Ginseng Supplementation Does Not Change Lactate Threshold and Physical Performances in Physically Active Thai Men

Onanong Kulaputana MD, PhD*,
Siriwan Thanakomsirichot MSc*, Wilai Anomasiri PhD**

** Department of Physiology, Faculty of Medicine, Chulalongkorn University, Bangkok*
*** Department of Biochemistry, Faculty of Medicine, Chulalongkorn University, Bangkok*

Background: *Ginseng has been one of the most popular herbs said to improve human exercise performance. Unclear and anecdotal information is known about the effect of ginseng on lactate threshold and aerobic performance in humans.*
Objective: *The purpose of the present study was to investigate the effect of ginseng supplementation on lactate threshold in physically active young men.*
Material and Method: *Sixty men from the Naval Medical Corps, Royal Thai Navy, aged 17 – 22 years old, were randomized into either the ginseng (n = 30) or placebo (n = 30) group. The ginseng group took 3 grams of 100% ginseng orally, while the placebo group took an equal amount of lactose powder each day, for 8 weeks. Blood lactic acid levels for determination of lactate threshold (LT) were measured during an incremental cycle ergometer work. LT, exercise performance, and heart rate (HR) responses to exercise were determined at baseline and after 8 weeks of ginseng and placebo consumption. Substrate oxidation rates during steady state exercise were assessed upon study completion. Selected markers for liver and kidney functions, including serum aspartate aminotransferase, alanine aminotransferase, blood urea nitrogen, and creatinine were monitored for possible side effects of ginseng.*
Results: *LT before and after 8 weeks of supplementation in the ginseng group (164.5 $\pm$ 32.8 and 170.9 $\pm$ 26.4 watts), and in the placebo group (163.7 $\pm$ 25.1 and 163.7 $\pm$ 17.3 watts) were not different (p = 0.448). Both groups had a similar pattern of exercise heart rate (p = 0.918), total exercise time (p = 0.241), and peak power output (p = 0.411). After 8 weeks, the magnitude of difference between ginseng and placebo groups on oxidation rates of fat (3.82 $\pm$ 10.0 $cal.kg^{-1}.min^{-1}$, p = 0.704) or carbohydrate (4.36 $\pm$ 12.6 $cal.kg^{-1}.min^{-1}$, p = 0.731) was not statistically significant. There were no abnormal changes of markers of liver and renal functions after ginseng administration.*
Conclusion: *Daily administration of 3 g of ginseng for an 8-week period did not improve LT nor did it affect physical performances. Therefore, ginseng supplementation did not exert an ergogenic property on aerobic fitness enhancement in well-fit individuals.*

Keywords: *Ginseng, Lactate threshold, Exercise performance*

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Ginseng, one of the most popular herbs, has been used for several thousand years in oriental countries as a revitalizing agent(1). Accumulative evidence has shown that prolonged use of ginseng or its active components affect behavior, psychomotor, and exercise performance(2).

Ginseng supplementation has been reported to impact physiological functions in a manner similar to that of endurance training(3-5). The active substances in ginseng have been shown to enhance endurance

Correspondence to : Kulaputana O, Department of Physiology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand. Phone & Fax: 0-2256-4267, E-mail: onanongt@hotmail.com

exercise performance by altering substrate metabolism[2-3]. There is evidence that ginseng may exert a stimulating effect by changing carbohydrate and lipid mobilization and utilization[6]. Due to its potential ergogenic effect, many people have attempted to use ginseng to enhance physical performance.

The lactate threshold has been reported to be more closely associated with endurance performance than maximal oxygen uptake, both in healthy individuals and athletes[7-8]. Despite a theoretical relationship of ginseng and endurance performance, there is a limited body of research on the effect of ginseng supplementation on lactate threshold in humans[9]. In addition, well-controlled studies examining the ability of ginseng to enhance endurance performance in humans are limited[2]. The fact that the lactate threshold in endurance athletes is normally higher than sedentary folks, it would be of interest to investigate whether or not ginseng can affect lactate threshold in physically active individuals. Therefore, the research hypothesis of the present study was that ginseng supplementation could exert an ergogenic effect by further increasing lactate threshold in active individuals.

Material and Method

Subjects

Sixty young men from the Naval Medical Corps, Royal Thai Navy were assigned into experimental (received ginseng; n = 30) and control (received placebo; n = 30) groups by simple randomization. The subjects were healthy without conditions that may limit the exercise tests in the present study. They revealed no medications or substances that may interfere with the effect of ginseng or physical performance. The present study was conducted where all subjects were living, having meals, and doing routine daily activities together. Written informed consent was provided by each subject after the entire study and the risks had been described. The present study was approved by the Ethic Committee of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand.

Materials

Ginseng in the markets mostly comprises total ginsenosides, the active substances, in the range of 4.140-7.953% with the chemical compositions such as Rg1, Re, Rf, Rb1, Rc, Rb2, Rd[10]. Each ginseng capsule used in the present study contained 500 mg of 100% finely ground Korean ginseng powder with ginsenoside contents of approximately 3.49% (Lot# 0005, Mfd 24.09.2004, IL HWA, Thailand). The placebo capsule contained an equal amount of 500 mg lactose powder. Both ginseng and placebo capsules were made of gelatin and come in identical size and color.

Ginseng Administration

The present study followed a standard practice of double blinded, controlled trial procedure using similar appearance of capsules containing either ginseng or placebo. All subjects were instructed to take three capsules in the morning and three more capsules in the evening everyday for 8 weeks. They were also asked to keep a log on taking ginseng throughout the study period.

Lactate Threshold

Lactate threshold (LT) was determined during an incremental exercise test on a calibrated cycle ergometer (Corival 400, Lode B.V., Groningen, Netherlands) before and after 8 weeks of ginseng supplementation. Blood lactate levels were plotted against cycling work rate. LT was taken as the point at which blood lactate concentration accumulated to a level of 4.0 mmol/L[11], using AutoCAD software version 2004.

Lactate Threshold and Peak Exercise Tests

After a 5-minute rest followed by a 5-minute warm up at 50 watts with a pedal speed of 50-60 rpm, the subjects started with a workload of 100 watts. The intensity was then increased by 30 watts every 3-minutes. The exercise heart rate was recorded at the end of each incremental stage. The test was terminated at volitional fatigue where the subject could not maintain the prescribed workload, or the heart rate achieved $\pm$ 10% of age predicted maximal heart rate. Blood samples for lactate measurement were collected from an indwelling venous catheter in the antecubital area. The lactate determination was performed by immobilized enzyme electrode technology on a lactate analyzer (YSI 1500 Sport, Ohio, U.S.A.). Equipment calibration was done by lactate standard (5 mmol/L) every 10 lactate analyses. Blood lactate level was analyzed within the last 30 seconds of each workload.

Metabolic Measurement

After 8 weeks of ginseng supplementation, oxidation rates of fat and carbohydrate were obtained by calculations from indirect calorimetry data[12,13]. Average oxygen uptake (VO_2) and carbon dioxide production (VCO_2) from the last 3 minutes of a 10-minute constant load (140 watts) cycling exercise were continuously measured breath-by-breath using a computerized system (Quinton Metabolic Cart, Quinton Inc, Washington, USA). Gas exchange data were expressed in a standard condition of temperature, humidity, and barometric pressure.

Biochemical Analyses

Blood levels of urea nitrogen (BUN), Creatinine (Cr), Serum Aspartate Aminotransferase (AST), and Serum Alanine Aminotransferase (ALT) were determined before and after 8 weeks of ginseng supplementation. The analyses of BUN, Cr, AST, and ALT were performed by the standard clinical laboratory of King Chulalongkorn Memorial Hospital, Bangkok, Thailand. Blood samples for glycerol level were obtained from 10 subjects in each group during the 10-minute steady state exercise test at baseline and the end of the present study protocol. Glycerol levels were analyzed using glycerol assay test combination (Roche/Boehringer Mannheim, Germany).

Monitoring of Compliance and Side Effects

Subjects were given a list of potential side effects from ginseng and asked to fill out a report form if they experienced any. An investigator visited the subjects on site every 2 weeks to follow up the compliance and monitor the side effects. If there was any concern with the present study, the subjects were advised to give the investigator team a phone call as soon as possible.

Statistical Analyses

Data are presented with mean $\pm$ standard deviation (S.D.). Analysis of covariance (ANCOVA) using baseline data as covariates was employed to determine group differences on variables that were measured before and after the 8-week experiment. A 2 x 8 (group x time points) repeated measures ANOVA was performed to detect a difference of heart rates during incremental exercise test between the two groups. Differences between groups of blood glycerol levels and calorimetric estimated substrate oxidation rates only measured at the end of the experiment were determined by unpaired t-tests. The alpha level was set at 0.05 for all statistical analyses.

Results

Subject Characteristics

Three subjects (1 from the placebo group, 2 from the ginseng group) could not complete the lactate threshold tests. Therefore, the results presented here were obtained from 57 subjects. The average age, body weight, height, and body mass index of all subjects were 19.3 $\pm$ 0.9 yr, 62.2 $\pm$ 5.6 kg, 171.6 $\pm$ 6.2 cm, and 21.1 $\pm$ 1.7 kg/m^2, respectively. The mean level of baseline lactate threshold in combined groups was 164.1 $\pm$ 28.4 watts with a maximal work output of 207.9 $\pm$ 20.8 watts. While a statistically significant difference of age was detected ($p = 0.047$), there were no significant differences between the ginseng and placebo groups on height, weight, and body mass index (Table 1). The compliance of the subjects consuming ginseng was similar to that of the placebo group (91.82% vs. 91.89%, $p = 0.978$).

Lactate Threshold and Substrate Metabolism

Although lactate threshold tended to increase with ginseng supplementation, it was not statistically different when compared to the control group ($p = 0.448$) (Table 2). During a constant sub-maximal exercise, the magnitude of difference on oxidation rates of fat (3.82 $\pm$10.0 cal x kg^{-1}x min^{-1}, $p = 0.704$) and carbohydrate (4.36 $\pm$ 12.6 cal x kg^{-1}x min^{-1}, $p = 0.731$) between control and ginseng groups did not reach a statistical significance. Blood glycerol levels during steady exercise were not different between the two groups ($p = 0.083$).

Exercise Performance and Cardiovascular Measures

Repeated measures ANOVA revealed no significant difference on the heart rate response during

Table 1. Characteristics of the subjects in the ginseng and placebo groups

Characteristics	Ginseng (n = 28)	Placebo (n = 29)	p-value
Age (yr)	19.6 $\pm$ 0.8	19.1 $\pm$ 0.9	0.047
Body weight (kg)	63.4 $\pm$ 6.0	61.1 $\pm$ 4.9	0.123
Height (cm)	173.2 $\pm$ 6.5	170.1 $\pm$ 5.6	0.059
Body mass index (kg/m^2)	21.5 $\pm$ 1.8	21.1 $\pm$ 1.6	0.978

Values are mean $\pm$ SD

Table 2. Lactate threshold, total exercise time, peak workload, and glycerol levels in the ginseng and placebo groups at baseline and after 8 weeks of supplementation

Variables	Ginseng (n = 28)		Placebo (n = 29)	
	Baseline	After	Baseline	After
Lactate Threshold (watts)	164.5 ± 32.8	170.9 ± 26.4	163.7 ± 25.1	163.7 ± 17.3
Total exercise time (minutes)	18.6 ± 2.8	19.7 ± 2.6	17.2 ± 2.6	18.3 ± 2.0
Peak workload (watts)	213.6 ± 22.6	214.6 ± 27.1	202.4 ± 17.7	211.7 ± 22.5
Glycerol levels (mg/L)	20.5 ± 9.4	22.8 ± 9.7	26.4 ± 11.0	19.3 ± 10.4

Values are mean ± SD

Table 3. SGOT, SGPT, BUN, Cr in the ginseng and placebo groups at baseline and after 8 weeks of supplementation

Blood Chemistry	Ginseng (n = 28)		Placebo (n = 29)	
	Baseline	After	Baseline	After
AST (U/L)	27.6 ± 14.7	25.4 ± 5.9	37.5 ± 26.1	26.6 ± 5.7
ALT (U/L)	17.6 ± 8.2	14.9 ± 6.1	22.0 ± 16.2	16.9 ± 9.3
BUN (mg/dl)	10.8 ± 2.1	12.1 ± 2.8	10.4 ± 2.0	11.5 ± 2.0
Cr (mg/dl)	1.06 ± 0.1	1.03 ± 0.1	1.07 ± 0.1	1.04 ± 0.1

Values are mean ± SD
AST = Aspartate Aminotransferase
ALT = Alanine Aminotransferase
BUN = Blood Urea Nitrogen
Cr = Creatinine

graded exercise between placebo and ginseng groups ($p = 0.918$) (Fig. 1). There was no significant difference between the ginseng and placebo groups on total exercise time ($p = 0.241$) and peak workload ($p = 0.411$) (Table 2).

Blood Chemistries

Blood levels of AST, ALT, BUN, and Cr were determined to monitor whether there would be possible serious side effects of ginseng supplementation on liver and renal functions. Both ginseng and placebo groups did not show a significant change of AST, ALT, BUN, or Cr through the period of experiment. Moreover, none of the subjects in both groups demonstrated abnormal levels of SGOT, SGPT, BUN, or Cr with 8 weeks of ginseng or placebo supplementation (Table 3).

Discussion

The authors found that 3 grams a day of 100% ginseng supplementation for 8 weeks did not improve lactate threshold nor exercise performance in physically active young men. Additionally, the authors demonstrated that ginseng supplementation did not change the substrate metabolism, particularly, total fat and carbohydrate oxidation rates during a constant load exercise. The fact that the authors studied subjects who had a similar daily routine, food intake, and physical activities, helped to minimize the possibility that food intake and physical activity could confound the results of the present study. To the authors' knowledge, this was the first well-controlled study in a relatively larger sample to demonstrate that ginseng has no effect on enhancement of lactate threshold in physically fit young men.

The LT has been shown to be a good predictor of aerobic exercise training status[7,8] due to its high relation to maximal oxygen uptake and endurance exercise[8]. It would be interesting to see whether endurance performance can be further enhanced by ginseng supplementation in physically fit individuals. This double blinded, randomized, controlled study was designed to evaluate the effect of ginseng on lactate threshold in active young men. The present study showed a similar result to that of Andrzej et al[9] who

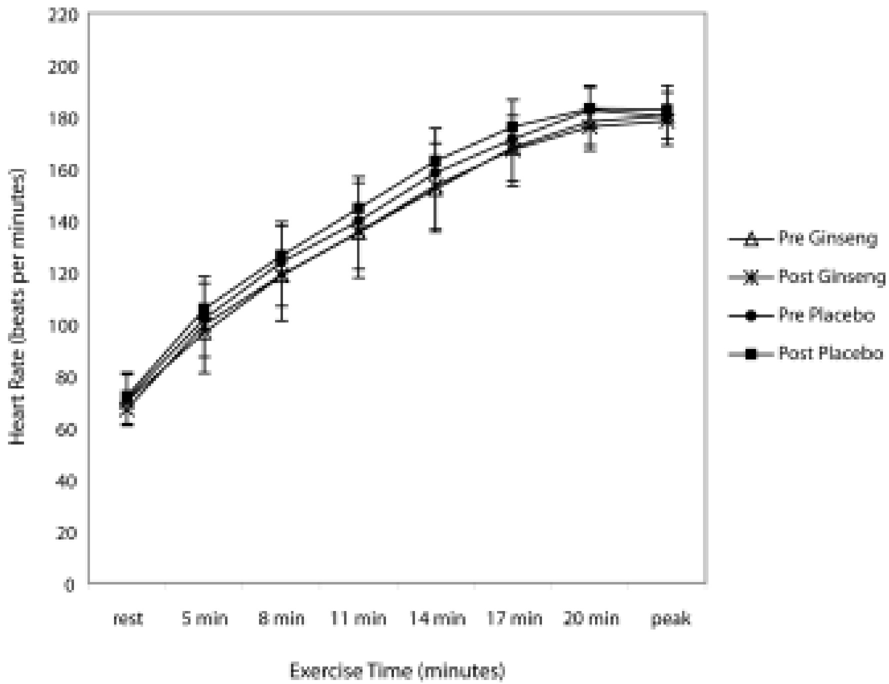

Fig. 1 Heart rate responses during incremental exercise in the ginseng and placebo groups at baseline and after 8 weeks of supplementation
Pre Ginseng = HR response in the ginseng group at baseline
Post Ginseng = HR response in the ginseng group after 8 weeks of ginseng supplementation
Pre Placebo = HR response in the placebo group at baseline
Post Placebo = HR response in the placebo group after 8 weeks of placebo supplementation

reported that consuming 350 mg of ginseng for 6 weeks did not change lactate threshold in seven young soccer players. Thus, the advantage of consuming much greater dosage, longer supplementing duration, and larger sample size in the present well-controlled study helped confirm the lack of ginseng effect on LT. However, a possibility that more than 2 months duration of ginseng supplementation could exert an effect on LT may not be excluded.

It is not known whether the initial fitness level of the subjects could contribute to a non-significant change in LT with ginseng supplementation. The fact that the subjects in the study of Andrzej et al[9] were athletes and baseline LT of 79% of maximal workload found in the presented subjects was close to the levels commonly reported in trained athletes[14] makes this doubt a possibility. High levels of baseline LT indicate a high fitness status of the subjects as they regularly engaged in physical activities and sports. Thus, it is likely that 8 weeks of ginseng supplementation did not increase LT in individuals who are relatively healthy, active, and fit. In contrast, ginseng might be effective in individuals who are older, unhealthy, unfit, or even in a convalescent condition. The customary and traditional use of this herb indicated in Chinese or Korean traditional medicine information should be followed.

The mechanisms underlying changes in blood lactate response to exercise and enhanced exercise performance with aerobic exercise training have been explored by various investigations[15-17]. Aerobic training has an impact on substrate metabolism as well as increasing muscle mitochondrial density[15]. An alteration of carbohydrate utilization occurred with aerobic exercise training as evidenced by reduced glycogenolysis and lower blood sugar levels[15-17]. In addition, aerobic training increased fatty acid oxidation to synthesize ATP, resulting in a decrease in lactate production from glycolysis. Therefore, blood lactate is attenuated and thus, delay the point at which lactate would accumulate during exercise[18].

Similar to the effects of aerobic training, ginseng increased plasma free fatty acid and maintained blood sugar levels during exercise in rats[3]. Moreover, animals received ginseng increased the number of oxidative fibers, capillary density, and mitochondrial content in skeletal muscle[4]. Limited research in humans reported that ginseng supplementation may enhance endurance performance as shown by increased maximal oxygen uptake, prolonged time to exhaustion, decreased resting heart rate, increased arteriovenous oxygen difference, and reduced lactate production during exercise both in athletes and healthy volunteers[5,19,20].

Logically, enhanced mobilization and oxidation of fat with preserved carbohydrate utilization account for an increase in LT in aerobic conditioning. In contrast, the authors demonstrated that ginseng supplementation had no effect on LT and exercise performance improvement. This was also confirmed by a simultaneous lack of effect on substrate utilization in our volunteers. Both the ginseng and placebo groups had no change in carbohydrate and fat oxidation rates during exercise. Thus, unlike an aerobic training, ginseng supplementation has no impact on substrate utilization.

The authors also explored the glycerol levels during exercise in 10 subjects in each group. The result of no difference in glycerol levels confirmed the negative finding of ginseng effect on fat mobilization and utilization. Similar to the result reported by Eschbach et al[21] demonstrating no effect of 1,200 mg of Siberian ginseng (*Eleutherococcus senticosus)* supplementation for 7 days on substrate utilization in 9 endurance cyclists. Thus, ginseng supplementation clearly did not alter fat mobilization or substrate oxidation, resulting in no improvement in lactate threshold and exercise performance in humans.

It is well accepted that aerobic exercise training has a positive effect on the cardiovascular system. A reduced resting heart rate is commonly found in endurance athletes. Additionally, due to its blood pressure lowering effect, aerobic exercise has been introduced to clinical practice as a conjunctive treatment in hypertension. In contrast to the effect of aerobic training, the authors found that ginseng supplementation did not result in changes in blood pressure. Despite a linear increase in heart rate in response to a progressive exercise before and after 8 weeks of ginseng supplementation, the exercise heart rate did not differ between the ginseng and placebo groups. It is likely that ginseng consumption had no effect on the cardiovascular system in those who are basically healthy and fit.

In addition to the lack of an impact on resting blood pressure and exercise heart rate, ginseng supplementation did not have an adverse effect on AST, ALT, BUN, and Cr. There was no report on serious symptoms during the period of the present study. Thus, ginseng supplementation at 3 grams per day for 8 weeks was relatively safe to cardiovascular, kidney, and liver functions in active young men.

In conclusion, ginseng supplementation at 3 grams per day for 8 weeks did not improve LT, substrate utilization, exercise performance, and cardiovascular measures in healthy and fit young men. However, this amount and duration of ginseng consumption is relatively safe. Thus, the presented evidence did not support the ergogenic property of ginseng in terms of enhanced lactate threshold and endurance exercise performance in this subset of subjects. Therefore, ginseng may not be considered as a supplement for improved aerobic fitness and performance, particularly in active young men.

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การรับประทานโสมไม่ทำให้เกิดการเปลี่ยนแปลงของระดับกักกั้นของแล็กเตทและสมรรถภาพทางกายในชายไทยสุขภาพดี

อรอนงค์ กุละพัฒน์, ศิริวรรณ ธนาคมศิริโชติ, วิไล อโนมะศิริ

ภูมิหลัง: *โสมเป็นสมุนไพรที่ได้รับความนิยมและเชื่อกันว่ามีผลเพิ่มสมรรถภาพการออกกำลังกายได้ ข้อมูลยังไม่ชัดเจนว่าโสมมีผลต่อระดับกักกั้นของแล็กเตทและสมรรถภาพการออกกำลังกายแบบแอโรบิคในคน*

วัตถุประสงค์: *เพื่อศึกษาผลของการบริโภคโสมต่อระดับกักกั้นของแล็กเตทในชายไทยสุขภาพดี*

วัสดุและวิธีการ: *กลุ่มตัวอย่างเข้าร่วมโครงการศึกษาวิจัยเป็นนักเรียนจ่าพยาบาลของกองทัพเรือจำนวน 60 คน อายุระหว่าง 17-22 ปี ได้ทำการจับสลาก เพื่อแบ่งกลุ่มอาสาสมัครเป็น 2 กลุ่ม ได้แก่ กลุ่มที่ได้รับโสมจำนวน 30 คน และกลุ่มที่ได้รับสารหลอกจำนวน 30 คน กลุ่มโสมรับประทานผงโสม 100% เป็นปริมาณ 3 กรัม ต่อวัน เป็นเวลา 8 สัปดาห์ อีกกลุ่มรับประทานสารหลอกเป็นผงแล็กโทสในปริมาณเท่ากัน ทำการทดสอบวัดระดับกรดแล็กติกในเลือดในระหว่างการปั่นจักรยานเพื่อคำนวณหาระดับกักกั้นของแล็กเตท การศึกษาระดับกักกั้นของแล็กเตท สมรรถภาพการออกกำลังกาย และการตอบสนองของอัตราการบีบตัวของหัวใจขณะออกกำลังกายทำทั้งก่อนและหลังการรับประทานโสมหรือสารหลอก ส่วนอัตราของซับสเตรทออกซิเดชันทำการศึกษา ภายหลังสิ้นสุดการบริโภคโสม ทำการหาค่าตัวบ่งชี้บางตัวของการทำงานของตับและไต เพื่อได้ทำการติดตามผลเสียจากการรับประทานโสมหรือสารหลอกที่อาจมีต่อตับและไต*

ผลการศึกษา: *ค่าระดับกักกั้นของแล็กเตทที่วัดก่อนและหลังการรับประทานโสมหรือสารหลอกในกลุ่มโสม (164.5 $\pm$ 32.8 และ 170.9 $\pm$ 26.4 วัตต์) มีค่าไม่แตกต่าง ($p = 0.448$) จากของกลุ่มสารหลอก (163.7 $\pm$ 25.1 และ 163.7 $\pm$ 17.3 วัตต์) ทั้งสองกลุ่มมีค่าเวลาทั้งหมดที่ใช้ในการทดสอบสมรรถภาพทางกาย และค่างานสูงสุด ใกล้เคียงกัน ภายหลังจาก 8 สัปดาห์ของการทดลอง พบว่าค่าความแตกต่างของอัตราออกซิเดชันของไขมันและคาร์โบไฮเดรตระหว่างกลุ่มไม่มีนัยสำคัญทางสถิติ ไม่พบการเปลี่ยนแปลงที่ผิดปกติของตัวบ่งชี้ของหน้าที่การทำงานของตับและไตจากการรับประทานโสม*

สรุป: *การบริโภคโสมในปริมาณ 3 กรัมต่อวันเป็นเวลา 8 สัปดาห์ไม่ทำให้เกิดการเปลี่ยนแปลงของระดับกักกั้นของแล็กเตทและสมรรถภาพทางกาย ดังนั้นการศึกษานี้ไม่พบว่าโสมมีคุณสมบัติเป็นตัวส่งเสริมสมรรถภาพด้านแอโรบิคในบุคคลที่มีร่างกายฟิต*