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The Effects of *Tribulus Terrestris* on Body Composition and Exercise Performance in Resistance-Trained Males

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The purpose of this study was to determine the effects of the herbal preparation *Tribulus terrestris* (tribulus) on body composition and exercise performance in resistance-trained males. Fifteen subjects were randomly assigned to a placebo or tribulus (3.21 mg per kg body weight daily) group. Body weight, body composition, maximal strength, dietary intake, and mood states were determined before and after an 8-week exercise (periodized resistance training) and supplementation period. There were no changes in body weight, percentage fat, total body water, dietary intake, or mood states in either group. Muscle endurance (determined by the maximal number of repetitions at 100–200% of body weight) increased for the bench and leg press exercises in the placebo group ($p < .05$; bench press ±28.4%, leg press ±28.6%), while the tribulus group experienced an increase in leg press strength only (bench press ±3.1%, not significant; leg press ±28.6%, $p < .05$). Supplementation with tribulus does not enhance body composition or exercise performance in resistance-trained males.

Key Words: supplement, nutrition, exercise, herb

Introduction

Tribulus terrestris (tribulus) is a herbal preparation that purportedly enhances plasma testosterone levels and promotes skeletal muscle hypertrophy (1). According to Arcasoy et al. (3), tribulus has been commonly used as a diuretic as well as treatment for hypertension, hypercholesterolemia, and colic pains. Wang et al. (14) found that tribulus supplementation may reduce the remission rate of angina pectoris and decrease myocardial ischemia without any untoward effects on hepatic or renal function. On the other hand, tribulus has been shown to have deleterious effects on locomotor behavior in sheep (4, 5).

Work from Dimitrov et al. (7) found that Tribestan (a tribulus containing herbal preparation) increased plasma testosterone levels and reversed sexual im-

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potence in rams. The purported mechanism for augmenting plasma testosterone is via the stimulation of luteinizing hormone production (1). However, there is no evidence that tribulus is an effective ergogenic aid for humans. Therefore, the purpose of this study was to determine if tribulus supplementation could affect body composition and exercise performance in resistance-trained young males.

Methods

Subjects

Healthy, resistance-trained males (i.e., recreational bodybuilders) were recruited from the University of Nebraska-Kearney (UNK) student population via advertisements according to the following inclusion criteria: (a) 18–35 years; (b) in good health (free from diabetes, cancer, or heart disease); (c) consistent resistance-training (average of three times per week) for the past year; and (d) not currently taking a dietary supplement that contains tribulus. Subjects had experience using free-weights and various weight-training machines (e.g., Universal, Cybex) and did not require instruction on lifting technique or protocol. With regards to other dietary supplements (e.g., multi-vitamin, creatine), we instructed each subject not to change their current consumption habits (i.e., remain on the supplements they were on for the duration of the study and not start ingesting any additional supplements). Informed consent was obtained from each subject, and the experimental procedures were approved by the institutional review board of UNK.

Dietary Supplement/Analysis

Subjects orally ingested capsules that contained tribulus (Metabolic Response Modifiers, Newport Beach, CA) at a dose of 3.21 mg per kg body weight. This dose was taken in pill form (approximately 6–8 pills) once per day. The tribulus supplement was an extract that was standardized to 45% saponins and protodyosin, the active ingredients in tribulus. The concentrations of the active ingredients of this tribulus preparation were determined by the manufacturer. Subjects in the placebo group ingested an equal number of identical looking pills that contained cellulose. All subjects were instructed not to change their dietary habits. Each subject reported his dietary intake (24-hr dietary recall) on a random day during the 1st, 4th, and 8th week of the study. Total kilocalories, carbohydrate, protein, and fat intake were determined via computer analysis (Nutribase '98, Phoenix, AZ).

Training Program

All subjects followed a split-routine (i.e., divided into body parts) periodized weight-training program devised by the assistant strength and conditioning coach of UNK (Table 1). This program is a variation of the classic periodization program (8).

Performance Measures

After three warm-up sets, subjects were instructed to perform the maximal number of full repetitions for the supine free weight bench press (100% of body weight) and leg press (45°; 200% of body weight) exercises. Subjects were given a 5-min rest interval between the bench press and leg press attempts. For the bench press, subjects

Table 1 Resistance Training Program

Monday: chest, shoulders, triceps	Wednesday: legs	Friday: back, biceps
Bench press	Squats	Lat pull-downs
Incline bench press	Calf raises	Dumbell rows
Dumbell military press	Leg extensions	Seated rows
Front raises	Leg curls	Hammer curls
Cable crossovers	Leg press	Reverse grip pulldowns
Pec deck	Dumbell lunges	Shoulder shrugs
Dumbell bench press		Dumbell bicep curls
Tricep kickbacks		
Lateral raises		

Note. Weeks 1, 2, 3 (three sets of 10–12 repetitions); Weeks 4, 5, 6 (three sets of 8–10 repetitions); Weeks 7, 8 (three sets of 6–8).

had their feet fully planted on the floor, their hips and scapula maintained contact with the bench at all times, and a slight lumbar lordosis allowed. Repetitions were performed such that the concentric phase was performed as quickly as possible and the eccentric phase was performed in a slow, controlled descent. Hand position was slightly greater than shoulder width. For the 45° leg press, subjects planted their feet slightly greater than shoulder width, with the toes angled slightly outward (external rotation of the leg and thigh) and their back flat against the padded surface of the machine. Repetitions were performed using a similar tempo as the bench press. It was up to the judgement of the tester to determine if repetitions were performed correctly for the bench or leg press.

Body Composition

Skinfold thickness was assessed using a Lange caliper; seven sites on the body were measured (chest, abdomen, thigh, triceps, subscapular, suprailiac, and midaxillary) with the median of three measurements used to represent skinfold thickness (9). Hydrostatic weighing with residual volume measured by oxygen-dilution was used to determine percentage fat (13, 14). Bioelectrical impedance analysis (BIA) was used to estimate total body water (Model 3.10, Biodynamics, Seattle, WA; ref. 12). The same technician performed the pre- and post-tests on each subject for skinfolds and underwater weighing. For the BIA, subjects were instructed to do the following: no eating or drinking within 4 hr of the test, no exercise within 12 hr of the test, no alcohol consumption within 2 days of the test, urinate within 30 min of the test, and no diuretic medications during the week of the test.

Profile of Mood States (POMS)

To determine if tribulus influenced the perception of fatigue or vigor, a POMS questionnaire (Educational and Industrial Testing Service, San Diego, CA) was used.

Statistical Analyses

Pre and post differences for bench press, leg press, body composition, and POMS were analyzed by a paired *t* test. An unpaired *t* test was used to assess between-group differences in body composition, exercise performance, and POMS. Pre-, mid, and post-dietary intake data were analyzed via ANOVA for repeated measures (treatment group × time). Statistical significance was set at $p < .05$; data are shown as means ± standard deviation. Data were analyzed using SigmaStat (SPSS, Chicago, IL).

Results

There were no baseline differences in age, height, or weight between groups (Table 2). There was no within- or between-group differences in percentage body fat, sum of seven skinfolds, and total body water (Table 3). Maximal repetitions for the leg press increased significantly ($p < .05$) for both the placebo and tribulus groups; however, only the placebo group experienced an increase ($p < .05$) in maximal repetitions for the bench press (Table 4).There were no within- or between-group differences in levels of perceived vigor or fatigue (Table 5). There were no differences between pre-, mid, and post-measures of total kilocalories, protein, carbohydrate, or fat intake for either group (Table 6). Furthermore, the caloric and protein intake per kilogram of body weight did not differ between groups (Table 7). No subjects reported any untoward side effects from the tribulus.

Discussion

Tribulus terrestris (tribulus) is commonly known as *puncture vine* and has been used for centuries in Europe as treatment for impotence (2). Supplement manufacturers claim that tribulus can enhance testosterone production via the stimulation luteinizing hormone from the pituitary gland; thus, gains in skeletal muscle mass may occur secondary to an augmentation of plasma testosterone. However, there are no data published in peer-reviewed scientific journals that support an ergogenic effect of tribulus. This is the first study that has examined the effects of tribulus on body composition and exercise performance in resistance-trained individuals.

The results of this study indicate that tribulus supplementation in male resistance-trained individuals has no effect on percentage fat or total body water. Subjects in the placebo and tribulus group had similar body weight and percentage body fat at baseline. This did not significantly change in either group despite the intensive 8-week resistance training program. The lack of improvement in body composition in both groups may be attributed to the fact that these subjects were already lean (~12% body fat). One could speculate that without significant alterations in their diet, it is difficult for lean, resistance-trained individuals to make significant changes in body composition. In this study, the energy and protein intakes reported by these subjects did not change appreciably over the course of the study for either group and thus would not be a confounding variable in this study.

However, the reported caloric and protein intake per kilogram body weight in the subjects of the current study may have been inadequate for the purpose of gaining skeletal muscle protein. Burke et al. (6) examined the macronutrient intakes of elite Australian male athletes and found that weightlifters ingested 44 kcal and 1.9 g protein per kg of body weight, respectively. Bodybuilders who were taking anabolic

Table 2 Physical Characteristics

Group	Age	Height (cm)	Weight (kg)	% body fat*
Tribulus ($n = 8$)	20.0 ± 1.7	182.9 ± 4.8	75.2 ± 6.6	12.0 ± 0.5
Placebo ($n = 7$)	22.4 ± 3.9	177.3 ± 3.9	81.1 ± 9.0	11.7 ± 0.5

Note. Values are means ± *SD*. There were no significant differences between groups. *Percentage body fat determined by underwater weighing.

Table 3 Body Composition

Group	Weight (kg)	TBW (L)	SUM 7 SKF (mm)	UWW (% fat)
Tribulus ($n = 8$)				
Pre	75.2 ± 6.6	50.1 ± 5.2	86.4 ± 22.3	12.0 ± 0.5
Post	76.1 ± 7.1	50.4 ± 4.6	84.3 ± 31.4	12.0 ± 0.5
Placebo ($n = 7$)				
Pre	81.1 ± 9.0	47.0 ± 4.7	83.5 ± 23.3	11.7 ± 0.5
Post	81.7 ± 10.0	47.9 ± 4.4	80.1 ± 24.3	11.9 ± 0.6

Note. Values are means ± *SD*. SKF = skinfolds; TBW = total body water from bioelectrical impedance analysis; UWW = underwater weighing. There were no significant within- or between-group differences.

Table 4 Exercise Performance—Maximal Number of Repetitions at 100–200% of Body Weight

Group	Bench press ($n = 8$)	Leg press ($n = 7$)
Tribulus ($n = 8$)		
Pre	9.8 ± 3.8	20.7 ± 10.8
Post	10.1 ± 3.2	26.1 ± 4.9*
% increase	+3.1%	+26.1%
Placebo ($n = 7$)		
Pre	10.9 ± 4.2	26.6 ± 7.5
Post	14.0 ± 5.3*	34.2 ± 9.2*
% increase	+28.4	+28.6

Note. Values are means ± *SD*. There were no between group differences in pre-test bench and leg press performance. Bench and leg press movements were tested at 100% and 200% of the subject's body weight, respectively.
*Indicates significant differences pre- vs. post ($p < .01$).

Table 5 Profile of Mood States

Group	POMS-fatigue	POMS-vigor
Tribulus ($n = 8$)		
Pre	8.9 ± 2.3	18.9 ± 7.9
Post	9.9 ± 5.3	20.3 ± 5.3
Placebo ($n = 8$)		
Pre	7.0 ± 4.0	21.4 ± 5.4
Post	7.0 ± 4.8	21.0 ± 4.9

Note. Values are means ± *SD*. There were no significant within- and between-group differences.

Table 6 Macronutrient Intake

Group	Total Kcals*	CHO (g)	PRO (g)	FAT (g)
Tribulus ($n = 8$)				
Pre	2853 ± 815	446 ± 165	106 ± 30	76 ± 29
Mid	2721 ± 145	402 ± 173	132 ± 33	72 ± 18
Post	2823 ± 835	457 ± 195	87 ± 21	75 ± 33
Placebo ($n = 7$)				
Pre	2245 ± 553	277 ± 114	140 ± 85	83 ± 44
Mid	2479 ± 985	358 ± 127	92 ± 35	79 ± 46
Post	2681 ± 1060	330 ± 118	102 ± 40	101 ± 57

Note. Values are means ± *SD*. There were no significant within- or between-group differences. *Conversion factor: 1 kilocalorie (kcal) = 4.1840 kilojoule (kJ)

Table 7 Average Daily Caloric and Protein Intake (Per kg Body Weight)

Group	Kcals/kg	Protein/kg
Tribulus ($n = 8$)	35.40 ± 11.84	1.36 ± 0.36
Placebo ($n = 7$)	33.08 ± 9.37	1.49 ± 0.56

Note. Data are means ± *SD*. These values were determined by averaging individual data collected for the three 24-hr dietary recalls and the average weight of each subject. There were no significant differences in average daily caloric or protein intake per kilogram body weight between groups.

steroids ingested approximately 48 kcal and 2.7 g of protein per kg of body weight, respectively (10). The protein and caloric intake of the subjects in the current study were substantially less than the subjects examined in previous work (6, 10). In fact, a recent review by Lemon (11) suggested that those involved in resistance training may need to consume 1.6–1.7 g of protein per kg of body weight daily. Thus, the subjects in the current study may not have consumed an adequate amount of protein or calories to promote gains in lean body mass.

Exercise performance improved equally well for the leg press exercise in both groups; however, the placebo group improved much more than the tribulus group for the bench press exercise. It is not clear why this difference exists inasmuch as they followed the same training program. The improvement seen in the placebo group's bench press performance, while the tribulus group did not change, is puzzling. Since body weight or lean body mass did not increase, it is possible that the improved exercise performance was due to a neural training effect. One could speculate that the placebo group was not as well-trained as the tribulus group; therefore, post-training gains were more likely to occur. However, this would be unlikely in that both groups had similar bench press and leg press performance at the beginning of the study. Moreover, given the significant changes in leg press performance in both groups (but not the bench press), one could speculate that our subjects were relatively less trained in the lower extremities versus the upper extremities. This might mask the effect of supplement use inasmuch as all subjects could improve.

Also, our choice of performance measure had a component of strength to it, though muscular endurance was emphasized. Perhaps using a one-repetition maximum or maximal voluntary contraction to assess muscular strength would have been a preferred method of assessing resistance-training induced adaptations.

Tribulus is touted as a mood enhancer (2), yet it is clear from our data that this herbal preparation had no effect on subjects' perception of vigor or fatigue. Although none of our subjects reported any adverse effects from the ingestion of tribulus, Australian *Tribulus terrestris* has been shown to induce staggers (irreversible, asymmetrical weakness of hindlimbs) and limb paresis in sheep (5). The mechanism(s) for this neuromuscular dysfunction are presently unknown.

The strength of this study includes the use of resistance-trained subjects and a double-blind, placebo-controlled design. Nonetheless, it is apparent that tribulus ingestion had no benefit for the small sample of resistance-trained individuals in our study. We did not measure plasma testosterone or luteinizing hormone levels; thus, it is unclear if tribulus affects the hypothalamic-pituitary-testicular axis. Since no other published studies exist on tribulus, it would be premature to conclude that tribulus has no effect in all individuals. The purity of the tribulus, the duration of supplementation, and the training status and hormonal milieu of the individual may affect the efficacy of this supplement. Future research should examine the acute and chronic responses of luteinizing hormone and testosterone to tribulus consumption. In addition, a longer duration and higher dosage of tribulus supplementation coupled with a long-term periodized resistance-training program may be necessary to determine if tribulus has an ergogenic effect.

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