Quercetin Supplementation Does Not Attenuate Exercise Performance and Body Composition in Young Female Swimmers

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ABSTRACT

Background: Quercetin is a health-enhancing antioxidant bioflavonoid (1-3). This flavonoid occurs in variety of natural fruits and vegetables such as apple, cranberry, onion, broccoli, and teas. Many studies have shown that quercetin has possible positive effects on exercise performance. The aim of this study is the evaluation of effects of quercetin supplementation on VO2max and exercise performance in female athletes.

Methods: This study was done on 26 young female swimmers. Participants were assigned in to groups and supplemented orally for 8 weeks with either Quercetin (Solaray®, USA, Inc) or placebo (dextrose). Before and after intervention, athletes performed a continuous graded exercise test (GXT) on an electronically braked cycle ergometer (Lode, The Netherlands) to determine VO2max and time to exhaustion (TTE).

Results: Participants in the quercetin group consumed higher energy and protein and lower carbohydrates and fats. There was no significant differences in VO2max, TTE, lactate, and body fat between pre- and post-supplementation neither in the placebo group nor in the quercetin group.

Conclusions: It is concluded that quercetin supplementation (1000 g/day) for 8 weeks in female athletes didn’t show any significant association with exercise performance.

Keywords: Performance, quercetin, swimmers

INTRODUCTION

Dietary supplements are becoming popular among athletes and being used for different reasons. Although supplements are necessary to acquire sufficient amount of essential nutrients such as vitamins and minerals for some athletes especially those using weight loss diet for weight-control sports, Sport supplements are being used for performance enhancement by many athletes.[1] In recent years, a large number of these supplements have been increasingly developed and are being used by athletes. Some of these supplements are classified as drug but most of them are nutritional supplements such as amino acids, protein, vitamins, minerals, and herbas. It has been hypothesized that Quercetin as
a phytochemicals which currently exists as a sport
supplement may improve physical performance,
enhance fitness, and increase energy.[2]
Dietary flavonols like quercetin have healthful
properties such as antioxidant, free radical
scavenging, anti-inflammatory, anti-carcinogenic
and cardio-protective,[3] reduce the risk of chronic
diseases and cancer,[4] and decrease the vulnerability
to viral infection.[5,6] Biosynthesis of quercetin
motivates by sunlight, so it collects in the external
and above ground tissues such as leaves and skin.
Flavonoids are found in most of the vegetables
and fruits but the main food sources for quercetin
are apples, berries, onions, tea, peppers, red grapes,
and green vegetables.[7] As a result of quercetin's
benefits, it is added to beverages and foods as
a nutritional supplement.[8] During exercise,
inflammation, oxidative stress, muscle microtrauma
and other immune changes occur in human body,[9]
and quercetin may have positive effect on these
exercise-induced events and could decrease oxidative
damage in muscles. Quercetin could be absorbed
sufficiently by human subjects[10] and may particularly
be accumulated in the liver, heart, thymus, lungs,
kidney, testes, and muscle.[5] Studies on human and
animal indicated that quercetin supplementation
does not have negative effect or adverse symptoms
and support the safety of quercetin supplement.[3,11,12]
Recent investigation in mice indicated that
quercetin positively affected endurance performance,
enhanced mitochondrial biogenesis mRNA and
DNA in skeletal muscle and brain.[13] The result of
another study demonstrate that quercetin could affect
aerobic capacity, skeletal muscle, and endurance
performance[14] and may have ergogenic effect in
humans. Another study indicated that however
in vitro investigation quercetin had antioxidant
action, quercetin supplementation didn't protect
against exercise-induced inflammation and oxidative stress.[15] Limited data available on the
ergogenic effect of quercetin supplementation in
humans, these findings are unclear. [8] Finding from
a study on adult male subjects demonstrated a
small but non-significant raise in some indicators of
mitochondrial biogenesis.[16] It has also been assumed
that antioxidant properties of quercetin may progress
physical performance. As a possible mechanism it
has been believed that antioxidant supplementation
minimize damage to proteins and membranes
of skeletal muscles during exercise, thus limit the
harmful effects of raised reactive oxygen generated.[17]
However, it is uncertain if antioxidants affect exercise
performance.[18] Several studies investigated the effect
of quercetin supplementation on VO_{2\text{max}} on untrained
participants. Although some studies showed small
but significant raise in VO_{2\text{max}} and cycling time before
tiredness,[16,19] others found no significant effect.[8,20]
However, few data are available in this regard and these
data are controversial. Therefore, we examined the
effect of 8 weeks quercetin supplementation (1000 mg
per day) in a case control study on VO_{2\text{max}} and exercise
performance in Iranian young female swimmers.

**METHODS**

**Participants**

This case-control study was conducted in
Isfahan, Iran in 2011. 26 young female swimmers
with convenience non-random sampling procedure
volunteered for this investigation. Participants were
asked to abstain from exercise 24 h before trial initiation
and to maintain their current physical activity and
dietary patterns. Participants were randomly assigned
to one of two groups: (a) Quercetin (1000 mg/day)
n = 14, (b) placebo (1000 mg dextrose per day) n = 12.
Cases and controls were matched for age and weight.

**Research design**

Participants were supplemented orally for
8 weeks with either Quercetin (Solaray®, USA, Inc)
or placebo (dextrose). The study was approved by
the Ethics Committee (Esfahan Sport Medicine
Association, Iran). Supplements were provided in
capsules of 500 mg and were administered each
day as two divided single doses, with at least 6 h in
between ingestions. Thus, daily doses consisted of
1000 mg/day during the study.

Venous blood samples were obtained from all
participants between 5:00 and 6:00 p.m., after
intensive endurance exercising, at the baseline and
after intervention. All measurements were done
before the start of the supplementation (Pre) and
after the intervention (Post).

Prior to and following the supplementation
protocol, participants performed a continuous
graded exercise test (GXT) on an electronically
braked cycle ergometer (Lode, The Netherlands) to
determine VO_{2\text{max}} and time to exhaustion (TTE).
For each GXT, the primary power output was set
at 30 watts and elevated 30 watts every 2 minutes until
the participant couldn't maintain the required power output at a pedaling rate of 70 rpm due to fatigue.

Lactate was analyzed using a Lactometer (Lactate ProLT-1710, Canada). Body fat percentage was measured by Bio Impedance Analyzor (BIA) (JAWON IOI 353, Korea). Dietary analyses were performed using Nutritionist IV software.

Statistical methods
Statistical analyses were conducted using the Statistical Program for the Social Sciences (SPSS version 13, Inc., Chicago, IL) computer software package. Data are presented as means ± standard deviation. The independent t test was used to analyze the differences in performance between the trials. Paired t test was used to analyze before and after test data for each group differences. An alpha level of P < 0.05 was considered statistically significant.

RESULTS
A total of 26 young female swimmers participated in this study. General characteristics and dietary intakes of study participants separately by case and control groups before intervention have been showed in Table 1. There was no difference in age and weight of two groups; however, participants in the quercetin group consumed higher energy and protein and less amount of carbohydrates and fats. Table 2 compared exercise performance indices in quercetin and placebo groups between pre- and post-supplementation. There is no significant differences in VO2max, TTE, lactate, and body fat between pre- and post-supplementation neither in the placebo group nor in the quercetin group.

DISCUSSION
The main purpose of current study was to realize the effect of quercetin supplementation on exercise performance indexes including VO2max, TTE, lactate, and body fat in young female swimmers. The results of this study do not support the theory that quercetin could increase exercise performance in trained individuals. Quercetin, as a natural polyphenolic flavonol, frequently is found in the diet. Dietary records showed that Quercetin was consumed between 5 and 500 mg based on frequency of vegetable and fruit consumption. Several experimental studies indicated the health beneficial effects of flavonoids. Quercetin, because of its biological properties, has been known for its performance benefits, ergogenic and health effects in animal models. It has also been indicated that quercetin supplementation could affect aerobic capacity, exercise performance and skeletal muscle practically the same as exercise training. The combination of anti-inflammatory and antioxidant activity was approved for these beneficial effects however recent studies recommended that mitochondrial biogenesis may be also responsible.

Our finding from the present study failed to find any significant effect of 1000 mg quercetin supplementation for 8 weeks on exercise performance indices including VO2max, TTE, lactate, and body fat in young female swimmers. Albeit, little is known regarding the effect of quercetin in humans, finding variables

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

<table>
<thead>
<tr>
<th>Variables</th>
<th>Case (Quercetin)</th>
<th>Control (Placebo)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n=14)</td>
<td>(n=12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>16.1±2.5</td>
<td>15.7±1.5</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>47.8±8.8</td>
<td>45.9±8.3</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m^2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1925±420</td>
<td>1,887±525</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>125±27</td>
<td>107±18</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>251±82</td>
<td>254±152</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>47±26</td>
<td>49±34</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

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

Table 2: Comparison of exercise performance indices, pre- and post-supplementation

<table>
<thead>
<tr>
<th>variables</th>
<th>Case (Quercetin)</th>
<th>Control (Placebo)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Post</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO2max (L/min)</td>
<td>2.02±0.34</td>
<td>1.98±0.73</td>
<td>0.35</td>
</tr>
<tr>
<td>TTE (sec)</td>
<td>433.6±107.4</td>
<td>426.4±98.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Lactate (mg/dl)</td>
<td>11.5±4.2</td>
<td>10.9±6.4</td>
<td>0.19</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>18.7±6.6</td>
<td>18.5±5.4</td>
<td>0.54</td>
</tr>
<tr>
<td>Pre</td>
<td>Post</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO2max (L/min)</td>
<td>2.05±0.47</td>
<td>2.01±0.59</td>
<td>0.28</td>
</tr>
<tr>
<td>TTE (sec)</td>
<td>417.5±112.8</td>
<td>395.5±103.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Lactate (mg/dl)</td>
<td>8.8±5.1</td>
<td>9.2±6.6</td>
<td>0.15</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>17.4±7.5</td>
<td>17.0±7.1</td>
<td>0.26</td>
</tr>
</tbody>
</table>

^1 Data are means±standard deviation, TTE=Time to exhaustion
no significant effect of quercetin supplementation in our study is in line with the most of previous studies. Previous studies on trained individuals couldn't find any improvement on physical performance.\textsuperscript{[17,21,22]} MacRae in a study couldn't find any improvement in cyclist performance after 600 mg/day quercetin supplementation for 6 weeks.\textsuperscript{[17]} In another study, 1 g/day supplementation for 3 weeks in marathon runners had not any effect on race time.\textsuperscript{[22]} Likewise, acute supplementation (2 g/day) on cyclists couldn't improve athlete's performance.\textsuperscript{[23]} Moreover, having no change in muscle oxidative capacity and VO\textsubscript{2max} had been reported in preceding studies.\textsuperscript{[8,16,20,24]}

Furthermore, in another study on moderately trained military persons, quercetin supplementation (1 g/day) for 6 weeks didn't advanced exercise performance or VO\textsubscript{2max}.\textsuperscript{[25]} However, other studies using 1 g/day quercetin supplementation for 1-2 weeks found a small significant improvement in physical performance in untrained or moderately trained individuals.\textsuperscript{[16,19]} Similarly, quercetin supplementation (1 g/day) for 5-9 days slightly enhanced VO\textsubscript{2max}.\textsuperscript{[19]} Several mechanisms may explain the possible effects of quercetin on improving VO\textsubscript{2max} and exercise performance. Based on a possible mechanism exercise performance would be supposedly improved by quercetin through reducing damage to skeletal muscle and contractile proteins, so quercetin could reduce muscle damage, tenderness, fatiguing, and negative effects of increased reactive oxygen production following exercise;\textsuperscript{[17]} however, the evidences are contradictive.\textsuperscript{[26,27]} Another theory explained that quercetin practically the same as caffeine, by reducing the sensitivity of pain, may influence exercise performance.\textsuperscript{[28]} Additionally, positive effects of quercetin on skeletal muscles may partially elucidated via increases in mitochondrial protein, stimulating mitochondrial biogenesis and increasing oxidative enzyme activity. Failure to find a significant improvement in exercise performance indices in trained individuals in the current study could be reasoned that supplement of quercetin may improve endurance performance in untrained people.

**CONCLUSION**

Additionally, positive effects of quercetin on skeletal muscles may partially elucidated via increases in mitochondrial protein, stimulating mitochondrial biogenesis and increasing oxidative enzyme activity. Failure to find a significant improvement in exercise performance indices in trained individuals in the current study could be reasoned that supplement of quercetin may improve endurance performance in untrained people.

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