

Effects of tomato juices (*Lycopersicum esculentum* Mill) consumption on plasma lycopene levels of male light smokers

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Abstrak

Penelitian ini merupakan penelitian eksperimental dengan desain pre dan post test, untuk mengetahui pengaruh konsumsi jus tomat (*Lycopersicum esculentum* Mill) terhadap kadar likopen plasma. Sampel darah dari 27 orang subyek penelitian dengan rata-rata usia $34,70 \pm 5,74$ tahun, mempunyai tingkat pendidikan menengah (85,2%), mengalami paparan langsung terhadap debu panas dalam pekerjaannya (40,74%) dan merokok jenis rokok kretek (77,78%), diberi perlakuan dengan jus tomat (*Lycopersicum esculentum* Mill) yang telah diolah sebanyak 350 gram/hari selama 4 hari berturut-turut. Kadar likopen plasma diperiksa sebelum dan sesudah perlakuan. Hasil penelitian menunjukkan bahwa kadar likopen plasma setelah perlakuan mengalami peningkatan yang secara statistik bermakna. Hal ini membuktikan bahwa konsumsi jus tomat yang diolah dengan benar ternyata mampu meningkatkan kadar likopen plasma. (*Med J Indones* 2004; 13: 146-50)

Abstract

The study was an experimental study with pre and post test design, to evaluate the effects of tomato juices (*Lycopersicum esculentum* Mill) consumption on plasma lycopene level. Blood sample of 27 subjects with average age of 34.70 ± 5.74 years old, moderate education level (85.2%), experienced direct contact with working environmental pollutant (40.74%) and smoked kretek cigarettes (77.78%) were given treatment with 350 gram/day of tomato juices (*Lycopersicum esculentum* Mill) which had been properly prepared for 4 consecutive days. The lycopene plasma level was examined before and after treatment. The findings showed that after treatment, the lycopene plasma level significantly increased. This showed that consumption of properly prepared of tomato juices will increase the lycopene plasma level. (*Med J Indones* 2004; 13: 146-50)

Keywords: light smoker, tomato juices, lycopene plasma

There is an increasing evidence that diet can play an important role in human health by providing important substances that increase the body defense system against several diseases. Recent studies suggest that consumption of tomatoes products which are rich in lycopene, an antioxidant, can decrease the risk of the development of disease related to oxidative stress.¹

Analysis of carotenoids profile in tomato (*Lycopersicum esculentum* Mill) as: lycopene (60-64%), phytoene (10-12%), γ -carotene (10-11%), neurosporene (7-9%), phytofluene (4-5%), β -carotene (1-2%), δ -carotene

(1-2%) and lutein (trace-1%). It has been showed that high intake of some carotenoids (such as β -carotene, lutein, etc) may influence or antagonize the bioavailability and absorption of lycopene, although some researcher thought that this process remain a theoretical possibility, definitive data remain to be generated.²

Lycopene is reddish pigments, which can be found in fruits and vegetables (for examples tomato, watermelon, red grape, etc) including major carotenoids, without pro-vitamin A activity and fat soluble. It has been proved that lycopene has antioxidant activity by quenching singlet oxygen 2 times β carotene and 10 times α tocoferol.^{3,4}

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The bioavailability of lycopene is reported to be highly variable and can be affected by a number of dietary factors, food properties, biologic and life style

factors. These factors include amount of lycopene consumed in a meal, food matrix in which lycopene is incorporated, co ingestion of high amounts of dietary fiber, co-ingestion of fat as a delivery medium, interaction of lycopene with other carotenoids, aging and smoking habits.^{2,3}

Cigarettes contains 4000 organic materials which are categorized as free radical^{5,6} and can cause oxidative damage to cells, for example per-oxidation of lipid membrane, damage of protein and deoxyribonucleic acid (DNA). The continuation oxidative damage is a significant contributor to the development of degenerative diseases.^{7,8} An adequate intake of lycopene is suggested to be one factor that protects the body from oxidative damage, such as smoking.

According to the Indonesian Household Health survey in 2002, the number of smokers have increased from 51.2% to 54.5% as compare to 1995's survey.^{9,10} However, data on plasma lycopene level of Indonesian smokers are remained to be explored. Hence, our interest to study the effect of tomato juices (*Lycopersicum esculentum Mill*) consumption on plasma lycopene level of Indonesian male light smokers.

METHODS

An experimental study with *pre* and *post* test design was applied on 28 healthy male light smoker subjects (n = 28, 1 dropped out because of diarrhea),¹¹ characterized as 20 – 55 years old, not taking any medication or vitamin supplements. Informed written consent was obtained from each participant and the protocol was approved by the ethics committee of the Medicine Faculty of the University Indonesia.

The data was collected from December to May 2003 at one of Multinational Company located in West Java. The study was done in 3 periods: **(1) Pre-intervention period**, to obtain baseline data of demographic characteristic, food intake and lycopene plasma level. **(2) Intervention period**, tomato juices consumption 350 gram/day was given to each subject

and food intake data were collected for 4 consecutive days. **(3) Post intervention period**, to obtain laboratory data for plasma lycopene level.

Food intake data were collected by 2 x 24 hours recall method. Tomato juices were produced by steaming 350 gram fresh tomatoes for 10 minutes, juiced for 2.5 minutes and sift. The sifted volume was around 330 mL then mixed with *coco pandan* syrup about 20 mL, which make the final volume about 350 mL.

Lycopene plasma level was analyzed with HPLC based on SEAMEO laboratory method. Forty μ L plasma was mixed with 100 μ L solution (ethanol : butanol = 50 : 50) for 1 minute. The mixture was centrifuged for 3 minutes at 1200 x g. Twenty μ L supernatan was analyzed for lycopene level with HPLC, which performed by using a RP18 column (Waters, Novapack) fitted with a guard column. The eluent consisted of acetonitril : tetrahydrofuran : methanol : 1% ammonium (342 mL : 110 mL : 34 mL : 14 mL) at a flow rate of 0.9 mL/minute and signal length was set at 450 nm.

RESULTS

The average age of the subjects was 34.70 ± 5.74 years old, 85.2% had moderate education level with monthly income below the poverty line, 40.74% had direct contact with the working environmental pollutant and 77.78% smoked *kretek* cigarettes.

Nutrition intake (energy, fat, fiber, lycopene and β carotene) after the intervention significantly increased ($p < 0.05$), except for β carotene was not significantly increased (Table 1). As compare to the recommended intake in Table 2, only lycopene intake after the intervention and fat before and after intervention, were above the recommendation.

Based on SPSS (Statistical Product and Service Solutions) method, lycopene plasma level after intervention significantly increased ($p < 0.0001$) (figure 1).

Table 1. Intake of energy, fat, fibre, lycopene, β carotene before and after intervention

| Variable | Before (n=27) | After (n=27) | p | Test | Significance |
|-----------------|----------------------|----------------------|--------|------|--------------|
| Energy (kcal) | 1752.05 ± 260.41 | 1858.26 ± 230.68 | 0.040 | t | S |
| Fat (g) | 61.40*(33.95-108.20) | 74.33*(45.30-102.90) | 0.012 | W | S |
| Fiber (g) | 9.50*(5.75-18.80) | 12.13 ± 2.31 | 0.009 | W | S |
| Lycopene (mg) | 0.74*(0.10-2.41) | 11.85 ± 0.96 | 0.0001 | W | S |
| β carotene (mg) | 0.10*(0.05-0.75) | 0.13*(0.05-3.88) | 0.105 | W | NS |

Note: data is presented by mean ± standard deviation

* = median value (minimum – maximum)

t = pair t test

W = Wilcoxon test

S = significance (p<0.05)

NS = non significance (p>0.05)

Table 2. The intake percentages of fat, fibre, lycopene, and β carotene compare to the recommendation by 2 x 24 hours recall method

| Variable | Before (n=27) | During (n=27) | Recommendation |
|-----------------|------------------|------------------|----------------------|
| Fat (%) | 31,54 | 35,99 | 20 – 30 ^a |
| Fibre (g) | 9,5*(5,75-18,80) | 12,13 ± 2,31 | 20 – 30 ^a |
| Lycopene (mg) | 0,74*(0,10-2,41) | 11,85 ± 0,96 | 2,3 ^b |
| β Carotene (mg) | 0,10*(0,05-0,75) | 0,13*(0,05-3,88) | 2,9 ^b |

Note: a = data from Konsensus Nasional Pengelolaan Dislipidemia di Indonesia (KNPDI), 1996

b = data from National Health Interview Survey (NHIS) 1992

* = median value (minimum – maximum)

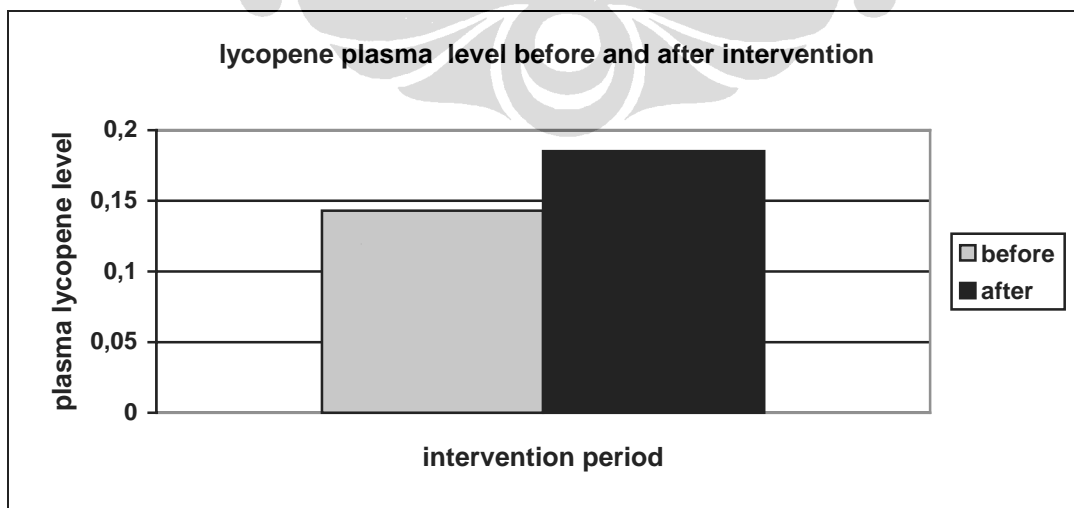


Figure 1. Plasma lycopene level before and after intervention

DISCUSSION

Smoking tobacco correlates directly or indirectly with degenerative disease such as cancer, cardiovascular disease, etc. The increased risk of smoking tobacco might be due to oxidative damage of cellular components such as protein, lipid and DNA. Smoke of cigarettes contain of higher load of free radicals and other reactive oxygen species such as nitrogen oxides, carbon mono-oxide, tar, phenol, etc. Consequently the oxidant/antioxidant balance of smokers become perturbed, leading to oxidative stress.

In this study, most of the subjects (82.52%) had moderate education level and monthly income below the poverty line. The level of education and monthly income had impact on the eating habit.^{12,13} By the moderate education level, it was expected that subjects had sufficient knowledge in choosing good quality of antioxidant food, but with a price matches their monthly income.

There were 40.74% subjects exposed directly to chemical pollutants especially hot dusts (with active lead) in their working environment. Lead (Pb) can cause oxidative damages through free radical formation, which cause the decrease of body's antioxidant level.^{14,15}

In addition, 77.78% subjects smoke *kretek* cigarettes which contain higher tar and nicotine level compare to mild/light cigarettes. Hence the oxidative damage is increased.^{15,16,17}

According to Shi and Maguer study, it was proved that 100 gram tomatoes contain 3-5 mg lycopene.⁴ Porrini et al (1998)¹⁸ has been demonstrated that plasma lycopene level has achieved a steady state in the 4th – 7th day of 16,5 mg/day lycopene treatment. In order to achieve a higher level of lycopene, the tomato juices are properly prepared as described by Van Het Hoff et al (2000).¹⁹

The bioavailability of lycopene can be influenced by fat, fiber and β carotene intake. Fat intake during intervention was higher than before intervention, which was 61.40 (33.95 – 108.20) gram vs 74.33 (45.30 – 102.90) gram. The higher fat intake can support the bioavailability of lycopene. The fiber intake during intervention was higher than before the intervention, which was 9.50 (5.75 – 18.80) gram vs (12.13 \pm 2.31) gram. Fiber intake can reduce lycopene

bioavailability as it increased the viscosity condition. Intake of β carotene before and during the intervention i.e 0.10 (0.05 – 0.75) mg and 0.13 (0.05 – 3.88) mg was considered lower as compare to NHIS 1992's data, which is 2.9 mg. This occurred because of the competitive characteristics when it mixed with fat and micelle in intestine; in enterocyte during the intra-cellular transport; during transport by plasma lipoprotein and released & retrieved of tissue.²⁰ However the competitive characteristics will occur only when the subject has high dosage of β carotene supplement, it was stated that by 300 mg/day of β carotene supplement for 21 days, will reduce lycopene serum level significantly.^{21,22} However in this study we assumed that the lower of β carotene intake will not influenced the bioavailability of lycopene. This assumption was explained in the Australian polyp prevention project that used supplementation of β carotene (20 mg/day) for 2 years, which increase the plasma lycopene concentration of approximately 175% was compared with placebo.²

The lycopene intake during the intervention was higher than before the intervention, which was 0.74 (0.10 – 2.41) mg vs (11.85 \pm 0.96) mg. This was related to the consumption of tomato juices of 350 mL, made from a 350 gram tomatoes (estimated around 100 gram tomatoes contain 3 – 5 mg lycopene).²³ Although most subject have moderate education level, the lycopene intake before the intervention was considered lower than NHIS 1992's data,¹⁷ which was 0.74 mg vs 2.3 mg. This findings showed that the food source of lycopene, especially tomato is not the day-to-day food consumed by Indonesian, like the westerners.

After determination with HPLC method for plasma lycopene level, the median value of plasma lycopene level before and after intervention showed a significant increase (39.1%; $p < 0.0001$), although lycopene intake before intervention of 0.74 mg was less than NHIS 1992 data which is 2.3 mg. It may be due to the higher bioavailability of lycopene caused by the higher fat intake. The plasma lycopene level of the subjects before intervention (0.143 μ mol/L) was considered normal (0.05 – 1.05 μ mol/L).²⁵

In this study showed that the bio-availability of lycopene is very much influenced by nutritional factors especially fat other than biology factors such as age, sex, alcohol and smoking.

CONCLUSION

Tomato juices consumption in properly dose and prepared can increased the plasma lycopene level. Further study are required to observe the effect of increasing plasma lycopene level on the repair of oxidative damage as well as the prevention of degenerative diseases, especially in smoker subject.

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