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Lycopene and Mr. Prostate: Best Friends Forever

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## Meet Lycopene

Prostate cancer is one of the leading causes of cancer death among men in the United States. Dietary factors are considered an important risk factor for the development of prostate cancer in addition to age, genetic predisposition, environmental factors, and other lifestyle factors such as smoking. Recent studies have indicated that there is a direct correlation between the occurrence of prostate cancer and the consumption of tomatoes and tomato-based products. Lycopene, one of over 600 carotenoids, is one of the main carotenoids found in human plasma and it is responsible for the red pigment found in tomatoes and other foods such as watermelons and red grapefruits. It has been shown to be a very potent antioxidant, with oxygen-quenching ability greater than any other carotenoid. Recent research has indicated that its antioxidant effects help lower the risk of heart disease, atherosclerosis, and different types of cancer-especially prostate cancer.

## Lycopene's Characteristics

Lycopene is one of approximately 600 known carotenoids. Carotenoids are red, yellow, and orange pigments which are widely distributed in nature and are especially abundant in yellow-orange fruits and vegetables and dark green, leafy vegetables. They absorb light in the 400-500nm region which gives them a red/yellow color. Only green plants and certain microorganisms such as fungi and algae can synthesize these pigments. Animals are dependent on these plants as sources of these essential elements. Carotenoids contain a conjugated backbone made of isoprene units and many different cis and trans isomers exist. The body absorbs carotenoids in the intestine with the aid of dietary fat and they are transported in the serum via incorporation into chylomicrons. Their hydrophobic character results in the majority of their interactions occurring with lipid portions of tissues, cells, and membranes (1).

Lycopene is an acyclic carotenoid with 11 conjugated double bonds that are all in the trans form, which is the most thermodynamically stable form. The estimated half-life of lycopene has been estimated to be 11-14 days (1). In vitro experiments have shown that lycopene quenches singlet oxygen more efficiently than other carotenoids such as beta-carotene, lutein, and zeaxanthin, and thus possesses more potent antioxidant properties in battling free radical damage. In another study, the effects of 15 kinds of carotenoids on the viability of three lines of human prostate cancer cells showed that lycopene was one of the most effective in reducing cancer cell viability (2).

## Some Words on Prostate Cancer

Prostate cancer is the second most common type of cancer found in American men, next to skin cancer. It is the second leading cause of cancer death in men, just behind lung cancer. According to the American Cancer Society, there will be approximately 189,000 new cases of prostate cancer in the United States in the year 2002, and about 30,200 men will die of this disease. Prostate cancer can occur in men of any age, but it is most commonly found in men over 50 and men over 65 years of age constitute more than 70% of all prostate cancer incidences. Furthermore, this form of cancer has significantly higher rates in African-American men than in white American men, and the mortality rates are twice as high for African-American men than white men. North America and northwestern Europe account for the majority of the cases, while Asia, South America, and Africa have a much lower incidence of this form of cancer (3).

The exact causes of prostate cancer are not yet known, however, several risk factors responsible for increasing the risk of the disease have been identified. As already mentioned, age, race and nationality all play a role in prostate cancer. In addition to those risk factors are a diet high in fat, a lack of physical activity, a family history of prostate cancer, and other lifestyle factors such as smoking (3). Also, recent studies have shown that high levels of certain hormones such as androgens and insulin-like growth factors may potentially lead to a greater risk of developing prostate cancer (4).

### Lycopene's Secret Weapon

Lycopene's ability arises from its antioxidant power. During aerobic metabolism, the body naturally produces electron hungry molecules known as free radicals. The development of many chronic diseases has been associated with free radical formation and the damage they cause to DNA, proteins, and lipids (5). Exposure to environmental perils such as disease, infection, pollution, exposure to radiation, and smoking contribute to increasing oxidative stress beyond the individual's ability to cope with it. The natural means by which our body protects us from free radicals weakens with age and increases our risk of developing a degenerative disease. One source of protection against the damaging effects of free radicals are antioxidants-molecules that act as free radical scavengers and give up their own electrons to the free radicals so that oxidation of other molecules will not occur (6). Our body has an extensive network of different types of antioxidants that help to protect us; however, we cannot produce an adequate amount of antioxidants to offset the high number of free radicals our body is exposed to everyday. We therefore have to depend on other outside sources to supplement us. Such sources would include diets rich in fruits and vegetables which contain vitamin C, vitamin E, and carotenoids like beta-carotene and lycopene (6-8). Lycopene has been found to be one of the most powerful and effective dietary sources of antioxidants and is the best known biological quencher of free radicals derived from oxygen (9).

Increasingly, research has indicated that lycopene's antioxidant effects play an important role in disease prevention. Studies of prostate cancer patients have shown that these patients have less lycopene and more oxidized lipids and proteins in their body in comparison to controls (10). Diets that are rich in tomatoes and tomato products may protect DNA from oxidative damage (11). In a study conducted by Chen et al., 32 patients with localized prostate adenocarcinoma consumed pasta dishes consuming tomato sauce for a period of 3 weeks. Results indicated that leukocyte oxidative DNA damage was statistically significantly lower after the intervention (12). Recent research has also indicated that individuals who consumed tomato juice or sauce every day for a period of one week have increased blood lycopene content and lowered oxidation of proteins, DNA, and lipids (13). This demonstrates that increased consumption of lycopene may result in less oxidative stress on the body and thus lead to a decrease in free radical damage and risk for chronic diseases.

### Heat or Process Thy Tomato

In order for lycopene to combat reactive oxidized molecules in the human system, it has to be absorbed. Scientists have discovered that lycopene from heat-processed tomato juice is absorbed more easily than unprocessed juice. The trans form of lycopene, the form found in unprocessed juice, is absorbed less readily than is the cis form of lycopene. Heating tomato juice in the presence of corn oil for one hour converts lycopene from trans to cis form, and results in

increased absorption by the body (14). In a randomized trial study held by Johnson et al., subjects were maintained on a low-carotenoid diet and were given either 400 grams of tomatoes (equivalent to 22 mg of lycopene) with corn oil and bread or 40 grams of tomato paste (23 mg of lycopene). Subjects who ingested tomato paste had blood lycopene levels two and a half times greater than subjects who ingested tomatoes.

In a similar study, 19 subjects (10 male and 9 female), from 25 to 40 years of age, participated in a randomized cross-over study. During the course of the experiment, the subjects were instructed to avoid consumption of tomatoes, tomato-based products, and other sources of lycopene. The subjects were divided into four groups; three which consumed different amounts of lycopene (0, 75mg, 150mg per day) in a capsule form, and the fourth group were not given capsules but instead drank 540mL of tomato juice per day. The results indicated that blood lycopene levels were higher in subjects who had consumed tomato juice; supporting the notion that lycopene is better absorbed by the body when it is processed into juice versus when it is ingested in its pure form (15).

The above data indicates that lycopene found in tomatoes is converted by the temperature used in processing tomatoes into products such as tomato juice, sauces, paste, and ketchup.

#### Sources and Storage of Lycopene

Tomatoes and tomato-based products account for 85% of dietary lycopene in North America. Bright red, ripe tomatoes have more lycopene than green or yellow, unripe ones. Other sources of this powerful antioxidant include pink grapefruit, papaya, and watermelon (16).

Product	Lycopene(mg/100g)	Serving Size
Tomato Paste	42.2	30 mL
Spaghetti Sauce	21.9	125 mL
Chili Sauce	19.5	30 mL
Seafood Sauce	17	30 mL
Tomato Ketchup	15.9	15 mL
Tomato Sauce	14.1	60 mL
Tomato Juice	9.5	250 mL
Tomato Soup	7.2	250 mL
Watermelon	4	368 g
Pink Grapefruit	4	123 g
Raw Tomato	3	123 g

In the body, lycopene is stored in the liver, lungs, prostate gland, colon, skin, testes, and adrenal glands, with the latter two having the highest levels than the other tissues and organs. It is stored in tissues at a higher concentration than all other carotenoids.

#### Dietary Intake of Lycopene

An important, comprehensive study conducted at Harvard School of Medicine involved assessing the dietary intake of various carotenoids of 47,894 males who were prostate cancer-free. Information was gathered using a detailed questionnaire. High lycopene intake had a

statistically significant 21 percent prostate cancer risk reduction, while intake of none of the other carotenoids, including beta-carotene, had any significant relevance. Also, approximately 46 different food items that contained carotenoids were ingested by various participants, however, only four were significantly correlated with a reduced risk, and three (tomato sauce, tomatoes, and pizza) of those four contained lycopene. Furthermore, subjects that consumed 10 or more servings of tomatoes or tomato-based products per week had an approximately 35 percent lower risk of prostate cancer than did those who consumed less than 1.5 servings per week. Tomato sauce accounted for the most protection (66%) than all of the other food items analyzed (17).

Studies have also demonstrated that supplementation with lycopene in a pill may decrease the growth of prostate cancer. In a study by Kucuk et al., 26 men who had been newly diagnosed with a clinically-localized prostate cancer were randomly assigned to receive 30 mg of lycopene or no supplementation, for a period of three weeks prior to undergoing a prostatectomy. The results indicated that the supplementation lead to increased levels of lycopene in prostate tissue, which lead to a positive affect on biomarkers of growth and differentiation, and a decrease in clinical signs for prostate cancer progression (18).

In another large study, Mills et al. in 1989 examined lifestyle and dietary habits and the risk of developing prostate cancer. Over 14,000 men were studied over a span of six years, and the findings indicated that only pea, lentil, bean, and tomato consumption had a significant correlation with a reduced risk of prostate cancer. Interestingly, carrots and other foods rich in beta-carotene were shown to be unrelated to risk (19).

A case-control study conducted in New Zealand in 1996 also provided data demonstrating that beta-carotene does not provide protection against prostate cancer. The study compared 317 prostate cancer patients with 480 controls. The experimenters found that dietary intake of foods rich in beta-carotene was not associated with protection against prostate cancer, while tomato-based foods rich in lycopene did show a small association with reduced risk (20).

### Blood and Tissue Lycopene Levels

Analysis of prostate tissue has shown the presence of lycopene. Also, lycopene levels in the prostate seem to be the highest in comparison to all other carotenoids. Prostate cancer patients have been shown to have a lower concentration of lycopene in their prostate than do control subjects (21). Furthermore, a cell culture study conducted by Pastori et al. showed that when lycopene is combined with Vitamin E, the growth of prostate cancer cells was significantly prevented (22).

Blood lycopene levels have also been shown to be related to the incidence of prostate cancer. The plasma concentrations of lycopene of 65 patients with prostate cancer and 132 cancer-free controls were analyzed by Lu et al. Their findings indicated an inverse relationship-an 83% reduction in prostate cancer risk was observed in the group with the highest plasma concentration of lycopene. The higher the content of lycopene, the lower the risk (23).

### The Final Word

The above studies have provided substantial evidence to the powerful antioxidant effects associated with lycopene. The protective effects of lycopene not only reduce the risk of prostate

cancer, but also positively influence the risk of other forms of cancer and other chronic diseases such as atherosclerosis. However, one should naturally be aware that the benefits afforded by lycopene are a very small element of the body's use of food in battling degeneration and cellular damage. Although we have learned that tomatoes are more essential to our diet than we had originally expected, if you are not a big fan of tomatoes, you can take comfort in the fact that a healthy diet should go beyond tomato consumption and include fruits and vegetables so that other essential antioxidants, vitamins, and nutrients that are vital for proper functioning of the body's immune system and other protective mechanisms can be consumed. However, for those of you who are tomato, pizza, or ketchup lovers, keep up the love and lycopene will do the rest.

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