The Effects of Green Tea on Serum Lipids, Antioxidants, and Coagulation Tests in Stable Coronary Artery Disease: A Prospective Interventional Study

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Abstract

Introduction- Brewed from the leaf of *Camellia sinensis*, which is derived from the family *Theaceae*, tea is the most common beverage in the world after water. It has various pharmacological effects. In this study, we investigated the effect of green tea on the paraclinical parameters of patients with chronic stable coronary artery disease.

Methods- This prospective, interventional study was conducted on 100 patients with known coronary artery disease, referred to our cardiac clinic. The diagnostic criteria were physical examination, electrocardiogram, exercise stress test, thallium scan, and coronary angiography where necessary. The patients consumed brewed green tea for one month (4g per day in 2 divided doses). Lipid levels, antioxidants, fibrinogen level, homocysteine level, prothrombin time (PT), partial thromboplastin time (PTT), bleeding time (BT), and clotting time (CT) were assayed before and after the consumption of green tea for the one month's study period. The antioxidants of serum were measured with the ferric reduction antioxidation power (FRAP) method. PT, PTT, fibrinogen, and homocysteine were measured with the ELISA method. For the statistical analysis, the paired t-test was used.

Results- The mean age (± SD) was 50.9 ± 9.2 years. The mean total cholesterol, LDL, triglycerides, and lipoprotein a (Lp–a) were decreased significantly after one month's consumption of green tea (P< 0.001). Also, there was a significant decrease in fibrinogen and homocysteine levels. There was an increase in HDL and antioxidant levels after the consumption of green tea (P<0.001). In addition, average PT and PTT measurements were decreased significantly (P = 0.001 and P= 0.012, respectively).

Conclusion- Regular consumption of 4g/d green tea for one month had beneficial effects on serum lipid parameters and antioxidant levels ***(Iranian Heart Journal 2008; 9 (3):47 -52).***

Key words: coronary artery disease ■ green tea ■ serum lipids ■ antioxidants ■ homocysteine ■ fibrinogen

Tea, the most common beverage in the world after water, is a leaf of *Camellia sinensis* from the family of *Theaseae.*[1] Green tea is prepared without the process of fermentation and heating. The process of fermentation of black tea leads to the activation of various enzymes and intensive changes with respect to color, aroma, and flavor. These changes are usually desirable for taste. Since green tea is heated before the process of fermentation and the fermentation is not carried out for green tea as it is for black tea, it is not usually suitable for taste with respect to aroma and flavor. However, the consumption of steamed green tea has various beneficial pharmacological effects.

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black tea and green tea are powerful sources of flavonoids and other polyphenolic antioxidants, which have a protective effect in coronary artery disease (CAD).[2-4] Published data have documented the potential beneficial effects of tea on atherosclerosis, hypertension, serum lipids, antioxidant levels, and aging.[5,6] In particular, it was documented that regular consumption of tea and green tea increases the level of antioxidants and thus reduces the risk of CAD.[4,7-9] It was also shown that catechin contained in green tea prevents the cell proliferation of arterial wall muscle.[4] The protective effects of flavonoids contained in green tea are not only antioxidant, anti-thrombotic, and anti-inflammatory properties,[2,7,8] but also additive to the rate of the coronary flow velocity reserve.[10] In addition to the positive effects of tea on CAD and stroke,[12, 14] the beneficial effects of tea in breast,[15] colon, [5,16] prostate, and pancreatic cancers [12] have been documented. Also, tea has antimicrobial effects, and its protective effect against Alzheimer's and Parkinson's disease[17,18] and tooth decay[6, 19] has been addressed in the literature.

Although green tea is more frequent in the northern Iranian provinces of Guilan and Mazandaran, it is rarely used for daily consumption as a drink. In spite of the high production of green tea in the north of Iran, there are no documented data on its beneficial effects on lipid levels and its antioxidant effect at the national level. We, therefore, conducted this prospective, interventional study into the effect of green tea on lipids, coagulation parameters, and antioxidant levels of patients with chronic CAD.

Methods

This is a prospective, interventional (before - after) study of 100 patients with a diagnosis of chronic CAD. The patients referred to a cardiac clinic in the Iranian city of Babol were recruited into the study. The diagnostic criteria were based on physical examination, electrocardiogram, exercise stress test, thallium scan, and coronary angiography where necessary. Our inclusion criteria were volunteer patients with hyperlipidemia who did not respond to 3 months' intervention with dietary regimens. Patients who did not tolerate the taste of green tea, high-risk patients with myocardial infarction and unstable angina, and patients who suffered from gastric disorders were excluded. For ethical purposes, all the patients gave written consent at the study entry. All the patients took their usual drugs for CAD except anti-lipid agents, and there was no change in their dietary regimens.

Green tea bags were prepared with the coordination of a factory for the production and packaging of pharmaceutical plants (Gol-Chai, Karaj, Iran). Each tea bag contained 2g of green tea prepared with a different method of fermentation from that of black tea. Each volunteer patient recruited into the study consumed steamed green tea for one month (4g in 2 divided doses). For the purpose of rapidly preparing steamed green tea, we recommended that the patients open the tea bag, pour the contents into hot water, and steam it for consumption as a beverage.

Serum lipids, antioxidants, fibrinogen, homocysteine, prothrombin time (PT), partial thromboplastin time (PTT), bleeding time (BT), and clotting time (CT) were assayed before and after one month's consumption of green tea. The antioxidation of serum was determined via the ferric reduction antioxidation power (FRAP) method in the Department of Biochemistry of Babol University of Medical Sciences. In this method, using reaction molecule to Fe2+ (2,4,6-tripyridyl-S-triasine from Sigma Co.), the converting rate of Fric to Fro, which shows the antioxidant activity of the environment, was measured. Given the standard FeSo4, the measurements were reported in micromolar (µmol) units. Total cholesterol, LDL, HDL, and Lp-a were measured via enzymatic methods using a Clirometry kit (CHOD-APA), and TG was also measured via the enzymatic method (TG

MAN). PT, PTT, fibrinogen, and homocysteine were measured using the ELISA method. All of these experiments were carried out in Razi Lab in Babol.

The data were analyzed using SPSS software version 10.0, and the paired t-test was applied to analyze the changes in the lipids, antioxidants, and the other paraclinical parameters under study. A P-value less than 0.05 was considered significant.

Results

The mean age (±SD) of the patients was 50.9 (±9.2) years; 48 (48%) patients were aged less than 50 years and 8(8%) aged 65 years or over. 50% of the patients were male. Table I shows that after one month's consumption of green tea, cholesterol, triglyceride, LDL, Lp-a, and homocysteine levels significantly decreased (P<0.001), with the average reduction being 22.26mg/dl, 23.14mg/dl, 10.8mg/dl, 16.19mg/dl, and 2.53µmol/L, respectively. HDL and antioxidant levels increased significantly, and the average significant increase within the one-month study period was 8.62mg/dl and 200.24µmol, respectively (P<0.001). The decrease in PT (P=0.001) and PTT (P=0.012) was significant, but the change in BT and CT did not reach significance. All the changes were significant in both genders; however, the amount of reduction in the lipid parameters of the females tended to be greater than that of the males, and also the average increase in antioxidant parameters tended to be greater in the females than that in the males (210.7 vs. 189.7 µmol).

Discussion

Our findings showed that one month's consumption of green tea significantly decreased cholesterol, TG, LDL, and Lp-a levels, while it significantly increased the HDL and antioxidant levels.

Kuhn DJ et al., expanding on the molecular mechanism of green tea, reported that green tea reduced cholesterol levels via the up-regulation of LDL receptors.[20] Tokunaga et al.

They also emphasized that the regular and long-term consumption of green tea increased antioxidant concentration and thus reduced the risk of CAD.[4]

Table I. Mean (±SD) of paraclinical characteristics of patients with stable coronary artery disease before and after one month's consumption of green tea (both males and females)

Parameter	Status	No	Mean ±SD	Mean Difference	P value
Cholesterol (mg/dl)	before	100	238± 33.5	-22.26	<0.001
	after	100	215± 37.1		
Triglycerides (mg/dl)	before	100	181± 75.7	-23.14	<0.001
	after	100	157 ± 52.2		
HDL (mg/dl)	before	100	41± 11	8.62	<0.001
	after	100	49.6 ± 12		
LDL (mg/dl)	before	100	136±27.5	-10.82	<0.001
	after	100	125.8± 26.7		
LP- a (mg/dl)	before	100	54.7 ± 45.1	-16.19	<0.001
	after	100	38.5± 25.3		
Homocysteine (µ mol/L)	before	100	11.14 ± 2.5	-2.53	<0.001
	after	100	8.6 ± 1.4		
Fibrinogen (mg/dl)	before	100	322.8 ± 43.4	-10.72	0.009
	after	100	312.1± 32.4		
Antioxidants (µmol)	before	100	1027.3±158.6	200.24	<0.001
	after	100	1227.5±229.5		
PT (sec)	before	100	12.2 ± 0.70	-0.20	<0.001
	after	100	12.02 ± 0.14		
PTT (sec)	before	100	42.9± 8.7	-1.06	0.012
	after	100	41.9 ± 5.3		
BT (sec)	before	100	122.7 ± 63.6	-2.95	0.30
	after	100	119.8 ± 47.9		
CT (sec)	before	100	263.6 ± 37.6	1.4	0.65
	after	100	265 ± 26.5		

Table II. Mean (±SD) of paraclinical characteristics of male patients with stable coronary artery disease before and after one month's consumption of green tea

Parameter	Status	No	Mean ±SD	Mean Difference	P-Value
Cholesterol (mg/dl)	before	50	237 ± 29.16	- 20.18	<0.0001
	after	50	217.5 ± 33		
Triglycerides (mg/dl)	before	50	167.1± 40.6	-17.2	<0.1
	after	50	149.9 ± 37.2		
HDL (mg/dl)	before	50	41.6 ± 11.8	9.1	<0.001
	after	50	50.7 ± 12.7		
LDL (mg/dl)	before	50	136.9 ± 29	-11.04	<0.001
	after	50	125.9 ± 28.9		
LP- a (mg/dl)	before	50	50.33 ± 45	-14.98	<0.001
	after	50	35.3 ± 25.2		
Homocysteine (µ mol/L)	before	50	11.3 ± 2.6	- 2.58	<0.001
	after	50	8.7 ± 1.3		
Fibrinogen (mg/dl)	before	50	327.9 ± 33.7	-13.74	<0.001
	after	50	314.1 ± 34.4		
Antioxidants (µmol)	before	50	1033.1 ± 176	189.78	<0.001
	after	50	1222 ± 267.6		
PT (sec)	before	50	12.2 ± 0.64	- 0.20	0.01
	after	50	12 ± 0.14		
PTT (sec)	before	50	41.5 ± 3.1	- 0.38	0.169
	after	50	41.1 ± 2.9		
BT (sec)	before	50	121.9 ± 61.9	- 4.5	0.177
	after	50	117.4 ± 50.8		
CT (sec)	before	50	259 ± 42.1	3.6	0.548
	after	50	262.6 ± 24.4		

Consequently, our results of a decrease in the level of serum lipids and an increase in antioxidants are consistent with those previously published reports.

Based on our findings, the mean level of fibrinogen and homocysteine, two important risk factors for CAD, decreased significantly after one month's consumption of green tea. This decrease corresponded to that in the Vinson et al. study, where both black tea and green tea decreased the fibrinogen in the serum of normal animals.[5] A probable mechanism of its action is that polyphenol and other gallates contained in black tea and green tea bonded with the fibrinogen of the serum; black tea and green tea are, therefore, the inhibitors of fibrinogen.[5] Probably, a similar mechanism can be found in humans. Both black tea and green tea are major sources of catechin, a powerful combination of antioxidants. This combination is able to both reduce superoxide radicals and alkyl peroxy radicals and amend vitamin E radicals. This antioxidant power has an important role in inhibiting the oxidation of LDL and VLDL, which causes atherosclerosis.[5,6] In this regard, green tea has a significantly greater beneficial effect than does black tea on cholesterol, LDL, and TG levels as well as on the atherogenic index.[5, 6]

Table III. Mean (±SD) of paraclinical characteristics of female patients with stable coronary artery disease before and after one month's consumption of green tea

Parameter	Status	No	Mean ±SD	Mean Difference	P-Value
Cholesterol (mg/dl)	before	50	238.46± 37.7	-24.34	<0.001
	after	50	214.12± 41.1		
Triglycerides (mg/dl)	before	50	194 ± 97.7	-29.08	0.01
	after	50	165 ± 36.1		
HDL (mg/dl)	before	50	40.4 ± 10.3	8.14	<0.001
	after	50	48.5 ± 11.3		
LDL (mg/dl)	before	50	136.4±26.2	-10.6	<0.001
	after	50	125.8± 24.5		
LP- a (mg/dl)	before	50	59.1 ± 45.2	-17.4	<0.001
	after	50	41.7± 24.9		
Homocysteine (µ mol/L)	before	50	10.9 ± 2.3	-2.48	<0.001
	after	50	8.4 ± 1.4		
Fibrinogen (mg/dl)	before	50	317 ± 51.2	-7.7	0/292
	after	50	310± 30.5		
Antioxidants (µmol)	before	50	1021 ±140.5	210.7	<0.001
	after	50	1232± 186.4		
PT (sec)	before	50	12.23 ± 0.77	-0.21	0.026
	after	50	12.02 ± 0.14		
PTT (sec)	before	50	44.36± 11.9	-1.7	0.028
	after	50	44.62 ± 6.9		
BT (sec)	before	50	123.6 ± 65.8	-1.4	0.765
	after	50	122.2 ± 45.2		
CT (sec)	before	50	268.2 ± 32.3	-0.7	0.786
	after	50	267.5 ± 28.5		

We also found a small significant reduction in the mean PT and PTT after one month of green tea consumption. Nonetheless, we did not observe a significant change in BT and CT parameters. Kang et al. also reported that catechin contained in green tea did not produce a significant change in coagulation parameters such as PT and PTT,[24] while it inhibited the accumulation of platelets and thus prolonged BT.[22, 23] In addition, our findings showed a different change in the mean paraclinical parameters under study with respect to gender. The beneficial effects of green tea (decrease in cholesterol, TG, LDL, and Lp-a levels and increase in antioxidant levels) were greater in the females compared with the males, while the decrease in fibrinogen was greater in the males. It seems that further studies are required to explore the reasons for the apparent interaction between green tea and gender.

In conclusion, our results indicated that long-term (one month) regular daily consumption of green tea (4g/day) caused a significant reduction in cholesterol, LDL, TG, Lp-a, fibrinogen, and homocysteine and an increase in HDL and antioxidants. Since green tea is relatively common in the north of Iran, we recommend a daily consumption of 4 g/day (divided into 2 doses of 2g) in order to decrease the risk of CAD.

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Conflict of Interest

No conflicts of interest have been claimed by the authors.

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