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Original article

Effects of quercetin and catechin on blood lactate level

Meral Miyaç Göktepe[1], *Mehmet Göktepe*[2], *Erdil Durukan*[2], *Mehmet Günay*[3], *Ferhat Güder*[4], *Meriç Eraslan*[5]

[1] School of Applied Sciences, Istanbul Ayvansaray University, Istanbul, Turkey
[2] Faculty of Sport Sciences, Balıkesir University, Balıkesir, Turkey
[3] Faculty of Sport Sciences, Gazi University, Ankara, Turkey
[4] Faculty of Sport Sciences, Bartın University, Bartın, Turkey
[5] Faculty of Sports Sciences, Akdeniz University, Antalya, Turkey

Abstract. *Study Objectives:* This study was aimed to investigate the effects of combined administration of Catechin and Quercetin on blood lactate level. *Methods:* The research was conducted on 12 male Wistar rats weighing 300-350 gr. Rats were divided into two groups as the control group (n=6) and the test group (n=6). After the rats were quarantined for 10 days; each rat heart blood was taken on the first test day (pre catechin+quercetin supplementation), and again after they were participated to exercise on the second test day (pre catechin+quercetin supplementation). Between days 3 and 12 after testing (for 10 days), each rat in the test group was given 20 ml/kg of catechin+quercetin once daily, and each rat in the control group was given 1ml/kg of 0.05% Dimethyl Sulfoxide (DMSO) by gavage. On days 13 (post catechin+quercetin supplementation), each rat was participated to exercise and take their heart blood. On day 14, the animals were allowed to rest and on day 15 (post catechin+quercetin supplementation), rats' heart blood were taken under anesthesia. Mann-Whitney test was used to analyze data. *Results:* There was no significant difference between control and test groups during the rest day and during exercise (day 2) testing. Significant changes were observed according to the results of the rats, which were practiced to exercise after administration of catechin+quercetin for 10 days, between day 3 and day 12 after testing. A significant reduction was determined in lactate levels ($p<0.01$). *Conclusion:* Combined administration of catechin+quercetin was found to reduce lactate levels during exercise, suggesting a performance-enhancing effect.

Keywords: Antioxidants, Flavonoids, Quercetin, Catechin, Exercise, Lactate

Introduction

Although physical exercise has many beneficial effects on health, there are reports in the literature that reactive oxygen species (ROS) and formation of free radicals increase especially during violent exercise, and oxidative damage occurs in muscle, liver, blood, and other tissues (1,2). Major antioxidant enzymes among enzymatic systems effective at the cellular level including SOD (superoxide dismutase), CAT (catalase), GPx (glutathione peroxidase), GST (glutathione S- transferase) (3). Acute exercise is said to have the potential to directly affect the activity of these enzymes (1). Vitamin E, vitamin C, glutathione, and flavonoids can be given as examples to non-enzymatic antioxidants (3). Flavonoids have been known to be plant pigments for over a century. They are from the group of polyphenolic compounds and spread across all plants. Catechins are flavonols from the group of polyphenols, which are found in wine, tea, fruits, and chocolate. They are known for their natural antioxidant activity (4). Quercetin, another flavonol, is largely found in foods (especially in onions). Also, tea is rich in quercetin and kaempferol

from the group of flavonols and flavones (5). The most important function of quercetin is to speed up metabolism (6). Metabolism is also accelerated by exercise. Quercetin, known as a powerful antioxidant, is used for its antioxidant and anti-inflammatory effects, and it was investigated in detail to determine what it means for exercise (7). There is very little research determining the effect of catechin and quercetin on exercise together. Therefore our research is important. In light of the abovementioned information, the objective of this research was to investigate the effects of combined administration of catechin+quercetin on blood lactate levels.

Material and Method

In this study aimed to determine the effects of administration of catechin+quercetin on blood lactate levels, male Wistar rats weighing 300-350 g supplied from Ankara University, Faculty of Medicine were used as subjects. Rats were quarantined for 10 days before the administration. They were kept in special cages, fed standard laboratory diet, and given water. They were maintained at an ambient temperature of 18- 22 °C under a photoperiod of 12-hour light and 12-hour dark. They were placed in such a way that each cage contained 6 animals. Applications were carried out at Gazi University, Faculty of Science, Biology laboratory, and study protocol was approved by Gazi University, Local Ethics Committee for Animal Experiments (G.Ü.ET-10.091). Chemicals used in the study: catechin and quercetin (Flavonoid), Dimethyl Sulfoxide (DMSO) were supplied from Sigma-Aldrich.

Experimental Design

Rats were divided into two groups as the control group (n=6) and the test group (n=6). Quercetin and catechin were administered to non-fasting rats in the morning (between 09.00 and 10.00 am). In the control group, 1 ml/ kg of body weight of 0.5% DMSO was administered to each rat daily by oral gavage (Figure 1). In the test group, 20 mg/kg of body weight of catechin and quercetin dissolved in 0.5% DMSO was administered to each rat daily by oral gavage.

After a quarantine period of 10 days; on day 0 of the test (pre catechin+quercetin supplementation), the animals were allowed to rest. On day 1 of the test (pre catechin+quercetin supplementation), each rat heart blood were taken. On day 2 (pre catechin+quercetin supplementation), each rat was practiced to exercise and heart blood was taken. Between days 3 and 12 of the test (for 10 days), each rat in the test group was given 20 ml/kg of body weight catechin and quercetin dissolved in 0.5% DMSO daily in the morning between 9.00 and 10.00 am. Each rat in the control group was given 1ml/kg of 0.05% DMSO by gavage. On day 13 of the test (post catechin+quercetin supplementation), each rat was practiced to exercise and heart blood was taken. On day 14, the animals were allowed to rest. On day 15 (post catechin+quercetin supplementation), the animals were euthanized by heart blood were taken under anesthesia.

Exercise Protocol

On day 2 and day 13 of the test, swimming exercise was performed by making animals swim until

Figure 1. An image of rats being fed by gavage and swimming exercises.

exhaustion in an 80x60x60 cm pool. Meanwhile, it was ensured that animals became exhausted. Rats were made to swim in water at 28 °C until exhaustion. The emergence of uncoordinated movements (small limb movements that fail to make the animal stay above water), staying under water without swimming for10 seconds were considered exhaustion criteria for rats (2,8).

Lactate Analysis

Blood samples of the subjects were analyzed using YSI 1500 Sport Lactate Analyzer and lactate values were determined16. Blood lactate levels of the subjects during rest and during exercise were measured using blood samples collected from heart and recorded.

Statistical Analyses

Statistical data used in the research were evaluated by Windows SPSS 15.0 software package. Before testing data with statistical methods, the Shapiro-Wilk normality test was used to identify whether they satisfy normal distribution. It is concluded that not all data meet the normal distribution assumption. In that case, the Mann-Whitney test was used to compare control and catechin+quercetin groups. Additionally, descriptive (summary) statistics are given in tables. Significance was set at $p<0.05$ and $p<0.01$.

Results

According to the results in Table 1, in view of statistical results for lactate levels obtained from values of blood collected during rest, no statistically significant difference was found between control and test groups($p>0.05$). According to the results regarding blood samples collected during exercise, no significant difference was found ($p>0.05$). When the statistical results obtained from values regarding blood samples of rats forced to exercise after administration of catechin+quercetin are considered, a significant difference was established between the control group and test group in terms of lactate levels ($p<0.01$). According to this, lactate levels of rats forced to exercise after administration of catechin+quercetin decreased.

Discussion

The purpose of the study was to determine the effects of the administration of catechin+quercetin to rats participated on swim on their lactate levels. Lactate levels during rest and exercise before administration of catechin+quercetin to control and test groups and lactate levels during exercise and recovery after administration of catechin+quercetin were measured. Lactate levels of rats administered catechin+quercetin and practiced to exercise were found to be significantly reduced compared to the control group ($p<0.05$).

Table 1. Comparison of Lactate Levels before and after Administration of Catechin+Quercetin.

	Time of measurement	Group	n	X	SD	Statistics	p
Lactate mmol/L)	**Rest 1 (Pre suppl.)**	Control	6	0.76	0.08	Z_M=-0.241	0.810
		Cat+que	6	0.76	0.17		
	Exercise 1 (Pre suppl.)	Control	6	4.62	0.65	t=-0.941	0.368
		Cat+que	6	5.14	1.18		
	Rest 2 (Post suppl.)	Control	6	0.87	0.27	t=-0.911	0.384
		Cat+que	6	1.00	0.24		
	Exercise 2 (Post suppl.)	Control	6	5.42	1.40	**Z_M=-2.882**	**0.004****
		Cat+que	6	3.39	0.37		

***p<0.01*

Smith et al. (2011) determined that blood lactate levels of cyclists and triathlon athletes administered 1000 mg of quercetin daily for 3 weeks were reduced at exercise intensities of 75% VO2 peak level and above (9). Gasparin et al. (2003) suggested that the administration of quercetin significantly reduced glucose and lactate production (10). Su-Juan et al. (2007) demonstrated that quercetin could markedly prevent increased lactate dehydrogenase after exhausting swimming exercise (11). Gai-ning (2006) investigated the effects of quercetin on muscle tissue in rats made to exercise and determined that the MDA level was remarkably reduced (12). In another study by Adewole et al. (2007) combined administration of quercetin and exercise was found to significantly reduce the MDA level (13). Duarte et al. (2001) found that MDA levels of rats administered quercetin for 5 weeks were reduced (14). Phachonpai et al. (2010) noted reduced levels of MDA in quercetin administered rats. MacRae and Mefferd21 found that quercetin has a performance-enhancing effect on cyclists (15). Davis et al. (2009) checked the effects of a 7-day quercetin supplement in their study conducted on humans. When the results of volunteers made to exercise following administration of quercetin were evaluated, they found a statistically significant increase between groups (16). In a study conducted on non-athlete men, Nieman et al. (2010) administered 1000 mg of quercetin to adults daily, and 2 tests of 12-min were applied to them on a treadmill. People administered quercetin during their second trial time continued for an extra period of 3% (17).

In studies conducted on athletes, quercetin was demonstrated to have no positive effect on physical performance (18,19). In another study, supplementing 600 mg/day of quercetin for 6 weeks was found to have no positive effect on cyclists' performance (3). It was reported by previous studies that quercetin administration has no effect on muscle oxidative capacity or VO_{2Max} values (20,21). In another study, no significant effect was determined in exercise performance and VO2max values of people administered quercetin supplement (1g/day) for 6 weeks6.

Murase et al. (2006) when they compared lactate values in blood samples collected after exercise, they identified that catechin significantly affected dosage-based lactate levels of catechin administered test group to such an extent that they approached the values of the control group which wasn't made to exercise. However, catechin administered groups made to exercise were also found to have lower lactate levels compared to the control group made to exercise (22). In a study of 14 days conducted on 28 young soccer players, Fraga et al. (2005) divided the players into two groups as FCMC group (n=14) consuming 105 grams of milk chocolate containing flavanol (168 mg of flavanol) daily and CBC group (n=14) consuming 105 grams of cocoa butter chocolate (<5mg of flavanol) daily in addition to their normal diet. Data obtained at the end of the study showed that consuming milk chocolate containing 168 mg of flavanol (Catechin) caused a reduction of 5mmHg in diastolic blood pressure, of 11 % in plasma cholesterol level, of 15% in LDL- cholesterol, of 12 % in MDA, of 11 % in uric acid and of 11 % in lactate dehydrogenase (LDH) activity (23).

Conclusion

As a result, it can be suggested that the intake of Catechin in combination with quercetin suppresses lactate levels during exercise, resulting in positively increased performance. Such studies allow athletes to develop in terms of nutrition and training program is proposed to be beneficial.

Conflicts of Interest

The authors declare that there is no conflict of interest in this manuscript.

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Correspondence:
Meriç Eraslan
Faculty of Sports Sciences, Akdeniz University, Antalya, Turkey
E-mail: mericeraslan@hotmail.com