Effect of Eight Weeks of Quercetin Supplementation on Exercise Performance, Muscle Damage and Body Muscle in Male Badminton Players

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ABSTRACT

Background: Quercetin is a bioflavonoid which occurs in many food items. Some previous studies on quercetin showed inconsistent results on exercise performance, muscle damage and body muscle in athletes. The aim of this study was to determine the effects of eight weeks of quercetin supplementation on exercise performance, muscle damage indices and body muscle in badminton players.

Methods: This placebo-controlled, double-blind clinical trial was conducted on 26 badminton players for eight weeks. The subjects were randomly assigned to one of two groups to receive quercetin (1000 mg) or placebo (1000 mg dextrose). VO_2 and time to exhaustion (TTE) for measuring performance and body fat percentage (BFP) were measured before and after intervention. Plasma sample swere obtained for the determination of plasma lactate before and after intervention.

Results: Lactate concentration, body fat percentage and VO_2 max did not show any significant difference ($P > 0/05$) after eight weeks of supplementation with placebo and quercetin between two groups and within one group. There was a significant increase in TTE after intervention in the quercetin group ($P < 0/05$) but a significant change was not observed in the placebo group ($P > 0/05$).

Conclusions: The current study shows that intake of quercetin may improve endurance exercise performance but may not reduce the body fat percentage.

Keywords: Body mass, exercise performance, muscle damage, quercetin

Original Article

INTRODUCTION

Polyphenolic compounds, or polyphenols, are hydroxylated phytochemicals, of which the two main classes include flavonids and phenolic acids.[1] Quercetin is a flavonol that constitutes the aglycone of the plant glycosides rutin and quercetin.[2-4] Human subjects can absorb significant amounts of quercetin, with a reported half-life ranging from 3.5 to 28 h.[4,5] High concentrations are found in apples, red wine, onions and tea.[6]

Cardiorespiratory endurance exercise increases active skeletal muscle mitochondrial density by 20-100%.[7,8] Exercise-induced

mitochondrial biogenesis is mediated by expression of mithochondrial and nuclear genes.[9,10] A few recent studies have shown that quercetin may increase expression of mithochondrial and nuclear genes and effects on endurance performance and mitochondrial biogenesis[11,12] similar to some other nutrients.[13-15] Recent studies have examined whether quercetin supplement enhances endurance exercise capacity.

One study of 11 elite male cyclists reported 1.7% performance enhancement above placebo after six weeks of quercetin supplementation.[16] Another study using sedentary mice showed that quercetin feeding (both 12.5 and 25 mg/kg) increased treadmill run time to fatigue by 37%. Another study of trained cyclists showed no effect of 1000 mg of quercetin a day compared with placebo on cycling time trial performance.[17]

Quercetin also has non-selective anti-inflammatory actions that rely on a wide range of mechanisms of action.[18] For instance, quercetin may inhibit nuclear factor kappa-light-chain-enhancer of activated B cells (NF-KB) activity, inducible nitric oxide synthesis expression and lipoxygenase activity.[19] Many studies report that quercetin has potent anti-oxidative properties.[20,21] Aerobic exercise elevates free radical generation in muscle and free radicals increase fatigue and muscle damage.[22]

Badminton is both an aerobic and anaerobic sport with emphasis on the aerobic aspect so this sport generates free radicals. However, supplementation with an antioxidant may reduce oxidative stress, muscle damage and fatigue.[22]

In vitro studies suggest that quercetin affects adipogenesis and basal metabolism,[23] however, whether this metabolic effect translates into reductions in body mass or improvement in body composition in humans is unknown.

As per our knowledge, this is first time that the effect of quercetin on exercise performance, muscle damage and body muscle was investigated in male badminton players.

Given the potential of quercetin to decrease body fat percent and mediate anti-oxidative and anti-inflammatory activity the purpose of this study was to measure the influence of eight weeks of quercetin supplementation on exercise performance, muscle damage and body muscle in male badminton players.

METHODS

A randomized double-blind placebo-controlled clinical trial was conducted on 26 male badminton players. The study was approved by the Ethics Committee, Isfahan Sport Medicine Association, Iran. The written informed consent form was obtained from all of them. Anthropometric indices including weight, height and body mass index (BMI) were obtained through physical examination. None of the participants had consumed quercetin, or any other dietary supplements, for a minimum of three months before the study. Athletes kept a record of their physical and dietary intakes and they did not have exhaustive exercise 24 h before the study. Participants filled a food record for two days before intervention.

Subjects were randomly allocated to one of the two groups according to pre-arranged balanced block randomization to receive quercetin (1000 mg) or placebo (1000 mg dextrose). Supplements and placebo had the same appearance and were supplied by Solaray®, USA, Inc. According to the findings of a previous study the supplementation procedure for quercetin was set at two capsules per day for two months—this amount provided a total daily dose of 1000 mg per day. Venous blood samples were taken from all participants between 5 and 6 PM, after intensive endurance exercising, before intervention and after intervention.

At pre- and post-supplementation protocol all participants performed a graded exercise test (GTX) on an electronically braked cycle ergometer (Lode, The Netherlands) to determine Vo_2 peak and time to exhaustion (TTE). Ped al cadence was maintained at 70 rpm, while the power output was initially set at 30 watts and increased by 30 watts every 2 min, until the participants could no longer maintain the required power output.

Plasma samples were obtained for the determination of plasma lactate immediately prior to each GTX and 2 min post exercise. We used a lactometer (Lactate Pro LT-1710, Canada) to analyze lactate and a Body Composition Analyzer (JAWON IOI 353, Korea) to determine body fat percent pre and post supplementation.

Dietary analyses were performed using the Nutritionist IV software. We used SPSS Version 13 for statistical analyses. Data are presented as mean ± standard deviation. Significant differences among and between the groups were determined

by independent *t*-test and paired sample *t*-test. An alpha of $P < 0.05$ was considered statistically significant.

RESULTS

General mean ± SD for all study samples for age (years), weight (kg) and Body Mass Index (BMI) is shown in Table 1. As shown in Table 1 there was no significant difference between the two groups in age, weight and BMI ($P > 0/05$). Table 2 shows the mean ± SD values of time to exhaustion (TTE), lactate concentration, VO_2 max and body fat percent pre and post supplementation. Dietary intake before trial initiation was not similar ($P<0.05$) for energy and macronutrients between the two groups [Table 1].

Lactate concentration, body fat percent and VO_2 did not show any significant difference ($P > 0/05$) after eight weeks of supplementation with placebo and quercetin between the two groups and within one group. There was a significant increase in TTE after intervention in the quercetin group ($P < 0/05$) but significant change was not observed in the placebo group ($P > 0/05$).

Table 1: General characteristics and dietary intakes of study participants separately by case and control groups before intervention[1]

Variables	Case (Quercetin) (*n*=14)	Control (Placebo) (*n*=12)	*P*
Age (years)	17.5±2	17±1.5	0.34
Weight (Kg)	54.5±3.5	52.5±3.2	0.21
BMI (kg/m^2)			
Energy (kcal)	2,355±470	2,225±515	0.01
Protein (g)	120±35	112±23	0.01
Carbohydrates (g)	344±82	331±77	0.01
Fat (g)	61±34	54±26	0.01

[1]Data are means±standard deviation, BMI=Body mass index

DISCUSSION

The finding of our study suggests that eight-week supplementation with quercetin may improve the endurance exercise performance as measured by TTE. This result has been showen in several studies.

Dumke *et al.,* used a randomized crossover trial and showed that two weeks of supplementation with 1000 mg/day quercetin on 26 untrained men resulted in a significant increase in exercise performance.[24]

In the Davis study, treadmill run time to exhaustion increased by 37% in sedentary mice that fed with quercetin (12.5 and 25 mgkg^{-1}) for 7 days.[25]

The one mechanism for enhanced exercise performance that is followed by quercetin is quercetin' potential to induce mitochondrial biogenesis and quercetin may increase VO_2 max and endurance exercise performance.[26] Our study showed no significant difference in VO_2 max in the quercetin group after intervention.

TEE and VO_2 max are considered to be predictors of endurance exercise performance but subjects with already elevated mithochondrial density would be less likely to obtain benefit from quercetin, especially for VO_2 max.[27]

In our study supplementation with quercetin did not cause reduction in BFP. Fat may be oxidized as a preferential fuel source if mithochondrial biogenesis is stimulated by quercetin ingestion so BFP may decrease.[24] However, studies in animals and humans have exhibited little success.[28] Studies indicate that quercetin has beneficial effects on adipocytes *in vitro* and causes apoptosis of adipocytes through the adenosine monophosphate-activated protein kinase pathway (AMPK).[29]

For example Stewart *et al.*, found that quercetin supplementation for eight weeks in mice caused no difference in body mass or body composition between the quercetin group versus placebo.[30]

Similar to our findings Egert *et al.*, showed that two-week supplementation with low doses

Table 2: Comparison of exercise performance indices, pre and post supplementation[1]

Variables	Case (Quercetin) (*n*=14)			Control (Placebo) (*n*=12)		
	Pre	Post	*P* values	Pre	Post	*P* values
VO_{2max} (L.min^{-1})	3.15±0.32	2.98±0.58	0.9	3.08±0.55	3.16±0.51	0.6
TTE (min)	13.45±1.29	14.84±1.83*	0.48	13.02±1.11	13.65±1.14	0.21
Lactate (mg/dl)	13.5±3.2	12.9±3.4	0.07	12.8±4.1	11.6±5.5	0.06
Body fat (%)	16.7±5.4	16.8±5.2	2.1	18.1±4.5	18.2±4.4	0.35

[1]Data are means±standard deviation

of quercetin did not alter BFP in healthy human subjects.[31-33]

CONCLUSIONS

The current study shows that intake of quercetin may improve endurance exercise performance but may not reduce the body fat percent. Thus, more studies with longer periods of supplementation and larger doses that may increase quercetin bioactive effects are necessary.

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