) were rather

high but statistically insignificant. Changes in these variables in the other two groups were marginal.

Table 1

Serum testosterone, estradiol and luteinizing hormone (LH) concentration, before and after 4 weeks of supplementation with "Acetosteron" (group I), "Tribusteron 90" (group II) and placebo (group III)

Group	Time	Testosterone (nmol/l)		Estradiol (nmol/l)		LH (IU/l)	
		X	SD	X	SD	X	SD
I	Before	14,43	4,25	0,31	0,06	2,32	1,41
	After	16,45	5,45	0,45*	0,04	3,18	1,62
	%	13,99		45,16		37,01	
II	Before	22,19#	6,22	0,28	0,07	2,73	1,32
	After	17,50	5,32	0,40*	0,10	3,14	1,75
	%	21,14		42,85		15,02	
III	Before	17,48	6,89	0,34	0,09	2,80	1,28
	After	17,75	7,11	0,40	0,12	3,09	1,89
	%	1,54		17,65		10,36	

Note: # significant difference ($p<0.05$) in relation to initial values, *significant difference ($p<0,01$) after treatment

Table 2

The results of the bench press and hack squat before and after 4 weeks of supplementation with "Acetosteron" (group I), "Tribusteron 90" (group II) and placebo (group III)

Group	Time	Bench press (kg)		Hack squat (kg)	
		X	SD	X	SD
I	Before	88,75	14,13	115,75	9,25
	After	95,50	15,24	115,63	8,97
	%	7,61			
II	Before	93,21	11,23	119,30	8,86
	After	95,00	9,87	127,14	8,79
	%	1,91		6,59	
III	Before	94,50	9,99	101,25	9,25
	After	95,13	10,16	98,75	7,98
	%	0,66		2,46	

Table 3

Body mass, fat content, fat free mass before and after 4 weeks of supplementation with "Acetosteron" (group I), "Tribusteron 90" (group II) and placebo (group III)

		Body mass (kg)		Fat (%)		FFM (kg)	
Group	Time	X	SD	X	SD	X	SD
I	Before	87,39	10,11	14,89	7,25	74,11	6,25
	After	92,74	12,31	15,77	8,98	78,10	7,46
	%	6,13		5,93		5,38	
II	Before	90,81	11,32	16,76	10,11	75,46	8,25
	After	91,17	12,58	16,61	9,26	75,71	9,64
	%	0,39		0,85		0,34	
III	Before	92,03	8,98	17,00	8,78	76,40	10,12
	After	92,25	10,25	17,25	9,45	76,28	8,49
	%	0,23		1,47		0,16	

Discussion

Tribulus terrestris (tribulus) is an herb that supposedly enhances plasma testosterone levels and promotes skeletal muscle hypertrophy. According to Arcasoy et al. (1998), tribulus has been commonly used as a diuretic as well as treatment for hypertension, hypercholesterolemia and colic pains. Wang et al. (1990) found that tribulus supplementation may reduce the remission rate of angina pectoris and decrease myocardial ischemia without any unwanted effects on hepatic or renal function. Dimitrov et al. (1987) found increased plasma testosterone levels and reversed sexual impotence in rams following supplementation with tribulus.

Tribulus terrestris is commonly known as *puncture vine* and has been used for centuries in Europe as treatment for impotence (Sharifi et al. 2003). Supplement manufacturers claim that tribulus enhances testosterone production via the stimulation of luteinizing hormone from the pituitary glands; thus, gain in skeletal muscle mass may occur secondary to an augmentation of plasma testosterone. However, there is no data published in peer-reviewed scientific journals that support ergogenic effects of tribulus.

The active ingredient in tribulus is unknown, but is thought to be a component known as furostanol saponins (DeCombarieu et al. 2003). There has been very little research conducted on the effectiveness of tribulus in elevating testosterone levels – the main claim of body building products, which contain the herb (Bourke et al. 1992). In some cultures, Tribulus terrestris has been used as a

„tonic" to increase energy levels and treat sexual dysfunction (usually in males). It may be an effective supplement for individuals with reduced testosterone levels such as athletes at risk for overtraining and in those individuals on a prolonged low-calorie diet. It is more likely to benefit older and middle aged men than younger individuals with naturally high levels of testosterone.

A typical dosage of 250-1500 mg tribulus per day is fairly common. A large amount of potential active components have been identified in tribulus, including steroidal saponins, lignanamides, alcaloids and flavonoids (Huang et al. 2003). Current research indicates that the steroidal saponins, particularly the dominant saponin protodioscin, are responsible for the pharmacological activities of tribulus (Ganzera et al. 2001, Wu et al. 1996, Xu et al. 2000).

Tribulus is considered an aphrodisiac, a putative testosterone elevator. Tribulus increase sexual function in animal studies and also reportedly improves libido in humans (Adaikan et al. 2000, Dimitrov et al. 1987).

However this is not necessarily indicative of a testosterone-increasing effect. There are other possible reasons, such as the hypotensive effect of tribulus. There is limited information regarding the effect tribulus ultimately has on testosterone levels. Bucci (2000) indicates that tribulus increased testosterone and luteinizing hormone (LH) levels in depressed men who were infertile. When protodioscin is administered to castrate rats, it increases levels of testosterone, LH, dehydroepiandrosterone (DHEA), and dihydrotestosterone (DHT) (Gauthaman et al. 2002).

Two mechanisms have been proposed for these increases, the first being that protodioscin directly increases LH, and the second being that protodioscin increases levels of DHEA (which would ultimately) mildly increase testosterone, perhaps by functioning as a precursor (Al-Ali et al. 2003). The neural effects of DHEA would also explain the aphrodisiac properties (Gauthaman et al. 2002). However, it should be noted, if the latter is the case, it would open the possibility that tribulus could ultimately lead to lower natural production of testosterone. Antonio et al. (2000) and Brown et al. (2000) showed that supplementation with tribulus over an eight week period did not improve body composition or strength.

Biological properties of tribulus extracts include diuretic properties, increased endothelial nitric oxide production, direct smooth muscle relaxant effects (Arcasoy et al. 1998). Human supplementation trials using tribulus have been reported as safe and free of side effects.

In this research project, two products containing extracts from Tribulus terrestris were used (Acetosteron and Tribusteron 90). The first one besides steroidal saponins contained acetyl L-carnitine which donates acetyl groups for

octane condensation, a crucial phase of testosterone synthesis. This specimen also contained zinc and magnesium, important cofactors of enzymes stimulating testosterone synthesis as well as vitamin B_6 a significant component of enzymes catalyzing the metabolism of amino acids. Considering the short period of supplementation and the high level of conditioning of the tested athletes, the changes in BM, FFM and muscular strength of the upper limbs seem high.

On the other hand supplementation with "Tribusteron 90", containing only extracts from Tribulus terrestris showed a detrimental effect on the serum level of anabolic hormones and no beneficial changes in body mass and composition as well as muscular strength of the basketball players. This confirms that steroidal saponins have little ergogenic effects on young, well trained men.

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