Effect of Tomatoes on the Inflammatory Response in Active College Age Adults

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Abstract

Consumption of tomato products, primarily products high in lycopene, has been linked to a decrease in inflammation and inflammation related diseases. C-reactive protein concentration (CRP) can be used to quantify the acute inflammation within the body brought on during exercise. In this study, eight male and eight female volunteers participated in two dietary cycles each with a two week duration. A high lycopene diet was simulated with daily V8® supplements, and a low lycopene diet was simulated by asking the participants to refrain from eating tomatoes and products containing tomatoes. After each two week diet, saliva samples were taken from participants both before and after a controlled 15 minute inflammation inducing workout to measure CRP concentration. No significant difference ($P > 0.05$) in CRP concentrations were found between diets or genders. Further studies with larger sample sizes, different lycopene supplements, and a more controlled diet may produce different results.

Keywords: Lycopene, tomato/tomato products, inflammation, anti-inflammatories, cytokines, C-reactive protein

Introduction:

Inflammation is a complex cascade of events that makes up part of the biological response of vascular tissues to injury (Palozza et al. 2010). While inflammation has a protective role aimed at removal of the injurious stimuli and initiation of the healing process, it can cause temporary discomfort. Chronic inflammation can cause irreversible damage to vascular integrity, circulatory fluid loss, hypoperfusion, organ dysfunction, and even death (Lee et al. 2012).

HMGB1 is a protein secreted by cells of the immune system upon exposure to pro-inflammatory signals, serving to induce the production of inflammation-mediating cytokines such as C-reactive protein (Lee et al. 2012). C-reactive protein levels can be detected in
plasma, saliva, and oral mucosal transudate, and are commonly used to infer levels of inflammation (Fernandez-Botran et al. 2011).

The production of cytokines is reduced by anti-inflammatory and immunomodulating compounds (Riso et al. 2006), including lycopene, an open chain non-provitamin A carotenoid antioxidant (Aydemir et al. 2012) produced by tomatoes. Lycopene inhibits HMGB1 surface receptors and helps to reduce markers of inflammation (Lee et al. 2012). Studies have shown a relationship between consumption of a tomato containing meal high in fat (46% of 850 kcal) and reduced cardiovascular inflammation (Burton-Freeman et al. 2012) and a direct relationship between daily ingestion of tomato paste and endothelial function (Xalanteris et al. 2012). The purpose of this study was to investigate the effect of a diet containing tomatoes, tomato products, and V8® as a lycopene supplement, on levels of the inflammatory marker, C-reactive protein, in saliva of active age college aged adults. Previous studies focused on other sources of lycopene supplementation, strictly female population, in vitro/in vivo experiments or different testing durations.

**Materials and Methods**

The protocol for this experiment was approved by the Institutional Review Board at Brigham Young University Hawai’i. Ten male and ten female volunteers, 18-26 years of age, that participate in a minimum of ten hours of physical activity per week with no prior knowledge of personal cardiovascular, hepatic, gastrointestinal, renal disease or pregnancy, were selected from among students attending Brigham Young University-Hawaii. Half the participants were subjected to a high lycopene diet, consisting of a minimum daily
consumption of 25.5 mg lycopene from V8® Original 100% Vegetable Juice and tomato-based products, for a period of two weeks. This was immediately followed by a low lycopene diet, characterized as a diet free of tomatoes and products known to contain tomatoes for two weeks. The remaining volunteers were subjected to the same low lycopene diet followed by the same high lycopene diet. Participants were provided a list of foods known to contain tomatoes and tomato based-products and a diet journal to guide them and log their food choices for later analysis.

At the termination of each two week portion of the test, participants performed a 15 minute ascending and descending stair workout to increase overall inflammation in the body. Saliva samples of 125 μL were collected using cryo tubes (Salimetrics, LLC 2013) and inflammation markers were measured using an ELISA research assay kit and data were analyzed using a one way ANOVA and Fisher individual tests.

**Results**

Observed CRP concentrations among participants, both on high and low lycopene diets were varied. One female participant’s high lycopene diet CRP values (pre-exercise: 21,278 pg/mL; post exercise: 6,996 pg/mL) was identified during statistical analysis as potential outliers, and therefore, the subject was removed from the analysis. The mean values and standard deviation of CRP concentrations for participants on the high lycopene diet before and after exercise were 1,679 ± 2,319 and 3,577 ± 2,722 pg/mL, respectively, whereas the mean values for participants on the low lycopene diet before and after exercise were 3,577 ± 2,722 and 6,517 ± 5,009 pg/mL, respectively (Figure 1). However, Fisher individual
tests of analogous groups and ANOVA identified no significance difference ($P = 0.225$ to $0.643$) in the concentration of CRP between diets with V8® as a source of lycopene.

![Box plot showing CRP levels](image)

**Figure 1.** The average C-reactive protein concentration in participants on high and low lycopene diets, pre and post exercise. The upper and lower shaded region of the box plot represents the third and first quartile respectively. The crosshair delineates the mean value (in bold) and the bar indicates the median value.

The mean values and standard deviation of CRP concentration for males on the high lycopene diet before and after exercise were $611 \pm 1,024$ and $2,961 \pm 3,039$ pg/mL respectively, while values for males on the low lycopene diet were $2,738 \pm 2,938$ and $5,721 \pm 6,070$ pg/mL respectively (*Figure 2*). The mean values and standard deviation of CRP concentration for female participants on the high lycopene diet before and after exercise were $3,014 \pm 2,944$ and $4,347 \pm 2,455$ pg/mL respectively, whereas the values females on the low lycopene diet were $4,405 \pm 3,679$ and $7,513 \pm 3,924$ pg/mL respectively (*Figure 2*). There was no significant difference between analogous groups of males and females ($P > 0.05$).
Figure 2. The box plots of C-Reactive protein concentration in females (pink) and males (blue) on high and low lycopene diets, pre and post exercise. The upper and lower most shaded region represents the third and first quartile respectively. The crosshair delineates the mean value (in bold). The bar indicates the median value of the measurements.

Discussion

Previous studies by Riso et al. 2006, Xplanteris et al. 2012, and Lee et al. 2012 found a relationship between lycopene and inflammation however the results of this study were not significant ($P > 0.05$). The large variance in CRP concentration among samples as well as the small sample sizes used in this study may explain these results. The variance in CRP concentrations in this study may be attributed to the lack of controlled diets of the participants. The low lycopene diet participants were asked to keep dietary journals and refrain from consuming foods high in lycopene however, the diets were not standardized between individuals. In the previous studies, Lyco-mato® was used to supplement lycopene, however in this study V8® was used as a lycopene supplement. This over the counter product
may have been pasteurized which may have altered the lycopene. There is also the potential that other supplements and/or chemicals contained within the V8® drink actually counteract the inflammatory inhibition of the lycopene. Finally, the lack of statistical difference between pre and post exercise inflammation on either diet may reflect an experimental failure to induce inflammation during the ascending and descending stair workout. Increasing the duration or intensity of the workout in future studies to ensure a strong inflammatory response is recommended.

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Works Cited


