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Effects of acute grape seed extract supplementation on muscle damage after eccentric exercise: A randomized, controlled clinical trial

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ABSTRACT

Background/objective: High intensity eccentric exercise causes muscle damage. Polyphenol supplementation is one nutritional intervention available to limit muscle damage, but there is a lack of published data concerning the use of polyphenol-rich grape seed extract (GSE). This study investigated the effect of acute GSE supplementation on muscle damage markers after eccentric exercise.

Methods: Sixteen healthy male university students (mean age: 20.3 ± 0.4 years, height: 176.1 ± 4.7 cm, weight: 69.9 ± 10.2 kg) were included. Participants were randomly assigned to GSE group ($n = 8$) or placebo group ($n = 8$); 300 mg/day of GSE or placebo was consumed from the time of eccentric exercise to 72 h after exercise. For the eccentric exercise, the elbow flexor muscle was activated using a modified preacher curl machine at 25 repetitions for 2 sets. For the muscle damage markers, maximal muscle strength, muscle soreness, and creatine kinase (CK) level were measured.

Results: There was no difference in maximal muscle strength and muscle soreness between groups in the recovery stage after eccentric exercise ($p > 0.05$); CK level, a marker of cell membrane damage, was significantly decreased 96 h after exercise in the GSE group compared with the placebo group ($p < 0.05$).

Conclusion: Acute GSE supplement can be an effective way to decrease cellular membrane damage after eccentric exercise. These results could be helpful in the application of GSE supplementation as a nutritional intervention to reduce muscle damage after high intensity strength training, especially in the early stage of a new strength training program. However, a larger scale study is necessary to validate these results.

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Introduction

High intensity repetitive eccentric exercise causes muscle damage.¹ This muscle damage decreases maximal muscle strength and increases delayed onset muscle soreness and serum creatine kinase (CK) level.² Polyphenols are a chemical material found in plants with various biological effects, and have antioxidant and anti-inflammatory properties.^{3,4} Grape seed extract (GSE) is one polyphenol supplement that has received attention due to reports of strong antioxidant activity that protects against aging and disease and promotes health.^{5,6}

Two previous studies have reported that GSE supplementation reduces muscle damage and promotes muscle regeneration.^{7,8} However, both of these were animal studies, and human studies on GSE supplementation and muscle damage are lacking. In addition, muscle damage in the abovementioned two studies was not caused by eccentric exercise, but by contusion. Thus, the effect of GSE ingestion on muscle damage due to eccentric exercise is unclear. To the best of our knowledge, there is no previous study investigating this topic. This study aimed to evaluate the effect of acute GSE supplementation after eccentric exercise on a muscle damage index based on maximal muscle strength, muscle soreness, and CK level measured up to 96 h after exercise.

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Table 1
Participant characteristics.

Group	Age (years)	Height (cm)	Weight (kg)
Placebo (n = 8)	20.5 ± 0.5	176.2 ± 6.1	68.9 ± 9.4
Grape seed extract (n = 8)	20.1 ± 0.3	176.0 ± 3.3	71.0 ± 11.4

Values are mean ± standard deviation.

Tested by the independent sample *t*-test; no statistically significant differences between groups.

Methods

Participants

Sixteen healthy male university students participated in this study. The study participants had no regular participation in strength training for the previous 6 months, no musculoskeletal diseases, were non-smokers, and did not take any drugs or dietary supplements. The study was approved by Kookmin University. Participants were randomly assigned to placebo (n = 8) and GSE (n = 8) groups, and the characteristics of the participants in each group are shown in Table 1.

Eccentric exercise

Before starting the eccentric exercise, the participant's non-dominant arm was placed on the pad of a modified preacher curl machine (Kookmin University, Seoul, Korea) and the elbow joint was set at 90 degrees. When the participant pulled the pad with maximal muscle strength based on signaling by the researcher, the researcher lowered the lever attached to the modified preacher curl machine on the opposite side of the participant to produce eccentric muscle contraction by extension (0 degrees). A total of 2 sets consisting of 25 repetitions were performed; rest time between sets was 5 min.⁹

Grape seed extract supplementation

GSE was consumed in capsule form (MegaNatural-BP, Polyphenolics Inc., Madera, CA, USA). The GSE group consumed the capsule (300 mg) with water once per day in the evening up to 72 h after eccentric exercise.^{10,11} The placebo group consumed a capsule (300 mg) that was manufactured with similar shape and color to the GSE capsule, using starch, at the same time points.

Maximal muscle strength

Maximal muscle strength was measured by strain gauge (Jackson Strength Evaluation System Model 32628CTL, Lafayette Instrument Co., Lafayette, IN, USA) attached to a modified preacher curl machine (Kookmin University, Seoul, Korea).

Muscle soreness

The visual analogue scale (VAS) was used to measure muscle

soreness. Participants repeated flexion and extension of the elbow flexor muscle in a standing position and marked the degree of recognized pain on VAS perpendicularly at each measurement.

Creatine kinase

Serum was collected through venous blood samples to measure CK level. To draw the blood sample, a needle was inserted into the antecubital vein of the forearm of each research subject and approximately 5 ml of blood was collected. CK analysis was conducted using a kit (AceChem CK Kit, YD-Diagnostics Corp., Yongin-si, Korea) and automated clinical chemistry analyzers (Miura One, I.S.E. S.r.l, Rome, Italy).

Statistical analysis

Repeated-measure analysis of variance was conducted to examine the interaction effect by time and group in this study. Post-hoc analysis was performed using the Tukey method. Statistical significance was set at $p < 0.05$ with SPSS ver. 21.0 (IBM Corp., Armonk, NY, USA).

Results

Based on the analysis of the difference between the GSE and Placebo groups during recovery after eccentric exercise, there was no significant interaction between GSE supplementation and maximal muscle strength and muscle soreness ($p > 0.05$, Tables 2 and 3). However, the CK level showed a significant difference between the GSE and placebo groups ($p < 0.05$); the CK level was significantly decreased 96 h after exercise in the GSE group compared with the placebo group (Table 4).

Discussion

This study investigated the effect of acute GSE supplementation (300 mg/day) on muscle damage index as measured by maximal muscle strength, muscle soreness, and CK level. The results of this study showed that CK level was significantly decreased with acute GSE supplementation after eccentric exercise.

Polyphenol supplementation promotes the stability of cell membranes by increasing anti-oxidant and anti-inflammatory activity,¹² and decreases secondary muscle damage including vascular permeability, neutrophil infiltration, and free radical production.^{13,14} The anti-oxidation and anti-inflammatory effect of GSE are well-known, and experimental studies have reported significantly decreased levels of oxidative stress and inflammatory factors with GSE.^{15,16} Thus, there is a possibility that supplementation with phenol content-rich GSE would decrease CK levels by decreasing oxidative stress or the inflammatory response.

Some studies reported that high intensity eccentric exercise induces local endothelial dysfunction,^{17,18} and there is a possibility that acute change induced by GSE supplementation increases functional recovery of endothelial and vessel vasodilation, promoting CK clearance by increased blood flow. CK levels could also

Table 2
Changes in maximum muscle strength after eccentric exercise.

Group	Pre (%)	Post (%)	24 h (%)	48 h (%)	72 h (%)	96 h (%)	<i>p</i>
Placebo (n = 8)	100.0 ± 0.0	47.0 ± 15.8	55.4 ± 25.0	66.0 ± 28.8	71.8 ± 13.3	79.4 ± 22.3	Time: <0.001
Grape seed extract (n = 8)	100.0 ± 0.0	46.6 ± 8.0	71.8 ± 15.8	75.8 ± 21.7	85.6 ± 24.8	94.7 ± 29.6	Group: 0.269 Interaction: 0.258

Values are mean ± standard deviation.

Analyzed using repeated-measure analysis of variance.

Table 3
Changes in muscle soreness after eccentric exercise.

Group	Pre (mm)	24 h (mm)	48 h (mm)	72 h (mm)	96 h (mm)	p
Placebo (n = 8)	0.0 ± 0.0	53.8 ± 20.3	54.2 ± 22.0	43.3 ± 22.0	32.5 ± 23.3	Time: <0.001
Grape seed extract (n = 8)	0.0 ± 0.0	36.8 ± 26.0	44.3 ± 26.3	31.7 ± 22.2	19.1 ± 19.2	Group: 0.237 Interaction: 0.408

Values are mean ± standard deviation.

Analyzed using repeated-measure analysis of variance.

Table 4
Changes in creatine kinase level after eccentric exercise.

Group	Pre (U/L)	24 h (U/L)	48 h (U/L)	72 h (U/L)	96 h (U/L)	p
Placebo (n = 8)	121.5 ± 36.1	210.8 ± 72.8	563.6 ± 610.1	670.0 ± 584.6	745.7 ± 487.1	Time: 0.004 Group: 0.048 Interaction: 0.040
Grape seed extract (n = 8)	155.0 ± 168.7	157.2 ± 140.2	164.2 ± 74.7	194.7 ± 114.2	304.6 ± 246.8*	

Values are mean ± standard deviation.

Analyzed using repeated-measure analysis of variance.

*Significant between groups at 96 h, analyzed by the independent sample *t*-test (*p* < 0.05).

decrease as increased nitric oxide (NO) levels prevent further damage or oxidative stress of the muscle cells.¹⁹ However, the evidence to support these hypotheses is insufficient, and additional study is required.

Acute supplementation with GSE after eccentric exercise did not affect maximal muscle strength and muscle soreness in the present study. Previous advanced polyphenol studies have evaluated this effect using eccentric exercise of the elbow flexor, as in the current study.^{13,14,20} However, these studies did not investigate GSE and the supplement methods were different. Possible reasons for the conflicting results among studies could be differences in the polyphenol profiles of the various supplements tested, the length of the supplementation period, and the different dosages of supplement used.

This study has limitation that the number of subjects was minimal; future studies should incorporate a larger sample size of both men and women to better understand the benefits of GSE as an ergogenic aid.

Acknowledgement

The authors declare no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jesf.2019.01.001>.

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