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ORIGINAL ARTICLE

The effect of ginseng supplementation on anabolic index, muscle strength, body composition, and testosterone and cortisol response to acute resistance exercise in male bodybuilders

Effets de la supplémentation en ginseng sur l'indice anabolique, la force musculaire, la composition corporelle et la réponse de la testostérone et du cortisol à un exercice aigu chez les culturistes masculins

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KEYWORDS
Ginseng;
Testosterone;
Cortisol;
Resistance training;
Waist-hip ratio;
Body mass index

Summary
Aims. — Bodybuilders are among the athletes who are more likely to take nutritional supplements such as ginseng. The aim of this study was to investigate the effect of ginseng supplementation on anabolic index, muscle strength, body composition, and testosterone (T) and cortisol (C) response to acute resistance exercise in male bodybuilders.
Methods. — In a pretest—posttest control group design, twenty male bodybuilders were randomly divided into two experimental (EG, $n = 10$) and control (CG, $n = 10$) groups. The assessments were carried out in three stages: pre-supplementation (Pre-S), post-supplementation (Post-S), and post-exercise (Post-Ex = after a bodybuilding exercise session as acute resistance exercise). General characteristics of subjects, muscle strength, body composition and blood levels of T and C were measured. The supplementation period was six weeks (two ginseng capsules, twice daily, times of ingestion). The CG group also consumed similar capsules containing starch. Analyses of variances with repeated measures were used to test the significance of changes of variables between three stages of the assessment. $P < 0.05$ was set as level of significance.

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Results. — Ginseng supplementation has no significant effects on C ($P = 0.059$), anabolic index (T/C ratio, $P = 0.463$), body mass index ($P = 0.182$), waist to hip ratio ($P = 0.828$), and muscle strength (bench press $P = 0.684$, leg press $P = 0.717$), while it significantly decreased T levels after acute resistance exercise (EG: Pre-S 4.87 ± 2.54, Post-S 4.80 ± 2.46, Post-Ex 4.17 ± 2.85 ng/mL, CG: Pre-S 4.15 ± 1.36, Post-S 3.73 ± 1.30, Post-Ex 4.46 ± 1.40 ng/mL, $P = 0.026$) in male bodybuilders.

Conclusion. — It does not appear that six weeks ginseng supplementation simultaneously with bodybuilding exercises has an extra effect on anabolic index, muscle strength and body composition in male bodybuilders, but it does have a decreasing effect on T levels response to acute resistance exercise.

MOTS CLÉS
Ginseng ;
Testostérone ;
Cortisol ;
Entraînement en résistance ;
Rapport taille-hanche ;
Indice de masse corporelle

Résumé

Objectifs. — Les culturistes font partie des athlètes les plus susceptibles de prendre des suppléments nutritionnels tels que le ginseng. Le but de cette étude était d'étudier l'effet de la supplémentation en ginseng sur l'indice anabolique, la force musculaire, la composition corporelle et la réponse de la testostérone (T) et du cortisol (C) à un exercice de résistance aiguë chez les bodybuilders masculins.

Méthodes. — Dans une conception de groupe témoin pré-test—post-test, vingt culturistes masculins ont été répartis au hasard en deux groupes expérimentaux (GE, $n = 10$) et témoins (GT, $n = 10$). Les évaluations ont été réalisées en trois étapes : présupplémentation (Pré-S), postsupplémentation (Post-S) et postexercice (Post-Ex) après une séance d'exercice de musculation comme exercice de résistance aiguë). Des caractéristiques générales des sujets, la force musculaire, la composition corporelle et les niveaux circulants de T et C ont été mesurés. La période de supplémentation était de six semaines (deux capsules de ginseng, deux fois par jour, temps d'ingestion). Le groupe GT a également consommé des capsules similaires contenant de l'amidon. Des analyses des variances avec des mesures répétées ont été utilisées pour tester la signification des changements de variables entre trois étapes de l'évaluation. $p < 0{,}05$ a été défini comme niveau de signification.

Résultats. — La supplémentation en ginseng n'a aucun effet significatif sur la C ($p = 0{,}059$), l'indice anabolique (rapport T/C $p = 0{,}463$), l'indice de masse corporelle ($p = 0{,}182$), le rapport taille/hanche ($p = 0{,}828$) et la force musculaire (développé couché $p = 0{,}684$, et presse jambes $p = 0{,}717$), alors qu'elle diminuait significativement T niveaux après un exercice de résistance aiguë (GE : Pré-S $4{,}87 \pm 2{,}54$, Post-S $4{,}80 \pm 2{,}46$, Post-Ex $4{,}17 \pm 2{,}85$ ng/mL, GT : Pré-S $4{,}15 \pm 1{,}36$, Post-S $3{,}73 \pm 1{,}30$, Post-Ex $4{,}46 \pm 1{,}40$ ng/mL, $p = 0{,}026$) chez les culturistes masculins.

Conclusion. — Il ne semble pas que six semaines de supplémentation en ginseng simultanément avec des exercices de musculation aient un effet supplémentaire sur l'indice anabolique, la force musculaire et la composition corporelle chez les bodybuilders masculins, mais cela à un effet décroissant sur la réponse des niveaux de T aux exercices de résistance aiguë.

1. Introduction

The effectiveness of resistance training depends partly on changes in hormones to improve muscle strength and mass [1]. During strength training, an anabolic environment enhances protein synthesis and muscle hypertrophy (type IIb muscle fibers) [2]. Testosterone (T) is an anabolic hormone that results in the activation of many important anabolic processes [3]. In contrast, cortisol (C) is a catabolic hormone that responds to psychological and physiological stressors to drive lipolysis and proteolysis [4]. Increasing C concentrations can inhibit the anabolic effects of T, and therefore, the ratio between T and C concentrations may affect performance and potential exercise adaptations [5]. T, as a primary anabolic hormone, is associated with muscle strength and gain [6]. Stress hormone C has also been shown to increase during resistance training due to increased metabolic need [7].

The T/C ratio is used as an indicator of relative anabolic or catabolic status [8,9], and positive changes in this ratio are associated with an increased environment for muscle growth [10]. In the absence of other variables, the researchers use this ratio as a useful instruction in assessing the acute and chronic effects of exercise training, both in strength training and endurance training [2].

Panax Ginseng (PG) also called Asian or Korean ginseng, has been traditionally used in Korea and China to treat various diseases [11]. PG contains triterpene glycosides as its principal active constituents, commonly known as ginsenosides or saponins. More than 40 ginsenosides distinct from

PG have been identified [12]. PG is a well-known adaptogen [13] and is believed to be an enhancer of physical performance [14]. Adaptogens are safe supplements which enhance ''non-specific resistance to stress'' [9].

Ginseng may regulate the pituitary-testis axis at both the hormonal and neuronal levels [15]. Also, when people are confronted with a stressful environment, ginseng can improve their response by regulating HPA (Hypothalamic-Pituitary-Adrenal) axis function [16]. Feeding rats with 5% purified PG for 60 days resulted in a significant increase in blood T levels, whereas 1% purified PG had no effect [17]. In another study, after six weeks of PG supplementation in endurance athletes, no change in T, C or T/C ratio was observed [18].

Some evidence has shown that ginseng can improve physical performance properties such as endurance time to exhaustion [19]. Supplementation with Malaysian ginseng for five weeks can increase muscle strength [20]. However, following twelve weeks of ginseng supplementation during a period of aerobic and resistance exercise training in healthy adults, although the ginsenoside complex (high dose 500 mg/d but not low dose 100 mg/d) was shown to enhance aerobic capacity improvement induced by exercise training, however, no significant effect on the muscle strength of the dominant knee was reported [21].

Few studies have examined the effect of ginseng supplementation on body weight and body composition in humans, and especially in athletes. Bodybuilders are among the athletes who are more likely to take nutritional supplements (such as ginseng) [22]. However, the effect of ginseng consumption on muscle strength and body composition indices in bodybuilders has been less studied [20,21]. There are also few studies that have examined the effect of ginseng consumption on the anabolic index (i.e. T/C ratio) or T and C response to acute resistance exercise (a bodybuilding exercise session) [18]. The purpose of the present study was to investigate the effect of ginseng supplementation on anabolic index, muscle strength, body composition, and T and C response to acute resistance exercise in male bodybuilders.

2. Materials and methods

2.1. Subjects and study design

In a pretest—posttest control group design, male bodybuilders in Boukan city (Iran) were studied. Study groups included experimental (EG) and control (CG) groups and measurements included pre-supplementation, post-supplementation and post-exercise. The study was conducted in winter 2018 in Boukan city. The study was a double-blind study. Male bodybuilders with at least two years of regular participation in bodybuilding exercises (three days per week, basic exercises of resistance training for upper- and lower-body, using free weights and machines) were studied. Subjects were selected by availability sampling and the method of assigning the subjects to the groups was replacement randomization.

Exclusion criteria included: consumption of any ginseng-containing product; drug consumption; food or supplement allergies; hypersensitivity to caffeine, obesity (body mass index > 30 kg/m^2); musculoskeletal injuries or physical limitations affecting the ability to exercise; cardiovascular disease such as myocardial infarction and previous cardiac surgery, osteoarthritis, respiratory disease, and other conditions that could make exercise difficult; current use of any hormonal substance including testosterone, anabolic steroids, or growth hormones; ongoing use of any anti-inflammatory medications; diagnosis of hypothyroidism, renal disorders, hepatic disorders, diabetes, hypertension, or cardiovascular disease; use of cholesterol or blood pressure-lowering medications; the use of tobacco products; alcohol consumption [21,23]. Sample size was estimated 18 subjects using GPower software version 3.1.9.2, with adjusted for repeated measures analysis of variance (interaction effect), error probability $\alpha = 0.05$, statistical power = 0.80, and partial $\eta 2 = 0.1$; and given the probability sample drop, 20 individuals were selected and randomly divided into two 10-subject groups (EG and CG). Twenty volunteers were randomly divided into EG ($n = 10$) and CG ($n = 10$) groups. A table with randomly assorted digits was used to allocate the subjects into two groups. All subjects completed the health history questionnaire, written consent form, physical activity readiness questionnaire, and daily nutrition record form. The study proposal was approved by Islamic Azad University, Saghez branch, research council.

2.2. Assessment procedures

During a first visit to the lab, the aim and stages of the study, ginseng supplementation and laboratory evaluations (e.g. blood sampling) were described and the participants were asked to avoid any changes in their behavior or diet during the study; do exercise according to their typical training program and avoid performing excessive physical activity over the bodybuilding exercises. To ensure strict adherence to these guidelines, these aspects were monitored weekly by researchers.

Pre-test and post-test measurements were performed in the same environmental conditions and by the same equipments and individuals for about a week, in the following order: on the first and second days, individuals were asked to avoid performing any excess physical activity over daily living activities and consuming any drug or diet supplement (including ginseng for the post-test phase). To control the possible effect of nutrition of the day before blood sampling on blood variables, subjects were asked to record whatever they eat on the daily diet record sheet 24 hours prior to the blood sampling, and repeat the same diet at the day before post-test blood sampling [24]. On the third day, blood samples were taken. In the post-test phase, after blood sampling, subjects in both groups performed a bodybuilding training session as an acute resistance exercise and blood sampling was performed thereafter. On the fourth day, the subjects were trained or reviewed on how to perform muscle strength tests (for pre-test and post-test, respectively). On the fifth day, the characteristics assessments (including body composition) of subjects were performed. Muscle strength tests were performed on the sixth day.

2.3. Blood sampling

Subjects were asked to be present at the Shafa Lab in Boukan city after 12 hours of fasting in the morning. After a ten-minute rest, in the sitting position, blood samples (10 cc) were taken from the antibiotic vein. T and C concentrations were measured using ELFA technique (VIDAS® Testosterone kit, VIDAS® Cortisol S kit, Biomérieux, France). The T/C ratio was obtained by dividing the T concentration by the C concentration.

2.4. Muscle strength and body composition

Bench and leg press tests were performed to assess muscle strength [25]. Before and after the tests, the subjects were warmed and cooled for 5 to 10 minutes (respectively). Muscle strength tests were performed using bench press and leg press sets and by determining a maximum repetition for each movement. The person chooses the weight and lifts as many times as he can lift it correctly. By the way, the weight chosen should not be enough to lift more than 12 times. In this case, one should rest for 15 minutes and choose a heavier weight to lift and repeat the test. 1 RM was determined for each movement by the following formula [26]:

Predicted 1 RM = weight lifted/[1.0278−(0.0278 × the number of repetitions performed)].

Height (cm) was measured using height scale (0.1 cm) and body weight (kg) was measured using body weight scale (0.1 kg). Body mass index (BMI, kg/m^2) was calculated by dividing weight (kg) by height (m^2). Using a non-elastic tape meter, waist circumference (cm) was measured in the narrowest part of the waist, above the umbilicus and below the xiphoid process, and the hip circumference (cm) was measured at the maximum pelvic circumference. Waist-to-hip ratio (WHR) was also calculated by dividing waist circumference by hip circumference.

2.5. Training program and acute resistance exercise

The training program was designed based on the recommendations of the American College of Sports Medicine for resistance training with a hypertrophy approach [1]. Training program and acute resistance exercise was supervised by a bodybuilding trainer and one of the researchers. All participants performed the resistance training program on three non-consecutive days per week. Each training session included warm-up, main exercise, and cool-down. Duration of each training session was 70 minutes. At each training session, the basic exercises of resistance training were performed using free weights and machines. The training exercises consisted of the lateral raise, lateral pull-down, shoulder press, biceps curl, triceps extension, pectoral fly, abdominal crunch, back extension and abdominal crunch exercises [27]. Each exercise was performed at three sets of eight repetitions, intensity of 70-80% of one repetition maximum, and 1−2 minutes rest between sets. Acute resistance exercise was also a bodybuilding training session in accordance with above mentioned training program.

Table 1 Characteristics of subjects (mean ± SD).

	EG (n = 10)	CG (n = 10)
Age (year)	30.6 ± 7.4	31.2 ± 3.9
Height (cm)	177.6 ± 7.0	180.4 ± 6.9
Body weight (kg)	81.1 ± 9.4	80.7 ± 9.1
Body mass index (kg/m^2)	25.7 ± 2.3	24.8 ± 3.3

EG: experimental group; CG: control group.

2.6. Supplementation method

The ginseng supplementation period was six weeks. According to previous evidence [28], the volunteers of EG consumed two ginseng capsules (Ginseng, Gol Daroo Co., Isfahan, Iran) twice daily, immediately after breakfast and dinner. Each capsule contained 250 mg granules of ginseng rhizome powder and was standardized on the basis of Rgl based on 3.6−7.7 mg ginsenosides. Subjects of CG received two capsules twice daily, each with the same form and taste containing starch [29]. Supplement and placebo capsules were indistinguishable in appearance both externally and internally. Capsules were given directly to participants by an unblinded pharmacy technician; treatment allocation was concealed from participants and all study personnel but the study analyst.

2.7. Statistical analysis

Descriptive statistics (mean ± SD) were used to describe the data. Shapiro−Wilk test for normality distribution of the population, Levene test for homogeneity of variances, independent t-test for comparing pre-test (baseline) means of variables and analyses of variances with repeated measures for testing hypotheses were used. Group (EG/CG) was considered as between-subject factor and measurement time (pre-supplementation/post-supplementation/post-exercise) as within-subject factor. The Mauchly test was used to test the spherical hypothesis, and if the test was significant (the spherical hypothesis was not established), the Greenhouse−Geisser Epsilon correction factor was used. In case of significant interaction effect, independent t-test was used to compare means of pre-/post-supplementation differences and post-supplementation/post-exercise differences between two groups. Significance level was set at 0.05. Statistical analyses were performed by SPSS software version 23 and GPower version 3.1.9.2.

3. Results

Attendance at this study was voluntary. All participants attended all the training sessions and completed the entire assessments. The characteristics of the subjects at baseline are reported in Table 1. Results of independent t-test for comparing the mean of general characteristics showed no significant difference between groups ($P > 0.05$) and the groups were homogeneous at baseline.

Table 2 Changes in anabolic index, muscle strength, body composition, T and C (Mean ± SD).

Parameters	EG/CG	Measurements			Time × group effect		
		Pre-supplementation	Post-supplementation	Post-exercise	F	*P*-value	Effect size f[a]
T (ng/mL)	EG	4.87 ± 2.54	4.80 ± 2.46	4.17 ± 2.85	5.164	0.026*	0.53
	CG	4.15 ± 1.36	3.73 ± 1.30	4.46 ± 1.40			
C (ng/mL)	EG	161.7 ± 35.7	143.4 ± 43.1	214.5 ± 49.6	3.512	0.059	0.40
	CG	162.6 ± 66.3	125.5 ± 66.1	155.8 ± 60.6			
T/C ratio	EG	0.031 ± 0.020	0.035 ± 0.023	0.020 ± 0.014	0.601	0.463	0.31
	CG	0.031 ± 0.021	0.056 ± 0.076	0.039 ± 0.035			
BMI (kg/m^2)	EG	25.73 ± 3.0	25.92 ± 3.3	—	1.931	0.182	0.39
	CG	24.81 ± 3.3	24.80 ± 3.3	—			
WHR	EG	0.91 ± 0.1	0.90 ± 0.1	—	0.049	0.828	0.29
	CG	0.90 ± 0.1	0.89 ± 0.1	—			
Bench press (kg)	EG	110.5 ± 11.7	109.0 ± 8.8	—	0.171	0.684	0.30
	CG	108.0 ± 14.8	107.5 ± 14.0	—			
Leg press (kg)	EG	233.0 ± 49.6	246.5 ± 53.7	—	0.136	0.717	0.32
	CG	255.0 ± 53.6	264.5 ± 53.3	—			

EG: experimental group; CG: control group; *: significant different at $P \leq 0.05$ (analyses of variances with repeated measures).
[a] Calculated by GPower software using partial eta squareds.

Pre-supplementation, post-supplementation and post-exercise (for some) values of variables are reported in Table 2.

The results of independent t-test for comparing the mean of dependent variables showed no significant difference between groups at baseline ($P > 0.05$).

Also, the results of the analysis of variance with repeated measures for the dependent variables of the research are shown in Table 2. Based on these results, the interaction effect (time × group) of T was significant ($P < 0.05$), while it was not significant for other variables ($P > 0.05$). Independent *t*-tests to compare means of pre-/post-supplementation differences and post-supplementation/post-exercise differences between two groups were non-significant ($t = -1.552$, $P = 0.147$) and significant ($t = 2.476$, sig = 0.023), respectively. After the supplementation period, T levels following acute resistance exercise in the EG decreased by 13%, while in the CG showed an increase by 19.5%.

According to the results of the statistical analysis, ginseng supplementation has no significant effects on C, T/C ratio, BMI, WHR, and muscle strength (bench press and leg press) ($P > 0.05$), while it significantly decreased T levels after acute resistance exercise ($P < 0.05$) in male bodybuilders.

4. Discussion

After six weeks of ginseng supplementation, levels of C, T/C ratio, BMI, WHR and muscle strength did not change in male bodybuilders, but T levels decreased after one session of bodybuilding exercise.

Ginseng is often referred to as the king of all plants and has been found to be a promising factor in improving general health [15]. According to the findings of the present study, ginseng supplementation for six weeks had no effect on C levels and anabolic index and their response to one session of bodybuilding exercise in male bodybuilders. Also, despite the unchanged T levels following this period of ginseng supplementation, its levels decreased after bodybuilding exercise compared to the control group. In general, the T response to an acute resistance exercise session is an increase in its blood levels. This response is largely determined by upper regulatory elements including the acute exercise programme variable domains, sex and age. [30]. It has been indicated that high power resistance exercise (10 × 5 speed squats at 70% of 1 repetition maximum + body weight with 2 min inter-set rest intervals) can contribute to an anabolic hormonal response with this type of training [31]. In some studies, the effect of ginseng consumption on resting T levels and its response to an exercise session has been studied. In one study, the effect of twelve weeks of Korean red ginseng (1000 mg, 3 times daily) and placebo on impotent men with erectile dysfunction was investigated. Serum T levels showed no significant difference between the two groups [32]. Oral administration of American ginseng (10—100 mg/kg) for 28 days has not been shown to alter T levels in rats [33]. However, a clinical trial of 66 participants showed that the use of Asian ginseng extract significantly increased plasma T levels [34].

However, it has been suggested that PG plays an important role in maintaining healthy levels of steroid hormone receptors, including the androgen receptor, which in turn guarantees the proper function of androgens [35]. Little information is available on the effect of ginseng consumption on C levels. Ginseng has been suggested to be a potential therapeutic agent for patients with HPA axis disorders associated with hypersecretion of C, such as depression, asthma, hypertension, and posttraumatic stress disorders [36]. In one study, the effects of 20 g of ginseng root extract (experimental group) and water (control group) immediately after an acute resistance exercise session on hormonal responses in male students were investigated. Plasma hormone responses (including T and C) were not significantly different between the two groups during the

2-hour recovery period [37]. However, few studies have examined the effect of ginseng consumption on testosterone and cortisol levels at rest, as well as following a resistance exercise session.

The findings of the present study showed that muscle strength (bench press and leg press) did not change in male bodybuilders after six weeks of ginseng supplementation. The findings of the present study are in line with the findings of some researchers [21,38], but are inconsistent with the findings of others [20,21]. In a study comparing the effect of Chinese ginseng, Siberian ginseng and placebo for six weeks, the findings showed that Chinese ginseng significantly increased pectoral and quadriceps strength, but the handgrip strength did not change after supplementation [39]. In another study, the effects of supplementation of PG and salvia miltiorrhiza were investigated during eccentric strength training for 12 weeks in middle-aged and older adults. Results showed that maximal leg strength and muscle quality increased in both supplement and placebo groups and relative increases in muscle mass were significantly greater in placebo group [40]. Panaxatriol extracted from ginseng (0.2 g/kg) has been shown to promote resistance exercise (isometric resistance exercise using percutaneous electrical stimulation)-induced protein synthesis through mTORC1 (the mammalian target of rapamycin complex 1) signaling [41].

Comparing the effects of ginseng directly is difficult because the amount, quantity and composition of ginseng supplements used in previous studies are different [19]. On the other hand, a review of existing data on the effects of ginseng on human exercise performance reveals dose-response and duration effects that may be responsible for the reported equivocal results [42]. It has also been reported that the ergogenic effect of ginseng depends on the physical condition. In fact, higher function of ginseng has been shown in sedentary individuals than in trained subjects [43]. It seems that several factors such as duration of supplementation period, dose and combination of supplements used and the level of physical fitness of the subjects have a direct effect on the effect of ginseng on physical fitness components such as muscle strength.

Based on the findings of the present study, BMI and WHR indices in male bodybuilders did not change after six weeks of ginseng supplementation. In one study, after eight weeks of PG extract administration, significant changes in body weight and BMI were observed in obese middle-aged Korean women, but no significant decrease in waist circumference and body fat percentage was reported [44]. In a systematic review and meta-analysis, the effects of PG on animal models were investigated. The results showed that PG administration significantly inhibited weight gain in animal obesity models. Various factors such as processing method, administration duration, and extraction method of ginseng and sample size have influenced the results of previous studies and therefore, more detailed studies are needed [45]. In addition, most studies on the anti-obesity effects of ginseng are limited to animals and little evidence supports the suggestion that ginseng exerts an anti-obesity effect in humans [46]. However, a definitive comment about the effect of ginseng on body composition indices in bodybuilders and resistance trainers requires further investigation.

Sample size and dietary control during the study were the limitations of the present study that considering them in subsequent researches may help to complement the findings. Further studies comparing ginseng supplementation with different doses, compositions and time periods strengthen available knowledge about the effect of ginseng supplementation on anabolic index, stress hormone levels, physical fitness and body composition indicators in male bodybuilder.

5. Conclusions

It does not appear that six weeks ginseng supplementation simultaneously with bodybuilding exercises has an extra effect on anabolic index, muscle strength and body composition in male bodybuilders, but it does have a decreasing effect on T levels response to acute resistance exercise. Accordingly, ginseng consumption for six weeks is not recommended to promote the anabolic and muscular strengthening effects of bodybuilding exercises in male bodybuilders.

Disclosure of interest

The authors declare that they have no competing interest.

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