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Effect of a Period of Selected Aerobic and Anaerobic Exercises with Green Tea Consumption on Cortisol Hormone

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Abstract: Due to lack of complete information about the effects of aerobic and anaerobic exercises with green tea supplementation on cortisol hormone, the current study was conducted by investigating the effect of a period of selected aerobic and anaerobic exercises (resistance) with the consumption of green tea on cortisol hormone in male athletes with 20-35 years. The 60 male athletes that with (age mean 26.30 and standard deviation 10.73 and weight mean 71.68 and standard deviation 12.47) were selected and randomly divided into 6 groups: Group: aerobic exercise with green tea, group aerobic exercise, group: anaerobic exercise (resistance) with green tea, group: anaerobic exercise (resistance), group: only green tea and group: only did their exercises (control). Each 6 group of protocol of 8 weeks that include: exercises are in 2 types, aerobic exercise (aerobics) which with 65-75% of maximum heart rate and anaerobic exercises (resistance exercises) that implement working with weight by 60-70% of a the maximum repeat. The experimental group during the study, 3 days a week received 200 mL of green tea. Before exercises and 8 weeks after the last training session, participants were taken blood sample in fasting state. Inferential statistics was used for one-way ANOVA in addition to all the hypotheses; Tukey post hoc test was used. As well as it was used in the significant level (p = 0/05). Results showed that although resting CORT values increased in all groups but statistically isn't significant so the hypothesis is rejected but to point out that the greatest increase in the aerobic exercise and after is has been in the control group. It can be concluded that green tea consumption with resistance exercise and resistance exercise on resting levels of CORT has significant and different effect of aerobic exercise and green tea. The results showed that doing aerobic exercises, anaerobic (resistance), aerobic and resistance with green tea may effect increase of CORT and some other factors of oxidative stress and inflammation.

Key words: Green tea, anaerobic exercise (resistance), aerobic exercise, oxidative stress, inflammation

INTRODUCTION

Oxidative stress by damage to types of cellular infrastructures cause to reduce cellular and physical function and fatigue and muscle damage. Since, oxidative stress during and after exercise occurs only if producing varieties of reactive oxygen due to exercise exceeds the potential of body's antioxidant defense (Konig *et al*., 2000).

Green tea plant is cultivated and grown in Southeast Asia, including China, India, Japan as well as in many African countries including South Africa (Ramma *et al*., 2005). Tea leaves are consumed for medical as well as for drinks in social. From 3000 years before Christ, traditional Chinese medicine used green tea for headache, body ache, ease digestion, increase immunity defense (safety), avoid poisoning as well as energy material and the lifetime (Ferrara *et al*., 2001). Among the most important group of antioxidants can note flavonoids. Green tea is an important source of flavonoids. Tea contains a group of polyphenolic flavonoids compounds called catechins and among catechins, Epi-Gallo Catechin Gallate (EGCG) is a powerful antioxidants and the most common and most abundant polyphenols in green tea (Murase *et al*., 2002).

In the research that was conducted, believed that tea is one of the major beverages after water among people and more than two-thirds of the world people drink tea (Gupta *et al*., 2002). Among drinks rich in flavonoids, green tea is one of the most common (Alessio *et al*., 2002), (Morillas-Ruiz *et al*., 2006). Epi-gallo-catechin-3-gallate (forms about 95% of the total available catechin. This part of polyphenols is the most studied and most active in green tea) has the highest power so that its power is 100 and 25 times more than the antioxidant vitamins C and E

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(Gupta *et al*., 2009). Researchers in the study have confirmed the protective effect of green tea [(600 mL per day) 3 times a day, 200 mL of boiling water with 2 g of dry green tea] in reducing lipid peroxidation at the time of intense resistance exercises (Panza *et al*., 2008) also in another study have reported green tea can increase antioxidant capacity and reduce oxidative stress due to strength exercises with an intensity of 60% (1RM) (Jowko *et al*., 2011). However, Belo *et al*. (2012) in studies that vitamin C and endogenous cortisol in inflammatory reaction of foreign body did in pacus (several species of omnivorous freshwater fish in South America), found that the objective is to evaluate the effect of Food supplement with vitamin C in macrophages and multi-core large cell activities (pacus) MGC in two stocking density. Test was carried out as factorial arrangement 2×2×3 of split plot: 0 and 500 mg kg vitamin C; 5 and 20 kg m density stocking, time of evaluation at 3, 6 and 12 days after subcutaneous implantation of the coated glass (DPI). The number of macrophages and MGC as well as plasma levels of cortisol and glucose was carried out.

Macrophages and MGC with two to five cores in fish with vitamin C and 5 kg per m density stocking in 3 DPI (Kidd) compared to those which were non-supplement significantly were higher.

MGC and macrophage counts in fish with high plasma cortisol concentrations were lower. Supplementation with 500 mg of vitamin C had benefits of macrophages activity in foreign body inflammatory and high cortisol concentration with suppression effects in this reaction.

However, in researches which were carried out, concluded that aerobic exercises, aerobic exercises combination and green tea supplementation and green tea consumption not create a significant change in the amount of leptin and insulin resistance index. Green tea consumption significantly decreased body weight and body mass index. Aerobic exercise was led to significant reduction of body weight, body mass index and percentage of body fat, combining aerobic exercise and green tea was caused significant increase in maximum oxygen consumption and significant reduction in weight, body mass index and body fat percentage. In conclusion, aerobic exercises and taking supplements of green tea not have effect on the (leptin) value and resistance index to insulin. Therefore, further study is necessary to achieve more conclusive results.

Therefore, due to contradictory obtained results and the paucity of information in the field of green tea supplementation at the time of aerobic and anaerobic activities (resistance) and its role in some inflammatory factors and indicator of oxidative stress in athletes after this type of exercises, conducting detailed and controlled studies in this area has not been studied, this study is designed.

MATERIALS AND METHODS

The research method is semi-experimental test; population consisted of all male athletes of Tehran which were 100 volunteers (participants). Which among them (N = 100) 60 people as targeted (questionnaire) were randomly selected as samples and divided into 6 groups [5 experimental groups ((N = 50 and 1 control group (N = 10)] which includes:

- Group A: aerobic exercise with green tea
- Group B: anaerobic exercise (resistance) with green tea
- Group C: only drink green tea
- Group D: only aerobic exercise
- Group E: only anaerobic exercise (resistance)
- Group F: only did ordinary exercises (control)

A week before conducting test, measurements of height, weight, age and familiarity with the method of conducting test and receive written consent were taken from the subjects. In addition, all subjects were in perfect physical and mental health and not had any history of cardiovascular diseases, respiratory diseases and specific diseases. Before starting, a pretest and after ending exercises after 8 weeks, a posttest was conducted.

The 200 mL of green tea (2 g of dry leaf green tea in 200 mL of water at 80-100°C) was given to 30 subjects (Panza *et al*., 2008) and 30 other subjects were without green tea.

Blood test was used for conducting pretest and posttest (fasting). Exercises were in 3 days a week for 24 sessions means 8 weeks and its time was 60 min each session.

Aerobic exercise: Aerobic exercises include aerobics exercises which includes 15 min of warm-up (walking, stretch, stretch, running and do stretch exercises, lift weight (light), ball, working on step and perform a series of movements on 35 and 10 min cool-down that totally is 60 min aerobics that is 3 sessions every other day of the week (3 days a week). Doing exercise intensity was between 65-75% of maximum heart rate. (New aerobic exercise, Kastan and Jordan), (Aerobics-education and its benefits, Veisi and Keshtidar).

Anaerobic exercise (resistance): Anaerobic exercise (resistance) that included 10 min warm up and then start

doing exercises with weight that includes two programs for 1-4 weeks (front foot with the back foot system with sitting system, bench press with system, the back of the shoulder with system, biceps with system, back of arm with system, triceps machine, stretch back with system, crunch with system) which contains 1set and 12-8 repetitions and 1-2 min resting.

Exercise program of 58th weeks (leg press, behind the leg with seated system, the chest with system, behind the shoulder with system, biceps with system, triceps with cable, stretch of back with system, Crunch of abdomen with system) which includes 1 set 8-12 reps and 1-2 min break and do exercise intensity is 60-70% (1RM) (planned reference book of strength exercises: Physiology of power science and system of study with weight (Brown, 2012).

Green tea supplementation: In the groups that green tea supplementation was considered the subjects were asked to brew 200 mL of green tea by maintaining their diet for 8 weeks, 3 days per week (2 g of dry leaf of green tea in 200 mL water at a temperature of 80-100) and after exercise, subjects were given a drink.

Blood sampling and measurement of research indices: After 12-14 h of fasting, blood sample was done in two stages (before exercise the day before the exercise and after 8 weeks of exercise). In the first stage of sampling that was done in the gym of Masjed Al-Nabi at 8 am that from the right hand vein of each subject in the sitting and resting state, 5 cc mL bloods was taken. In the sec step after the 8th week, the same way was done.

How to measure cortisol: To measure the cortisol, a serum from Monobind Company, Made in America, in wavelength of 45° nm was used by Elisa Reader and Elisa Method (Elisa Microwells) was used. Before starting study all solutions, standards, controls and patient serum must reach to 20-27°C of room temperature. This procedure should be made by qualified personnel The method includes the following.

To the number of patient samples control and standard Micro Elisa wells (wells within the microplate as a square) where the kit is kept at 2-8°C, taken and to standardize and control samples, we pour 25 mL to each well then 50 mL of enzyme solution of prepared cortisol is added to each micro and we shake thoroughly in 20-30 sec.

We cover micro for 60 min and keep at room temperature then empty micro and we wash them by buffer 50 times after these steps, we add 100 mL of prepared substrate solution to each of the micro. Notable in this approach is that after the addition of substrate shouldn't shake microplate, then we will keep the microplate at room temperature for 15 min, after this time 50 mL of stop solution is added to each of the wells then we mix them very well for 15-20 sec.

The optical density of each of the wells in wavelength of 45onm nm is read by Elisa reader system and the optical density of standard curve is drew and using this curve we calculate the amount of cortisol samples.

Finally at the end should be read maximum to 30 min after the addition of stop solution of optical absorption (Burtis and Ashweed, 1994; Wilson and Foster, 1985; Ruder *et al*., 1972; Crapol, 1979; Hyams and Carey, 1988; Krieger, 1975; Leisti *et al*., 1983; Alsevier and Goltin, 1978; Watts and Tindall, 1988).

Statistical methods: To detect and normality of data, Kolmogor of-Smirnof was used and found that groups not have any difference together. Descriptive statistics were used to calculate central and dispersion indices. Inferential statistics were used for one-way ANOVA and Tukey post hoc test. Significant level of alpha 0.05 was considered. All statistical analyzes were performed using SPSS Software Version 20.

RESULTS

Part 1: investigating the effect of aerobic exercise and green tea on variable CORT

The first hypothesis

The null hypothesis: Aerobic exercise with green tea has no significant effect on CORT of male athletes 20-35 years.

The results of ANOVA for comparison of changing CORT of resting plasma did not show significant difference between changes in four groups: Aerobic exercise with green tea, aerobic exercise, green tea and control ($F_{3, 36} = 0.721$, Sig. = 0.546). Table 1 shows one-way ANOVA for comparison of changing CORT of resting in four groups: Aerobic exercise with green tea, aerobic exercise, green tea and control.

According to the results it can be found that although the values of CORT resting in all four aerobic exercise group with tea, aerobic exercise, green tea and control (positive changes) have increased. However, these changes have not statistically been significant. Also, it can be said that the greatest increase of CORT

Table 1: The results of ANOVA for changing CORT rest plasma of four research group (aerobic exercise)

Groups	Sum of squares	d	Mean of squares	F-value	Sig.
Between group	51.148	3	49.17	721	546
Intergroup	850.828	36	634.23		
Total	901.976	39			

has been in the aerobic exercise group and then most of CORT changes in the control group. So, we can conclude that green tea consumption with aerobic exercise, aerobic exercise and green tea consumption has no significant effect on values of CORT resting in men aged 20-30 and hypothesis is rejected.

Part 2: investigating the effect of anaerobic exercise (resistance) and green tea on variable of CORT

The second hypothesis:

The null hypothesis: Resistance exercise with green tea has no significant effect on CORT in male athletes 20-35 years.

The results of ANOVA for comparison of changing CORT of resting plasma show a significant difference between changes in four groups: resistance exercise with green tea, aerobic exercise, green tea and control ($F_{3, 36}$ = 8.301, Sig. = 0.000). Table 2 shows one-way ANOVA for comparison of changing CORT of resting in four groups: resistance exercise with green tea, resistance exercise, green tea and control.

According to the results it can be found that although the values of CORT resting in all four resistance exercise group with tea, resistance exercise, green tea and control (positive changes) have increased. However, these changes have statistically been significant. The results showed that the increase of CORT in the resistance exercise group with green tea and resistance exercise group has been more significantly from its increase in two groups of control and green tea. But there was no significant difference between the control group and green tea. Also, the difference between resistance exercise groups with green tea with resistance exercise wasn't significant, despite the fact that CORT increase in the resistance exercise group with green tea was higher than resistance exercise group.

The results show that resistance exercise with green tea and resistance exercise has a significant increase on CORT but green tea alone has no effect. So, we can conclude that green tea consumption with resistance exercise and resistance exercise has significant effect on values of CORT resting in men aged 20-30 and hypothesis is confirmed.

Part 3: comparing the effect of aerobic and anaerobic exercise (resistance) and green tea on three variables of CORT

The third hypothesis

The null hypothesis: There is no significant difference between aerobic exercise with green tea and between resistance exercise with green tea and green tea on CORT in male athletes 20-35 years.

Table 2: The results of ANOVA for changing CORT rest plasma of four research group (anaerobic exercise)

Groups	Sum of squares	d	Mean of squares	F-value	Sig.
Between group	885.817	3	27.295	301.8	0
Intergroup	1280.593	36	57.350		
Total	2166.410	39			

Table 3: The results of ANOVA for changing CORT rest plasma of six research group

Groups	Sum of squares	d	Mean of squares	F-value	Sig.
Between group	1094.021	5	804.218	172.7	0
Intergroup	1647.365	54	507.300		
Total	2741.386	59			

The results of ANOVA for comparison of changing CORT of resting plasma show a significant difference between changes in six groups ($F_{5, 54}$ = 7.172, Sig. = 0.000) Table 3 shows one-way ANOVA for comparison of changing CORT of resting in six groups.

According to the results it can be found that although the values of CORT resting in six research groups have increased (positive changes). However, these changes have statistically been significant. The results showed that the increase of CORT in the resistance exercise group with green tea and resistance exercise group has been more significantly from its increase in four other groups of research. The results showed that resistance exercise with green tea and resistance exercise on CORT has significant effect but aerobic exercise with green tea, aerobic exercise and green tea had no significant effect on CORT values.

The results showed that the CORT changes after resistance exercise with tea consumption and resistance exercise have significant difference with its changes in three groups of aerobic exercise with green tea, aerobic exercise and green tea.

Therefore, resistance exercise and resistance exercise with green tea has a different effect with aerobic exercise and green tea and their combination. So, we can conclude that green tea consumption with resistance exercise and resistance exercise on resting values of CORT in men 20-30 has significant and different effect of aerobic exercise and green tea so the hypothesis is confirmed. (Note that in this hypothesis focusing is on investigating difference of two methods of exercise with green tea not the effect of them in the first and the second hypotheses were investigated but comparing effects have been investigated in the third hypothesis).

DISCUSSION

These findings indicate that aerobic exercises, anaerobic (resistance), aerobic and resistance with green tea increases CORT and affect some factors of oxidative stress and inflammation.

Cortisol is a known marker for physiological and mental stress so use it as an indicator of global stress in previous research (Kirschbaum and Hellhammer, 1994) with (Neary *et al*., 2002) is shown.

While some studies have suggested that cortisol secretion is increased with increasing intensity of exercise and found that cortisol concentrations during submaximal exercise is declined with short-term moderate intensity. However, the time of exercise is also known as impacting factor on hormone cortisol response.

Among the most important group of antioxidants can note flavonoids. Green tea is an important source of flavonoids. Tea contains a group of polyphenolic flavonoids compounds called catechins and among catechins, Epi-Gallo Catechin Gallate (EGCG) is a powerful antioxidants *in vitro*, the most common and most abundant polyphenols in green tea. (EGCG) prevents the activity of enzyme Catechol O Methyl Transferase (COMT) that is the reduction of noradrenaline and with the effect of regulation on sympathetic lipolysis activity increases energy expenditure, fat oxidation and reducing body fat mass, the effect that catechin has on green tea on body composition is that COMT is an enzyme that reduces the activity of norepinephrine and this mechanism prolongs the activity of norepinephrine (Murase *et al*., 2002). In addition to the effect on fat metabolism, green tea can affect the action of glucose and resistance to insulin (Wu *et al*., 2004). It has been shown that green tea flavonoids can improve insulin function and improve the ability to produce insulin. EGCG with increase of phosphorylation of tyrosine kinase and insulin receptor substrates mimic the function of liver cells and protect the liver cells against cytokine.

In another study that was conducted by Hamzezadeh titled the effect of 4 weeks of Intensity Interval Training (HIT) on the levels of GH, IGF-1, IGFBP-3 and cortisol serum of Iranian national basketball team, found that a HIT program with short rest periods can increase levels of anabolic hormones of serum in short time and observed hormonal changes support anabolic compatibilities from exercises.

Also, Delfan in a study titled the effect of aerobic and anaerobic exercises on anxiety and hormone cortisol secretion of young wrestlers blood, found that a single session of aerobic exercise has been effective in reducing anxiety of wrestlers as well as the continuation of exercises in the long run by reducing cortisol levels can reduce anxiety and balanced psychological conditions in athletes.

In researches that (Ormsbee *et al*., 2013) titled the effect of high-intensity interval exercise on salivary cortisol response to a psychological stress action and mode of mood in sedentary college students, found that 10 sessions of gradual HIIT (0-8 duration/session) on the bicycle of ergometer of time isn't sedentary enough to see the change in saliva cortisol concentration in response to stress or mood state in college-age men and women. Clearly it is shown that HIIT changes physiological processes similar to traditional endurance exercise (5, 15 and 26). However, the scopes of hormonal and psychological changes that may arise from HIIT are not well known.

In a study that (Oz *et al*., 2013) titled polyphenols of green tea and Solfa-Salazyn with anti-inflammatory anaerobic properties in models of colitis, found polyphenols in green tea and EGCG improve antioxidants and intensity of the treatment of Inflammatory Bowel Disease (IBD) weakened similar to sulfa-Salazyn.

Also, Azimi *et al*. (2011) concluded that doing 6 weeks aerobic exercise with green tea consumption in combining with moderate intensity exercise to improve body composition, aerobic capacity and to improve lipid profiles by decreasing the amount of C-reactive protein was beneficial.

While Arent *et al*. (2010) titled the effects of a nutraceutical drink after exercise on body composition, function and hormonal and biochemical reactions in part 1 college football players, found that it seems that the diet supplement after exercise from part 1 college football players with a medical nutrition drink has favorable effects on body composition and peak power output and biochemical markers. Based on the difference between two groups that emerged at rest state in the second experiment, it seems that the physiological responses of the supplements have positive effect on advanced recovery index of physiological reactions of acute and chronic.

Studies that (McKeeveret, 2009) titled the effect of black tea extract rich in (T Flavin) on muscle pain responses, oxidative stress, inflammation and endocrine anaerobic to acute interval training: randomized crossover study, found that black and white tea extract rich in T Flavin was led to improve and reduce oxidative stress and reaction of DOMS to anaerobic exercise of acute interval. The recovery improvement can be to the benefit of all people who act in high-intensity anaerobic exercises because it facilitates the increased frequency of exercise.

Perhaps the reasons for these disagreements could be due to age (Hassan, 2013), gender and type of sport, exercise intensity (Ormsbee *et al*., 2013), samples in human or animal model (Oz *et al*., 2013), the time of exercise, type of supplement (Ozkol *et al*., 2011), the type of exercise (Trivic *et al*., 2011; Arent *et al*., 2010) and test type while in the current findings, subjects age

20-35 years and while in the current findings the used green tea supplementation (2 g dry leaf of green tea per 200 mL of water at a temperature of 80-100) was given to subjects as drink, doing aerobics exercises with intensity of 65-75% of maximum heart rate and anaerobic exercises (resistance) weightlifting that was done with intensity of 60-70% (1RM) for 8 weeks and in healthy male athletes and doing exercise was without the test.

Hormone cortisol secretion in stressful situations can change, on the other hand testosterone is known as neutral of interaction of cortisol at the time of physical activity.

These hormones affect in response to factors such as exercise intensity, duration, time and type of exercise and individual fitness level. The most difficult part of exercise programs is awareness of the ideal level of exercise and time of exercise that in this area there is very little information. In some recent studies, changes in serum cortisol level was observed in the morning and evening.

Given the foregoing, it appears that the type of supplement, type of sport, exercise type, intensity and duration of exercise, samples (human or animal) and healthy people and sick people, gender, age, physical and psychological conditions and other factors which may be increased or decreased cortisol.

CONCLUSION

Doing aerobic exercises, anaerobic exercise (resistance), aerobic and resistance exercise with green tea may increase in CORT and affect a number of factors of oxidative stress and inflammation. But green tea can inhibit the increase of oxidative stress and inflammation and decrease the damage.

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