

Effect of tomato juice consumption on lipids profiles

ผลของการบริโภคน้ำมะเขือเทศต่อระดับไขมันในเลือด

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ABSTRACT

Lycopene from tomatoes and tomato products is an antioxidant that are associated with lower risks of cardiovascular disease. This research aims to study the effect of tomato juice consumption on lipid profiles. A randomized, crossover study design was conducted in 57 dyslipidemic subjects, they were randomly divided into 2 groups, In the first group received tomato juice (400 ml/day) in conjunction with the nutrition education. The second group received nutrition education only. After 2 months, they asked to switch Intervention, 4-months trial period. Lipid profiles, antropometry, and blood pressure were assessed at the beginning of the experiment, after 2 months, and after 4 months period. Statistical analysis was performed using pair t-test with Repeated Measurement ANOVA. The results showed that consumption of tomato juice 400 ml/day did not effect on lipid profiles, weight, body mass index, waist circumference, hip circumference and blood pressure. However, these results indicate that the nutrition education tend to improve consumption behavior of subjects.

บทคัดย่อ

ไลโคปีนที่พบในมะเขือเทศ เป็นสารต้านอนุมูลอิสระที่มีความสัมพันธ์กับการลดปัจจัยเสี่ยงของการเกิดโรคหัวใจ และหลอดเลือด งานวิจัยนี้มีจุดประสงค์เพื่อศึกษาผลของการบริโภคน้ำมะเขือเทศต่อระดับไขมันในเลือด โดยทำการศึกษาในกลุ่มผู้ที่มีระดับไขมันในเลือดสูง 57 คนโดยทำการสุ่มเพื่อแบ่งออกเป็น 2 กลุ่มกลุ่มที่หนึ่งบริโภคน้ำมะเขือเทศ(400 มล/วัน)ร่วมกับการให้โภชนศึกษา กลุ่มที่สองได้รับ โภชนศึกษาอย่างเดียว เมื่อครบ 2 เดือนจะมีการสลับ Intervention รวมระยะเวลาการทดลอง 4 เดือนโดยจะมีการตรวจระดับไขมันในเลือด วัดสัดส่วนร่างกาย วัดความดันโลหิตช่วงเดือนที่ 0, 2, 4 วิเคราะห์ผลการทดลองโดยใช้สถิติ pair t-test ร่วมกับ Repeated measurement ANOVA. ผลการศึกษาพบว่า การบริโภคน้ำมะเขือเทศในปริมาณ 400 มล/วัน ไม่มีผลต่อระดับไขมันในเลือด น้ำหนักตัว ดัชนีมวลกาย เส้นรอบวงเอว เส้นรอบวงสะโพก ความดันโลหิต อย่างไรก็ตามการให้โภชนศึกษาส่งผลให้พฤติกรรมการเลือกบริโภคอาหารเหมาะสมมากขึ้น

**Key Words:** Tomato juice, Lipid, Nutrition education

**คำสำคัญ:** น้ำมะเขือเทศ ระดับไขมันในเลือด โภชนศึกษา

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## Introduction

Nowadays, cardiovascular disease is of great importance to focus about for public health in developing and developed countries throughout the world, which also includes Thailand. Three separate surveys were carried out of Thai people by physical examination (Cardiovascular risk factor levels in urban and rural Thailand 2003, Polpinit, Ungsununtawiwat et al. 1992, Swaddiwudhipong, Mahasakpan et al. 1999) found that prevalence of risk factors: overweight and obesity, hyperglycemia, and hypercholesterolemia altogether tend to increase completely in these studies. The cause of cardiovascular disease has many factors, but an important factor is due to hyperlipidemia. Several studies have indicate that an increased serum low density lipoprotein (LDL) associated with the increased risk of atherosclerosis (Brown and Goldstein 1983, Dart and Chin-Dusting 1999), which is the leading to the cardiovascular disease .

In resent experimental and epidemiological studies, tomatoes and tomato products consumption containing lycopene has been shown associated with diseased cardiovascular disease (Agarwal and Rao 2000, Kohlmeier, Kark et al. 1997). Wherewith lycopene is the most potent antioxidant contained in tomatoes, an estimated 80% of dietary lycopene comes from tomato fruit and tomato based (Bramley 2000). In recent experimental studies, the tomato juice supplementation have shown associated with higher plasma concentrations of antioxidant (Hadley, Clinton et al. 2003). Lycopene intake for 3 months can reduce LDL cholesterol (Agarwal and Rao 1999). And higher plasma lycopene concentrations are

associated with a lower risk of cardiovascular disease in women (Sesso, Buring et al. 2004).

At present, association studies between lycopene and prevention of cardiovascular disease shows an increase all over the world. However, in Thailand there are only few studies despite the fact that. Thailand is an agricultural country rich in natural resources, and which produces large amounts of agricultural products, especially a large amount of tomatoes, including, besides fresh tomatoes, also, processed tomato products. Therefore researchers need to pay attention to carry out studies of association between tomato juice consumption and lipid profiles to encourage consumer health awareness by showing how important consumption of tomato juice is for health.

## Objective

The purpose of this study is to determine the effect of tomato juice consumption and nutrition education on serum lipid profiles in dyslipidemic subjects.

## Materials and methods

**Subjects.** Fifty-seven dylipidemic subjects (29 male and 28 female), age group 24 to 67 years (mean  $\pm$ SD;43.98 $\pm$ 9.94 years), not taking medicine or treatment resulting in lipid profiles, not using hormone replacement therapy, were selected for this study which, recruited from the Cardiovascular Prevention Clinic at Siriraj hospital. All included subjects signed an informed consent, after an explanation regarding the course of the trial. The study protocol was approved by the Siriraj Ethics Committee, Faculty of Medicine Siriraj Hospital, Mahidol University.

**Study design and protocol.** A randomized, crossover study design was used. At the beginning allocated subjects started a 2 months run-in period to confirm the diagnosis of dyslipidemia ( $LDL-C \geq 130$  mg/dl) and entered the study. At the baseline visit, a thorough physical examination was performed by cardiologist, later all subjects were randomly divided into two groups (in group I had 27 persons, in group II had 28 persons) and they were advised to a research method, and practice of protection of human subjects, then all subjects answered a questionnaire relevant with regard to the general characteristics of each subject. Then

The first group started with experimental period for 2 months after that they changed to be control period for 2 months. Wherein the experimental period they were asked to receive 200 ml tomato juice (16.434 mg lycopene/200 ml) that not contain added sugar twice a day. Moreover, they were received the nutrition education entire 4 times during this period. For the second group, they started in the control period for 2 months then switch to experimental period, which is receive only nutrition education entire 4 times for 2 month. After 2 months, all subjects were to alternate intervention, trial period is about 4-months.

All subjects would record their 3 day food record for assess the energy and nutrient consumption. Blood samples, blood pressure, pulse rate, height, weight, waist circumference, and hip circumference were measured, body mass index(BMI) and waist to hip ratio were calculated. The participants were ask to visit every 2 months, at the baseline, at the end of period 1(2 months from the baseline), at the end of period 2 (2 months from the end of period 1) at cardiovascular prevention clinic at Siriraj hospital. On

every follow up visit all subjects met cardiologist and researcher for physical examination.

#### Ingredients of tomato juice per 1 box (200 ml)

Analysis lycopene level in tomato juice by Institute of Nutrition, Mahidol, University. Which method of Analysis applied from HPLC AOAC 992.06, with the following detailed an arrangement;

**Table 1** The nutrient content of the tomato juice per 200ml

Ingredients	Amount
Lycopene	16.434 mg.
Calcium	16 mg
Iron	0.6 mg
Vitamin C	42 mg
Vitamin A	480 mcg.Re
Total fat	0 g.
Cholesterol	0 g.
Protein less than	1 g.
Total Carbohydrate	12 g.
– Dietary fiber	1 g.
– Sugar	10 g.
Sodium	45 mg.
Energy	50 kcal

#### Statistical Analysis

In the study, all data were analyzed by computer program for windows.

Questionnaire data analysis was described by percentage, mean, and standard deviation to explain general characteristic of each subject such as age, sex, education, marital status, income, family history.

Three-day food record was calculated for energy and nutrient intake using the computer software and the food exchange list.

Physical examination, bio-chemical, and nutrient analysis were described by Paired-samples t-test and Multivariate analysis. Repeated Measures ANOVA was used to verify the effect of the tomato juice consumption and lipids.

Serum total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDL-C) were measured by Spectrophotometry at general clinical chemistry laboratory, Siriraj Hospital.

**Table 2 General Characteristics of Subjects (frequency and percentage)**

Parameter	Total		Group I <sup>a</sup>		Group II <sup>2</sup>		p-value <sup>3</sup>
	(n=57)		(n= 27)		(n = 30)		
	n	%	n	%	n	%	
<b>sex</b>							
man	29	50.9	15	55.6	14	46.7	0.503
woman	28	49.1	12	44.4	16	53.3	
<b>Marital status</b>							
Single	16	28.1	6	22.2	10	33.3	0.582
married	32	56.1	17	63.0	15	50.0	
separate	9	15.8	4	14.8	5	16.7	
<b>History of Disease</b>							
None	47	82.5	23	85.2	24	80.0	0.607
disease	10	17.5	4	14.8	6	20.0	
<b>Family history disease</b>							
cardiovascular	10	17.5	2	7.4	8	26.7	0.056
hypertension	22	38.6	9	33.3	13	43.3	0.439
DM	17	29.8	4	14.8	13	43.3	0.019
Dyslipidemia	13	22.8	4	14.8	9	30.0	0.172
Cancer	3	5.3	2	7.4	1	3.3	0.492
<b>Exercise</b>							
Rarely or never	16	28.1	9	33.3	7	23.3	0.164
< 1 time/wk	25	43.9	12	44.4	13	43.3	
1-3 time/wk	10	17.5	3	11.1	7	23.3	
≥ 4 time/wk	6	10.5	3	11.1	3	10.0	
<b>Alcohol consumption</b>							
Rarely or never	36	63.2	16	59.3	20	66.7	0.164
1-3 drinks/mo	14	24.6	5	18.5	9	30.0	
1-6 drinks/wk	6	10.5	5	18.5	1	3.3	
≥ 1 drink/d	1	1.8	1	3.7	0	0.0	
<b>Smoking status</b>							
Never	41	71.9	20	74.1	21	70.0	0.798
Former	3	5.3	2	7.4	1	3.3	
Sometime	7	12.3	3	11.1	4	13.3	
Every day	6	10.5	2	7.4	4	13.3	

□ = Intervention period follow with control period

□ = Control period follow with intervention period

□ = p-value between group I and group II

No statistically significant difference between groups

Table 3 Comparison level of lipid profile, anthropometric, and blood pressure (mean±SD) at the baseline, at the end of period 1, and at the end of study in both groups.

Parameter	Group	Baseline	End of period I	End of study	p-value	
					Between arm	Within arm
Total Cholesterol, mg/dl	Group I	227.33±18.46	237.81±33.06	231.81±26.08	0.092	0.615
	Group II	224.10±19.31	228.93±25.15	228.53±28.16		
Triglyceride, mg/dl	Group I	135.07±57.28	157.07±69.39	151.04±58.49	0.298	0.391
	Group II	146.37±71.45	148.87±88.01	137.20±57.37		
HDL, mg/dl	Group I	49.38±12.65	51.74±13.83	49.55±11.49	0.063	0.876
	Group II	49.22±9.04	51.63±10.09	51.54±7.99		
LDL, mg/dl	Group I	161.40±17.08	165.50±26.51	163.67±24.48	0.694	0.236
	Group II	159.84±16.78	160.16±21.83	162.09±25.16		
Body mass index, kg/m <sup>2</sup>	Group I	25.07±3.92	25.09±4.02	25.11±3.84	0.790	0.342
	Group II	25.42±3.51	25.32±3.56	25.21±3.74		
Waist circumference, cm	Group I	86.43±11.59	85.81±11.22	85.13±10.69	0.013	0.627
	Group II	86.45±9.28	85.20±9.91	84.17±9.62		
Hip circumference, cm	Group I	96.93±6.91	97.56±6.87	95.63±6.77	0.007	0.213
	Group II	97.45±6.28	97.37±6.53	97.22±6.72		
Waist over hip ratio	Group I	0.88±0.07	0.88±0.07	0.89±0.06	0.175	0.308
	Group II	0.89±0.07	0.87±0.07	0.86±0.06		
Systolic blood pressure, mmHg.	Group I	122.56±20.08	122.30±17.23	118.56±17.16	0.112	0.074
	Group II	119.57±14.04	120.77±10.99	116.73±14.68		
Diastolic blood pressure, mmHg.	Group I	75.67±11.54	73.89±9.18	74.67±9.54	0.260	0.336
	Group II	75.03±9.91	76.47±7.87	72.60±9.45		

Table 4 Comparison energy and nutrients (mean  $\pm$  SD) at the baseline, at the end of period 1, and at the end of study in both groups.

Parameter	Group	Baseline	End of period I	End of study	p-value	
					Between arm	Within arm
Energy(kcal)	Group I	1536.82 $\pm$ 382.67	1520.44 $\pm$ 430.92	1397.94 $\pm$ 329.34		
	Group II	1395.65 $\pm$ 489.06	1462.82 $\pm$ 338.48	1468.52 $\pm$ 350.01	0.287	0.595
Carbohydrate(g)	Group I	191.60 $\pm$ 51.38	235.63 $\pm$ 74.31	206.57 $\pm$ 62.82		
	Group II	190.09 $\pm$ 71.66	216.34 $\pm$ 58.63	222.51 $\pm$ 59.51	0.011	0.244
Sugar (g)	Group I	42.65 $\pm$ 33.21	81.88 $\pm$ 62.10	59.72 $\pm$ 51.05		
	Group II	40.13 $\pm$ 31.39	36.75 $\pm$ 27.47	69.29 $\pm$ 37.55	0.005	0.011
Protein(g)	Group I	65.36 $\pm$ 23.46	57.17 $\pm$ 19.60	56.11 $\pm$ 14.68		
	Group II	56.64 $\pm$ 24.76	58.61 $\pm$ 18.64	56.71 $\pm$ 14.71	0.287	0.160
Fat (g)	Group I	56.21 $\pm$ 23.35	38.24 $\pm$ 13.67	37.83 $\pm$ 11.40		
	Group II	46.98 $\pm$ 17.78	38.48 $\pm$ 10.93	37.59 $\pm$ 12.20	<0.001	0.566
Cholesterol (mg)	Group I	885.03 $\pm$ 489.97	544.62 $\pm$ 467.95	570.28 $\pm$ 400.02		
	Group II	662.07 $\pm$ 390.91	595.11 $\pm$ 307.91	490.70 $\pm$ 357.08	0.001	0.124
Dietary fiber (g)	Group I	22.24 $\pm$ 12.81	40.13 $\pm$ 16.65	29.92 $\pm$ 12.38		
	Group II	22.27 $\pm$ 13.39	36.57 $\pm$ 18.93	38.28 $\pm$ 14.59	<0.001	0.297
CHO	Group I	50.77 $\pm$ 6.67	62.76 $\pm$ 6.99	58.94 $\pm$ 8.09		
	Group II	54.45 $\pm$ 6.95	58.25 $\pm$ 7.34	61.44 $\pm$ 5.16	<0.001	0.482
PRO	Group I	17.12 $\pm$ 4.64	15.24 $\pm$ 2.82	16.25 $\pm$ 3.29		
	Group II	16.01 $\pm$ 3.14	15.89 $\pm$ 3.37	15.41 $\pm$ 2.60	0.338	0.087
FAT	Group I	32.10 $\pm$ 7.93	21.94 $\pm$ 6.21	24.80 $\pm$ 6.51		
	Group II	29.53 $\pm$ 5.89	25.85 $\pm$ 6.02	23.14 $\pm$ 5.65	<0.001	0.141

## Results

Fifty-seven participants were include in the trial and completed all study phases, which all subjects be able to drink tomato juice 2 times/day for 2 months follow protocol. Baseline characteristics of the subjects were not significant different between the two groups ( $p > 0.05$ ). The demographic data of the subjects are represented in terms of frequency distribution of percentage in table 2.

### Plasma lipids

Total cholesterol, triglyceride, LDL-cholesterol, and HDL-cholesterol of all subjects were measured at the baseline, at the end of period 1, and at the end of study in both groups to compare between two groups in each period. There were not significant difference between two groups ( $p$  value  $> 0.05$ ) and within each group ( $p$  value  $> 0.05$ ). As shown in table 3.

### Anthropometry

In group I at the end of study, they have found that the hip circumference which decrease from before to nutrition education from  $97.56 \pm 6.87$  to  $95.63 \pm 6.77$  cm. And in group II at the end of period 1, they have that the waist circumference which decreased from before to nutrition education from  $86.45 \pm 9.28$  to  $85.20 \pm 9.91$  cm. However there was not significant changed throughout the course of the trial as shown in table 3. Included body weight, body mass index, waist over hip ratio in both groups.

### Blood pressure

At the end of study in group II, they have found that diastolic blood pressure which decreased after tomato juice consumption from  $76.47 \pm 7.87$  to  $72.60 \pm 9.45$  mmHg and Systolic blood pressure also decreased from  $120.77 \pm 10.99$  to  $116.73 \pm 14.68$  mmHg. But there was not significant changed

throughout the course of the trial when we using Repeated Measurement ANOVA. As shown in table 3.

### Nutrients

During the experimental period, subjects receive nutritional education by researcher under the concept of STEP I diet, subjects were allowed to cook or choose food by themselves and to estimate the energy, nutrient to suit each individual and all subjects will record their 3-day food record at the baseline, at the end of period 1, and at the end of study in both groups. Three day food record were calculated for energy and nutrient intake using the software computer and the food exchange list, then using Repeated Measurement ANOVA to compare between two groups in each period. They have found energy, carbohydrate, cholesterol, vitamin, fiber, beta carotene, and minerals. There was no significant changed in each group ( $p$  value  $> 0.05$ ) as shown in table 4.

However, the data showed the reduction of fats consumption in both groups when compared from baseline to the end of period I and the end of study. In group I, from  $56.21 \pm 23.35$  to  $38.24 \pm 13.67$  and  $37.83 \pm 11.40$  gram. In group II from  $46.98 \pm 17.78$  to  $38.48 \pm 10.93$  and  $37.59 \pm 12.20$  gram respectively. It showed that subjects have better eating behavior. Food consumers can choose the same energy, but fat in food reduction. Consistent with protein intake from animal, revealed that there was significantly changed in the protein from animal in both groups ( $p = 0.012$ ). In group I protein intake decreased from  $43.33 \pm 21.49$  to  $29.83 \pm 14.93$  and  $30.73 \pm 14.59$  gram. In group II from  $35.28 \pm 20.83$  to  $33.49 \pm 15.28$  and  $29.55 \pm 10.67$  gram respectively. There was found that, energy distribution of carbohydrate: protein: fat (C:H:F) decreased from baseline. In group I, at the baseline



C:H:F 50.77±6.67 : 17.12±4.64: 32.10±7.93 , at the end of period I 62.76±6.99: 15.24±2.82: 21.94±6.21 and at the end of study 58.94±8.09: 16.25±3.29: 24.80±6.51. In group II, at the baseline C:H:F 54.45±6.95: 16.01±3.14: 29.53±5.89 at the end of period I 58.25±7.34: 15.89±3.37: 25.85±6.02 and at the end of study 61.44±5.16: 15.41±2.60: 23.14±5.65 as shown in table 4.

There was significantly changed on sugar in both groups ( $p = 0.011$ ), which found an increased in sugar during the period of tomato juice consumption. In group I from 42.65±33.21 to 81.88±62.10 gram and in group II from 36.75±27.47 to 69.29±37.55 gram.

## Discussion

The analyzed data indicated that tomato juice was a decent source of lycopene secondary tomato paste. The result showed that tomato juice contained approximately 16.43 mg of lycopene/ 200 g wet weight, which was similar to the lycopene content in database of Jean Michel Lecerf, which was 5 - 11.6 mg of lycopene/ 100 g wet weight. Moreover Bohm and Bitsch, likewise concluded that, processed tomato products has lycopene absorption better than unprocessed sources and wherewith from lipid rich diets. In a recent study, 23-35 mg lycopene/day for 15 day from processed tomato products (condensed tomato soup, ready to serve tomato soup, and vegetable juice) resulted in significantly similar higher plasma lycopene concentrations compare to baseline. Amount of lycopene in this study was selected based on previous studies. 15 day of tomato products consumption approximately 23-35mg lycopene/day were increased plasma lycopene concentrations but did not effect on lipid profiles

(Hadley, Clinton et al. 2003). Whilst another study, they supplementation of tomato's lycopene 60 mg/day for a 3 months, result in significantly reduced the LDL cholesterol (Furhman, Elis et al. 1998).

In this study indicates that human subjects receive lycopene of processed tomato product that is tomato juice 400 milliliters consist of lycopene 32.86 mg per day. Consuming the tomato juice with nutrition education for 2 months in each group resulted in throughout the trial no significantly changed on level of lipid profiles, anthropometry, and blood pressure. Similar to Agrawal and Rao were studied the effect of dietary supplementation of lycopene on lipid they found that, after consumption tomato products and lycopene capsule in different amount of lycopene (0, 39.2, 50.4, 75 mg lycopene) for 1 week, the parameters of the lipid status did not change significantly (Agrawal and Rao 1998). The six week supplementation with 5 mg lycopene from difference matrices (capsules, tomatoes, tomato juice) did not effect on parameters of lipid status (Bohm and Bitsch 1999).

Several studies suggest that tomato has antioxidant substances, it helps to prevent LDL oxidation, which reduces the incidence of atherosclerosis (Fuhrman, Volkova et al 2000, Jialal and Grundy 1993). Therefore, blood pressure is lower, which has a research report of Engelhard , Gazer et al. confirming that tomato extract can reduce blood pressure in patients with grade-1 Hypertension (Engelhard, Gazer et al. 2006).

## Conclusion

The consumption of 400 milliliters of tomato juice consists of 32.868 mg of lycopene, when



consume daily for 2 months, did not influence the plasma lipid profiles. Additionally, the tomato juice did not take effect on the anthropometry and blood pressure. On the other hand, the effect of nutrition education was improve the eating behavior. Further research about the effect of supplementation with tomato juice on lipid profiles, which education takes longer than three months and study about the effect of supplementation with tomato juice to a different amount of lycopene on plasma lycopene level and lipid parameters.

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