

# Biochemical and Molecular Action of Nutrients Research Communication

## Dietary Tomato Paste Protects against Ultraviolet Light-Induced Erythema in Humans<sup>1</sup>

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**ABSTRACT** Carotenoids are efficient antioxidants capable of scavenging reactive oxygen species generated under conditions of photooxidative stress. It has been shown that supplementation with high doses of  $\beta$ -carotene protects skin against UV-induced erythema. This study was designed to investigate whether intervention with a natural dietary source rich in lycopene protects against UV-induced erythema in humans. Tomato paste (40 g), providing  $\sim 16$  mg/d of lycopene, was ingested with 10 g of olive oil over a period of 10 wk by 9 volunteers. Controls ( $n = 10$ ) received olive oil only. Erythema was induced by illumination of dorsal skin (scapular region) with a solar simulator at the beginning of the study, after 4 wk and after 10 wk. Intensity of erythema was measured by chromatometry; the  $a$ -value was determined directly before and 24 h after irradiation. Serum carotenoid levels were measured by HPLC. At the beginning of the study, carotenoid levels did not differ between the two groups. Serum levels of lycopene increased in supplemented subjects; the other carotenoids did not change significantly, and no change in serum carotenoids was observed in the control group. At wk 10, dorsal erythema formation was 40% lower in the group that consumed tomato paste compared with controls ( $P = 0.02$ ; Wilcoxon-Mann-Whitney test). No significant difference between groups was found at wk 4 of treatment. The data demonstrate that it is feasible to achieve protection against UV light-induced erythema by ingestion of a commonly consumed dietary source of lycopene. *J. Nutr.* 131: 1449–1451, 2001.

**KEY WORDS:** • lycopene • sunburn • skin carotenoids • erythema • humans

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Photooxidative stress is induced by UV-irradiation via light-dependent formation of reactive oxygen species such as singlet molecular oxygen, superoxide radical anion or peroxy radicals (1). Chemical reactions of these reactive intermediates with cellular lipids, proteins and DNA are thought to play a role in the pathobiochemistry of diseases affecting light-exposed tissues such as the skin or the eye. These disorders include erythema formation, premature aging of the skin, development of photodermatosis, skin cancer, cataract and age-related macular degeneration (2–5).

Carotenoids are lipophilic micronutrients with antioxidant activities, occurring in human blood and tissues, including the skin and the eye (6,7). Carotenoids in humans originate from intake of fruits, vegetables and dairy products. There are correlations between a high intake of a diet rich in carotenoids and the occurrence of several degenerative diseases (8). Such potential protective effects of carotenoids are thought to be related to their antioxidant properties (9). In vitro studies showed that carotenoids are among the most effective naturally occurring quenchers of  $^1\text{O}_2$ , with bimolecular rate constants in the range of  $10^9$ – $10^{10}$  (mol/L) $^{-1}$  · s $^{-1}$  (10–12). In addition, carotenoids interact with peroxy radicals, thus inhibiting the process of lipid peroxidation (13,14). Several in vitro studies indicate that among the natural carotenoids, lycopene is the most efficient antioxidant (10,15).

$\beta$ -Carotene has been used as a so-called oral sun protectant due to its antioxidant properties, and its efficacy has been shown in human studies (16–19). After administration of a  $\beta$ -carotene supplement for 8 wk, there was a 35% lowering of erythema compared with pretreatment response toward a 1.5 individual minimal erythema dose (MED) (19). The MED is the minimal amount of energy required to induce a uniform, clearly demarcated erythema response, with a maximum  $\sim 24$  h after irradiation.

Tomatoes and tomato products are the major source of lycopene in the human diet in Western countries (20). Bioavailability of lycopene from tomato paste is higher than from other natural sources such as tomato juice or fresh tomatoes (21).

On the basis of the pronounced antioxidant activities of lycopene and its enhanced availability from tomato paste, we investigated whether protection against UV-induced erythema can be provided by dietary intervention with tomato paste.

### SUBJECTS AND METHODS

**Study design.** Healthy adults ( $n = 22$ ), 26–67 y old (8 men and 14 women), skin type II, took part in the study. Subjects were recruited by retrieval of names from a list of volunteers available to the Institute of Experimental Dermatology (Universität Witten-Herdecke); they were assigned randomly to the control group or the group that received tomato paste. Skin-type grading was according to skin coloration, hair and eye color, and history of sensitivity toward sun exposure (22). Skin type II criteria were white skin, blonde or light-brown hair, blue eyes, sensitivity to sun exposure and minimal tanning.