Journal of Education and Training Studies
Vol. 5, No. 4; April 2017
ISSN 2324-805X E-ISSN 2324-8068
Published by Redfame Publishing
URL: http://jets.redfame.com

Effects of Quercetin Supplementation on Lipid and Protein Metabolism after Classic Boxing Training

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Received: February 3, 2017 Accepted: February 28, 2017 Online Published: March 3, 2017

doi:10.11114/jets.v5i4.2193 URL: https://doi.org/10.11114/jets.v5i4.2193

Abstract

The metabolic fitness (MF) is a component of athletes' physical conditioning. This study aims to investigate the effects of quercetin supplementation on Turkish Junior athletes' lipid and protein metabolism relating to MF after one month classic boxing training. Totally 20 voluntary junior male athletes were separated into two equal groups as the experimental group (EG) and control group (CG). The participants were supplemented with 500 mg quercetin fifteen minutes before each workout in one month boxing training program. Blood samples during pre and post training were taken from athletes in order to determine metabolic fitness related parameters. Lipid profile contains low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), trigliserid (TG), total cholesterol (TC) variables while protein metabolism includes the albumin, total protein, direct bilirubin and total bilirubin parameters. The Mann Whitney U analyzes were used for comparison of the means between experimental and control groups during pre and posttest and between pre and post test results in experimental and control groups. This study showed that EG had a similar physical characteristic with CG. There were significant decrease in TC and LDL-C and an increase in HDL-C in EG while there was only significant increase in HDL-C of in controls. A significant difference of HDL-C was observed between EG and CG during pretest. In other side, TC and LDL-C and HDL-C were significantly differentiated between EG and CG during posttest. Conclusion: it can be concluded that quercetin plays an important role on lipid metabolism not protein.

Keywords: quercetin, lipid profile, protein metabolism, metabolic fitness, boxing

1. Introduction

The free radical production is accelerated in parallel with the increase in oxygen consumption depending on the intensity of the exercise. Quercetin has similar effect with exercise in the acceleration of energy metabolism (Palmer et al., 2003; Chen et al., 2005). Cardiovascular disease is one of the most important health problems in the world and the most common symptom of this problem is atherosclerosis. Low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) are often associated with diet-induced atherosclerosis (Made Harumi et al., 2015).

The control of lipid profile, obesity and overweight risk factors is one of the most important strategies for improving human health and any disorder in these parameters can lead to the development of cardiovascular diseases (Hopper et al., 2001). Some studies suggest that regular intensive exercise decreases lipid profile, in other words total cholesterol, triglycerides and LDL-C, while increases HDL-C (Crimi et al., 2009; Zabet et al., 2010). Conversely, some other studies have reported that there are no changes in these parameters following the exercises (Davis et al., 1992; Mousavizadeh et al., 2009).

Quercetin is a flavonoid found in many plants and is a strong antioxidant due to its ability to sweep free radicals (Kelly, 2011; Nam et al., 2016). Quercetin appears to play an important role in human health and has beneficial effects in preventing human diseases. Quercetin is effective on multiple biological pathways, clearing free radicals as antioxidants and leading to oxidation of endothelial cells, extracellular collagen matrix and plasma lipids (TC, LDL-C) and consequently reducing the probability of developing atherosclerosis (Larson et al., 2012).

In the study of Lee et al. (2011), quercetin supplementation in healthy smokers for 10 weeks leads to a decrease in TC and LDL-C while an increase HDL-C. Also Talirevic and Jelena (2012) administered quercetin supplementation to patients with dyslipidemia for 2 months and they obtained similar results. Yi et al. (2011) reported that quercetin supplementation to 15 healthy subjects lowered their LDL-C levels and inhibited atherosclerosis. Similarly, Askari et al. (2013) reported that the administration of 500 mg quercetin in 60 healthy males for 8 weeks reduced significantly the LDL-C concentration while no significant change HDL-C lipoprotein level. Conversely, Brüll et al (2015) examined the effect of quercetin supplementation on 68 obese subjects for 6 weeks and they found that there was no significant effect on TC, LDL-C and HDL-C levels.

Intensive training and competition in boxing needs high level of metabolic fitness is the base of athlete's physical conditioning. This capacity makes possible the athlete to get fast recovery and energy regeneration after workouts and competitions. Quercetin can play an important role in complex oxidative functions involving the oxygen binding to a biochemical substance during physiological reactions. In addition, quercetin is considered to be an important antioxidant in the extracellular fluid and it has been shown to effectively oxidized superoxide, hydrogen peroxide, lipid peroxidation and also protein carbonyl compound (Selvakumar et al. 2013). This study aims to investigate the effects of quercetin supplementation on Turkish Junior athletes' lipid and protein metabolism relating to MF after one month classic boxing training.

2. Material and Methods

2.1 Participants

Data were collected from 20 voluntary junior male athletes separating into two equal groups as the experimental group (EG) and control group (CG). The participants were supplemented with 500 mg quercetin fifteen minutes before each workout in one month boxing training program. The mean values of participants were 18.95±1 years for age, 167.35±2.81 cm for body height, 62.85±0.99 kg for body weight and 22.46±0.92 for BMI, respectively. All the details of the study were explained to the subjects and the study was approved by the ethics commission of Medical Faculty at the Kafkas University and it was conducted in line with the relevant directive specified in Helsinki Declaration.

2.2 Exercise Protocol (Classic Boxing Training)

Control and experimental group an exercise program of two hours applied to the athletes three times a week for one month. Athletes performed classic boxing training after 20 minutes warm up including jogging, stretching and calisthenics exercises. This workout was consisted of rope skipping, shadow boxing, foot working and technical exercises with partners. It was ensured that the participants did not take any medicine within 15 days before the test, which may affect antioxidant defense, and their diets were standardized. Quercetin group was supplemented with 500 mg Quercetin 15 minutes before daily training for 30 days.

2.3 Blood Sampling and Assessment

Blood samples during pre and post training were taken from athletes in order to determine metabolic fitness related parameters. In the study, blood samples were taken from all athletes before and 30 days after the training.

Lipid profile contains HDL-C, LDL-C, TG, TC variables while protein metabolism includes the albumin, total protein, direct bilirubin and total bilirubin parameters. All data were collected in the Medical Faculty laboratory at Kafkas University. Blood samples were withdrawn into heparinized tubes from a cubital vein after overnight fasting and immediately stored in ice. Plasma was separated from cells by centrifugation at 4000 rpm for 15 minutes and the plasma samples were stored at -20 ℃ until analysis. All parameters was analyzed by COBAS c311 system (Roche Diagnostics, Germany)

2.4 Statistical Analyzes

All statistical analyses were performed by SPSS version 13.0. Results of descriptive statistics in this study are presented as mean, standard deviation, and minimum and maximum values. The Mann Whitney U analyzes were used for comparison of the means between experimental and control groups during pre and posttest and between pre and post test results in experimental and control groups.

3. Results

There was no significant difference between the groups in terms of physical characteristics ($p>0.05$*) (Table 1). The results of this study showed that pre and post test results in the control group was only significantly differentiated in HDL-C levels after exercise with respect to the lipid profile after quercetin supplementation ($P<0.01$) (Table 2). No difference was observed in protein metabolism in control group.

Table1. Comparison of physical properties between experimental and control groups

		N	M.	SD.	Mann Whitney U	Asymp. Sig.
Age (Years)	Experimental	10	18,90	0,99		
	Control	10	19,00	1,05	47,500	,841
	Total	20	18,95	1,00		
Body Height (cm)	Experimental	10	167,20	3,01		
	Control	10	167,50	2,76	48,500	,908
	Total	20	167,35	2,81		
Body Weight (kg)	Experimental	10	63,00	1,05		
	Control	10	62,70	0,95	40,500	,453
	Total	20	62,85	0,99		
Body Mass İndex (BMI)	Experimental	10	22,56	1,06		
	Control	10	22,37	0,80	45,500	,733
	Total	20	22,46	0,92		

On the other hand, quercetin supplementation decreased significantly the TC and LDL-C (P<0.01) and increased the HDL-C levels in the experimental group while there was no significant change in the means of control group according to the pre and posttest results (P<0.05). Conversely, the small differences in the levels of protein metabolism between two groups were not statistically significant depending on quercetin supplementation (p>0.05) (Table 2).

Table 2. Comparison of lipid profiles, protein metabolism between pre and posttest in experimental and control groups

Variables	Group	N	EXPERIMENTAL GROUP M	SD	MW U Test	Asymp. Sig	CONTROL GROUP M	SD	MW U Test	Asymp. Sig
Total Bilirubin mg/dL	Pre test	10	0,94	0,39			0,74	0,20		
	Post test	10	0,87	0,31	46,000	,761	0,74	0,20	48,500	,910
	Total	20	0,90	0,34			0,74	0,19		
Direct Bilirubin mg/dL	Pre test	10	0,16	0,05			0,13	0,03		
	Post test	10	0,14	0,05	40,000	,447	0,12	0,03	43,500	,620
	Total	20	0,15	0,05			0,13	0,03		
Total protein g/dL	Pre test	10	7,43	0,21			7,28	0,47		
	Post test	10	7,35	0,11	37,500	,336	7,25	0,39	49,000	,939
	Total	20	7,39	0,17			7,27	0,42		
Albumin g/dL	Pre test	10	4,65	0,29			4,71	0,25		
	Post test	10	4,52	0,35	38,000	,360	4,67	0,24	44,500	,674
	Total	20	4,59	0,32			4,69	0,24		
Total Cholesterol mg/dL	Pre test	10	140,80	24,62			149,30	16,76		
	Post test	10	108,90	10,95	6,000	,001**	148,70	14,87	46,000	,762
	Total	20	124,85	24,73			149,00	15,42		
HDL-C mg/dL	Pre test	10	46,10	7,46			40,20	4,47		
	Post test	10	55,10	7,40	18,500	,016*	46,50	5,38	16,000	,009**
	Total	20	50,60	8,58			43,35	5,80		
LDL-C mg/dL	Pre test	10	80,40	13,01			90,20	17,09		
	Post test	10	64,10	6,31	13,500	,006**	82,80	15,49	32,500	,185
	Total	20	72,25	13,00			86,50	16,32		
Trigliserid mg/dL	Pre test	10	59,70	18,25			65,70	14,90		
	Post test	10	54,50	13,83	41,000	,491	60,90	12,17	41,000	,492
	Total	20	57,10	15,99			63,30	13,47		

* Significant difference at p<.05 level. ** Significant difference at p<.01 level. Mann Whitney U Test=MW U Test

There was only a significant difference (P<0.05) in the pre-exercise HDL-C levels between experimental and control group in the comparison of the lipid profile and protein metabolism results (Table 3). On the other hand, significant decreases in TC and LDL-C (P <0.01) and increase in HDL-C levels were observed in the experimental group between pre- and posttest results in both groups (P<0.05) while no significant difference in the control group. Pre and posttest levels of protein metabolism were not differentiated between experimental and control group (p>0.05) (Table 3).

Table 3. Comparison of lipid profile and protein metabolism between experimental and control groups during pretest and posttest

Variables	Group	N	PRE TEST M	SD	MW U Test	Asymp. Sig	POST TEST M	SD	MW U Test	Asymp. Sig
Total Bilirubin mg/dL	Experimental	10	0,94	0,39			0,87	0,31		
	Control	10	0,74	0,20	33,500	,212	0,74	0,20	39,000	,405
	Total	20	0,84	0,32			0,80	0,26		
Direct Bilirubin mg/dL	Experimental	10	0,16	0,05			0,14	0,05		
	Control	10	0,13	0,03	34,500	,239	0,12	0,03	40,000	,444
	Total	20	0,14	0,04			0,13	0,04		
Total protein g/dL	Experimental	10	7,43	0,21			7,35	0,11		
	Control	10	7,28	0,47	38,000	,361	7,25	0,39	40,000	,443
	Total	20	7,36	0,36			7,30	0,28		
Albumin g/dL	Experimental	10	4,65	0,29			4,52	0,35		
	Control	10	4,71	0,25	46,000	,760	4,67	0,24	36,500	,304
	Total	20	4,68	0,26			4,60	0,30		
Total Cholesterol mg/dL	Experimental	10	140,80	24,62			108,90	10,95		
	Control	10	149,30	16,76	32,500	,186	148,70	14,87	1,500	,000**
	Total	20	145,05	20,95			128,80	24,05		
HDL-C mg/dL	Experimental	10	46,10	7,46			55,10	7,40		
	Control	10	40,20	4,47	23,500	,042*	46,50	5,38	16,500	,010**
	Total	20	43,15	6,71			50,80	7,69		
LDL-C mg/dL	Experimental	10	80,40	13,01			64,10	6,31		
	Control	10	90,20	17,09	28,000	,096	82,80	15,49	12,500	,004**
	Total	20	85,30	15,61			73,45	14,99		
Trigliserid mg/dL	Experimental	10	59,70	18,25			54,50	13,83		
	Control	10	65,70	14,90	34,500	,239	60,90	12,17	30,500	,138
	Total	20	62,70	16,51			57,70	13,10		

* significant difference at p<.05 level. ** significant difference at p<.01 level. Mann Whitney U Test=MW U Test

4. Discussion

Many studies focusing the effect of exercise on lipids and protein metabolism showed that intensive exercise changes the lipid and protein profiles of athletes depending on training variables including intensity, time, frequency and duration of exercise. It is observed that exercise leads to a decrease in TC, LDL-C, and an increase in HDL-C levels. This effect of exercise on serum lipid levels result in decreasing cardiovascular risk factors (La Monte et al.2001; Crimi et al., 2009; Zabet et al., 2010). Quercetin, on the other hand, is regarded as an agent that increases mental and physical performance during intense exercise and reduces the risk of infection due to its biological properties. Quercetin is not only beneficial with its anti-inflammatory effect but also for its antioxidant and psych stimulant effects as well as its stimulatory effect on mitochondrial biogenesis and Immunity enhancing effect on health (Cureton et al.2009). Thus the aim of this study is to investigate the effects of quercetin supplementation on Turkish Junior athletes' lipid and protein metabolism indicating their metabolic fitness level after one month classic boxing training.

According to the results of this study, pre and post test results in the control group was only significantly differentiated in HDL-C levels after exercise with respect to the lipid profile after quercetin supplementation (Table 2). In experimental group, quercetin had a significant decreasing effect on the TC and LDL-C and increasing effect on the HDL-C levels. Classic boxing training plus quercetin supplementation had a strong effect on lipid profile compare to controls. It was well established that quercetin had the antioxidant effect on free radicals and regulatory effect on lipid profile. Also, it appears to be the most effective flavonoid in protecting the body against reactive oxygen metabolites (Huy et al. 2008).

In the study of Prabu et al (2010), it was determined that the supplementation of 50 mg quercetin on rats for 4 weeks resulted in a significant increase in HDL-C and a decrease in LDL-C. Similarly; Lee and et al (2011) found that the supplying of quercetin (100 mg / day) to healthy male smokers for 10 weeks significantly reduced the TC and LDL-C concentration while a significant increase in serum HDL-C. These results had the similarities with the study of Prabu et al (2010) and Lee and et al (2011). Conversely, Brüll et al (2015) examined the effect of quercetin supplementation on 68 obese subjects for 6 weeks and they found that there was no significant effect on TC, LDL-C and HDL-C levels. Therefore, it can be evaluated that the implementation quercetin plus exercise had a protective effect on cell integrity while reducing oxidative stress.

Exercise induced a severe oxidative stress resulting in the depletion of plasma and tissue antioxidants have been shown to be an important inhibitor of cardiovascular disease (Dietz et al. 2012; Heckman and McKelvie 2008). Quercetin is particularly anti-carcinogenic and anti-atherosclerotic with its inhibiting the bioactivation process of carcinogens and inhibiting LDL oxidation (Nijveldt et al. 2001). It appears from these studies that the combination of exercise and quercetin supplementation may produce greater cardiovascular benefits than exercise alone.

Results of this study showed that the comparison of experimental and control groups during pretest were only significantly differentiated in HDL-C levels with respect to the lipid profile before quercetin supplementation. During posttest, differences between experimental and control was observed not only in HDL-C, but also LDL-C and TC (Table 3). Differences between experimental and control groups approved the strong effect of exercise plus quercetin effect on lipid metabolism. In an animal study, Harumi et al (2015) investigated the protective effect of quercetin by separating 20 male rats into 4 groups. was investigated by feeding on a high fat diet for 4 weeks. All treatment groups showed that quercetin had a positive effect on the prevention of hyper-cholesterolemia by the inhibiting increased LDL and the preventing decreased in HDL. These results were in accordance with the findings of our study. Several mechanisms have been described and attributed to the anti-atherogenic effects of exercise and quercetin. It is commonly accepted that moderate exercise is an important component of a healthy lifestyle that helps to prevent or delay the onset of coronary artery disease (Garelnabi et al. 2012; Fernandes-Silva et al. 2012).

On the other hand Quercetin has been shown to act through various mechanisms mainly linked to reducing the inflammation and oxidative stress levels which are responsible for the atherosclerotic pathogenesis. Earlier studies have shown that quercetin significantly inhibit in vitro LDL oxidation, and also protects macrophages from oxidized low-density lipoprotein induced apoptosis (Naderi et al. 2003; Yang et al. 2012). Similarly, it is well known that HDL-C levels play a protective role in cardiovascular disease, while elevated LDL cholesterol levels increase the risk of developing atherosclerosis (Silbernagel et al., 2013, Warnholtz et al., 2001). The formation of atherosclerosis depends on the blood lipid level. Hypercholesterolemia is an important risk factor for atherosclerosis, even in the absence of other factors. The main component of serum cholesterol associated with increased risk of atherosclerosis is LDL-C. Therefore high HDL-C levels correlate with reduced risk (Kumar et al., 2010).

In conclusion, the combination of classic boxing training and quercetin supplementation resulted in significant decreases in TC and LDL-C values and significant increases in HDL-C values in the experimental group compared to the control group while there was only an increase in HDL-C level of the control group after exercise. This means that quercetin plays an important role on lipid metabolism not protein. Thus quercetin intake plus exercise may lead to reduce the cardiovascular risk factors including hypercholesterolemia and lipid level by increasing metabolic fitness level in athletes.

Conflicts of Interest

There isn't any conflict of interest to be declared regarding the manuscript.

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