FABAD J. Pharm. Sci., 24, 207-210, 1999

RESEARCH ARTICLES / BİLİMSEL ARAŞTIRMALAR

Effects of Catechin Consumption on Plasma Lipid, Lipoprotein and Lipid Peroxidation Levels in Rats

S. Oktay ARSLAN*°, Abdurrahim KOÇYİĞİT*, Özcan EREL*, Necmettin AKTEPE*, Senel AVCI*

Effects of Catechin Consumption on Plasma Lipid, Lipoprotein and Lipid Peroxidation Levels in Rats

Summary : *Epidemiological studies indicated that tea consumption reduces the risk of cardiovascular disease. Catechins are abundant in tea and they may account for up to 30% of the dry weight of tea leaves. In this study, the effects of tea catechins on lipid, lipoproteins and lipid peroxidation (LPO) levels were studied in rats. Rats were fed with 1% catechin for three weeks. Thiobarbituric acid reactive substance (TBARS) levels, as the index of lipid peroxidation, were measured by using the colorimeter method in the plasma of animals. Plasma total cholesterol (TC), low density lipoprotein cholesterol (LDL-C) and TBARS levels were significantly decreased in catechin fed rats compared to controls. However, triglyceride (TG) and high-density lipoprotein cholesterol (HDL-C) levels were not significantly affected by catechin treatment. There was a strong positive correlation between plasma LPO and LDL-C or TC in catechin fed rats. These results showed that dietary supplementation of catechin caused decrease of plasma TC, LDL-C and LPO levels, and low LPO levels were probably due to the hypolipidemic effect of catechin.*

Key words: *Catechin, lipid, lipoprotein, lipid peroxidation*

Received : 1.09.1999
Revised : 29.11.1999
Accepted : 6.12.1999

Sıçanlarda Plazma Lipid, Lipoprotein ve Lipid Peroksidasyon Düzeyleri Üzerine Kateşin Tüketiminin Etkileri

Özet : *Epidemiyolojik çalışmalar çay içiminin kardiyovasküler hastalık riskini düşürdüğünü göstermektedir. Kateşin, çayda bol miktarda bulunan bir polifenol olup kuru çay yaprağının yaklaşık %30'unu oluşturur. Bu çalışmada sıçanlarda kateşinin lipid, lipoprotein ve lipid peroksidasyon seviyeleri üzerine etkileri araştırıldı. Sıçanlar %1'lik kateşin içeren normal diyetle üç hafta boyunca beslendi. Plazma lipid peroksidasyon (LPO) seviyeleri 2-tiyobarbütirik asit reaktif ürünleri (TBARS) düzeylerinin kolorimetrik ölçümü ile değerlendirildi. Kateşin grubunda plazma total kolesterol (TK), düşük dansiteli lipoprotein kolesterol (LDL-K) ve TBARS seviyeleri kontrol grubuna göre önemli derecede düşük bulunurken, trigliserid (TG) ve yüksek dansiteli lipoprotein kolesterol (HDL-K) seviyeleri çalışma grupları arasında anlamlı olarak farklı bulunamadı. Kateşin grubunun LDL-K ve TK seviyeleri ile TBARS seviyeleri arasında pozitif anlamlı ilişki tesbit edildi. Bu sonuçlar, diyetle kateşin alımının plazma TK ve LDL-K seviyeleri ile birlikte plazma lipid peroksidasyon seviyelerini de düşürdüğünü, lipid peroksidasyonundaki düşüşün özellikle kateşinin hipolipidemik etkisi ile ilişkili olabileceğini göstermektedir.*

Anahtar kelimeler: *Kateşin, lipid, lipoprotein, lipid peroksidasyonu*

INTRODUCTION

In several studies, it was indicated that there was a close relationship between the cardiovascular disease and plasma lipid, lipoprotein, and lipid peroxidation[1-3]. Lipid peroxidation is oxidative damage that can be initiated by reactive oxygen metabolites such as hydrogen peroxide, superoxide anion, and hydroxyl radical. These cause the oxidation of unsaturated fatty acids, hence the cell membrane stability is damaged[4]. On the basis of this event, it is used as an enzymic and non-enzymic antioxidant defense system, but oxidant/antioxidant balance might be adversely affected. In several studies, synthetic and natural antioxidants have been used to overcome the oxidative damage but, due to the toxic effect of synthetic ones, attention has been focused on natural antioxidants[5]. Tea is one of the most po-

* Department of Pharmacology, Faculty of Medicine, Harran University, Şanlıurfa, Turkey.
° Correspondence

pular traditional beverages widely consumed in the world. Green tea is a rich source of catechins, which have antimutagenic and anticarcinogenic effects[6-8]. In addition, it is suggested that it has both antioxidant activity and a hypolipidemic effect, and therefore may reduce the risk of coronary artery disease[8-10].

The present paper was designed to evaluate the relationships between catechin and plasma lipid and lipoproteins as well as lipid peroxidation levels, which are the risk factors for the atherosclerosis in rats.

MATERIALS and METHODS

Materials: Beta-catechin was purchased from Sigma Chemical Co., St Louis, MO, USA. The other chemicals and solvents were the highest grades commercially available materials.

Animals and diets: Male Sprague-Dawley rats weighing about 250-300 g were used. They were housed in an air-conditioned room at 22 ± 2°C and 40% relative humidity with a 12h light-dark cycle. Rats were randomly divided into two groups. The first group of rats was fed with a commercial basis diet as a control group. The second group was fed with the basic diet supplemented with 1% beta-catechin. The diets were prepared once a week and changed daily.

Diets and water were provided *ad libitum* for 21 day. At the end of the experimental period, rats were anesthetized with ether, and blood was collected in heparinized syringes by heart puncture.

Analytical methods: Blood samples were centrifuged at 1500 g for 5 min, and the clear supernatant was used for the determination of plasma lipids and lipid peroxidation. Lipid peroxidation (LPO) was estimated as thiobarbituric acid reactive substance (TBARS) which was determined by the fluorometric method of Yagi[11]. Plasma total cholesterol (TC), triglyceride (TG), and high density lipoprotein-cholesterol (HDL-C) levels were measured enzymatically with the Hitachi 911 automatic analyser (Boehringer Mannheim, GERMANY) using commercial kits. Low density lipoprotein-cholesterol (LDL-C) level was calculated according to the Friedewald's formula[12].

Statistical analysis: Statistical evaluation of the experimental data was carried out in the "SPSS 6.0 for Windows" program. The mean values obtained in the two groups were compared by the student's t test. The Pearson's correlation test was used to evaluate the correlation between two variables. All results were expressed as mean values ± SD.

RESULTS

No significant difference was detected between the body weight gain of the two groups and also no difference was observed in water and food consumption parameters over the 21-day experimental period.

The results of control and catechin fed rats were represented in Table I. Plasma TC, LDL-C, and LPO levels in the catechin-fed group were found to be lower than in the control group. The difference between plasma HDL-C and TG levels of the two groups were not statistically significant. On the other hand, there were a significant positive correlations between the plasma LPO levels , plasma LDL-C, and TC levels of the two groups (Table II).

Table I. Changes in serum total cholesterol (TC), high density lipid-cholesterol (HDL-C), low density lipid-cholesterol (LDL-C), triglycerides (TG), lipid peroxidation levels and atherogenic index after 21 days of catechin treatment in rats. Atherogenic index was calculated as TC-HDL-C/HDL-C. Lipid peroxidation was measured as ,thiobarbituric acid reactive substance (TBARS).

Parameters	Catechin group n= 10	Control group N=10	p
TBARS (nmol/ml)	2.9 ± 0.5	3.9 ± 0.6	<0.01
TC (mg/dl)	57.9 ± 12.2	78.0 ± 11.2	<0.01
LDL-C (mg/dl)	23.1 ± 5.3	40.4 ± 8.4	<0.001
HDL-C (mg/dl)	8.8 ± 1.9	9.2 ± 0.9	>0.05
TG (mg/dl)	79.9 ± 28.1	78.2 ± 19.4	>0.05
Atherogenic index	5.6 ± 2.1	7.9 ± 1.8	<0.01

Table II. The correlation between the parameters of control and catechin groups.

Parameters	Control group		Catechin group	
	r	p	R	p
TBARS - TC	0.553	<0.05	0.671	<0.01
TBARS - LDL-C	0.801	<0.01	0.932	<0.001

DISCUSSION

There is a great deal of evidence that dietary fat, cholesterol, sugar, protein and fiber can influence plasma cholesterol levels in experimental animals and humans. There is a positive correlation between atherosclerosis, coronary heart disease and plasma cholesterol levels[2]. Lipid peroxidation in the cell membrane is a free radical mediated event and substrates are in the form of polyunsaturated fatty acids. The peroxidation of low density lipoprotein-cholesterol is involved in the pathophysiology of atherogenesis[3].

In the present study, we showed that catechin both inhibited the lipid peroxidation and reduced the atherogenic index (Table I). The previous studies also support the view that catechin has hypocholesterolemic activity[13-15]. It may inhibit the intestinal absorption of lipids and may prevent the reabsorption of bile acids by disrupting formation of micelles, which are reabsorbed from the small intestine, thereby increasing bile acid excretion[13,16]. It is known that the conversion of cholesterol to bile acids takes place in the liver. High density lipoprotein retards the progress of atherosclerosis because of transportation of excess cholesterol from peripheral tissues back to the liver[17].

It was found that a very significant positive correlation exists between plasma LPO and TC or LDL-C levels in rats fed with catechin supplemented diet (Figure I). Consequently we conclude that it can reduce LPO levels through its hypolipidemic activity[18]. However, Kumari et al[5] and Lotito et al[19] are reported that it could inhibit LPO as a result of its antioxidant property. The mechanism of hypolipidemic and LPO inhibitory effects of catechin is not yet clear, but catechin has the ability to scavenge for superoxide as well as hydroxyl radical and to inhibit the generation of hydroxyl radical by chelation with metal ions[20,21].

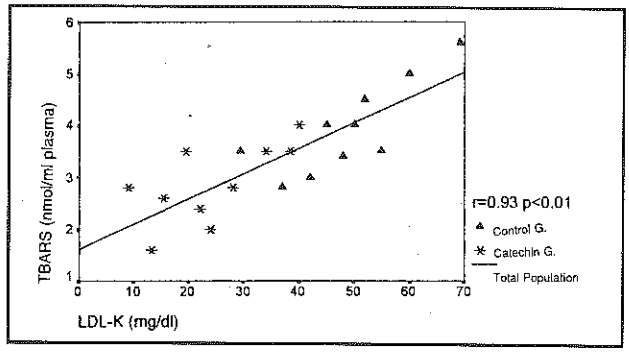

Figure 1. The relationship between TBARS and LDL-C levels of the catechin group.

There is no report of any adverse effect of tea catechin, but there are reports showing that catechin prevents the elevation of serum cholesterol as well as atherogenic index. Furthermore, it can also prevent LPO because of its antioxidant property. As a result of its useful properties it can be suggested that the risk of coronary heart disease may be reduced, if green tea, which contains cathechin as a major component is consumed regularly in certain amounts.

REFERENCES

1. Yamanake N, Oda O, Nagao S. Green tea catechins such as (-)-epicatechin and (-)-epigallocatechin accelerate Cu-induced low density lipoprotein oxidation in propagation phase. *FEBS Lett*, 401, 230-234, 1997.
2. Revean GM, Laws A. Coronary heart disease in the absence of hypercholesterolemia. *J. Int. Med.*, 228, 415-417, 1990.
3. Witztum JL, Steinberg D. Role of oxidised low density lipoprotein in atherogenesis. *J. Clin. Invest.*, 88, 1785-92, 1991.
4. Jha HC, Recklinghausen GV, Zilliken F. Inhibition of in vitro microsomal lipid peroxidation by isoflavonoids. *Biochem. Pharmacol.*, 34, 1367-1369, 1985.
5. Ramana Kumari MV, Yoneda T, Hiramatsuc M. Effect of "beta catechin" on the life span of senescence accelerated mice. *Biochem. Molecul. Biol. Intern.*, 41, 1005-1011, 1997.
6. Wang ZH, Das M, Bickers DR, Muhtar H. Interaction of epicatechins derived from green tea with rat hepatic cytocrome P-450. *Drug Metab. Disp.*, 16, 98-103, 1988.
7. Kada T, Kaneko K, Matsuzaki S, Matsuzaki T, Hara Y. Detection and chemical identification of natural bio-antimutagens. A case of the green tea factor. *Mutation Res.*, 150, 127-132, 1985.
8. Keli SO, Hertog MGL, Feskens EJM, Kromhout D. Dietary flavonoids, antioxidant vitamins and incidence of stroke. The Zutpten study. *Arch. Intern. Med.*, 154, 637- 642, 1996.
9. Hertog MGL, Feskens EJM, Hollman PCH, Katan MB, Kromhout D. Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutpten Elderly Study. *Lancet*, 342, 1007-1011, 1993.

10. Ho CT, Chen Q, Shi H, Zhan KQ, Rosen RT. Antioxidative effect of polyphenol extract prepared from various Chinese tea. *Prev. Med.*, 21, 520-525, 1992.
11. Yagi K. A simple fluorometric assay for lipoperoxide in blood plasma. *Biochem. Med.*, 15, 212-216, 1976.
12. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin. Chem.*, 18, 499-502, 1972.
13. Muramatsu K, Fukuyo M, Hara Y. Effect of green tea catechins on plasma cholesterol level in cholesterol-fed rats. *J. Nutr. Sci. Vitaminol.*, 32, 613-622, 1986.
14. Yang TTC, Koo MVL. Hypocholesterolemic effects of Chinese tea. *Pharmacol. Res.*, 35, 505-512, 1997.
15. Kono S, Shinchi K, Wakabayashi K. Relation of green tea consumption to serum lipids and lipoproteins in Japanese men. *J. Epidemiol.*, 6, 128-133, 1996.
16. Ikeda I, Imasato Y, Sasaki E, Nakayama M, Nagao H, Takeo T, Yayabe F, Sugano M. Tea catechins decrease micellar solubulity and intestinal absorption of cholesterol in rats. *Biochem. Biophys. Acta.*, 1127, 141-146, 1992.
17. Tall AR. Plasma high density lipoproteins metabolisms and relationship to atherogenesis. *J. Clin. Invest.*, 86, 374-384, 1990.
18. Nourooz-Zadeh J, Tajaddini-Sarmadi J, Ling KLE, Wolff SP. Low-density lipoprotein is the major carrier of lipid hydroperoxides in plasma. *Biochem. J.*, 313, 781-786, 1996.
19. Lotito SB, Fraga CG. (+)-Catechin prevents human plasma oxidation. *Free. Radic. Biol. Med.*, 24, 435-441, 1998.
20. Kashima M. Effects of catechins on superoxide and hydroxyl radical. *Chem. Pharm. Bull.*, 47, 279-283, 1999.
21. Kondo K, Kurihara M, Miyata N, Suzuki T, Toyoda M. Mechanistic studies of catechins as antioxidants against radical oxidation. *Arch. Biochem. Biophys.*, 362, 79-86,1999.