

Black Garlic Supplementation's Effect on Exercise-Induced Increase of Oxidative Stress

Lixin Wang^{1*}, Kanichi Mimura² and Shigeo Fujimoto³

¹Medical Fitness Association, Yodogawa-ku, Osaka, Japan

²Osaka Seikei University, Osaka, Japan

³Department of Sports Medicine, Graduate School of Medicine, Osaka City University, Japan

Abstract

This study investigated the effects of black garlic (BG) supplementation on exercise-induced increase of oxidative stress (EIOS) and recovery of muscle function. 20 healthy males were assigned to either a BG group (n=11, GG) or placebo group (n=9, PG), during a 14-day-study. Before and after eccentric exercise of elbow flexors, we measured muscle function, blood and urinary biochemistries. Maximal voluntary contraction strength decreased by 35% immediately post exercise in both groups. Recovery of circumference of biceps brachii in GG was significantly faster than in PG during 3-7 days post-exercise. reactive oxygen metabolites (d-ROMs) level was lower in GG than in PG during 1-3 days post-exercise, but no significant difference in anti oxidative potential (BAP) was observed between groups. Exercise induced leukocytosis and monocytes, lymphocytes and neutrophils all exhibited significant time effects. A significantly greater creatine kinase level was found on day 3 post-exercise in PG than in GG. Lipid peroxide concentration was lower during 3-7 days post exercise in GG than in PG and the 8-iso-prostaglandin F_{2α} level was significantly greater in PG than in GG at every post-exercise point. These results suggest that BG supplementation had certain effects on suppression of EIOS and might promote the recovery of edema in injured tissue.

Keywords: Black garlic; Exercise-induced oxidative stress; Muscle function

Introduction

Eccentric exercise often causes acute and chronic inflammation, as well as local muscle damage [1]. Chronic inflammation arises from the activation of leukocytes, which is closely related to the increase of oxidative stress, clinical muscle fatigue and muscle pain [2]. Therefore, it is possible to improve the clinical symptoms and promote muscle repair by reducing the oxidative stress. Garlic is widely used as a natural medicine in ancient civilizations [3]. Recent scientific studies have shown that many pharmacological effects of garlic are often related to its antioxidant properties [4]. The antioxidant capacity, plant polyphenols and free amino acids are greatly reinforced in black garlic made from raw garlic within a special environment; great improvement has been observed in the emergence of S-allyl-cysteine and a large number of Maillard compounds that are not found in raw garlic [5]. Therefore, the antioxidant performance and the effect of alleviating inflammation and accelerating the recovery of muscle fatigue of black garlic are noteworthy. The purpose of this study was to investigate the effects of black garlic supplementation on muscle injury, inflammatory response and the recovery of muscle fatigue caused by an acute eccentric exercise.

Methods

20 healthy, nonsmoking and untrained males were recruited and assigned to either a black garlic group (n=11, GG) or a placebo group (n=9, PG), by a randomly double-blind method, with the similar age and body mass index. One week before and after an acute exercise-induced injury experiment, totally lasted for 14 days, the subjects were continuously asked to take black garlic balls (200 mg/ball, 15 balls/time, 3 times/day, equivalent to 11.2 g black garlic every day) or placebo balls (consisted of starch, completely identical in weight and appearance to the BG balls) orally. An arm curl machine was used for the eccentric exercise protocol. Subjects performed 3 sets of 10 repetitions, with each repetition lasted 6 s, at 70% of their eccentric one-repetition maximum using only the non-dominant arm. At the 7 d pre-exercise (T1), immediately pre-exercise (T2), immediately post exercise (T3), 6 h

post-exercise (T4), 1 d post-exercise (T5), 3 d post-exercise (T6) and 7 d post-exercise (T7), blood sampling (7 times), urine collection (5 times) and muscle function tests (6 times) were performed.

Results and Discussion

Serum oxidative stimulation (d-ROMs) values in PG showed a significant increase ($P < 0.05 \sim 0.01$) at T3 and T5, while in GG a significant decrease at T5 and T6 ($P < 0.05$) were observed. Serum antioxidant capacity (BAP) values after one week supplementation were found no significant changes in PG, but it increased significantly ($p < 0.05$) in GG. The maximal voluntary contraction strength in two groups decreased by about 35% immediately after exercise, but it recovered more quickly on the 7th day after exercise in PG. Circumference of biceps brachii around working arm flexors was significantly lower on day 10 (T6) and day 14 (T7) in GG than in PG ($P < 0.05$, both). Muscle soreness and range of motion exhibited significant changes post-exercise (time effects: $P < 0.05$, respectively), but finally recovered to the baseline level, with no differences between groups. A significant increase after exercise (time effect, $p < 0.05$) in LDH was seen and both CK and LDH peaked at T6, but CRP and G-CSF exhibited no significant changes in either group during the study period. Exercise induced significant leukocytosis post-exercise, with significant time effects in leukocytes, lymphocytes and monocytes. Compared to the baseline (T1), leukocytes with peak values 6 h post-exercise increased 18.1% to 23.3% in GG and 26.1% to 32.1% in PG, respectively and then almost recovered to baseline (+5% approximately) in GG, while still greater (approximately +12.6% ~

*Corresponding author: Lixin Wang, Medical Fitness Association, Yodogawa-ku, Osaka, Japan, E-mail: wanglxhz@yahoo.co.jp

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18.4%) in PG 1-3 d post-exercise. The increase in lymphocytes positively correlated with circumference change at 6 h post-exercise ($r=0.52$, $P<0.05$), as did neutrophil count with blood d-ROMs immediately post-exercise ($r=0.47$, $P<0.05$). Although no time effect and supplement \times time effect were observed in blood LP, a significant supplement effect ($P<0.05$) was found and GG had significantly lower values at T6 and T7 than PG ($P<0.05$, both). 8-iso-PGF $_2\alpha$ level indicated significant supplement effect, time effect and supplement \times time effect ($P<0.05$, all), GG had lower values than PG post-exercise at T4, T5, T6 and T7 ($P<0.05$, all).

Summary

Black garlic supplementation at 11.2 g per day for 14 days indicated that it effective to, 1) promote the recovery of local edema caused by eccentric exercise, but had no significant effect on the recovery of strength; 2) curb exercise-induced oxidative stress significantly; 3) decrease urinary 8-iso-PGF $_2\alpha$ and blood LP concentrations markedly; and 4) inhibit the increases in blood LDH and CK levels caused by exercise. In conclusion, BG supplementation can be expected to improve

some physiological responses, such as chronic inflammatory responses (edema) and mitigate the extent of muscle injury due to eccentric exercise through decreasing oxidative stress. These results suggest that, black garlic supplementation might be useful to prevent metabolic syndrome, including obesity, diabetes, hypertension and hyperlipidemia, because the accumulation of oxidative stress and chronic inflammation are closely related to the occurrence and development of these diseases.

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