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Effects of Ginseng Ingestion on Growth Hormone, Testosterone, Cortisol, and Insulin-Like Growth Factor 1 Responses to Acute Resistance Exercise

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ABSTRACT

Ginseng, an herbal plant, has been ingested by many athletes in Oriental regions of the world in order to improve stamina and to facilitate rapid recovery from injuries. However, adequate investigation has not been conducted to examine the ergogenic effects of ginseng. To examine the effects of ginseng supplements on hormonal status following acute resistance exercise, eight male college students were randomly given water (control; CON) or 20 g of ginseng root extract (GIN) treatment immediately after a standardized exercise bout. Venous blood samples were drawn before and immediately after exercise and at 4 time points during a 2-hour recovery period. Human growth hormone, testosterone, cortisol, and insulin-like growth factor 1 (IGF-1) levels were determined by radioimmunoassay. The responses of plasma hormones following ginseng consumption were not significant between CON and GIN treatments during the 2-hour recovery period. These results do not support the use of ginseng to promote an anabolic hormonal status following resistance exercise.

Key Words: ergogenic aids, weight training

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Introduction

Ginseng is considered to be very important among the traditional Oriental medicinal herbs. It has been used for many centuries in China, Japan, and Korea as an energy booster. Today, it is widely believed that oral consumption of ginseng can have beneficial mental and physical effects in humans (3, 8). Thus it is widely marketed and consumed internationally. The basic effects of ginseng have been characterized as increased physical stamina and general resistance to a decrease in immune function (6). Consequently, of some interest to scientists has been the question of its potential to affect physical work performance capacity (3). Previous studies have shown ginseng consumption to significantly improve swimming and running endurance in rats (1, 2). Recently, Ferrando et al. (16, 17) reported that the consumption of ginseng extract in rats caused favorable changes in blood parameters and muscle enzymes for endurance running. Additionally, short-term (4 days) treatment with ginseng saponin has been shown to significantly prolong the aerobic endurance of nontrained rats exercising at approximately 70% $\dot{V}O_2max$ (35). Limited research has been conducted on the use of ginseng in humans. In a study by Engels and Wirth (15), an 8-week ginseng treatment in healthy men did not significantly improve submaximal or maximal aerobic exercise performance. All of the above-mentioned studies using ginseng supplementation examined aerobic performance. However, the main reasons for ginseng consumption in Oriental medicine are to improve muscular strength and stamina and to enhance the recovery of fatigue and injuries. If ginseng consumption results in these anabolic and ergogenic effects, it could be because of an increased protein synthesis. Protein metabolism has been shown to be affected by anabolic hormones such as plasma insulin, growth hormone, testosterone, and insulin-like growth factor 1 (IGF-1; 7). Therefore, the purpose of this study was to determine whether a hormonal environment conducive to the enhancement of protein synthesis could be induced by ginseng root extract ingestion after weight-training exercise.

Methods

Subjects

Eight healthy male college students were recruited to participate in this study. All subjects were physical education students with no prior weight-training experience. Questionnaires were used to determine health and drug-use profiles of the subjects. All subjects reported to be drug-free, although there was no drug testing conducted. Subjects ranged in age from 20 to 24 years with a mean of 21.3 ± 0.7 (*SE*). The mean body weight of the subjects was 68.6 ± 1.4 kg. Each subject was completely informed of the potential risks and possible benefits associated with participation in the study before signing an informed consent document.

Experimental Protocol

One week before the experimental treatments began, 7 repetition maximum (7RM) values for each subject were determined for the 8 exercises to be used in the experiment. Performed in this order, these exercises included the half-squat, bench press, 2-leg curl, arm curl, 2-leg extension, abdominal crunch, leg press, and chest press.

The subjects were asked to eat similar meals before each trial. On the day before an experimental trial, the subjects were asked to abstain from alcohol and caffeine consumption. In addition, the subjects were asked to report to the laboratory after 36 hours of rest and a 12-hour fast.

On the day of the experimental trials, the subjects reported to the laboratory at 7:00 AM. Immediately before the resistance training, each subject stretched for 5 minutes to prevent potential injuries. Exercises were performed in the order mentioned previously. For each exercise, the subject performed 3 sets of the previously determined 7RM. The rest interval between exercises and between sets was 30 seconds and 60 seconds, respectively. A common protocol used in resistance training studies are 8–10RM sets. Because the subjects in this study were beginner weight lifters, a 3-set 7RM protocol was used. Immediately following the exercise bout, subjects were randomly given either 500 ml water (control; CON) or 20 g of Korean red ginseng root extract (GIN) with 500 ml water. There were 2 treatments separated by 7 days.

Blood Collection and Analysis

Approximately 5 ml of pre-exercise venous blood was drawn when the subjects reported to the laboratory. Immediately after the exercise bout, a postexercise sample was collected. After a 20-gauge × 3.2-cm indwelling venous catheter was placed into an antecubital vein, blood samples were taken at 15, 30, 60, and 120 minutes postexercise. Each blood sample was placed into 250 μl of cold EDTA (anticoagulant) and 93 μl aprotinin (protein stabilizer). Two hundred microliters of this whole blood were immediately added to 400 μl perchloric acid (8% v/v) and centrifuged at 1,000 *g* for 15 minutes. The supernatant was removed and frozen at −70° C until analyzed for lactic acid content according to the method of Hohorost (19). The remaining blood was centrifuged at 1,000 *g* for 10 minutes. The plasma was removed, separated into aliquots, and frozen at −70° C for subsequent analysis. The plasma was assayed by radioimmunoassay for human growth hormone with intra- and interassay coefficient of variation (CV) of 2.72 ± 1.70% and 4.25 ± 2.37%, respectively (Diagnostic Products Corporation, Los Angeles, CA); testosterone with intra- and interassay CV of 5.42 ± 1.28% and 5.90 ± 0.37%, respectively (Diagnostic Products); cortisol with intra- and interassay CV of 4.11 ± 0.81% and 6.03 ± 1.08%, respectively (Diagnostic Products); insulin with intra- and interassay CV of 4.13 ± 0.91% and 7.30 ± 2.09%, respectively (Diagnostic Products); and insulin-like growth factor I with intra- and interassay CV of 3.71 ± 1.70% and 4.25 ± 2.37%, respectively (Diagnostic Systems Laboratories Inc., Webster, TX). All samples were run in duplicate and corrected for postexercise hemoconcentration according to the method of Dill and Costill (14).

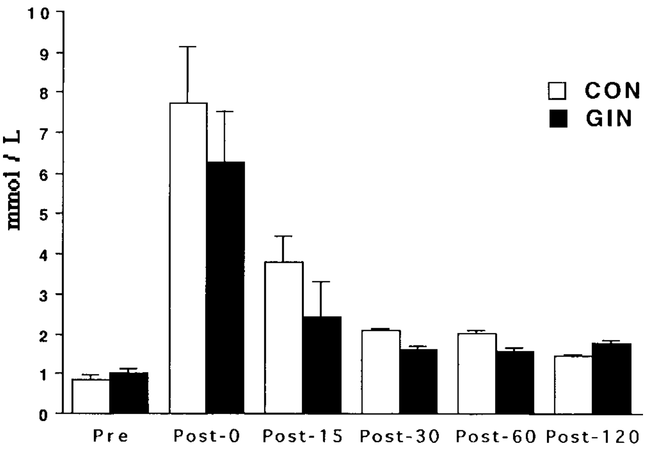

Figure 1. Results of lactate concentrations in control (CON) and ginseng (GIN) treatments.

Statistical Analyses

Standard statistical methods were used to calculate the means ± *SE* of the experimental variables. The data were analyzed using analysis of variance (ANOVA; treatment × time) with repeated measures. When appropriate, Tukey's post hoc comparisons were used to determine pairwise differences. Significance in this study was set at $p \leq 0.05$.

Results

Plasma lactate concentrations were not different between CON and GIN treatments pre- and postexercise and during recovery (Figure 1). These lactate concen-

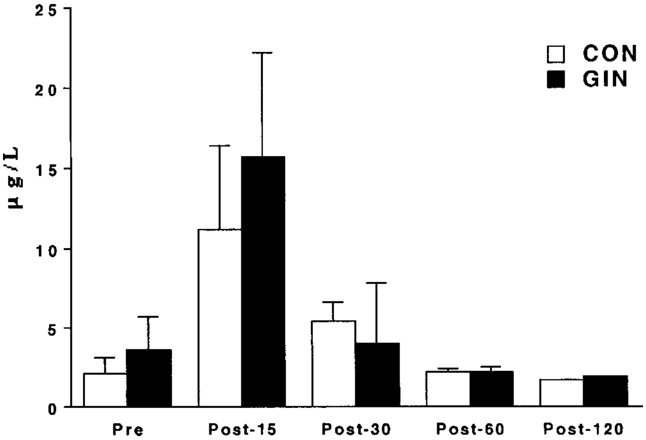

Figure 2. Plasma human growth hormone levels in control (CON) and ginseng (GIN) treatments.

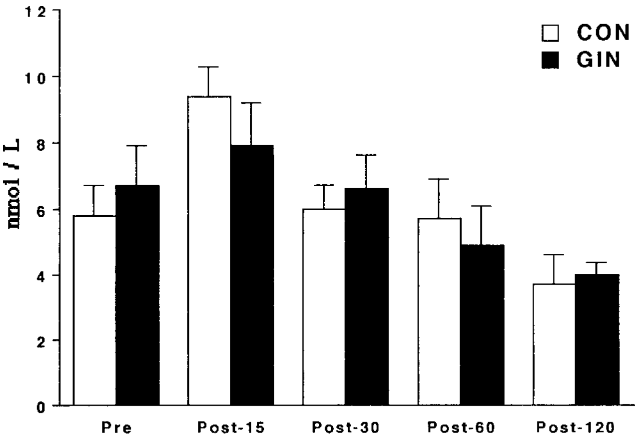

Figure 3. Plasma testosterone levels in control (CON) and ginseng (GIN) treatments.

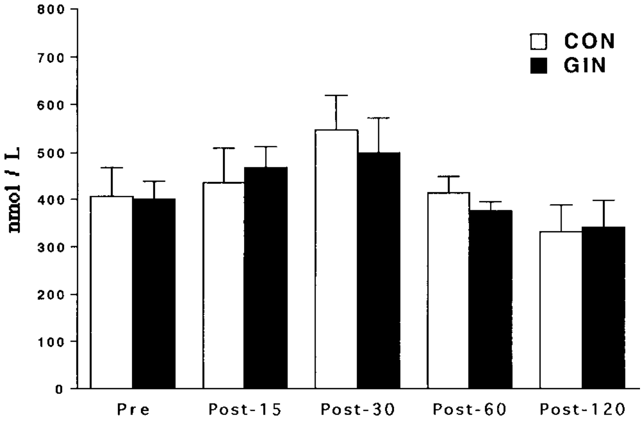

Figure 4. Plasma cortisol levels in control (CON) and ginseng (GIN) treatments.

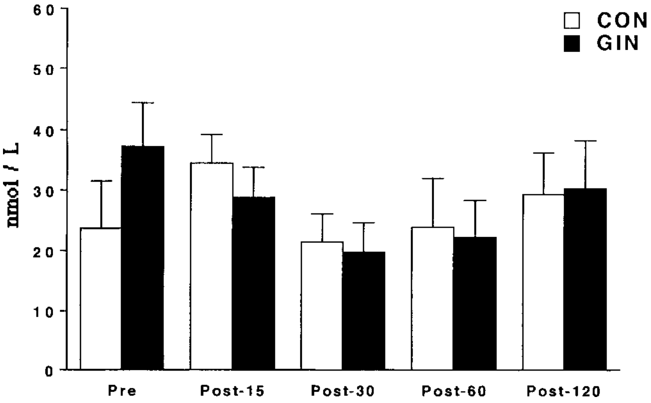

Figure 5. Plasma IGF-1 levels in control (CON) and ginseng (GIN) treatments.

trations indicate that the exercise stress was equivalent between trials.

The acute resistance exercise protocol caused a significant elevation of the plasma growth hormone 15 minutes postexercise in both trials (Figure 2). Thereafter, the growth hormone quickly declined, reached baseline concentration in 30 minutes, and remained at that level for the next 90 minutes. However, the growth hormone levels did not significantly differ between CON and GIN treatments at any time point.

Acute exercise slightly elevated testosterone levels at 15 minutes postexercise in the 2 treatments, but these elevations were not significant. At 120 minutes postexercise, the testosterone levels fell significantly below baseline exercise for both treatments. There was no significant difference in testosterone levels between CON and GIN treatments at any time point (Figure 3).

Plasma cortisol concentrations were slightly elevated until 30 minutes after exercise, but these elevations were not significant in either treatment (Figure 4). At 120 minutes postexercise, plasma cortisol levels in CON and GIN treatments were significantly lower than those at 30 minutes after exercise. There was no significant difference in plasma cortisol levels between CON and GIN treatments at any time point. Plasma IGF-1 (Figure 5) and plasma insulin (Figure 6) levels did not differ from baseline or between treatments at any time point during the 2-hour recovery period.

Discussion

Generally, heavy resistance exercise has been shown to result in increases in skeletal muscle protein synthesis and strength (30, 31, 34). Gains in muscle mass are likely influenced not only by the volume and intensity of exercise during training but also by the hormonal environment of the trained muscle. Several anabolic hormones associated with resistance exercise can affect maximal muscle growth, including growth hormone, testosterone, IGF-1, and insulin (7, 22, 28, 33).

Growth hormone stimulates an increase in amino acid transport and protein synthesis (23, 24). Many previous studies have reported that acute resistance exercise stimulates the secretion of growth hormone in humans (10, 22, 27). Crist et al. (11) found that heavy resistance training and synthetic growth hormone in-

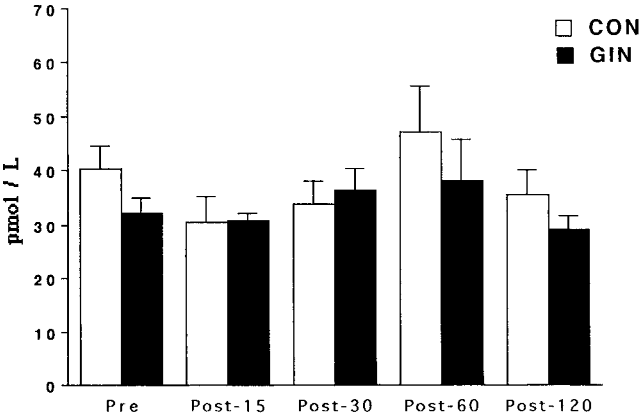

Figure 6. Plasma insulin levels in control (CON) and ginseng (GIN) treatments.

jections caused a significant increase in fat-free mass and decrease in fat weight in human subjects. It has been suggested that the consumption of the Oriental herb ginseng root can stimulate muscle and physical growth. According to the literature, ginseng consumption has been shown to enhance the general tonic, boost energy, allow more rapid recovery from fatigue, and/or improve muscular strength (3, 8). Thus it seems possible that protein metabolism could be affected by ginseng consumption by stimulating anabolic processes. Therefore, it was assumed that if the supplementation of ginseng root extract stimulates either amino acid transport or protein synthesis, or both, plasma growth hormone levels could be influenced by ginseng consumption. However, the results of the current study indicated that the consumption of ginseng root extract after acute resistance exercise had no effect on growth hormone release in humans. That is, the increase in growth hormone at 15 minutes postexercise was observed in both GIN and CON trials.

The anabolic effects of testosterone, although controversial, are well documented (29). In studies by Kraemer et al. (26, 27), testosterone concentration increased in response to weight-training exercise, but these results are in contrast to other observations (9, 25). However, it is possible that the differences in testosterone after resistance exercise between studies could have been due to the variations in experimental protocols and the training status of the subjects. According to the study by Danhaive and Roussear (13), it has been suggested that elevated testosterone can bind with a cortisol receptor, resulting in the suppression of protein catabolism and potentially allow anabolism to proceed. In the present study, testosterone levels were slightly elevated until 30 minutes postexercise and then significantly decrease at 120 minutes postexercise. However, no significant differences were found between CON and GIN treatments at any time point measured. Therefore, it was concluded that the GIN treatment did not affect the release of testosterone after resistance exercise.

Acute exercise stress has been shown to increase serum cortisol concentration in men, and the response depends on the magnitude of the exercise stress (12, 18, 26, 27). In the present study, plasma cortisol levels in CON and GIN treatments were slightly elevated at 30 minutes postexercise in comparison with pre-exercise values. However, no significant differences were found between CON and GIN treatments at any measured time point.

Growth hormone has been shown to stimulate the release of IGF-1 from the liver (21); however, the results of the present study do not support such an effect. The present experimental exercise protocol resulted in a significant increase in plasma growth hormone levels 15 minutes postexercise. This hormonal response, however, did not lead to a significant increase in IGF-1 in either treatment. This is in agreement with results from other studies (7, 25). Therefore, the results of the present study suggest that the ginseng consumption did not affect the release of plasma IGF-1 after resistance exercise.

In particular, insulin, which is mainly secreted after carbohydrate ingestion, may enhance muscular growth by increasing amino acid uptake and net protein synthesis (4, 5, 20). Furthermore, insulin can also enhance growth by affecting the secretion of the other hormones, which can directly affect protein synthesis (21, 32). Therefore, methods of supplementation after exercise that have been found to increase the plasma insulin concentration may be a sound means of enhancing exercise-induced muscle development without the intake of synthetic anabolic hormones. However, in the present study the consumption of ginseng root extract did not augment the secretion of insulin after resistance exercise while subjects were in a fasted state.

In summary, an acute consumption of ginseng root extract did not affect the anabolic hormonal milieu and cortisol secretion after acute heavy resistance exercises. However, we still do not have sufficient knowledge on the long-term effects of ginseng consumption. Future recommendations include the investigation of the ergogenic effects of long-term ginseng consumption.

Practical Applications

The use of ergogenic aids has become increasingly popular among athletes over the last decade. With numerous substances on the market that tout enhanced performance, it is important that well-controlled research studies document the impact of possible ergogenic aids on performance factors and physiological responses to exercise. The results of this study suggest that although ginseng may have physiological effects on performance, the mechanism of action is not to improve the anabolic hormonal environment to resistance exercise.

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