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EFFECT OF ANTIOXIDANT RICH DIETS ON LIPID PROFILE AND BLOOD PRESSURE IN CARDIOVASCULAR PATIENTS

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Abstract: A sample of 200 patients was randomly selected and interviewed. Various data related to their food consumption in previous weeks and other behavioral attitudes were recorded. Their blood pressure was measured and blood was analyzed for total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and triglycerides (TG). Spearman's correlation coefficient was worked out between blood pressure, serum lipid parameters and tea, vitamin C and fibre intake. Tea showed significant correlation with diastolic blood pressure (DBP) (-0.2373; $P<0.02$), systolic blood pressure (SBP) (-0.2299; $P<0.02$) and TC (-0.3454; $P<0.01$). Vitamin C showed a negatively significant correlation with TC (-0.4676; $P<0.01$), and LDL-C (-2661; $P<0.01$) and significant positive correlation with HDL-C (+0.2227; $P < 0.05$). The tea intake was found strongly correlated with blood pressure as compared to vitamin C, while vitamin C had stronger correlation with TC as compared to tea intake. Fibre was not found significantly correlated with any of the studied parameters. A 30-day control trial on 50 subjects revealed that antioxidant therapy during fat-restricted diet period significantly affected blood pressure and serum lipids. Comparative effect showed that lemon juice showed best results. Lemon juice decreased DBP, SBP, TC, TG and increased HDL-C, while tea added with lemon only significantly decreased DBP, SBP and TC. Salad, especially onion, only improved HDL-C and LDL-C levels. Vitamin C supplement also significantly lowered DBP, SBP,TC, LDL-C and TG. Tea had negative correlation with blood pressure and TC, while vitamin C has showed relationship with TC, LDL-C and positive with HDL-C. It is conceivable, therefore, that dietary antioxidants cause a significant improvement in blood pressure and serum lipids than vitamin C supplement and simple fat-restricted diets.

Keywords: Cardiovascular diseases, antioxidant diets, total cholesterol, high density lipoprotein cholesterol, low density lipoprotein cholesterol, triglycerides

Introduction

Cardiovascular diseases still account for about more than half of the deaths in countries where measures for the prevention and treatment of infectious diseases are generally ineffective [1]. The incidence of cardiovascular diseases in Pakistan has been reported to be increasing sharply and a substantial number of people suffer from their first heart attack between the age of 40 and 45 years. South East Asians residing in other parts of the world have also been reported to have a high prevalence of heart diseases [2]. No single known cause of heart diseases has been established. However, presence of a combination of certain factors such as family history of heart diseases, sex, age, diet, obesity, hypertension, diabetes and hyperlipidemia predisposes a person to higher risk of the diseases. A recent study conducted in India has shown that 32% subjects are in the highest risk category of heart disease with serum cholesterol level exceeding 239 mg/dl, while, in USA this fraction constituted only 18%. Other risk factors such as high blood pressure, high LDL-C, obesity, diabetes, sedentary life style

and smoking also show high prevalence in this population [3]. A study conducted at Karachi (Pakistan) showed that out of 237 adults, 32% of the males and 23% of the females aged 20-59 years had serum cholesterol levels of 6.2 mmol/litre [4]. This increased risk factor of high cholesterol has necessitated a research for safe and effective lipid lowering agents, but physiologically a dietary approach seems more desirable.

Adding fruits and vegetables in the diet has proved good for heart in many ways. These displace meat and dairy products and thus reduce the intake of saturated fatty acids and provide more vitamins and dietary fiber. In addition, plants are a rich source of non-nutritive components such as flavonoids and polyphenols, which are reported to have antioxidant properties. Few of the vitamins such as vitamin C (ascorbic acid), vitamin E (tocopherols) and carotenoids, especially beta carotene also play the role of antioxidants. Antioxidants prevent oxidation of free radicals and LDL-C that can turn into poisonous substances by lipid peroxidation i.e. an increased risk factor for heart diseases [5].

A Canadian study [6] has concluded that a combination of cholesterol lowering diet and antioxidant therapy improve the endothelium-dependent coronary vasomotion and lower cholesterol level more than American Heart Association's step I diet. Although in this study probucol was selected as the antioxidant, antioxidant vitamins were found to be more effective in this respect [6]. Thus, it seems imperative that people should know about the special benefits of inclusion of certain fruits and vegetables in their local diets.

Tea (*Camellia sinens*) is one of the most widely consumed beverages since centuries on account of its health giving, dietetic and therapeutic qualities. Its world wide per capita consumption is 0.1 litre per day. Tea liquor is chemically composed of caffeine, tannins, essential oils, pectin fiber, starch, ash, minerals, lead, copper, magnesium, barium, potassium, sodium, zinc, iron and nickel. Since tea (without milk and sugar) does not contain proteins, carbohydrates and fats, it does not possess any nutritional value. The major sources of ingestion flavonoids are black tea and red wine. Inverse association between flavonoid intake and mortality from myocardial infarction has been reported. The possible health related effects of flavonoids were reported to be due to their antioxidant properties [7]. Ascorbic acid or vitamin C is a simple sugar with a molecular weight of 176. It is a white crystalline substance which is stable when dry but is easily oxidized in water in alkaline state, and on exposure to heat, light and traces of metals (especially copper). Ascorbic acid is a powerful reducing agent being commercially used as antioxidant that plays a role in regulation of blood pressure and cholesterol [8]. In addition, dietary fiber, a non-nutritive component of diet has also been reported to exert hypolipidemic effect [9].

Based on the above facts, the present study was carried out to find the relationship of tea, ascorbic acid and fiber with serum lipids and blood pressure in cardiovascular patients, while keeping in view the type of daily food consumed by them. A contributory trial was also planned to provide antioxidant therapy along with fat restricted diet.

Materials and Methods

Selection of subjects

The cardiovascular patients of both sexes visiting different clinics and hospitals for routine check-ups were included in the study. The study was conducted in two phases i.e. survey and follow up.

Survey

A total of 200 cardiovascular patients were selected randomly and interviewed in detail to record

their data related to the disease diagnosis and history, including dietary patterns, food habits, age, weight, family history of heart disease, physical activity and other behavioral attitudes.

Follow up and experimental treatments

A total of 50 patients having total blood cholesterol of at least 190 mg/dl and without any gastrointestinal tract ailment, food allergy and family history of disease were randomly divided in to 5 equal groups and allocated 5 treatments under completely randomized statistical design (CRD). Treatments to these were carried out as follows:

In T-1 the subjects were offered lemon juice of at least three medium sized lemons daily, the T-2 subjects were kept on two cups of black tea added with juice of half lemon, the T-3 subjects were maintained on excess raw vegetables (salads, their major intake was the onion), and the T-4 subjects were given one tablet of vitamin C (100 mg) daily. In the T-5 group, fat was restricted by abstaining from eggs, "pratha", butter and other sources of fat. No ratio of saturated and unsaturated fat was fixed. The diet was planned as given in Table 1. All the subjects were recommended this diet along with antioxidant therapy. Each patient was followed up for 30 days.

Sample collection

Blood samples, without anticoagulant, were collected before and after treatment. The samples were centrifuged after clotting; serum was extracted and stored at -4ºC for further analysis.

Physical parameters

The subjects were presented with a list of foods and were interviewed to assess how often each of the common foods had been taken by them in the previous week. Quantitative assessments of the foods eaten were made on the basis of data thus obtained. The intake of vitamin C and fibre was worked out by using food composition tables developed for local foods by Israr-ul-Haq [10].

Body mass index (BMI) is an appropriate index for determining obesity. World Health Organization (WHO) has recently formalized a classification of body weight in adults based on individuals weight (kg) divided by height (meters) by a formula [11]. If BMI is >30, the person is considered to be obese. Blood pressure in each case was measured by portable mercury sphygmomanometer.

Biochemical parameters

Total cholesterol, triglycerides and HDL-cholesterol were determined by using kits (Merck, 14366, 14354 and 14210, respectively); following the methods described earlier [12]. LDL-cholesterol (mg/dl) concentration was obtained by subtracting triglycerides and HDL-cholesterol from total cholesterol.

Table 1. *Plan for computing diet for hyperlipidemia.*

Nutrition	**Recommended Intake**	
	Step One	**Step Two**
Fat	Less than 30% of total calories	
Carbohydrates	50-60% of total calories	
Protein	10-20 of total calories	
Cholesterol	Less than 30 mg/day	<200 mg/day
Total calories	To achieve and maintain desirable weight usually 2200-2500 kcal.	

Statistical analysis

Spearman's correlation coefficients were computed using Windows based statistical program "Microsoft Excel" on PC. Paired T-test was used to compare the means before and after treatment. Analysis of variance in experimental design CRD was performed by another statistical program "Minitab".

Results and Discussion

The study was conducted on patients suffering from any of the cardiovascular disease such as hypertension, angina pectoris, coronary heart disease and myocardial infarction. A total of 200 heart patients were randomly selected from population of heart patients. Middle aged men and women suffering from any of the cardiovascular diseases were included in the study. The results might have been exposed to potential biases arising from confounding effects of determinants of blood pressure, and heart attack such as tension, anxiety or other stress factors. The assessment of diet was comprehensive and included tea intake, fruits and vegetables, especially 7-day food recording was used to minimize the effect of day-to-day variation in the estimation of nutrients intake. The study was aimed to assess the role of antioxidants in regulation of blood pressure and serum lipids in general population and controlled trial. Their role in regulation of blood pressure and lipid metabolism has already been reported [13,14,15,16].

All the 200 subjects were categorized as obese (50%) or non-obese (50%), smokers (14%) or non-smokers (86%), active (27%) or sedentary (73%) and individuals on saturated fat (31%) or unsaturated fat (69%). Most of the patients were suffering from hypertension and CHD. The obesity was more among females (BMI>30) as compared to males (BMI>28.53). Means of diastolic blood pressure, systolic blood pressure and total cholesterol levels were comparatively high in male than female subjects. HDL-C and LDL-C were significantly ($P<0.05$) different in male and female subjects (Table 2).

Table 2. Gender variation in physical and biochemical parameters (Mean ± SD) in cardiovascular patients.

Parameters	Males (40%)	Females (60%)	T. value	P. value
Body Mass Index (BMI)	28.53 ± 3.53	31.96 ± 6.10	3.56	0.006*
Diastolic Blood Pressure (DBP)	89.87 ± 9.87	89.67 ± 12.80	1.04	0.3
Systolic Blood Pressure (SBP)	140.5 ± 19.42	138.5 ± 17.40	1.14	0.26
Total Cholesterol (TC)	177.73 ± 28.76	178.73 ± 35.04	1.08	0.24
High Density Lipoprotein cholesterol (HDL-C)	35.86 ± 6.103	40.43 ± 11.26	2.13	0.02*
Low Density Lipoprotein cholesterol (LDL-C)	113.5 ± 27.38	100.2 ± 29.68	0.62	0.54
Triglycerides (TG)	159.1 ± 66.6	179.8 ± 84.2	1.37	0.45
Tea	2.22 ± 1.165	1.82 ± 0.994	3.03	0.01*
Fiber	31.01 ± 6.033	35.44 ± 14.29	2.07	0.102
Vit. C	221.90± 88.6	222.40 ± 58.00	1.5	0.32

* Indicates difference between male and female subjects at P value indicated in the row.

The consumption of tea, vitamin C and fibre was assessed with the help of food tables. The mean consumption of vitamin C and fiber was not significantly different in males and females, however, tea consumption was significantly ($P<0.05$) higher in male than in female subjects (Table 2). It was found negatively correlated with blood pressure and serum lipids (Table 3). This negative association revealed a decrease in the parameter with increased intake of tea [17]. The tea intake showed a relationship with DBP, SBP and TC, while a weak and non-significant relationship was found with HDL-C, LDL and LDL and TG (Table 3). These findings are in line with those reported earlier [18].

In smokers, tea intake was significantly correlated with only TC (-0.5468; $P<0.05$). All other associations were non-significant; rather negative (Table 4). It suggested that intake of tea might have more effective relationship with blood pressure and serum lipids in non-smokers as compared to smokers because in smokers LDL-C is loaded with fatty acids and put to increased stress of oxidation [19].

The findings of the present study suggested that tea had a strong with blood pressure and serum lipids in the subjects consuming unsaturated fat, as compared to saturated fat, whereas it was not significantly associated with the other parameters (Table 4). In the sedentary people, tea intake was found to be inversely correlated with TG and TC, while in the active people, tea intake was also inversely related with HDL-C along with DBP, SBP and TC (Table 4). This indicates a marked decrease in HDL-C with increased tea intake in the active people. The tea intake had no significant relationship in the obese subjects, whereas in the non-obese subjects it was found inversely related with DBP, SBP and TC (Table 4).

The mean intake of vitamin C was (222.74 mg/ week) non-significantly different between males and females. Vitamin C showed a significant negative association with TC (-0.4676; $P<0.01$) and LDL-C (-0.2661; $P<0.01$), which indicates a decrease in LDL-C with increased consumption of vitamin C and an improvement in the levels of HDL-C was also observed (Table 5). These results were in line with those reported earlier [8]. The relationship with blood pressure was weak and non-significant. The negative correlation with SBP was greater as compared to DBP (Table 5). According to a previous study [20], vitamin C caused a greater reduction in SBP as compared to DBP.

Vitamin C did not have any significant correlation with any of the parameters in smokers and non-smokers (Table 6). In saturated fat group, increased intake of vitamin C improved HDL-C (+ 0.4325; $P<0.05$), while in the unsaturated fat group it showed positive but non-significant relationship

Table 3. Overall correlation coefficient (C.C.) of different parameters with tea consumption in cardiovascular patients.

Parameters	C. C.	Significance	P value
Diastolic Blood Pressure (DBP)	-0.2373	S*	P < 0.02
Systolic Blood Pressure (SBP)	-0.2299	S*	< 0.02
Total Cholesterol (TC)	-0.3453	S*	< 0.01
High Density Lipoprotein Cholesterol (HDL-C)	-0.1594	NS	
Low Density Lipoprotein Cholesterol (LDL-C)	-0.1594	NS	
Triglycerides (TG)	-0.1373	NS	

Level of significance=5%, S=Significant, NS=Non-Significant

Table 4. Effects of tea consumption on various biochemical parameters in different groups of cardiovascular patients.

Parameters	C. C.	Significance	C.C.	Significance
Smokers/Non- Smokers	Smokers (14%)		Non-smokers (86%)	
DBP	-0.2077	NS	-0.2429	S
SBP	-0.18250	NS	-0.2385	S
TC	-0.5468	NS	-0.3208	S
HDL-C	-0.1408	NS	-0.1964	NS
LDL-C	-0.5227	NS	-0.0367	NS
TG	-0.2524	NS	-0.1324	NS
Saturated/Un-Saturated	Saturated (31%)		Un-saturated (69%)	
DBP	-0.3147	NS	-0.2099	NS
SBP	-0.2134	NS	-0.2407	S
TC	-0.2337	NS	-0.3882	S
HDL-C	-0.2354	NS	-0.1347	NS
LDL-C	-0.1579	NS	-0.1706	NS
TG	-0.0354	NS	-0.1692	NS
Sedentary/Active	Sedentary (27%)		Active (73%)	
DBP	-0.1943	NS	-0.2822	S
SBP	-0.2910	NS	-0.2369	S
TC	-0.3545	S	-0.3576	S
HDL-C	-0.2373	NS	-0.2952	S
LDL-C	-0.1422	NS	-0.1105	NS
TG	-0.5436	S	-0.0229	NS
Obese/Non-Obese	Obese (50%)		Non-obese (50%)	
DBP	-0.0924	NS	-0.3284	S
SBP	-0.6019	NS	-0.2276	S
TC	-0.2096	NS	-0.2714	S
HDL-C	-0.5241	NS	-0.1128	NS
LDL-C	-0.0999	NS	-0.2023	NS
TG	-0.0456	NS	-0.0456	NS

Correlation coefficient=C.C., Level of significance=5%, Significant=S, Non-significant=NS
Diastolic Blood Pressure=DBP, Systolic Blood Pressure=SBP, Total Cholesterol=TC, High Density Lipoprotein cholesterol= HDL-C, Low Density Lipoprotein cholesterol=LDL-C, Triglycerides=TG

Table 5. Overall correlation coefficient of different biochemical parameters with vitamin C consumption in cardiovascular patients.

Parameters	Correlation coefficient	Significance	P value
Diastolic Blood Pressure (DBP)	-0.1406	NS	
Systolic Blood Pressure (SBP)	-0.1611	NS	
Total Cholesterol (TC)	-0.4676	S	<0.01
High Density Lipoprotein Cholesterol (HDL-C)	+0.2227	S	<0.05
Low Density Lipoprotein Cholesterol (LDL-C)	-0.2661	S	<0.01
Triglycerides (TG)	-0.0402	NS	

Level of significance=5%, Significant=S, Non-Significant=NS

Table 6. Effects of vitamin C on various biochemical parameters in different groups of cardiovascular patients.

Parameters	C. C.	Significance	C.C.	Significance
Smokers/Non- Smokers	Smokers (14%)		Non-smokers (86%)	
DBP	-0.4661	NS	-0.1936	NS
SBP	-0.5268	NS	-0.2348	S
TC	-0.1258	NS	-0.5574	S
HDL-C	+0.3695	NS	+0.3183	S
LDL-C	-0.0059	NS	-0.3100	S
TG	-0.1714	NS	-0.0255	NS
Saturated/Un-Saturated	Saturated (31%)		Un-saturated (69%)	
DBP	-0.2610	NS	-0.0953	NS
SBP	-0.1330	NS	-0.1804	NS
TC	-0.3514	NS	-0.5093	S
HDL-C	+0.4325	S	-0.4426	S
LDL-C	-0.1740	NS	-0.2904	S
TG	-0.0314	NS	-0.0393	NS
Sedentary/Active	Sedentary (27%)		Active (73%)	
DBP	-0.0845	NS	-0.2468	NS
SBP	-0.0120	NS	-0.1854	NS
TC	-0.0621	NS	-0.3900	S
HDL-C	+0.2413	NS	+0.2105	S
LDL-C	-0.4102	S	-0.2229	S
TG	-0.2073	NS	-0.1947	NS
Obese/Non-Obese	Obese (50%)		Non-obese (50%)	
DBP	-0.1245	NS	-0.0396	NS
SBP	-0.0459	NS	-0.0058	NS
TC	-0.7420	S	-0.0779	NS
HDL-C	+0.8635	S	-0.0697	NS
LDL-C	-0.4240	S	-0.1329	NS
TG	-0.2340	NS	-0.0423	NS

Correlation coefficient=C.C., Level of significance=5%, Significant=S, Non-significant=NS

with HDL-C. In the unsaturated fat group, vitamin C showed positive but negative association with serum TC and LDL-C. In the sedentary group, it significantly lowered LDL-C but in the active group it was significantly and negatively associated with TC and LDL-C and positively associated with HDL-C. In the non obese-group, Vitamin C consumption was significantly associated with TC, HHL-C and LDL-C, whereas the obese group did not show any significant association (Table 6).

Fibre did not show any significant relationship with any of the parameters (Table 7). Although previous reports [21, 22] have indicated a blood pressure and lipid lowering effect of fiber. It was noted that further adjustments for smoking, saturated fat, exercise, obesity and hypertension did not alter the results. The reason might be that the food composition table of Israr-ul Haq [10], used in this study for working out the amount of fibre, contained only small amount of crude fibre. It has been shown by Bell *et al*. [23] and Nishina *et al*. [24] that only soluble fiber has cholesterol lowering effect in lipid disorders They have found that oat and wheat bran does not show any change in lipid levels compared with control. So, in the present study, crude fibre estimation did not show any association with any of the parameters. Another reason could be that in all of the previous research works, fibre supplementation has been used while in the present study only normal daily consumption was recorded.

The overall findings of the present study suggest that tea has stronger negative relationship with blood pressure as compared with vitamin C intake, while, the vitamin C intake had stronger negative association with TC and LDL-C and positive association with HDL-C as compared with tea consumption. In both cases, the antioxidant showed poor relationship in the saturated fat group and the obese subjects. The reason might be that saturated and unsaturated fat modified the tissue antioxidant status [25]. Plasma antioxidants have also been reported to be lower in obese female subjects [26].

A 30-days control trial performed to determine the effects of antioxidant therapy showed that lemon juice decreased DBP, SBP, TC, TG and increased HDL-C, while tea added with lemon only significantly decreased DBP, SBP and TC (Table 8). Salad, especially onion, only improved HDL-C and LDL-C levels. Vitamin C supplement also significantly lowered DBP, SBP, TC, LDL-C and TG. During these trials, it was observed that only fat-restricted diet non-significantly lowered blood pressure and serum lipids; the decrease was marginal (Table 8). These results are supported by the earlier findings of Nelson *et al*. [27], who reported that the lowering effect on serum lipids and blood pressure is only due to unsaturated fatty acids. However, no ratio of saturated and unsaturated fat was fixed in the present study. The reason might be the short time period for that trial. But antioxidant therapy along

Table 7. Overall correlation coefficient of different biochemical parameters with fiber consumption in cardiovascular patients.

Parameters	Correlation coefficient	Significance
Diastolic Blood Pressure (DBP)	-0.10367	NS
Systolic Blood Pressure (SBP)	-0.0712	NS
Total Cholesterol (TC)	-0.0833	NS
High Density Lipoprotein cholesterol (HDL-C)	+0.1666	NS
Low Density Lipoprotein cholesterol (LDL-C)	-0.0333	NS
Triglycerides (TG)	-0.0940	NS

Level of significance =5%, Significant=S, Non-Significant =NS

Table 8. Means ± SD of serum lipids and blood pressure, before and after treatment with lemon juice in cardiovascular patients.

Parameters	Before Treatment	After Treatment	Difference	% Improvement	T-value	P-value
T1: Lemon Juice						
BBP	93.00 ± 16.36	87.00 ± 11.56	6.00 ± 10.32	6.40	2.71	0.024
SBP	141.00± 17.29	133.00± 12.60	8.00 ± 10.23	5.60	3.21	0.01
TC	224.15± 26.87	210.25± 21.50	13.95± 20.43	6.25	3.35	0.0085
HDL-C	43.30 ± 12.93	45.71 ±11.73	-2.4 ± 10.41	5.00	2.24	0.05
LDL-C	138.76± 22.03	128.57 ± 25.64	9.19 ± 20.63	6.50	2.47	0.036
TG	189.72± 53.28	174.00 ± 39.16	14.83 ± 20.23	7.80	2.17	0.058
T2: Tea with Lemon Juice						
BBP	96.50 ± 6.26	89.50 ± 6.00	7.00 ± 9.44	8.00	6.33	0.0001
SBP	144.00± 6.58	134.50±7.62	9.50 ± 3.28	6.60	5.46	0.0004
TC	199.40± 5.53	191.56± 16.29	9.9± 6.90	3.90	2.00	0.015
HDL-C	37.00 ± 5.70	36.70 ±5.03	-0.7 ± 26.10	0.80	1.61	0.86
LDL-C	119.84± 10.84	116.04 ± 13.22	1.90 ± 65.40	3.10	1.46	0.18
TG	222.80± 65.60	193.80 ± 51.35	4.83 ± 67.50	1.30	1.89	0.091
T3: Salad (Onion)						
BBP	91.00 ± 7.38	89.00 ± 5.68	2.00 ± 3.12	2.10	1.50	0.24
SBP	140.00± 13.33	138.00± 10.32	2.00 ± 9.31	1.40	1.53	0.13
TC	204.15± 12.32	203.40± 10.81	0.58±10.12	0.29	0.74	0.15
HDL-C	37.63 ± 8.39	39.50 ±8.49	-1.27±6.13	4.70	3.19	0.02
LDL-C	127.62± 23.42	125.42 ± 21.71	2.16 ± 19.41	1.70	2.57	0.04
TG	195.40± 86.80	194.40 ± 85.44	0.533 ± 70.86	0.50	1.80	0.22
T4: Vitamin C supplementation						
BBP	90.50 ± 13.01	89.00 ± 6.99	1.50 ± 6.94	1.60	0.51	0.34
SBP	139.00± 19.26	137.00± 8.23	2.50± 9.5	1.40	2.75	0.75
TC	214.14± 17.36	208.60± 18.76	5.76± 58.59	2.58	2.30	0.04
HDL-C	39.75 ± 14.62	40.38 ±14.39	-0.60 ± 7.53	1.60	-2.30	0.04
LDL-C	131.08± 23.91	123.44 ± 22.97	7.58 ± 17.22	5.80	2.73	0.02
TG	222.03± 109.9	218.90 ± 108.6	3.13 ± 9.70	1.40	3.18	0.01
T5: Fat-restricted Diet						
BBP	92.50 ± 14.77	88.00 ± 11.353	4.50 ± 10.22	4.80	2.08	0.06
SBP	136.00± 15.77	135.00± 16.50	1.00 ± 14.35	0.70	0.43	0.68
TC	213.15± 24.57	212.20± 30.76	4.50± 22.19	0.37	0.21	0.83
HDL-C	42.50 ± 3.27	42.30 ±5.25	-0.01 ± 2.23	0.47	0.21	0.84
LDL-C	128.76± 37.88	125.00 ± 37.54	2.78 ± 35.14	2.70	1.26	0.26
TG	210.10± 147.2	203.50 ± 143.57	6.60 ± 100.23	3.14	1.54	0.16

with fat-restricted diet had negatively affected all the parameters. These findings are also in line with an earlier report [28]. The sources of dietary antioxidant were lemon juice (vitamin c), tea (flavonoids), salads, especially onion (vitamin C and flavonoids), and supplement of vitamin C. Lemon juice significantly lowered blood pressure and serum lipids and improved HDL-C (Table 7). Two cups of black tea added with lemon juice significantly lowered blood pressure and total cholesterol but the effect on HDL-C, LDL-C and TG was non-significant. These results confirmed the correlation coefficients found in the survey work. Whereas tea showed significant correlation with DBP, SBP and TC, vitamin C showed correlation with TC, and HDL-C. Salad, especially onion which contained comparatively fewer amounts of vitamin C and flavonoids improved significantly only HDL-C and LDL-C. Similar results have also been reported previously [29].

The supplement of vitamin C improved all the parameters significantly. A comparison showed that maximum decrease in DBP was caused by tea with lemon but the effect of lemon juice and vitamin C supplement was also approximately the same. Systolic blood pressure (SBP) was maximally lowered by tea with lemon juice than by vitamin C supplement and lemon juice. This clearly indicates that the combined activity of the two antioxidants in case of blood pressure was greater. The greatest change in TC was caused possibly by lemon juice and the greatest improvement in HDL-C might be due to vitamin C, while the greater reduction in LDL-C might be caused by lemon juice.

The overall findings of this study suggest that lemon juice is the best antioxidant therapy, while tea with lemon juice also has significant effect. Onion also improved HDL-C and reduced LDL-C. It may be concluded from the study that:

1. Tea has negative correlation with blood pressure and TC, while vitamin C has negative relationship with TC, LDL-C and positive relationship with HDL-C.

2. Dietary antioxidants caused a significant improvement in blood pressure and serum lipids.

3. Dietary antioxidants proved to be more effective as compared to the vitamin C supplement.

4. Antioxidants-rich diets proved to be more effective as compared to the simple fat-restricted diets.

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