Progress in Nutrition 2021; Vol. 23, Supplement 2: e2021283 DOI 10.23751/pn.v23iS2.12032

Original article

Investigation of the Effects of Quercetin and Resveratrol Consumption on Lactic Acid Levels and Running Performance of Elite Adolescent Athletics Distance Runners

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Abstract. *Study Objectives*: The aim of this study is to examine the effects of quercetin and resveratrol consumption on lactic acid levels and running performance of elite adolescent athletics distance runners. *Methods:* Four female and four male adolescent athletes who are interested in elite level athletics participated in the study and the average age of elite adolescent athletes was 16.13 ± 2.03 years, the average body weight of the athletes was 52.02 ± 6.91 kg and their average height was 168.3 ± 10.61 cm. In order to measure athletic performances; in a randomized, single-blind, crossover method used, and the study lasted for 3 weeks, one week apart. They were taken to the camp on 2 determined days of each week and placebo supplements were given in the first week, 500 mg quercetin in the second week and 100 mg resveratrol in the third week. They were asked to run 1500 m without supplement on the first day of the camp. Lactic acid measurements were taken before and after the run and running times were recorded. On the second day, the same measurements were repeated with supplements. Paired - T Test was used for the analysis of the obtained data, the level of significance was accepted as 0.05. *Results:* According to quercetin and resveratrol interventions, only quercetin supplementation made a statistically significant difference in female elite adolescent athletes. However, although not statistically significant, there were differences in running time, which are very important for Track and Field sports. *Conclusion:* it can be said that this study explains quercetin supplementation decreases lactic acid levels and can provide a better performance by delaying fatigue, especially for female and relatively male athletes.

Key Words: Quercetin, Resveratrol, Sports Performance, Athletics, Nutritional Supplements

Introduction

Nutrition is the condition of taking sufficient amounts of nutrients that are necessary for the growth and development of people and a healthy life (1). In addition to adequate and balanced nutrition, regular physical activity and sports enable the individual to lead a better life (2). In addition to nutrition, athletes benefit from nutritional supplements that help reduce post-workout fatigue to perform better. Quercetin and resveratrol, which are phenolic compounds, are also included in the nutritional supplement group (3).

Quercetin is a polyphenol in the flavonoid group and classified as a flavonoid with a 3-hydroxyflavone backbone (4). Food sources of quercetin commonly consumed in human nutrition; It is found in nuts such as onions, apples, strawberries, blueberries, peppers, hazelnuts, tea, capers, dark green vegetables, tomatoes, grape and grape seeds, wine, many seeds, flowers, leaves and various fruits, vegetables and beverages (4–6).

In studies on the effectiveness of quercetin in humans, it is known that it can be absorbed from foods and supplements and its half-life varies between 3.5 and 28 hours (6,7). According to the pharmacokinetic data on quercetin doses, it is seen that 250-500 mg of quercetin can be seen in plasma within 15-30 minutes after taking the chewable tablet form, reaching peak levels in approximately 120-180 minutes (8). Plasma concentrations of quercetin as glycosides appear to occur approximately 30 min after the peak time is consumed (9).

Due to the health-promoting properties of quercetin, it is marketed as a nutritional supplement, food and beverage additive (10). As sports supplements, it is available in various forms such as beverages, soft chewable tablets, powder, concentrate, food bars (11). Another feature that enhances physical and mental performance is a caffeine-like psychostimulant effect. It is known to cause an increase in dopamine activity by partially blocking adenosine receptors in the brain through its psychostimulant effect and thus delaying fatigue during endurance exercise (8). With its antioxidant effect, it has been observed that there is an improvement in exercise performance by reducing the damage in cell membranes, skeletal muscles, contractile and structural proteins. Therefore, it reduces the acute negative and tiring effects that occur during exercise (12).

Resveratrol is a polyphenolic compound with cis and trans forms and is included in the subgroups of stilbenes (13–20). Resveratrol, a natural compound, is found in many plants, vegetables, and fruits, including grape, red wine, mulberry, raspberry, peanut, blueberry, strawberry, pine, cranberry, tomato peel, seeds, and rind. Red and black grapes, grape juice, red wine are rich in foods (13,16,19,21–26).

In pharmacological studies of resveratrol, it has been shown that therapeutic doses (150 mg / kg / day) given to humans are well absorbed and tolerated (27). In a study conducted in humans, it has been observed that resveratrol can be consumed up to 5 g in a single dose, it is well tolerated without serious clinical, hematological or biochemical events and has no harmful effects (13,20). When consumed in high doses, common side effects such as headache, nausea, and diarrhea are seen in humans (17).

The time to peak of resveratrol as glycosides in humans appears to occur approximately 30 min after consumption (9). Resveratrol, which is rapidly absorbed and delivered to the tissues, is primarily excreted in the urine. In studies of rats receiving resveratrol orally, the half-life is known to range from 12 to 15 minutes (28). In humans, the half-life appears to be 9 hours when ingested orally (14,17).

In recent studies, it is said that resveratrol has positive effects on endurance and sportive performance. Thanks to these effects, it has been stated that resveratrol can be used as an ergogenic supplement (27,29). Resveratrol has been observed to have an exercise effect by mimicking the SIRT1 and AMPK activation pathway associated with exercise (30–32). In different studies, it was observed that when resveratrol was consumed, there was an increase in exercise performance and a decrease in parameters such as lactate, creatine kinase, and ammonia associated with exercise-related fatigue, an increase in O2 level, an increase in mRNA levels in skeletal muscle associated with mitochondrial functions, and because of these findings. It has been said that resveratrol can be a nutritional supplement that enhances exercise performance (18,33).

Both anaerobic and aerobic energy systems are used in running, which is a sub-branch of the athletics branch. The anaerobic energy system is predominantly used in branches that do not continue for very long such as short distance running and middle-distance running. As a result, lactic acid accumulates in the muscles. Fatigue occurs in the athlete with the accumulation of lactic acid. The use of aerobic energy systems is predominant in long-distance sports such as marathons and half-marathon running. Therefore, durability is at the forefront in long-lasting performances (34). As the accumulation of lactic acid in the blood and muscle increases, the level of fatigue increases at the same rate. Due to the absence of muscle contraction, pain and burning sensation occur in the athlete's legs and the athlete has to slow down or stop (35,36).

Based on all this information, this study hypothesizes that quercetin and resveratrol supplements will reduce their effects on athletic fatigue and positively affect sports performance. However, the most important curiosity is how the performance will be positively affected and what this effect will be on the unit. Therefore, the aim of this study was to examine the effects of quercetin and resveratrol consumption on lactic acid levels and the running performance of elite adolescent athletics distance runners.

Materials and Methods

Participants

As participants, 10 elite athletes, 5 women and 5 men, participated in the research. The research started with 10 elite athletes, but the data of 1 female and 1 male athlete were not included in the analysis results due to reasons such as family and health absenteeism. The results of the study were conducted with 8 athletes and the average age of the elite adolescent athletes participating in the study was 16.13 ± 2.03 years. The average body weight of these adolescent athletes participating in the study, who have been in the athletics running branch for 7-10 years, is 52.02 ± 6.91 kg, and their average height is 168.3 ± 10.61 cm.

Nutritional Supplements

In the study, 15 mg Splenda sweetener tablet, 500 mg quercetin tablet, and 100 mg resveratrol tablet were used as nutritional supplements. The sweetener was given placebo.

Procedure

To measure athletic performances; in a randomized, single-blind, crossover method, the abovementioned nutritional supplements were presented to the athletes at separate times in consecutive weeks so that they do not affect each other. When the literature was examined, it was seen that resveratrol was excreted after 9 hours maximum and quercetin after maximum of 28 hours (6,7,14,17). Based on this, measurements were taken at the end of 3 repeated weeks in order not to interfere with the daily lives of the athletes and their school education. Placebo was given in the first week, quercetin in the second week, and resveratrol in the third week. The athletes were taken to the camp 24 hours before the measurement started every weekend, and they were asked to fill in the "24-Hour Food Consumption Registration Form" in order to find out how many calories they consumed in the last day.

During the camp, meals planned by the researcher were offered to the athletes. While these meals are planned, it has been observed that they do not contain quercetin and resveratrol. In the first week, after the lactic acid measurement after breakfast on the first day, they were warmed up for 30 minutes before the run as standard. After warming up on the first day, the athletes were allowed to run 1500 m in the regular athletic field without any nutritional supplements, and their running time was recorded. The next day, they were allowed to run 1500 m with the same program but taking the time to peak in the blood of supplements (quercetin and resveratrol) 30 minutes before this run (9), placebo was presented to the athletes. Lactic acid (LA) and running time (RT) were measured before and after running 1500 m. With the same method, after the second week without nutritional supplements, quercetin (Q) was offered instead of placebo (P), and resveratrol (R) in the third week, and the measurements were taken.

Statistical Analysis

The difference between the lactic acid values taken before the run and the lactic acid values taken after the run, the accumulated lactic acid was named as "ALA". The numbers 1, 2, and 3 are expressed to indicate the weeks. In addition, running times measured after each run were also recorded to determine performance.

In the analysis of normality in the context of accumulated lactic acid and running times, it was found that the data showed a normal distribution according to the Kolmogorov - Smirnov test. Accordingly, Paired - T test analysis was applied.

The "ALA" and "RT" calculated for the race performed every week without nutritional supplements, and the "ALA" and "RT" values calculated for the race performed by providing nutritional supplements for the same week were subjected to a paired T test. The significance value was accepted as 0.05.

Results

When Table 1 is examined; It was determined that the mean ALA2 was 11.79±4.69 mmol/L and ALA2Q was 8.60±2.88 mmol/L, and the decrease in the accumulated lactic acid levels was significant ($p < 0.05$). It was observed that the quercetin supplements taken by the athletes in the second week from the supplements they took had a significant effect on the amount of lactic acid accumulated, and there was a decrease in the accumulated lactic acid levels after taking the supplement quercetin. As a result of the analysis, it was found that quercetin supplement reduced the level of lactic acid accumulated ($p < 0.05$). The mean RT1 was 5.15±0.93 minutes and the mean RT1P was 5.21±0.97 minutes, and it was observed that there was a delay or deceleration between running times. However, it was seen that this delay was not at a significant level ($p > 0.05$). The mean RT2 applied in the second week was 5.13±0.86 min, the mean RT2Q was 5.11±1.04 min, and when the running times were compared, it was observed that the athletes accelerated with quercetin supplementation. However, there is no significant difference for this acceleration ($p > 0.05$). It was found that the mean RT3 was 5.14±0.93 minutes and the average RT3P was 5.06±0.95 minutes, and a serious acceleration was found when the running times were compared. However, there was no significant difference for this acceleration ($p > 0.05$). As a result of the analysis, it was seen that resveratrol provides acceleration for athletes in athletics, but it was not statistically significant.

To examine the reason for the values in Table 1 in more detail, it was felt the need to examine the athletes by separating them according to their gender. The analysis made accordingly is presented in Table 2 and Table 3 below.

Looking at Table 2; the mean RT1 of the male athletes was 4.50±0.40 minutes and the average RT1P was 4.51±0.40 minutes, and it was observed that there was a one second delay between running times. However, it was seen that this delay was not at a significant level ($p > 0.05$). It was seen that the mean RT2 was 4.48±0.40 minutes, the RT2Q average was 4.37±0.23 minutes, and when the running times were compared, it was seen that there was a very serious acceleration for the athletics branch of up to 11 seconds. However, no significant difference was observed for this acceleration ($p > 0.05$). It was found that the mean RT3 was 4.50±0.40 minutes and the mean RT3R was 4.34±0.20 minutes, and when the running times were compared, it was found that there was an acceleration of 16

Table 1. The Accumulated Lactic Acid Measurement and Running Time Measurement Analysis Taken from the Athletes Participating in the Study

Measurements		n	Min	Max	$\bar{x}$	SD	t	P
LA Measurements (mmol/L)	ALA1	8	4.6	21.2	10.94	4.91	0.822	0.438
	ALA1P	8	2.1	15.2	8.79	4.03		
	ALA2	8	5.9	21.0	11.79	4.69	2.596	0.036*
	ALA2Q	8	5.0	12.0	8.60	2.88		
	ALA3	8	-6.1	13.5	8.00	6.43	-0.479	0.646
	ALA3R	8	5.0	14.3	9.08	3.47		
RT Measurements (min)	RT1	8	4.06	7.05	5.15	0.93	-0.868	0.414
	RT1P	8	4.06	7.00	5.21	0.97		
	RT2	8	4.04	6.55	5.13	0.86	0.091	0.930
	RT2Q	8	4.05	7.32	5.11	1.04		
	RT3	8	4.08	7.07	5.14	0.93	1.292	0.237
	RT3R	8	4.08	7.04	5.06	0.95		

*p<0,05

Table 2. Running Time and Accumulated Lactic Acid Measurements of Male Athletes Measurements

Measurements		n	Min	Max	$\bar{x}$	SD	t	p
RT Measurements (min)	RT1	4	4.06	5.00	4.50	0.40	-0.480	0.664
	RT1P	4	4.06	5.02	4.51	0.40		
	RT2	4	4.04	5.00	4.48	0.40	0.940	0.416
	RT2Q	4	4.05	4.55	4.37	0.23		
	RT3	4	4.08	5.04	4.50	0.40	1.206	0.314
	RT3R	4	4.08	4.51	4.34	0.20		
LA Measurements (mmol/L)	ALA1	4	7.9	12.9	10.45	2.04	-0.413	0.707
	ALA1P	4	6.2	15.2	11.03	3.93		
	ALA2	4	5.9	13.9	10.28	3.37	0.680	0.545
	ALA2Q	4	7.0	12.0	9.70	2.35		
	ALA3	4	5.6	13.5	10.20	3.44	-0.661	0.556
	ALA3R	4	5.1	14.3	10.40	4.03		

Table 3. Running Time and Accumulated Lactic Acid Measurements of Women Athletes

Measurements		n	Min	Max	$\bar{x}$	SD	t	p
RT Measurements (min)	RT1	4	5.24	7.05	5.80	0.84	-0.778	0.493
	RT1P	4	5.20	7.00	5.92	0.84		
	RT2	4	5.20	6.55	5.77	0.66	-0.315	0.774
	RT2Q	4	5.22	7.32	5.86	0.99		
	RT3	4	5.25	7.07	5.79	0.86	0.511	0.645
	RT3R	4	5.21	7.04	5.77	0.85		
LA Measurements (mmol/L)	ALA1	4	4.6	21.2	11.43	7.17	0.974	0.402
	ALA1P	4	2.1	8.6	6.55	3.01		
	ALA2	4	8.0	21.0	13.30	5.82	4.357	0.022*
	ALA2Q	4	5.0	12.0	7.50	3.26		
	ALA3	4	-6.1	11.9	5.80	8.46	-0.408	0.711
	ALA3R	4	5.0	10.6	7.75	2.68		

*p<0,05

seconds. However, there was no significant difference for this acceleration (p> 0.05).

It was observed that the mean ALA1 was 10.45±2.04 mmol/L and the average ALA1P was found to be 11.03±3.93 mmol/L, and there was an increase in the accumulated lactic acid levels, but not significantly (p> 0.05). It was determined that the mean ALA2 was 10.28±3.37 mmol/L and ALA2Q was 9.70±2.35 mmol/L, and the decrease in the accumulated lactic acid levels was not statistically significant (p> 0.05). The average ALA3 was 10.20±3.44 mmol/L and the average ALA3R was 10.40±4.03 mmol/L, and the accumulated lactic acid levels increased by 0.20 mmol/L, but it was found that there was no significant effect (p> 0.05).

When Table 3 is examined; the mean RT1 was calculated as 5.80±0.84 min and the RT1P average was 5.92±0.84 min, and it was observed that there was an 8-second delay or deceleration between running times. However, this delay was not found to be statistically significant (p> 0.05). It was observed that the mean RT2 was 5.77±0.66 minutes, the average RT2Q was 5.86±0.99 minutes, and when the running times were compared, it was observed that a deceleration of about 9 seconds occurred. However, no significant difference was observed for this deceleration ($p > 0.05$). It was found that the mean RT3 was 5.79±0.86 min and the mean RT3R was 5.77±0.85 min. When the running times were compared, it was found that there was an acceleration of 2 seconds. However, it was determined that there was no statistically significant difference in this acceleration ($p > 0.05$).

The mean ALA1 was found to be 11.43±7.17 mmol/L and the average ALA1P was found to be 6.55±3.01 mmol/L, and a decrease in the accumulated lactic acid levels was observed, but it was not statistically significant ($p > 0.05$). It was determined that the mean ALA2 was 13.30±5.82 mmol/L and ALA2Q was 7.50±3.26 mmol/L, and the decrease in the accumulated lactic acid levels was statistically significant ($p < 0.05$). The average ALA3 was 5.80±8.46 mmol/L and the average ALA3R was found to be 7.75±2.68 mmol/L, an increase of 2.05 mmol/L was observed in lactic acid levels, and it was found that this was not at a statistically significant level ($p > 0.05$).

As a result of the measurements made by giving placebo, quercetin, and resveratrol, respectively, the nutritional supplements taken by adolescent female athletes for 3 weeks, it was seen that quercetin supplementation of female athletes had a significant effect only on the results of lactic acid measurement, but there was no statistically significant effect on the running time. It has been observed that resveratrol supplementation does not have a significant effect on female athletes in terms of both the accumulated lactic acid level and running time.

Discussion and Conclusion

When the studies in the literature are examined, it is possible to say that quercetin and resveratrol supplementation made a noticeable difference in lactic acid, running performances, and endurance performances on mice and rats, but it was not effective on sports performance and lactate studies on humans, especially on male individuals.

Göktepe and Günay (2014) and Davis et al. (2009) examined the changes in lactic acid levels and sportive performance of mice by exercising in mice studies in which they supplemented quercetin. As a result of these studies, it was found that there was an increase in maximum endurance capacities and sports performance, quercetin increased athletic performance without exercise training by reducing lactic acid levels, and increased running performance (37,38).

Quercetin supplement studies on humans are said to increase sporting performance (39). In one study, 26 male athletes playing badminton were given 1000 mg of quercetin and placebo supplements for 8 weeks, and their lactate concentrations, maxVO2 levels, and body fat percentage were examined. When the results of lactate concentrations were examined, it was found that there was no significant difference, it could not reduce the percentage of body fat and could increase endurance exercise performance (7). On the other hand, Dumke et al. (2009), 40 male cyclists were supplemented with 1000 mg/day quercetin and placebo for 3 weeks, and then muscle biopsies were examined. No difference was found between those taking quercetin and those taking a placebo in muscle activity, muscle mRNA expression, or other measurements (39).

MacRae and Mefferd (2006), on the other hand, supplemented quercetin consisting of antioxidant vitamins, caffeine, taurine, B1, B2, B6, B12 and green tea extract on 12 elite male cyclists for 3 weeks, given a total of 300 mg of quercetin. As a result of the study, it was found that elite cyclists who took the mixture without quercetin and the mixture containing quercetin traveled 1.7% faster than those who did not take quercetin in a 30-kilometer trial period (12).

In the light of all this information, it is concluded that quercetin supplementation has a significant effect on the branches where lactic acid is at the forefront, does not have any effect on muscle biopsy and cross section, but can be acted quickly with a decrease in lactic acid level. Again, in the literature studies, the chronic effect of quercetin supplements was examined rather than the acute effect, and it was observed that the supplementation period was not short. In this study, the acute effect of quercetin was examined, and it was found that a significant difference was obtained in the result, although the amount of daily dose given was less than the literature studies.

When the results of quercetin supplement were examined by gender, it was observed that there was no statistically significant effect on lactate levels and running times in men, and a statistically significant effect on lactate levels in women, but no statistically significant effect on running times. Table 3 explains that the difference in lactic acid caused by quercetin supplements is caused by women. However, the same situation is not observed with resveratrol supplements. With resveratrol supplementation, there is no significant difference between running time and lactic acid levels in both women and men ($p > 0.05$). Although it varies according to gender, there is a decrease in the performance of the athlete (35,36).

Since the fat ratio in women is higher than in men, the level of glycogen in the muscles is low. Glycogen in muscles provides energy for lactic acid. The lactic acid level is also low due to low muscle glycogen. The lactic acid levels in the blood of women appear to be 15-30% lower than men as a result of maximal exercises (35,40–42). In this case, female athletes are at a disadvantage compared to men in middle distance running or training that is equivalent in terms of intensity and duration. For athlete women, this event is decisive for them to improve their lactic acid system and to create a training program that is more suitable for them. In addition, in terms of other disadvantageous factors, it is stated in the studies in the literature that the menstrual cycle doesn't affect lactic acid concentration and oxidation in athletes (43,44).

The lactic acid values of the week of quercetin supplementation were found to decrease to 7.50±3.26 mmol/L when quercetin was taken while the mean accumulation of lactic acid was 13.30±5.82 mmol/L when running before supplementation ($p < 0.05$). When Table 1 was examined, it was seen that although there was an acceleration in running time as a result of quercetin supplementation, it was not at a statistically significant level. However, this acceleration is too important to ignore for the track and field running branch. Because it is known that athletes have a change in degrees with the differences of seconds or even fractions. For example, in the 2019 World Athletics Championships, the gold medal rank of 1500 m men was 3.29.26, the silver medal rank was 3.31.38 and the bronze medal rank was 3.31.46. In 1500 m female athletes, the gold medal degree was 3.51.95, the silver medal degree was 3.54.22 and the bronze medal degree was 3.54.38 (45). For this study, it is possible to say that the acceleration shown with the decrease in the degrees that are not statistically significant has a very important place in the performance of the athlete.

When the animal and human resveratrol studies in the literature are examined, it is said that resveratrol has a positive effect on exercise performance (27,29). Hart et al. (2013) and Dolinsky et al. (2012), in their studies, Hart et al. 100 mg/kg resveratrol, Dolinsky et al. Supplemented 4 g resveratrol per kg to high-capacity runner rats for 12 weeks, and treadmill endurance and running capacity were examined. Results showed that resveratrol increased the aerobic performance and strength of the upper extremities of these rats, physiologically positive effects were observed in rats with exercise training combined with resveratrol (27,31).

In another study, Kan et al. (2016) divided mice into 3 groups that only supplemented resveratrol, exercise training only, and did both resveratrol and exercise training on mice. Swimming exercise was given to mice with 25 mg/kg resveratrol and blood lactate levels were examined afterward. A significant difference was found in lactate levels of mice receiving exercise training and resveratrol ($p < 0.05$). This study suggested that combining resveratrol supplementation with exercise training for 4 weeks significantly improved muscle strength and endurance performance in aged mice compared to treatment with resveratrol alone or exercise training alone (46).

Kan et al. (2018), in their study, on mice divided into 4 groups, 25 mg/kg of resveratrol was given to a group, and measurements were taken with exercise. Resveratrol supplementation taken with exercise continued for 4 weeks, during which exercise capacities, including grip strength, aerobic and anaerobic performance, were evaluated. Physiological adaptations were evaluated using indexes associated with fatigue applied immediately after the exercise intervention. As a result of lactate and other biochemical measurements taken after 15 minutes of exercise, it was observed that the lactate levels of resveratrol combined with exercise were found to be significantly lower than the sedentary groups (19). On the other hand, Kim et al. (2013) divided them into two groups of 11 mice, the control group and the sedentary group, in their study. These mice were supplemented with 40 mg/kg of resveratrol over 6 weeks. Mice were physically exercised with gradual overload from weights (4-8% of body weight) attached to their tail for 3-minute periods separated by a 1-minute rest period throughout the reinforcement. During the resting periods, 25 ml of blood samples were taken from the tail vein to determine the lactate concentration. According to the results of the analysis, lactate concentrations were found to be stable in trained mice compared to sedentary mice. There was also a reduction in body weight, demonstrating that the exercise program was performed well and increased the aerobic resistance of the mice (47).

As a result of the review of the literature on resveratrol, it is observed that resveratrol generally has a chronic effect rather than an acute effect and that the supplementation times are quite long. In this study, it was determined that the acute effect was observed, and the effect of quercetin came to the fore under these conditions, but resveratrol did not show the same effect. It is also thought that resveratrol does not make a significant difference due to the supplemented dose.

When the studies in the literature are examined, it is possible to say that quercetin and resveratrol supplementation made a noticeable difference in lactic acid, running performances, and endurance performances on mice and rats, but it was not effective on sports performance and lactate studies on humans, especially on male individuals. This study also supports the literature studies by finding that there is no significant difference in running times and lactic acid levels in male athletes. In this study, the reason why quercetin made a significant difference in lactic acid levels in female athletes and not in men is thought to be due to gender. Other reasons are the differences in hormone levels caused by athletes being in adolescence, menstruation is seen in women during adolescence, high estrogen hormone in women, or it is thought to be due to external factors.

As a result, in quercetin and resveratrol interventions, only quercetin supplementation was found to make a statistically significant difference in female elite adolescent athletes. However, although not statistically significant, there are differences in running time which are important for the athletics sports branch. Therefore, in this study, it is thought that quercetin supplementation may perform better by reducing lactic acid levels and delaying fatigue, especially for female and relatively male athletes. When the literature studies are examined, this study is the first study of quercetin and resveratrol supplements on adolescent athletes who are interested in athletics at an elite level.

It is recommended that quercetin supplements be applied to more female athletes and adult women in order to examine the significant difference observed in the lactic acid levels of female athletes.

To ascertain the effects of quercetin and resveratrol supplements on humans, it is necessary to work in many branches such as cycling and swimming, which are sports branches where lactic acid is more determinant.

This study is important for female athletes, since males were generally selected for quercetin and resveratrol supplements studies conducted in the literature, and females were not selected.

It can be said that increasing the consumption of foods containing quercetin and resveratrol will have a positive effect on athletic performance. However, the importance of paying attention should not be underestimated.

In the literature, there is a small number of studies on the sportive performance of resveratrol and quercetin supplements in humans, and more studies are needed in different branches, in different age groups, considering gender discrimination.

Acknowledgements: This work was supported by Scientific Research Fund of the Suleyman Demirel University. Project Number: TYL-2019-7358

Conflict of interest: No potential conflict of interest relevant to this article was reported by the authors.

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