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The Combined Effect of Short Term Green Tea Extract and a Single Bout of Cycle Ergometer on Glycerol and Free Fat Acid of Trained Males

Sedigheh Hosseinpour Delavar [1, *] and Masoumeh Azizi [2]

[1] Department of Physical Education and Sport Sciences, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran
[2] Department of Physical Education and Sport Sciences, Abadan Branch, Islamic Azad University, Abadan, Iran

[*] *Corresponding author*: Sedigheh Hosseinpour Delavar, Department of Physical Education and Sport Sciences, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran, E-mail: delavar2009@yahoo.com

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Abstract

It seems that shortly after green tea extract (GTE) ingestion, fat oxidation increases as well as exercise training. The purpose of this study was to investigate the combined effect of short term GTE and a single bout of cycle ergometer upon post-exercise fat oxidation. Sixteen healthy volunteer males were recruited to participate in the study. They were divided to two groups; experimental group (n = 8) and placebo group (n = 8), respectively. They consumed three GTE or placebo capsules a day before and one capsule 90 minutes before a cycling protocol. Blood samples were collected from all participants before and after the protocol. Based on the current results, fat oxidation in the experimental group increased markedly during post-exercise period compared to the placebo group. Plasma glycerol levels of the experimental group were significantly higher after GTE consumption during the post-exercise period compared to placebo. Compared to placebo, plasma free acids of the experimental group increased significantly after GTE consumption as well as acute GTE. Therefore, it seems that acute GTE ingestion could increase fat oxidation after post exercise conditions.

1. Background

At rest and during exercise, carbohydrates and fat are two predominant substrates that provide energy requirements of working muscles (1). Fat is stored in different forms, such as adipose tissue, intramuscular triglyceride, and in the circulation as plasma free fatty acids (FFA). It has been reported that during one session of physical activity (long-term or short-term exercises), oxidation of FFAs is enhanced (2, 3). On the other hand, fat oxidation rate increases 5 to 10 folds in comparison with rest conditions in working muscles during a single bout of aerobic exercise (25% to 65% VO_2max) (2).

The relative and absolute contribution of these two substrates during a single bout of aerobic exercise was dependent on several acute variables, such as intensity, volume, and velocity of the exercise, nutrition, and muscle glycogen (3). In the recent years, combining physical activity with nutrient supplements, such as green tea, is recommended to reduce cardiovascular risk in individuals with dyslipidemia (4). It is assumed that green tea, due to a number of catechins, increases fat oxidation, improves the glycemic and lipid profiles in patients with diabetes and dyslipidemia, particularly during the postprandial period (5), nevertheless, the underlying mechanism of green tea fat oxidation has not been determined (6).

Gahreman et al. found that green tea ingestion increased fat oxidation at rest and post-exercise compared with the placebo condition (4). They also reported that plasma glycerol and epinephrine levels were significantly higher during and post exercise, after green tea consumption, compared with the placebo condition. Venables et al. also showed that green tea administration increased fat oxidation by 17%, compared with the placebo during a 30-minute continuous bout of moderate intensity aerobic cycling exercise (7). These researchers reported small increases in plasma catecholamine's levels following their exercise protocol. It seems that there are relationships between exercise-induced catecholamine response and fat oxidation after green tea ingestion. The effect of one bout of cycle ergometer with green tea ingestion on fat oxidation may be important to illustrate whether repeated use of this supplementation over weeks can reduce body fat mass of obese individuals. Therefore, the main target of this study was to hypothesize that the combination of green tea and one bout cycle ergometer would result in significantly greater fat oxidation during the post-exercise recovery period for both experimental and placebo groups.

2. Methods

2.1. Participants

This study was approved by the faculty of physical education and sport sciences of Islamic Azad University, Kermanshah Branch. Sixteen healthy males were ultimately recruited in the study. Relevant anthropometric characteristics of experimental participants (n = 8) were age: 24.2 ± 2.3 years; body weight 84.6 ± 5.6 kg; height 172.6 ± 6.1 cm; body mass index (BMI) 22.05 ± 2.1 kg/m^2; and maximal oxygen consumption (VO_2max): 59.8 ± 1.8 mL/kg/min, and that of placebo participants were (n = 8) age: 22.7 ± 1.1 years; body weight: 87.4 ± 6.4 kg; height: 174. 8 ± 8.1 cm; BMI 24.9 ± 2.1 kg/m2, and maximal oxygen consumption (VO_2max): 58.6 ± 2.3 mL/kg/min. The characteristics are also shown in Table 1. All participants were healthy and physically active at their worksite. They also signed a written informed consent. Exclusion criteria included the use of regular caffeine or drinking green tea more than 2 cups/day.

Table 1. Subject Characteristics and Anthropometry

Variables	GT	Placebo
Age, y	24.3 ± 2.4	22.7 ± 1.1
Height, cm	172.6 ± 6.6	174 ± 8.1
Weight, kg	64.6 ± 5.6	87.4 ± 2
BMI, kg/m^2	22.1 ± 2.6	24.9 ± 2.4
HDL, mg/dL	42.3 ± 3.2	41.7 ± 2.7
LDL, mg/dL	84.52 ± 4.1	85.23 ± 3.1
TG, mg/dL	108.81 ± 28.7	107.73 ± 26.7
Total cholesterol, mg/dL	137.33 ± 16.5	138.27 ± 19.2
VO_2max	59.8 ± 1.8	58.6 ± 2.3
Heart rate, bpm	65 ± 3	73 ± 2

2.2. Diet and Capsule Content

Participants were required to follow the same food diary for three days prior to the protocol. They also ingested one capsule containing either GTE or starch with breakfast, lunch, and dinner, the day before the exercise session. After an approximate 10-hour of overnight fasting, the last capsule was consumed in the morning of the next day, 90-minute before exercise (7). Each capsule contained 250 mg of Camellia sinensis extract (187.5 mg polyphenols and 125 mg EGCG) (4) consumed with 300 to 350 mL of water. Therefore, the three GTE capsules consumed the day before exercise contained a total of 562.5 mg polyphenols and 375 mg EGCG, and the one GTE capsule on the exercise day, contained 187.5 mg of polyphenols and 125 mg of EGCG. The placebo capsule contained 500 mg of starch as well. It has been shown that GTE peaked in the blood between 1.3 and 1.6 hours (8).

2.3. Experimental Protocol

After an approximate 10-hour overnight NPO, participants arrived at the laboratory between 7:00 and 9:00 am. Prior to the exercise session, testing included baseline anthropometric measurements, a VO_2max test (maximum power output assessment), fasting blood lipid profile, free fat acids, and glycerol concentrations for all participants. Blood samples were obtained from an antecubital vein and placed in 10 mL of EDTA. Blood lipid levels were immediately measured by a standard enzymatic kit (Pars Azmoon Co, Iran).

An electrically braked Monark 884E ergometer (Monark, 884E ergometer, Sweden), computer- was used to assess VO_2max. This is also linked to a MC-TA-200V Metabolic Cart to assess VO_2max. Participants were required to maintain a cycling speed of approximately 70 revolutions per minute (RPM) that was upon a metronome. One hour after green tea ingestion, the participants were prepared to perform the exercise. After a 5-minute warm-up at 25 Watts (W), the load was increased by 15 W per minute until exhaustion. Heart rate was recorded by using a Polar Watch RC3 GPS (Polar, RC3 GPS, Germany). VO_2max, fasting blood lipid profile, free fat acids, and glycerol concentrations were collected one-hour post-exercise period.

2.4. Statistical Analysis

The statistical analysis was initially performed using the Shapiro-Wilk normality test and the Levine homogeneity test. All data were presented as mean ± standard deviations. Differences within and between the groups of VO_2max, free fat acids, and serum glycerol in response to one session exercise were conducted by two-sample t-test. A P value of < 0.05 was considered statistically significant. All statistical analyses were also conducted using the SPSS package (Version 22).

Ethical approval: All procedures performed in this study involved human participants, and were in accordance with the ethical standards of the institutional and/or national research committee.

Informed consent: Informed consent was obtained from all individual participants included in the study.

3. Results

3.1. Participant Characteristics

Body composition, age, body mass index (BMI), VO_2max, lipid profiles, and resting heart rate (HR) are

summarized in Table 1. Heart rate and Vo_2max response of both groups before, during, and after exercise protocol are indicated in Table 2.

Table 2. Heart Rate and VO_2 Response of the Green Tea and Placebo Before, During, and After the Exercise Protocol[a]

Variable/Group	Rest	Exercise	Post Exercise (60 min)
Heart rate, bpm			
GT	64 ± 3	152 ± 4[b]	66 ± 2
Placebo	62 ± 2	148 ± 4[b]	63 ± 3
VO_2, mL/kg/min			
GT	3.8 ± 0.1	45.3 ± 1[b]	3.9 ± 0.1
Placebo	3.7 ± 0.1	44.3 ± 1[b]	3.8 ± 0.2

[a]Values are expressed as mean ± SD.
[b]Significantly different, $P < 0.05$.

There were no significant differences in HR and VO_2max (Table 2) between the two groups in different conditions.

Before exercise and during the resting period, fat oxidation was increased significantly by 9% after GTE ingestion compared to the placebo. During post exercise, in the 75th minute, fat oxidation rate was markedly increased by 10% in GT condition compared with the placebo. However, oxygen consumption was similar during rest in both the GT and placebo conditions yet not during post exercise condition. It was higher in the GT condition.

3.2. Glycerol and Free Acid Levels

Compared with the baseline, the mean of glycerol levels increased during post-exercise in both groups. However, it was significant for GT when compared to the placebo group during post-exercise. The mean plasma levels of free acid was also altered in the two groups. However, the mean free acid levels was increased significantly in the GT condition (Table 3).

4. Discussion

The combined effect of GT ingestion and one session exercise on fat oxidation of trained males was investigated. The GT ingestion increased fat oxidation during pre-exercise rest. Fat oxidation levels were also higher in the 75th minute of the post-exercise period. Plasma glycerol and free acids were significantly higher under the GT condition after exercise as well, compared with the placebo condition. Lipid profile differences were not significant between GT and placebo groups during post-exercise. The participants of the current study were athletes, who had performed two to four exercise sessions per week for at least six months. Therefore, the lower heart rate and higher VO_2max was expected in the pre-test condition (Table 1) and also quicker recovery response to exercise session was need compared with untrained counterparts. Based on these differences, GT indicated better response to one bout of exercise session, although catecholamine levels and lactate response were not measured during the protocol. Glycerol and free fat acid levels changed under the GT condition during post-exercise, thereby suggesting that green tea consumption may have a significant effect on fat oxidation.

Previous studies have shown that green tea ingestion results in greater fat oxidation at rest. Gahreman et al. indicated that fat oxidation was significantly greater in the resting condition after green tea ingestion compared with the placebo condition (4). Dulloo et al. (9) also observed that compared with placebo and caffeine, consumption of green tea significantly increased 24-hour fat oxidation by 20%. Using a comparable study design, Gregersen et al. indicated no increase in fat oxidation in any of the treatments compared with the placebo (10). Therefore, the exact effect of green tea on fat oxidation is unknown and requires further studies. In the present study, consumption of green tea resulted in greater fat oxidation increase by 9% and 10% during rest and 75 minutes after exercise, respectively, compared with the placebo condition. Similar to fat oxidation, plasma glycerol levels increased during post-exercise, and this might have indicated enhanced lipolysis in GT condition compared to the placebo group. It has been hypothesized that after the ingestion of GT, fat oxidation is promoted in humans during and after exercise. Possible mechanisms underlying GT-induced higher fat oxidation rates in post-exercise are enhanced catecholamine and glycerol levels release during exercise (11). It seems that catechins of green tea stimulate the nervous system leading to active adrenergic receptors, which finally lead to increased fat oxidation (6). Fatty acids as well as glycerol levels were higher during post-exercise for GT condition compared to the placebo. This response may suggest that green tea resulted more oxidized free acids from adipose tissue (12). However, there are unknown mechanisms.

Moreover, the current results showed no significant changes in lipid profiles after green tea consumption, post exercise period. Consistent with this study, several studies reported that there were no marked changes between lipid profile concentrations following green tea intake (12, 13). In contrast, Hsu et al. (14) reported that green tea intakes significantly decreased low density lipoprotein (LDL)-cholesterol and increased high density lipoprotein (HDL) cholesterol concentrations. They believed that green tea consumption results in an increase in serum concentrations of TC and HDL cholesterol, which could be due to

Table 3. Biochemical Measurements Before and After the Protocol

Variables	GT			Placebo		
	Pre-Test	Post-Test	Sig	Pre-Test	Post-Test	Sig
Glycerol	0.04 ± 0.006	0.09 ± 0.004	0.001[a]	0.04 ± 0.005	0.04 ± 0.004	0.211
Free acid	0.61 ± 0.03	0.68 ± 0.02	0.001[a]	0.59 ± 0.02	0.6 ± 0.02	0.076

[a] Significantly different, $P < 0.05$.

the action of caffeine (15). Accordingly, the exact effect of green tea on lipid profiles has not been positively established. There were several limitations in this study, including a need for hormonal response, such as epinephrine and norepinephrine, and no assessment of blood levels of the different phases after the exercise period, therefore, it is hard to show how GT directly influenced fat oxidation. Also, another limitation was the assessment of the lactate levels, which was not measured. In conclusion, it appears that green tea induces statistically significant fat oxidation in adults, compared to placebo. Indeed, the current study indicated that administration of capsules containing the green tea extract resulted in a significant increase in 24-hour energy fat oxidation in adults. Therefore, repeated use of combination of green tea ingestion and exercise training together probably reduce the fat mass of overweight males.

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Conflict of Interest: The authors declare that they had no conflict of interest.

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